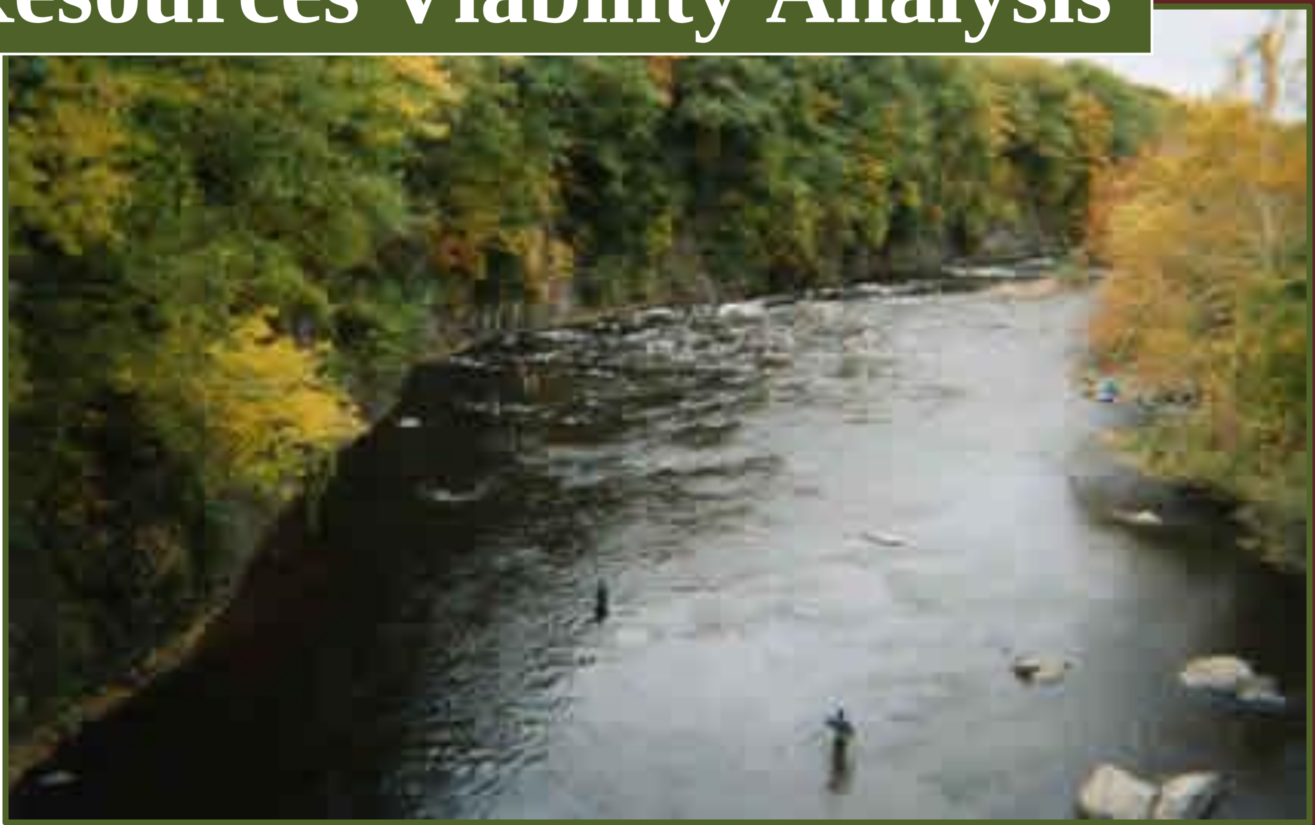
Salmon River Watershed Natural Resources Viability Analysis



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6/30/2008

This project was supported by the New York State Department of Environmental Conservation, with funding from the United States Fish and Wildlife Service, Wildlife Conservation and Restoration Program.

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ACKNOWLEDGMENTS

This Salmon River Watershed Viability Analysis represents the collective work of numerous individuals, agencies and organizations. Several local citizens, private and government resource managers, elected officials, and scientists attended a day-long workshop to identify the conservation targets that were the objects of this analysis. The participants of that workshop are included in Appendix 1. Several others participated in expert working group sessions to help inform the viability analysis component for the matrix forest, wetlands and aquatics conservation targets. Working group participants are listed in Appendix 2. These meetings included many fair, but candid, discussions of the condition and management of the Salmon River watershed's natural resources, oftentimes with divergent points of view being expressed. It should be noted that a person's participation in the process of preparing this report does not imply their individual or institutional agreement with all or any of the findings of this report.

Funding for this project was provided by the US Fish and Wildlife Service, Wildlife Conservation and Restoration Program, and obtained through a grant proposal submitted by Tracey Tomajer, NYSDEC Watershed Coordinator. The following agencies and organizations cooperated with NYSDEC to complete this project: NY Tug Hill Commission, Tug Hill Tomorrow Land Trust, The Nature Conservancy, NY Sea Grant, Oswego County Environmental Management Council, NY Natural Heritage Program, Salmon River Fish Hatchery, SUNY-Oswego, SUNY-ESF.

The following individuals provided oversight and guidance in the development of this report:

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John Bartow and Linda Gibbs of the New York State Tug Hill Commission administered the grant and facilitated the public participation and governmental outreach. Michelle Peach also provided valuable guidance in organizing public input throughout the process. Deborah Forester, Engaging People, facilitated the public workshop to identify conservation targets.

Mapping and geographic analyses were conducted by Michelle Peach; Jennifer Harvill and Linda Gibbs, Tug Hill Commission; Michelle Henry, USGS Tunison Laboratory of Aquatic Science; and Gregg Sargis, The Nature Conservancy. James McKenna, USGS Tunison Laboratory, provided raw data, and generously conducted GAP analyses of fish communities and aquatic conditions in the watershed specifically for this project. The datasets used for completing the geographic analyses within this report are listed in Appendix 3. Several NY State DEC offices provided raw data or summaries that were used to describe current condition of various resources in the watershed -- these contributions are cited within the text of the viability analysis.

Michelle Peach, Tracey Tomajer and Linda Gibbs provided careful review and criticism of earlier, draft reports.

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1.0 INTRODUCTION

1.1 Project Scope

The objective of this Salmon River Watershed Natural Resource Viability Analysis was to synthesize information from numerous, disparate sources to develop an integrated understanding of the biodiversity and ecological condition of the Salmon River Watershed's natural resources. The study will provide an analysis of natural resource quality for the entire ~176,000-acre drainage, as opposed to the more site specific, fragmented information presently available.

The purpose of this analysis is to articulate the current "State of the Watershed" as a component of a more extensive and forthcoming Salmon River Watershed Natural Resources Assessment Report. The purpose of the eventual Natural Resource Assessment will be to build on the efforts of several ongoing initiatives (e.g., the Ontario Lakewide Management Plan; the Great Lakes Strategy 2002; the New York Comprehensive Wildlife Conservation Strategy; and several projects of the NY Natural Heritage Program, NY Department of Environmental Conservation, The Nature Conservancy, the Tug Hill Commission, the Tug Hill Tomorrow Land Trust, etc.) in order to coordinate these efforts and focus resources to attain their greatest effectiveness. The Assessment will also be available as a resource for local officials, government agencies, local landowners, and non-profit organizations to inform local land use planning efforts and individual land management decisions.

This Viability Analysis is limited in scope to the Salmon River Watershed's *natural* resources – those resources of the land, air and water, which although manipulated, exploited and enjoyed by humans, are not created by humans. It is these natural resources that past and future generations have used and will continue to use to build communities and industry. The communities, ways of life, and traditions that exist in the region have been shaped, and in many ways, limited, by the array of natural resources at our disposal. Likewise, the opportunities of those who come after us to enhance communities, maintain local traditions, and advance industry will be limited, in large part, by the quality of the natural resources they inherit.

Proper planning and resource management do not take place in a vacuum, but rather include by their nature consideration of cultural, economic and social resources. However, a thorough understanding of the quality and viability of available natural resources is necessary to help guide resource management and planning efforts to ensure that those resources continue to support cultural, economic and social values and activities for generations to come. It is the purpose of this Viability Analysis to quantify the current state of natural resources as a tool for local organizations and individuals to use in promoting wise planning for community and economic development within the Salmon River Watershed.

1.2 Administrative Background

The Salmon River Watershed Natural Resource Assessment project was initiated through funding from the US Fish and Wildlife Service and made available through the State Wildlife Grant program to the New York State Department of Environmental Conservation (NYSDEC) - Division of Fish, Wildlife and Marine Resources. The NYSDEC became the eligible recipient of State Wildlife Grants funds for New York after completing a statewide Comprehensive Wildlife Conservation Strategy in 2005. An explicit conservation priority of New York's Comprehensive Wildlife Conservation Strategy includes the improved understanding of habitat distribution and condition within the state (NYSDEC 2006a: 75). Furthermore, the Comprehensive Wildlife Conservation Strategy recognized that watersheds can serve to unify conservation efforts aimed at disparate targets, and to integrate those conservation efforts into a geographically meaningful effort that synthesizes information regarding biotic, physical and chemical interactions within geographically large and diverse ecosystems. Subsequently, the NYSDEC established two watershed planning projects in New York: the Nissequogue River on Long Island; and the Salmon River along the eastern shore of Lake Ontario.

The NYSDEC asked the New York State Tug Hill Commission to assist with the project by facilitating a collaboration of interested parties, carrying information to local communities, and administering the grant funds. Cooperators in this project include NYSDEC, The Nature Conservancy, New York Natural Heritage Program, New York Sea Grant, Tug Hill Tomorrow Land Trust, Oswego County Environmental Management Council, State University of New York at Oswego, and State University of New York College of Environmental Science and Forestry.

1.3 Planning Process

The Salmon River Watershed Natural Resource Assessment process relied heavily on the expertise of local scientists, resource managers, planners and citizens to identify important natural resource targets, assess the current condition and threats to those targets, and develop strategies to abate those threats. The process occurred in open forums and expert working groups, and has been modeled after The Nature Conservancy's widely applied framework for site conservation planning (TNC 2003), which is briefly summarized below.

Step 1: Natural Resource Target Selection. The first step in this planning process was to identify natural resource targets that would become the subjects of further natural resource planning within the watershed. Targets can be species, natural communities, or whole ecosystems, and for the purposes of this Assessment, targets were selected to represent the entire range of biodiversity within the Salmon River Watershed. Thirty-eight people participated in the day-long Natural Resource Target Selection forum, held on September 25, 2006, in Pulaski (Forester 2007; Appendix 1). The following seven conservation targets were selected at this forum and further refined by consultation with additional experts and focus group meetings around each target. These targets are more fully defined in Section 2 of this report.

- Salmon River Freshwater Estuary and Dune/Beach System
- Main Branch and Major Tributaries to Salmon River
- Headwater Streams
- Open Waters
- Non-Estuarine Freshwater Wetlands
- Matrix Forests (including open terrestrial communities)
- Gorge, Cliff and Steep Slope Communities

Step 2: Target Viability Analysis.
Viability refers to the capacity for a natural resource target to persist over time and to be resilient to occasional natural fluctuations or disturbances, and human-caused stresses. The viability analysis of the seven natural resource targets occurred over several months beginning in November 2006. The findings of this analysis are presented in Section 2 of this report. Information was gathered through published reports, unpublished data, and personal communication with local experts. Working group meetings were held for several aquatic targets (November 2006), the matrix forest communities (January 2007) and wetlands (March 2007). Appendix 2 acknowledges the contributions of those who participated in the three working groups. In addition, this viability analysis utilized information previously compiled by the New York Natural Heritage Program in the Salmon River Watershed Inventory and Land Analysis (Howard 2006), which applied Geographic Information System (GIS) analyses to identify existing and new locations of rare & endangered species, and unique communities within the basin.

The viability analyses for each of the natural resource targets consisted of a three-step procedure, and the format of Section 2 parallels this procedure.

A. Identify Key Ecological Attributes (KEAs) of each target. A KEA is an aspect of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. As such, attributes define the target's viability or integrity (e.g. water chemistry, population size). Past exercises in viability analysis have organized KEAs into three broad categories: s**ize, condition** and **landscape context.**

Size includes measures of area or abundance of a natural resource target. For instance, if a target is a particular species of concern, then size would reflect population density or area of occupancy. For a community or ecosystem, size would simply consider area of occurrence.

Condition represents an integration of several measures of the quality of biotic and abiotic factors that influence a target or natural processes that are sustained by a target. For a species, condition might reflect reproductive success, size/behavior of individuals, or concentrations of contaminants in tissues. For communities, condition reflects species composition (e.g., occurrence of invasive species), ecological processes (altered hydrologic flow, declines in productivity), and abiotic factors (water/air quality, substrate stability).

Landscape Context considers the processes and conditions that surround a particular target which may influence the condition of the target. Context integrates pattern, connectivity, fragmentation, and patchiness of a target.

B. Establish Quantifiable Indicators of the respective attributes, and benchmarks suggestive of the viability of the attributes. Indicators must be measurable entities that are used to assess the status and trend of a key ecological attribute. Indicators need to be measurable (quantifiable), precise and practical. For example, if "water quality" is a Key Ecological Attribute, the indicators of water quality could include dissolved oxygen (mg/l), temperature (°C), or phosphate concentration (ppm).

C. Rate the Current Condition of the attributes based upon the benchmarks established for each indicator. Indicator ratings define the ranges of variation in an indicator that distinguish Very Good, Good, Fair, and Poor conditions for a KEA. The ratings are meant to provide a consistent, objective and scientific basis for assessing the status of each attribute. Even still, in many instances, quantifiable information was unavailable for several of the viability indicators within the watershed, and guidance was not readily available for ranking current condition of many indicators when they could be quantified.

Step 3: Threats and Situation Analysis. A second public workshop was held on May 4, 2007 during which participants (a) identified activities or conditions that may negatively impact each of the conservation targets; (b) developed an understanding of the causal factors influencing the level of each threat; and (c) rated the significance of each threat with respect to each target.

Step 4: Strategies. A third and final public workshop was held on June 21, 2007during which participants developed plans for moving forward on implementing conservation actions. Strategies were outlined to abate the threats identified in the previous workshop and maintain or enhance the current condition of the natural resource targets.

The final Salmon River Watershed Natural Resource Assessment Report will synthesize information from this Viability Analysis and from the subsequent Threats and Situation Analysis, and Strategies sessions.

2.0 VIABILITY ANALYSIS

This section presents the viability analysis for the seven natural resource targets in the Salmon River watershed. It is presented in seven subsections, one for each of the targets. The natural resource targets are more fully defined at the beginning of each subsection, and then an information synthesis is presented for each of several Key Ecological Attributes (KEAs). Indicators of viability for each of the KEAs are defined, and ratings of the current condition for each indicator are presented.

The natural resource targets that are the subjects of this analysis are readily segregated into aquatic and terrestrial types. While it is acknowledged in the broad context of the Salmon River ecosystem that these targets are integrated, with energy and material flowing between them and many organisms migrating among them, for organizational purposes they require independent treatment. For instance, the Salmon River freshwater estuary, Salmon River Main Stem, and headwater streams all form a continuum of the Salmon River stream system. Furthermore, this continuum is frequently punctuated by wetlands and open waters. Because many of the natural resource targets are, in fact, components of a single, interrelated continuum, they will share many similar biotic and physical characteristics, key ecological attributes and indicators of viability. Therefore, this viability analysis will be burdened by redundancy in order to provide each target with complete and thorough consideration.

2.1 Overview of Salmon River Study Area

The Salmon River Watershed is located in northern New York and is situated approximately midway between the cities of Watertown and Syracuse (Figure 1). The watershed ranges in elevation from 1,900 feet at the upper headwaters to 250 feet at the mouth of the Salmon River on eastern Lake Ontario, and drains approximately 181,000 acres. The Salmon River system is one of several that form the radial stream drainages of the Tug Hill Plateau. This landform slopes gently upward and eastward from the Ontario Lake Plain to its highest elevation (2100 ft) in the east-central portion of the region and is then terminated by an abrupt escarpment on its eastern edge at the Black River Valley.

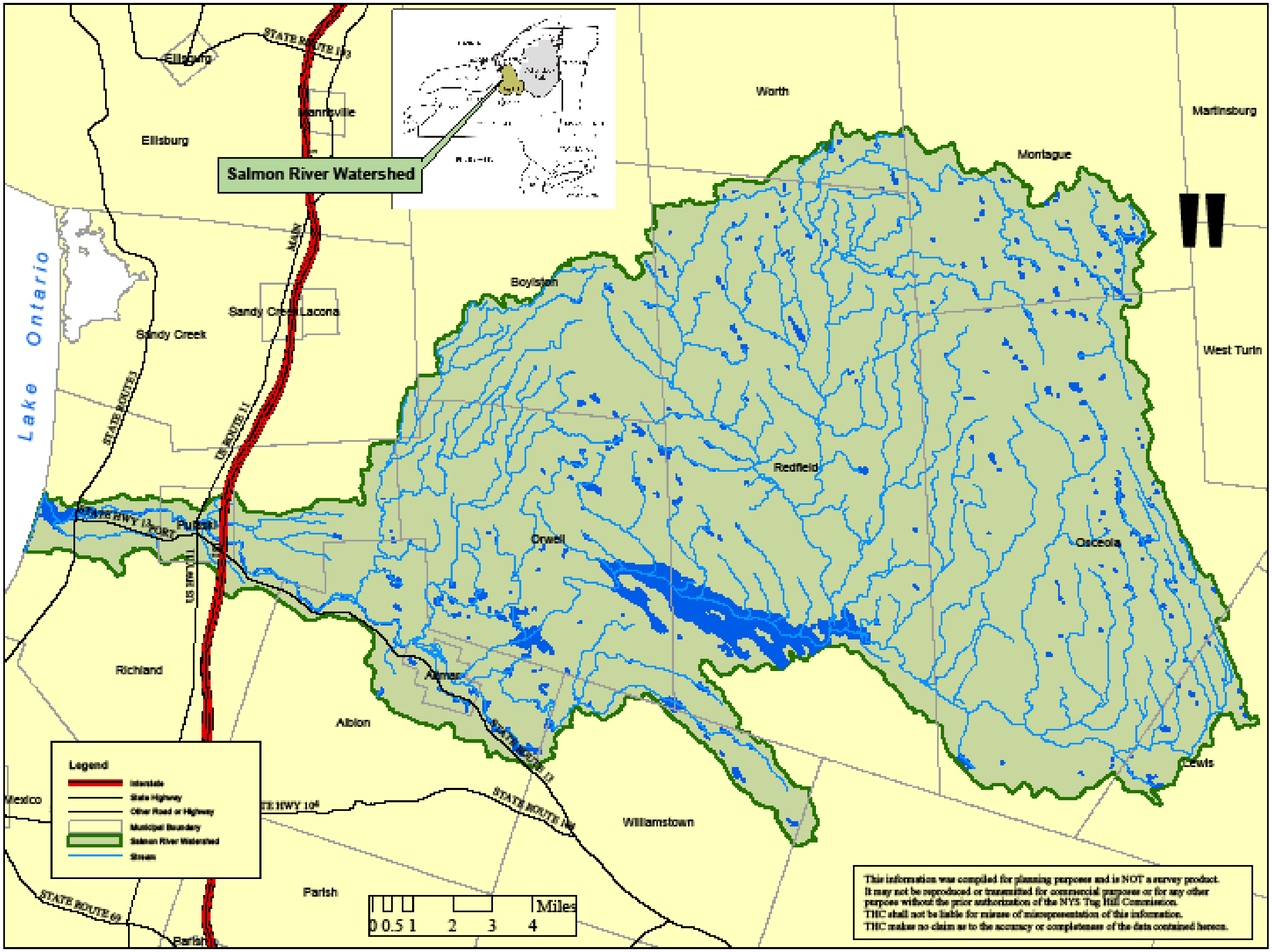


Figure 1. Salmon River Watershed Study Area.

The notable abundance of water resources (~4000 miles of streams, 117,000 acres of wetlands) within the Tug Hill region is due in large part to the high average annual precipitation that the region receives. An average of 42-50 inches of precipitation fall annually across the region (lesser amounts at lower elevations), including up to ~200 inches of average annual snowfall at highest elevations (Eschner et al. 1974). Precipitation patterns are influenced by the position of the Tug Hill on the eastern shore of Lake Ontario. Westerly air masses accumulate moisture as they pass over the lake and then as they are forced to rise over the Tug Hill they cool, which decreases moisture holding capacity. The condensing water falls as “lake effect” snow and rain. Substantially more precipitation falls over the region than can be evaporated or transpired by plants. Annual water surplus is a measure of excess precipitation (surplus = precipitation minus losses by evaporation and plant transpiration), and for the region water surplus ranges from 40” at the highest elevations to approximately 16” at Lake Ontario (Eschner et al. 1974). Consequently, an abundance of water is available during most of the year to create the extensive wetland systems, high velocity streams and eroded gulfs of the region.

The Salmon River drainage is a network of headwater stream communities (marsh headwater streams, rocky headwater streams), mid-reach and main channel stream communities, and a freshwater estuary at the river’s mouth. This stream network is punctuated with frequent occurrences of wetlands and open waters. The US Geological Service Hydrologic Unit Code (HUC) system places the Salmon River within the SE Lake Ontario Subregion (Subregion 0415) of the Great Lakes Hydrologic Region (Region 04), which represents the entire Great Lakes basin. The Salmon River System includes three 11-digit HUCs: the Lower Salmon River, Salmon River Reservoir, and the Upper Salmon River, which are the smallest hydrologic units recognized by this cataloguing system (Hunt et al. 2005). To facilitate more focused consideration on aspects of the Salmon River watershed, Howard (2006) further subdivided the watershed into fifteen sub-watersheds (Figure 2, Table 1). These smaller units will be referenced throughout this assessment.

Figure 2. Location of fifteen sub-watersheds within the Salmon River watershed (based on Howard 2006). See accompanying Table 1 for information on sub-watersheds.

Table 1. Summary of sub-watersheds within the Salmon River drainage (compiled from 2001 National Land Cover Data). "Location" references the situation of the sub-watershed above ("upper") or below ("lower") the Light House Hill Reservoir.

Code	Location	Name	Area (acres)	Sub-Watershed Towns
BBMC	Lower	Beaverdam Brook-Meadow Creek-Reservoir	17,285	Albion, Williamstown, Florence, Redfield, Orwell
BGWM	Upper	Beaver-Gillmore-Willow-McDougal	6,891	Worth, Redfield
COBR	Upper	Cold Brook	6,512	Worth, Redfield, Montague
FBTT	Upper	Fall Brook-Twomile-Threemile	9,780	Osceola
GRMM	Upper	Grindstone-Mill-Muddy	10,897	Redfield, Osceola, Montague
KESF	Upper	Keese-Smith-Finnegan	6,372	Osceola
LSRM	Lower	Lower Salmon River-Main Stem	11,197	Richland, Albion
MARI	Upper	Mad River	20,696	Worth, Redfield, Montague, Osceola
NOBR	Upper	North Branch	17,856	Boylston, Worth, Redfield
ORPE	Lower	Orwell-Pekin	12,793	Albion, Orwell, Boylston
PECK	Upper	Pennock-Coey-Kenny	19,888	Orwell, Redfield
PMLB	Upper	Prince-Mulligan-Little Baker	7,226	Redfield, Osceola
SBLB	Upper	Stony Brook-Lime Brook	4,572	Redfield, Osceola
TRBR	Lower	Trout Brook	12,866	Richland, Orwell, Boylston
UPSR	Upper	Upper Salmon River	16,098	Osceola, Lewis

The region is underlain by sedimentary limestone, shale, siltstone and sandstone bedrock that was deposited between 460 and 420 million years ago during the Middle Ordovician to Middle Silurian periods when the region was below sea level and receiving eroded materials from adjacent uplands of what is now the Adirondacks and Ontario (Leaf and Wittwer 1974). Approximately 220 million years ago the Appalachian Plateau, including the Tug Hill, was uplifted and these sedimentary deposits now form the bedrock of the Tug Hill upland (Figure 3). Around the perimeter of the plateau, a number of deeply eroded gorges (locally know as gulfs) occur at locations where high velocity streams have eroded through shale deposits. The Salmon River Gorge is one such notable gulf that occurs within the watershed. The region was further sculpted by a series of Pleistocene glaciations ending approximately 11,000-13,000 years ago. These glaciers deposited till and sorted outwash material from which a complex variety of soils with varying chemistry and drainage capabilities have formed (see Leaf and Wittwer 1974 and Cressey 1966 for more complete synthesis of geological processes shaping the region and influencing soil characteristics). In general, soils at mid- to upper elevations are predominantly stony, medium- to coarse-textured, highly acidic, and derived from glacial till of sandstone origin. Many are poorly drained. Soils at lower elevations tend to be of medium texture, with neutral or slightly acidic fragipans (dense subsurface soil layers with low permeability) (Leaf and Wittwer 1974; USDA NRCS 2008).

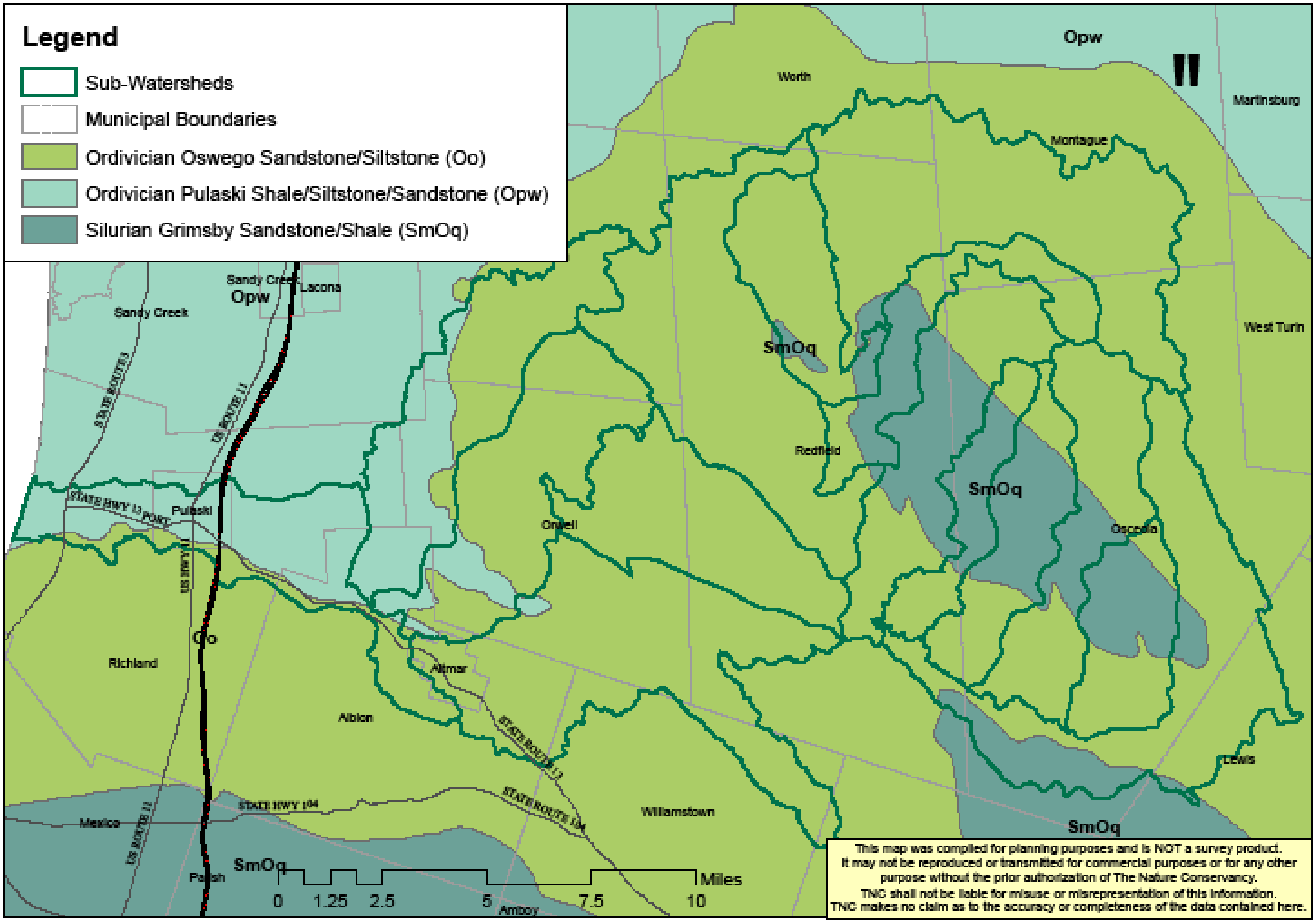


Figure 3. Bedrock geology of the Salmon River watershed.

In addition to the widespread till deposits of the region, a ~4-mile wide area of 20-30 feet-thick deposits of well-sorted glacial sand and gravel exists at mid-elevations of the watershed representing a segment of the 47-mile long Tug Hill Aquifer (Miller et al. 1989; Figure 4). Streams within the Salmon River drainage that intersect the aquifer formation lose water to the aquifer as they cross the east side and then regain water at the west side. Water discharges from the aquifer by seepage to streams, springs and wetlands along its west side; evapotranspiration; subsurface flow to adjacent deposits; and to groundwater wells (Miller et al. 1989). Private, municipal and industrial wells served ~14,500 people and pumped 6.12 Mgal/day from the aquifer in 1986 (Miller et al. 1989).

Historic and current land-use patterns have been influenced by broad geologic and hydrologic features of the region. Agriculture and larger accompanying settlements persist at lower elevations on better soils (Figure 5, Table 2). At the highest, eastern elevations, agriculture was never attempted and this area remains as intact forest. At mid-elevations subsistence agriculture was attempted and abandoned during the late 19th and early 20th centuries (Temporary State Commission on the Tug Hill 1976: 10). Many of these abandoned farmlands were incorporated into the New York State Forest system in the 1940s, and later into the New York system of Wildlife Management Areas. Consequently, state land holdings tend to be concentrated at the mid-elevations within the watershed.

The USDA Forest Service has established a hierarchical system of "ecoregional" mapping. Ecoregions represent geographic areas possessing similar types, quality and quantity of ecological resources. These ecoregions serve as a spatial framework for research, management and monitoring of ecosystems (USDA Forest Service 2004, 2005). Due to the range in elevation and location, the Salmon River watershed spans two ecoregional sections. The upper elevations of the watershed and Tug Hill form the western limit of the Northern Appalachian – Boreal Forest Ecoregion. The lower elevations of the western Tug Hill and Salmon River watershed along the Ontario Lake Plain fall within the Erie and Ontario Lake Plain Section of the Eastern Broadleaf Forest Province (Figure 6). Biological elements of the watershed's aquatic and terrestrial systems reflect the characteristics of these broad ecoregions, and much of the watershed shows transitional elements between the two ecoregions (Figure 5).

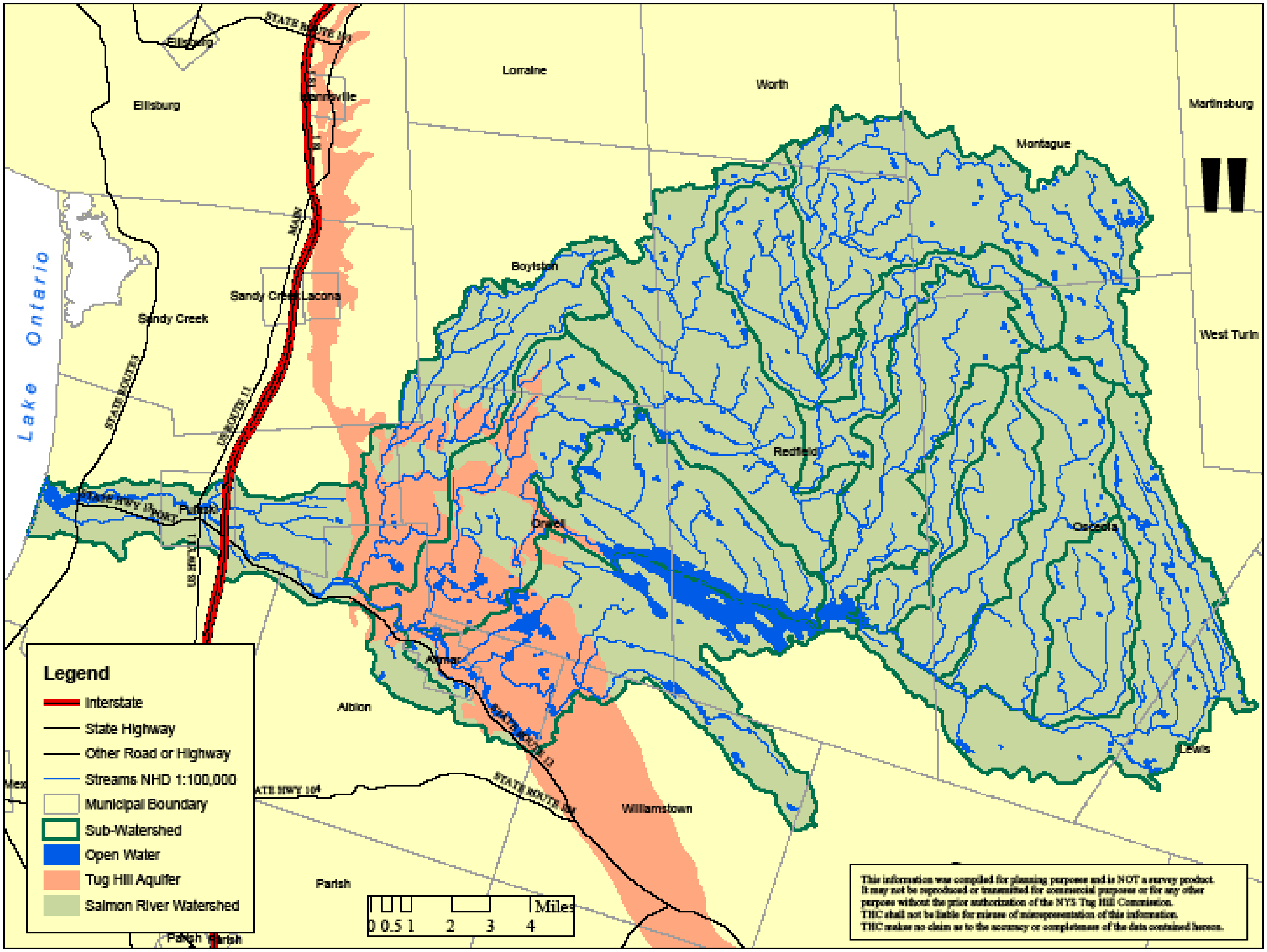


Figure 4. Location of the Tug Hill Aquifer.

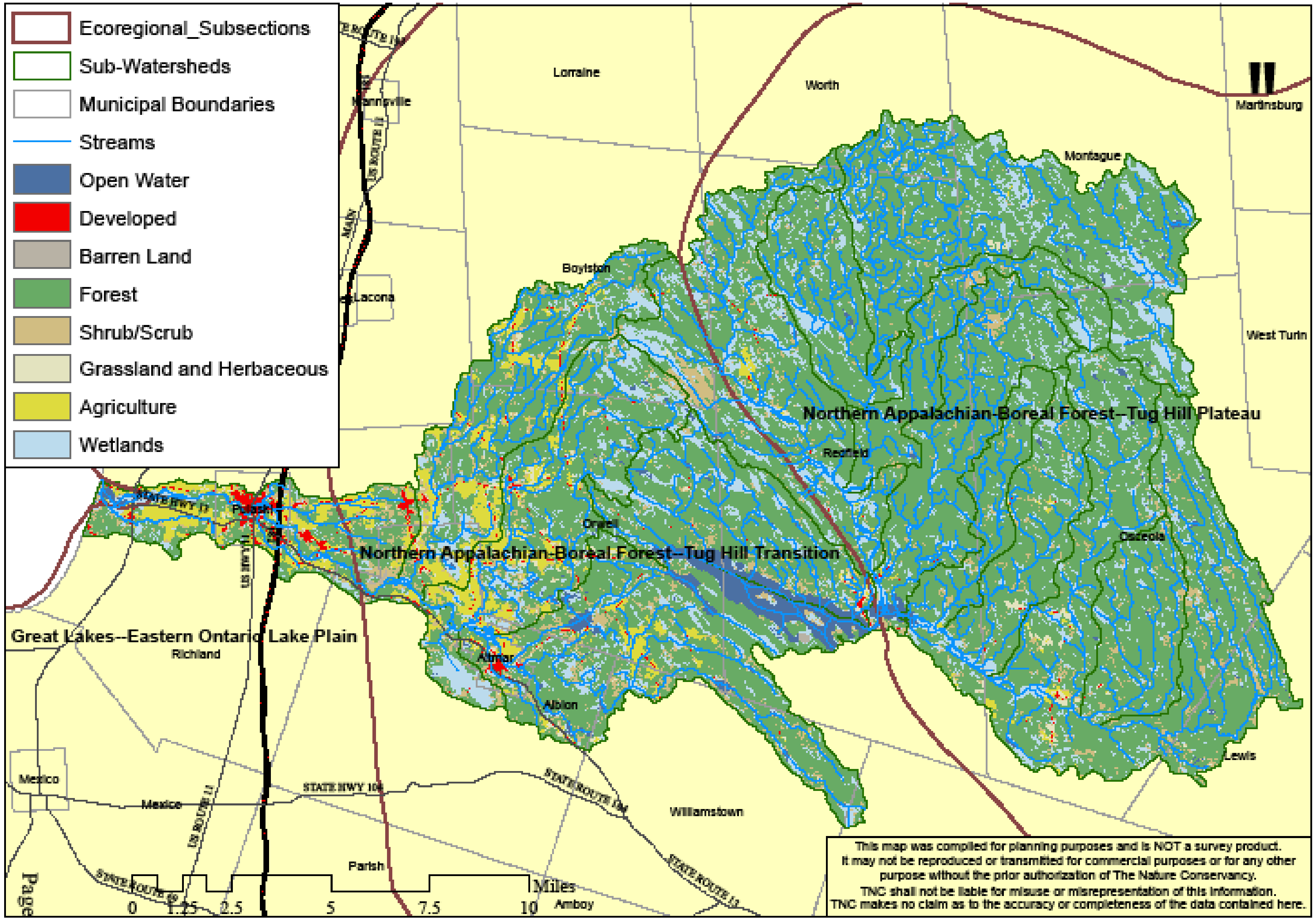
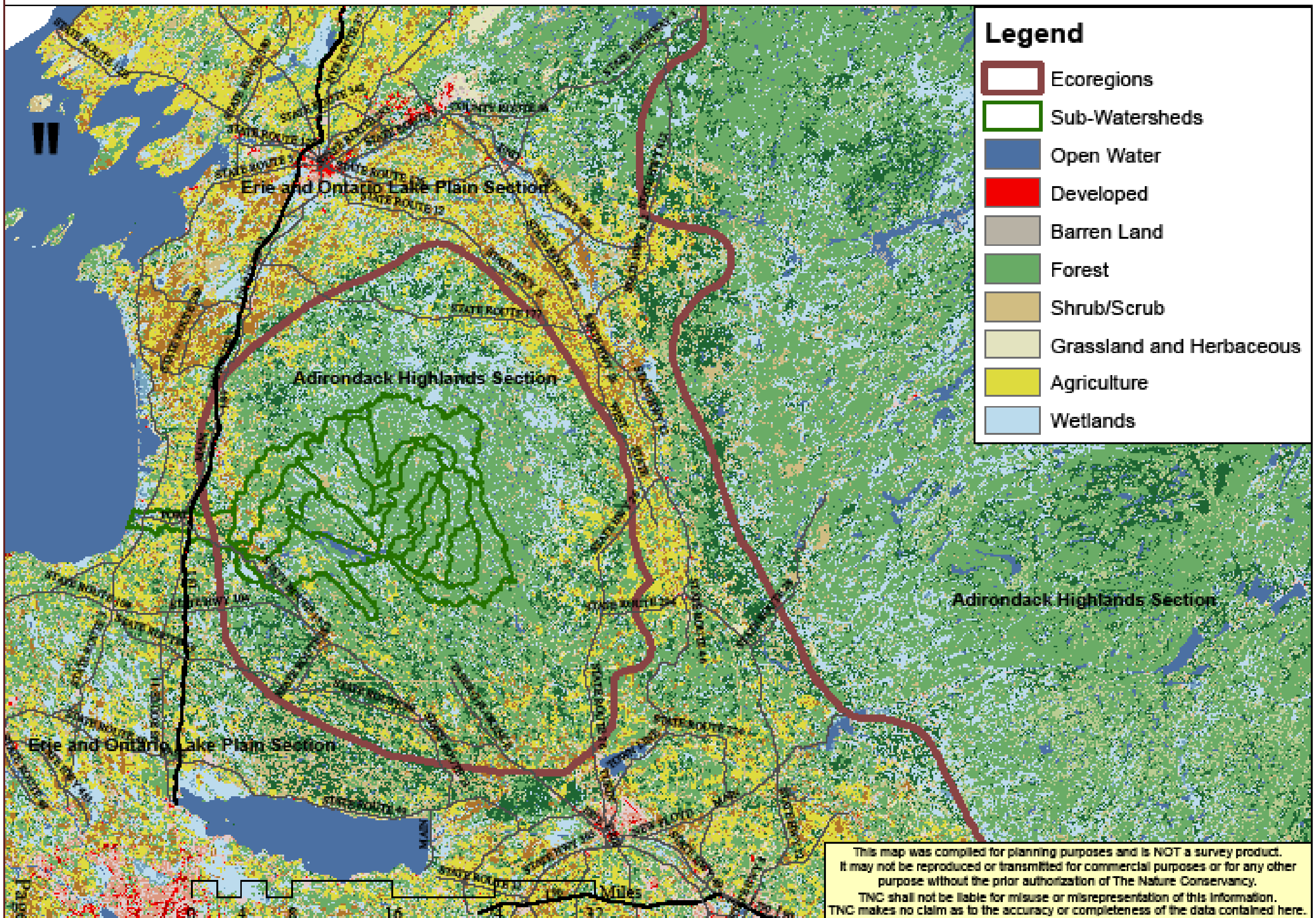


Figure 5. Land cover types and ecoregional subsections of the Salmon River watershed.

Table 2. Total acreage of land cover types by sub-watershed in the Salmon River watershed (compiled from 2001 National Land Cover Data).

				wetlands				forest			sub-watershed
	Developed	barren	agric.	woody	herbaceous	grassland	shrub	decid	conifer	mixed	total
BBMC	222	41	921	2482	212	173	1642	9624	1375	552	17285
BGWM	0	0	2	1292	79	1	100	5243	148	27	6891
COBR	0	4	0	997	36	1	194	5178	47	51	6512
FBTT	22	0	79	1506	61	159	374	7268	234	76	9780
GRMM	12	0	29	1316	31	9	346	8945	95	113	10897
KESF	1	0	1	586	10	12	279	5182	194	106	6372
LSRM	1025	38	2362	1482	126	142	1411	2990	1130	453	11197
MARI	0	2	11	4233	268	63	232	15551	77	258	20696
NOBR	50	0	181	4300	82	62	951	10903	766	562	17856
ORPE	127	0	1466	2244	95	291	902	6287	965	416	12793
PECK	1118	0	78	1614	53	80	565	5971	9870	539	19888
PMLB	14	0	28	959	12	74	284	5560	204	91	7226
SBLB	0	0	10	491	9	1	135	3844	54	28	4572
TRBR	149	0	2104	1400	71	281	1002	6783	567	510	12866
UPSR	15	4	128	1771	72	96	974	11762	869	403	16098
Watershed Totals	2755	90	7400	26673	1216	1444	9390	111092	16595	4184	180929



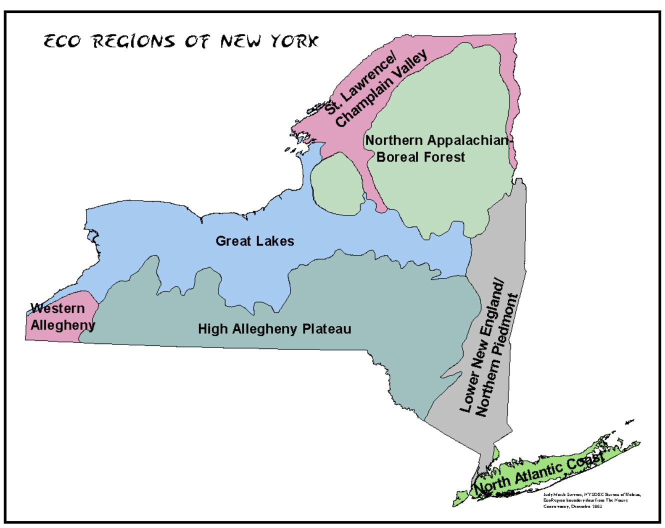


Figure 6. Ecoregional sections of northwestern New York. Inset map of New York ecoregions provided by NYSDEC.

2.2 Salmon River Freshwater Estuary

2.2.1 Salmon River Freshwater Estuary Definition

The Salmon River Freshwater Estuary is located at the mouth of the Salmon River at Port Ontario. For the purpose of this viability analysis, the ~270-acre freshwater estuary is defined as the reach of the Salmon River open waters and marshes that are bounded by the barrier dunes to the west and the last river riffle in the Salmon River, which is located approximately 1200 feet east of County Rt. 3 (Figure 7).

This system can be defined as a riverine-lacustrine estuary (*sensu* Albert 2001), which represents those sections of tributary rivers that are influenced by lake water levels. Such reaches (also referred to as "drowned river mouths") represent a transition zone from river to lake in which water level, geomorphic processes and biological interactions are controlled by fluctuations in the lake level. In the case of the Salmon River freshwater estuary, it can be further categorized as a "barred drowned river mouth" owing to the presence of a sand bar that partially isolates the river from the lake. Alternatively, it may be categorized as a Great Lakes aquatic bed (*sensu* Edinger et al. 2002:29), which represents a quiet bay protected by extreme wave action by sand bars or other barriers, and which typically support areas of aquatic macrophytes.

The freshwater estuary is a dynamic system of braided river channels and sandbars that are constantly in a state of flux from lateral erosion and sedimentation processes along with a shallow, open bay. The freshwater estuary system contains different wetland habitat types that correspond primarily with water depth, which averages approximately 3 ft, with a maximum of about 7 ft (Harman et al. 2000). These community types include the following.

- <u>Riverine</u> wetlands (~130 acres) associated with the river channels. Segments of river channel are periodically dredged to maintain a stable, navigable channel (FERC 1996).
- <u>Emergent marshes</u> (~110 acres) occur in shallow sections of the freshwater estuary, between the river channels and adjacent uplands or river bar islands. Both deep and shallow emergent marsh communities occur here.
- <u>Woody wetlands</u> (~30 acres), including shrub swamps and floodplain forests occupying higher microsites around the fringe of the freshwater estuary and on river bar islands.

The freshwater estuary is a significant habitat for migratory and resident waterfowl. The beds of emergent marsh vegetation and submergent aquatic plants provide habitat in this warm water fish concentration area. Further, it is a staging area for annual migrations of spawning salmonines on the Salmon River.

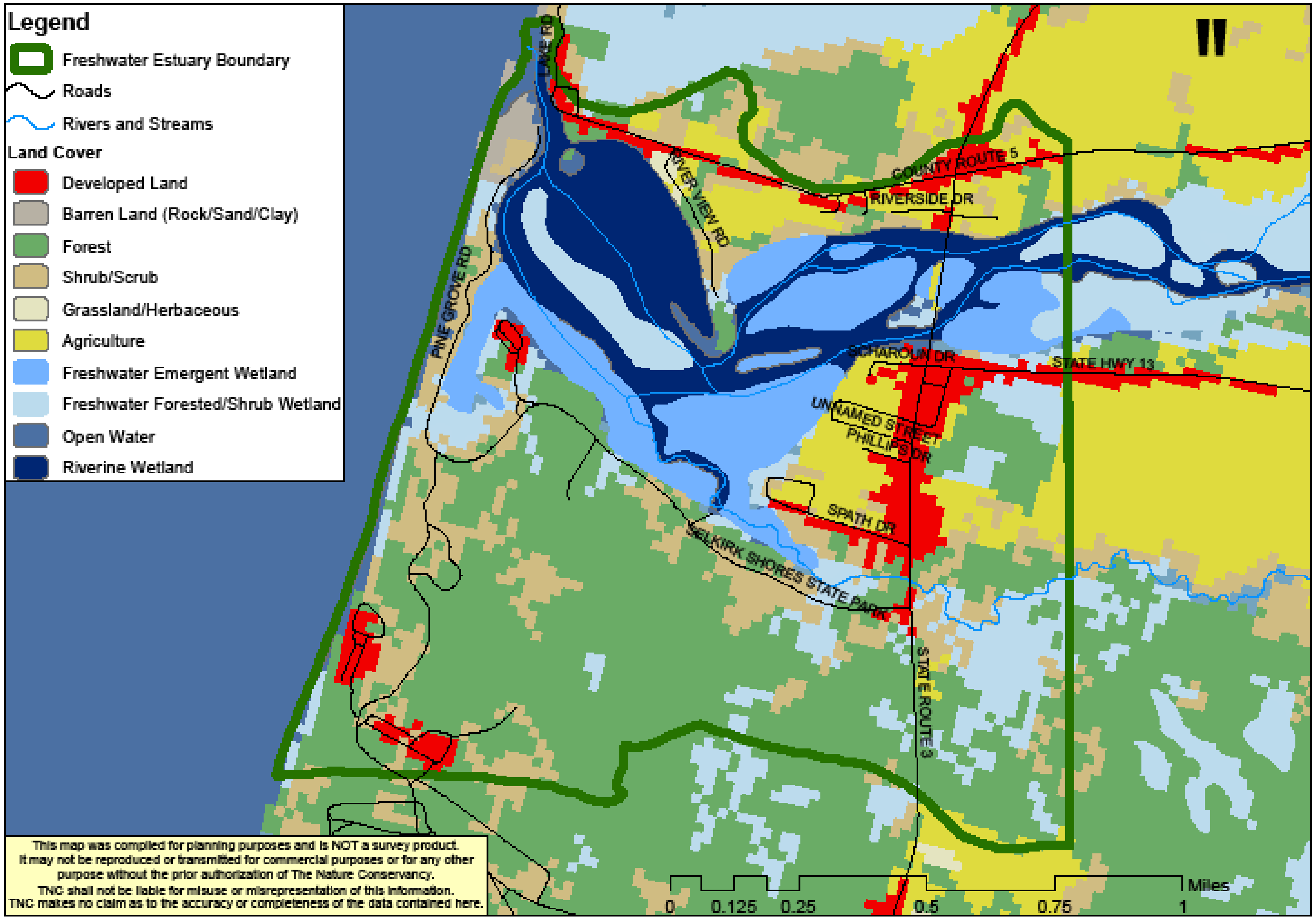


Figure 7. The Salmon River freshwater estuary and local sub-watershed.

In addition, the Salmon River freshwater estuary represents the southern extreme of the unique 17-mile long Great Lakes barrier beach/dune system along the eastern shore of Lake Ontario. This barrier dune system, with associated ponds, marshes and fens, represents the most extensive freshwater sand dune formation in New York and is of global ecological significance. This system begins at Selkirk at the south and continues northward to include Deer Creek Marsh, Lakeview Marsh, and North and South Sandy ponds, and provides habitat for a number of rare plant and animal species.

2.2.2 Salmon River Freshwater Estuary Viability

2.2.2.1. KEA: SIZE – Freshwater Estuary Area

Indicator – Freshwater Estuary Area (ac): The area of open water and wetlands within the freshwater estuary is a direct measure of it size.

Current Condition - Good: Total wetland area of the system is approximately 271 acres, consisting of ~132 acres of open water, 27 acres of forested/shrub wetland, and 112 acres of emergent wetland. The aerial extent of the freshwater estuary and proportions of wetland types will vary depending on lake water levels and in-system sediment transport dynamics. Lake Ontario water levels are currently maintained between 74.5-75.0 m. It is likely that estuarine wetlands were filled in the past prior to federal and state wetland regulations in order to develop along the shores. However, activities that would further reduce habitat beyond current conditions are unlikely due to NYSDEC and US Army Corps of Engineers regulations.

2.2.2.2. KEA: CONDITION – Plant Communities

The marsh communities within the freshwater estuary provide substrate, cover and food for a variety of birds, fish, mammals and invertebrates, and stabilize river bottom substrate. Two different marsh communities occur in the freshwater estuary (Edinger et al. 2002, Howard 2006).

- Shallow emergent marshes are meadow communities that occur on mineral or organic soils that are seasonally flooded. Water depths range from 0.5 to 3 feet during flooding, but surface water levels usually drop and the substrate is typically exposed during late summer.
- Deep emergent marshes occur on mineral soils or fine-grained organic soils that are flooded but not subject to erosive wave action. Water depths range from 0.5 to 6.5 feet, and water levels fluctuate seasonally, but soils rarely dry.

Indicator – Total Macrophyte Cover: Indicators of macrophyte abundance and community composition include total percent cover or biomass of plants. Abundance of resident fish communities, invertebrate communities and breeding birds are directly related to habitat availability. The state-protected marsh birds that breed in the freshwater estuary nest, hunt and forage in macrophyte beds.

No information is available on the natural range of variation in aquatic vegetation of the freshwater estuary that would serve as a quantitative baseline for estimating viability.

<u>Current Condition – Good:</u> Table 3 summarizes the available quantitative descriptions of the emergent marsh communities of the freshwater estuary. Harman et al. (2000) mapped beds of emergent macrophytes. They reported that macrophytes occurred in a patchy distribution across the freshwater estuary and that, in their judgment, total coverage was good. They further concluded that, given the mesotrophic status (moderate nutrient availability) of the system, vegetation removal was not necessary except in a few areas. Howard (2006) estimated over 90% cover of macrophytes in patches of shallow and deep emergent marsh vegetation. McKenna (unpublished data) randomly sampled vegetation at 35 stations in the freshwater estuary and found total percent cover averaged 35% and ranged from 0 to 100%.

Table 3. Community composition of macrophytes in the Salmon River freshwater estuary. Data are percent cover estimates from Harman et al. (2000) who sampled along transects within macrophyte patches at varying depths (reported data are minimums of cover classes); and Howard (2006) who estimated cover on subjectively located releves in deep and shallow emergent marsh communities. Species noted as present but with inconsequential cover are denoted with a diamond (♦). Exotic invasive species are indicated with an asterisk.

		Harman			Howard	
Common name	Scientific name	0.5 m	1 m	2 m	Deep	shallow
swamp loosestrife	*Decodon verticillatus*					5
	Phalaris arundinaceae					21
Sedges	*Carex* spp.	5			♦	
	C stricta					6
	C. lacustris					5
Rice cutgrass	*Leersia oryzoides*					13
bluejoint grass	*Calamagrostis canadensis*					14
Joe-pye weed	*Eupatorium maculatum*					5
common boneset	*Eupatorium perfoliatum*					5
	Peltandra virginica					5
Pickerelweed	*Pontederia cordata*	5			25	
Broadleaf arrowhead	*Sagittaria latifolia*	50				18
Cattail	*Typha* sp.	5			70	
*purple loosestrife	*Lythrum salicaria*	5			♦	♦
bullhead lily	*Nuphar variegatum*	25			♦	
Am. white water lily	*Nymphaea odorata*	5			♦	
coon's tail	*Ceratophyllum demersum*		1			
Canadian waterweed	*Elodea Canadensis*	5	25			
*Eurasian milfoil	*Myriophyllum spicatum*		1			
wild celery	*Vallisneria Americana*	25	50	50		
Bladderwort	*Utricularia vulgaris*		1			
*curly pondweed[1]	*Potamogeton crispus*	1				
Richardson pondweed	*P. richardsonii*	1	1			
nodding waternymph	*Najas flexilis*	5				
green arrow arum	*Peltandra virginica*				5	
Broadfruit bur-reed	*Sparganium eurycarpum*				♦	
*European frog-bit	*Hydrocharis morsus-ranae*				♦	♦
Total Invasives		6	1	0	<1	<1
TOTAL		~100	~75	~50	~100	~95

[1] *P. crispus*: was most abundant in several areas during spring sample.

Indicator – Invasive Plant Species Frequency and Abundance: Invasive species are those nonnative organisms whose introduction to an ecosystem causes or is likely to cause economic or environmental harm (New York State Invasive Species Task Force 2005). Many invasive plant species are competitive or weedy plants that are able to displace others, thereby reducing diversity of other plants and organisms that rely on a diverse assemblage of plants. Given the boating activity within the freshwater estuary and level of establishment by invasive macrophytes within the Great Lakes, potential exists for invasives to reduce diversity and ecosystem functions of the freshwater estuary's macrophyte beds.

Table 4 presents the criteria used to rank community viability in relation to the dominance of invasive species.

Table 4. Generalized criteria (modified from Drake et al., 2003) for ranking community viability in relation to the frequency of occurrence (proportion of observations in which an invasive species is present) and dominance (relative density, cover, biomass) of invasive species, pests and pathogens (ISPPs) within natural communities.

	Excellent	Good	Fair	Poor
Frequency	ISPPs not present in study area	ISPPs present on <5% of sites/plots	ISPPs present on 5-25% of sites/plots	ISPPs present on >25% of sites/plots
Abundance	ISPPs not present in study area	ISPPs comprise <5% density, cover or basal area	ISPPs comprise 5-25% of density, cover or basal area	ISPPs comprise >25% of density, cover or basal area

<u>Current Condition – Good to Fair</u>: Table 3 reports percent cover of component macrophyte species in the freshwater estuary. Harman et al. (2000) reported that several potentially invasive species are present within the system (purple loosestrife, Eurasian milfoil, curly pondweed), but that total cover of these species was low (ranging from 1-6%) and, given the relatively low nutrient levels in the freshwater estuary, these species were not expected to develop into problematic weeds and this location. Howard (2006) noted the presence of Eurasian milfoil, purple loosestrife and Euopean frog-bit, but cover never reached 1% in their sample. Eurasian milfoil occurred in 17% of McKenna's random samples. Using the Drake et al. (2003) guidelines for frequency, community composition with respect to invasive occurrences would be rated "fair" (up to 17% frequency of occurrence of milfoil in random samples). However, if guidelines for cover are applied, the freshwater estuary would be rated "good" given that invasive species typically account for less than 5% of the total estimated macrophyte cover.

2.2.2.3. KEA – CONDITION - Fish Communities

The Salmon River freshwater estuary is a warm water fishery that supports a variety of game fish species and forage species for several shore birds. Furthermore, it serves as a concentration area for migratory salmonines during annual spawning runs. Fish communities are assembled from populations in both the river and Lake Ontario. Maintenance of a diverse and productive fishery is vital for the viability of the system.

Indicator – Fish Community Diversity (Richness): Species richness is an important indicator of ecosystem health in that it reflects the potential complexity of food webs and often increases a community's capacity to prevent the establishment of invasive species. Greater fish richness provides for more diverse consumption of food types, thereby controlling population growth of a wide variety of plants, algae and invertebrates. In turn, diverse forage fish support a greater variety of bird, fish and mammal predators.

There are no quantitative accounts of historic species richness of the freshwater estuary upon which to base a viability ranking. However more recent surveys exist that can provide a baseline for future monitoring.

Current condition – Good: Two recent, unpublished and ongoing surveys of the freshwater estuary fish communities have together recorded 44 species between 1996 and 2003 (Table 5). A 1977 survey collected 43 fish species near the river's mouth (FERC 1996). By comparison, fish species richness in the summers of 2001-2002 in nearby protected embayments of southeastern Lake Ontario (Blind Sodus, Little Sodus, Floodwood, North Sandy Pond, Colwell) ranged from 20-43 (Meixler et al. 2005). Comparing data among these surveys requires caution since different sampling methods, intensities and timing were employed. Regional fisheries managers believe the freshwater estuary possesses a good level of species richness.

Indicator – Index of Biotic Integrity: An index of biotic integrity (IBI) was developed by Carlson et al. (2006) to describe the overall condition of fish community composition in 35 bays along the eastern and southern shores of Lake Ontario. The IBI synthesizes data describing thirteen metrics including species richness and composition, tolerance and sensitivity, feeding guilds, reproductive guilds, and abundance of native species. Bays obtaining IBI scores greater than 38 were ranked in "good" condition and those scoring less than 33 were ranked as "poor."

Current Condition – Good: The Salmon River Freshwater Estuary received the highest IBI score (41) of all 35 bays sampled along Lake Ontario.

Table 5. Relative density (percent of total catch) of fish species in samples from the Salmon River freshwater estuary. Data are from J.McKenna (unpublished, 1996-2003 sampling with combination of bottom and surface trawls, and large (1.5") and small (1/8") seines) and NYSDEC Rare and Endangered species survey 9/97. Sample methodology and intensity vary between the data sources.

	-------------J. McKenna-------------				NYSDEC R&E Survey
	Fall N=8	Spring n=7	Summer N=8	Avg. all seasons	Fall 1997
avg. total catch	**170**	**48**	**81**	**99**	**969**
shiner, golden	11.2	6.0	3.1	6.6	25.8
perch, yellow	6.1	35.3	19.0	20.1	22.2
pumpkinseed	5.3	6.0	14.4	8.6	20.6
shiner, bridled	8.6	0.3	0	3.0	8.2
minnow, bluntnose	37.5	11.7	1.8	17.0	6.2
bass, largemouth	0.2	0	2.2	0.8	5.5
bass, rock	5.1	3.6	4.8	4.5	1.8
darter, tessellated	2.2	20.7	13.5	12.1	1.6
crappie, black	0.2	0	0.8	0.3	1.0
bluegill	5.2	0.3	2.8	2.8	1.0
killfish, banded	0	0	0.2	0.1	1.0
minnow, fathead	0	0	0	0	1.0
alewife	0	1.5	0	0.5	0
bass, smallmouth	2.2	0	10.5	4.2	0.0
Bowfin	0	0.6	0	0.2	0.5
bullhead, brown	2.2	6.6	9.7	6.2	0.9
bullhead, yellow	0	0	0.3	0.1	0
carp, common	0	0	0	0	0.1
chubsucker, creek	<0.1	0	0	<0.1	0
chubsucker sp.	<0.1	0	0	<0.1	0
dace, blacknose	0.7	0	0	0.2	0
eel, American	0	0	0.2	0.1	0
lamprey	0	0	0	0	0.1
minnow sp.	0	1.2	0.5	0.6	0
minnow, cutlip	3.6	0.3	0	1.3	0.1
minnow, eastern silvery	0.7	1.8	0	0.8	0
Moxostoma sp.	0	0	1.1	0.4	0
mudminnow, central	0	0.3	1.4	0.6	0
Notropis sp.	0	0	2.2	0.7	0
perch, log	0	0.6	0	0.2	0

Table 5, continued

	J. McKenna				NYSDEC R&E Survey
	Fall N=8	Spring n=7	Summer N=8	Avg. all seasons	Fall 1997
pickerel, chain	1.1	0.6	5.6	2.4	0
pickerel, grass	0	0	0	0	0.3
pike, northern	0.4	0.6	0.2	0.4	0.8
redhorse, shorthead	0	0	0	0	0.3
redhorse, silver	0	0.9	0	0.3	0
salmon, Chinook	0.4	0.3	0	0.2	0
shiner, blacknose	0.2	0	3.4	1.2	0
shiner, common	6.3	0	0.2	2.2	0
shiner, emerald	<0.1	0	1.6	0.5	0
shiner, spottail	0	0.6	0.2	0.2	0.4
sucker, hognose	0	0	0	0	0.1
sucker sp.	0	0	0.2	0.1	0
sucker, white	0.4	0.3	0.5	0.4	0.1
sunfish sp.	0	0	0.2	0.1	0

Indicator – Invasive Species Densities: NYSDEC fisheries managers considered the sea lamprey (*Petromyzon marinus*) to be the most invasive species in the lower Salmon River and its freshwater estuary. Lampreys are parasitic and attach themselves to other fish with their suction-disk mouths and feed on the host fish's bodily fluids. Introduction of sea lampreys to the Great Lakes has caused declines in lake trout and whitefish populations. They spawn in tributary streams.

Common carp (*Cyprinus carpio*) is another potentially invasive fish species inhabiting the estuary. Carp are native to Eurasia, and inhabit slow-moving and standing freshwaters and brackish estuaries. They feed on invertebrates and aquatic vegetation. During feeding activities they uproot aquatic plants, thereby causing siltation that can disturb nursery areas of native fishes, and inhibit the ability of sight-oriented predatory fish (e.g., bass, sunfish) to forage (USGS 2006). Carp are present in several tributaries of the Great Lakes.

Current Condition – Lampreys, Good: Lampreys are present but not abundant in the freshwater estuary. They comprised only 0.1% of the fish collected during a NYSDEC sample for Rare and Endangered species in 1997 (Table 5). Based on ranking criteria for invasive species (Table 4), the condition of the freshwater estuary relative to lamprey densities is good. The freshwater estuary is included in the Great Lakes Fisheries Commission lamprey treatment program and is treated on a 4-yr cycle (D. Bishop, NYSDEC personal communication; for additional information see also http://www.glfc.org/lampcon.php).

Current Condition – Common Carp, Good: Carp are present but not abundant in the estuary. They comprised only 0.1% of the fish collected during a NYSDEC sample for Rare and Endangered species in 1997 (Table 5). Local fisheries managers do not believe carp currently present a threat to the Salmon River fishery.

2.2.2.4. KEA – CONDITION - Populations of Rare and Endangered Species.
Several wildlife species of concern are known to occur within the freshwater estuary. These include:

- black tern (*Chidonias niger*), status endangered
- least bittern (*Ixobrychus exilis*), status threatened
- pied-billed grebe (*Podilymbus podiceps*), status threatened
- sedge wren (*Cistothorus platensis*), status threatened

A fifth species, the lake sturgeon (*Acipenser fulvescens*), is believed to be extirpated from the freshwater estuary, and the system represents a potential site for restoration.

Indicator – Numbers of Black Tern Breeding Pairs: These insectivorous birds are known to nest within the freshwater estuary. They tend to nest in a colonial fashion, often with clusters of up to 11-50 nests in the same area of marsh. Nests are usually placed 11-50 m apart but can range from 1 to 600 m. Territories are defended to about 2 m from the nest. Nests are small collections of aquatic vegetation usually built on floating substrates of matted or decaying marsh vegetation, or on other features that provide a platform (US Fish and Wildlife Service 2007).

No quantitative determination of carrying capacity for nesting pairs has been proposed for this species at this location.

Current Condition – Fair: The New York Natural Heritage program rated this occurrence as fair (Howard 2006). That report indicated the number of nesting pairs (unspecified) has been lower than in recent years, but habitat availability is still excellent. Lower rating for the ranking is due to heavy development and use by boaters that may possibly lead to harassment of nesting pairs.

Indicator – Numbers of Pied-billed Grebe Breeding Pairs: This species breeds on seasonal or permanent ponds or bays with dense stands of emergent vegetation. It feeds on fish in open waters and among aquatic vegetation. It constructs its nest on floating vegetation (Cornell Lab of Ornithology 2007).

No quantitative determination of carrying capacity for nesting pairs has been proposed for this species at this location.

Current Condition - Good to Fair: The NY Natural Heritage Program reported one to two pairs in 2001 with at least four pairs encountered in 2005 (Howard 2006). Habitat of emergent vegetation is abundant with nearby open bay and channels.

Indicator – Numbers of Least Bittern Breeding Pairs: This species requires marshes with tall, emergent vegetation for both foraging and nesting purposes. It feeds on small fish and insects within emergent marshes and constructs nests made of plant materials in dense, tall vegetation (Cornell Lab of Ornithology 2007).

No quantitative determination of carrying capacity for nesting pairs has been proposed for this species at this location.

Current Condition – Good to Fair: The NY Natural Heritage Program reported at least two pairs of least bitterns were present at the site in 2005 (Howard 2006). The area of suitable habitat (emergent marsh, with open channel and bay) is large.

Indicator – Numbers of Sedge Wren Breeding Pairs: This species inhabits margins of wetlands dominated by grasses and sedges, and other damp grassland habitats. This species has experienced a noticeable decline in the northeastern United States and the Great Lakes region (Patuxent Wildlife Research Center 2005).

Current Condition – Unranked: The species has been observed in the freshwater estuary. No quantitative information exists regarding its abundance in the system.

Indicator – Numbers of Lake Sturgeon: This species is one of New York's largest freshwater fish, and can occasionally grow to more than seven feet in length. It is listed as threatened in all states where it occurs due to over exploitation for caviar and flesh, construction of dams that eliminate spawning and nursery areas, and habitat degradation from to pollution and channelization. Lake sturgeon spawn in clean, large cobbles along rocky shores of islands and in rapids in streams, and feed on invertebrates, small fish and algae that occur along river bottoms. In New York, sturgeon have been collected in the St. Lawerence, Niagara, Oswegatchie and Grasse Rivers, and in Lake Ontario, Erie, Champlain, and Cayuga (NYSDEC 2008). The NYSDEC is currently assessing restoration potential for this species in several waterways where it is known to occur (Zollweg et al. 2003, NYSDEC 2008) and some fisheries managers believe the Salmon River Freshwater Estuary has excellent potential to support a reintroduction effort (D. Carlson, NYSDEC, personal communication).

Current Condition – Poor: This species is not known to occur in the freshwater estuary.

2.2.2.5. KEA: CONDITION – Hydrology

Water level within the freshwater estuary determines the aerial extent and distribution of available wildlife and fisheries habitat. Due to the geomorphology of this drowned river mouth, the water levels within the freshwater estuary are influenced primarily by lake levels. However, the presence of the sandbar/dunes across the mouth of the embayment limits water circulation with the freshwater estuary. Therefore water chemistry is determined largely by surface water discharge by the Salmon River and locally by small tributary streams (Mud Creek), as well as possible groundwater discharge.

Indicator: Surface Water Level Variation: Variability in water level probably served as an historic periodic disturbance that regulated plant community composition and local biodiversity. Water fluctuations would flood or dry out patches of emergent plants and permit for the shifting of sand and gravel bars by the river. These changes would reduce the extent and density of dominant, competitive plants and open exposed substrate for colonization by less dominant species, thus maintaining wetland community types within the freshwater estuary in a constant state of flux.

Stabilization of water levels within Lake Ontario began in the late 1950s (Figure 8) to provide for unhindered shipping traffic through the St. Lawrence River. This stabilization in water levels using the current regulatory plan (1958-D with Deviations) has reduced variation in plant community types in coastal marsh communities along the lake, which in turn reduces potential breeding and feeding grounds for marsh-dwelling birds and fish. Greater variation in water levels leads to a greater variety of marsh communities, which in turn provides more productive habitat for animals. Since regulation of water levels began in the late 1950s, there has been an estimated 50% reduction in meadow marsh and emergent-floating vegetation, and a concomitant 29% increase in cattail-dominated emergent marsh areas within the Lake Ontario and St. Lawrence wetlands (ILOSLR Study Board 2006).

<u>Current Condition – Fair to Poor:</u> No specific information exists regarding the influence of water level fluctuations on the distribution and integrity of wetland communities within the Salmon River freshwater estuary. Guidance from ISOSLR (2006) suggests that ecological integrity of this and other similar embayments along Lake Ontario would benefit from greater fluctuations in lake water levels.

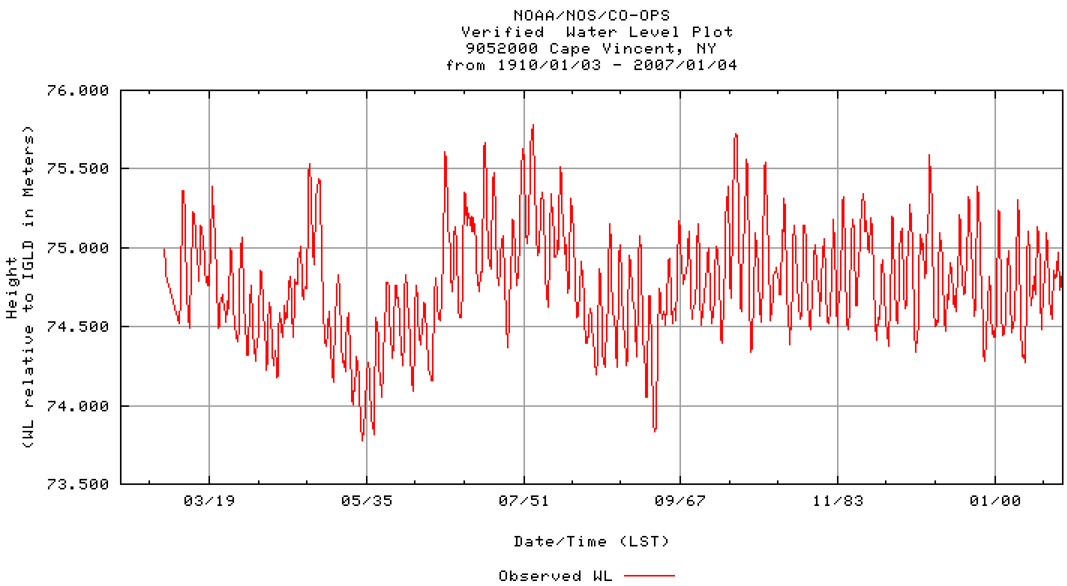


Figure 8. Historic water levels in Lake Ontario gauged at Cape Vincent, New York. Source: National Oceanic & Atmospheric Administration, Center for Operational Oceanographic Products and Services <http://www.great-lakes.net/envt/water/levels/levels-cur/ontwlc.html>.

Indicator – Salmon River Baseflow: Water levels of the freshwater estuary equilibrate with Lake Ontario levels, but water chemistry, temperature and circulation within the freshwater estuary are influenced greatly by flow from the Salmon River since the barrier dunes isolate the embayment from wave action on the lake. During summer periods of low flow, it is possible that environmental conditions within the freshwater estuary (e.g., temperature, dissolved oxygen) may become suboptimal for many organisms. Although measuring temperature and dissolved oxygen is more direct in assessing condition within the freshwater estuary, river baseflow is the hydrologic process that may be most important for controlling these factors. Baseflow conditions of the Salmon River at its mouth are regulated in large part by discharge from the hydropower reservoirs.

The licensing agreement (NERC 1996) for the hydropower plants require that continuous baseflow be maintained from the reservoirs under the following schedule:

January 1 – April 30	285 cfs
May 1 through August 31	185 cfs
September 1 through December 31	335 cfs.

This baseflow schedule represents a compromise between needs to maximize electricity generation and provide habitat that sustains a diverse river ecosystem. Importantly, the schedule sustains a minimum of 185 cfs of baseflow during the critical, dry summer months. This summer baseflow criterion was produced through several iterations of computer models that generated estimates of aquatic habitat availability and quality for all life stages of several indicator fish species under different baseflow release schedules.

Current Condition-Good: Baseflow input to the freshwater estuary by the Salmon River is maintained at a minimum of 185 cfs as determined by regulated discharge from the hydroelectric dams (Figure 9). This artificial flow schedule maintains high-volume river discharge into the freshwater estuary during the critical summer months at greater frequencies than historic flows without the influence of the upstream dams.

Indicator – Groundwater Discharge: Groundwater discharge into the freshwater estuary would influence freshwater estuary temperature and water quality and potentially help to maintain summer baseflow conditions.

Current Condition - Unranked: There is currently no information available regarding the volume and quality of any groundwater discharge into the freshwater estuary, and whether such discharge is consequential to freshwater estuary viability.

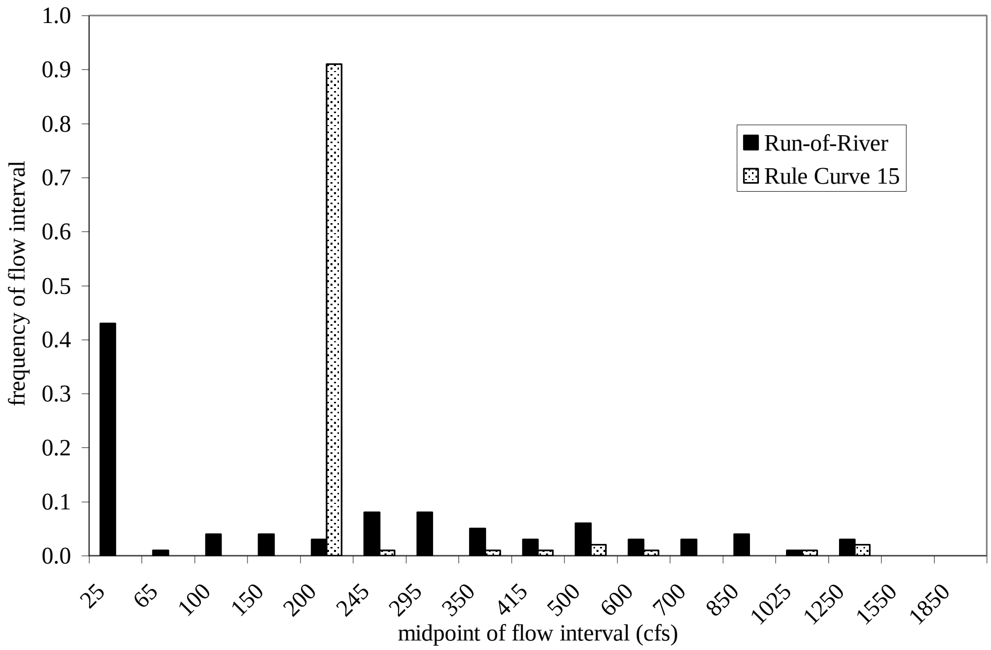


Figure 9. August flow distribution for different regulated flow regimes in the Salmon River . Run-of-river represents natural flow regimes. Rule Curve 15 maintains 200 cfs minimum baseflow during summer months (Sourc: F. Verdoliva, NYSDEC Altmar.)

2.2.2.6. KEA – CONDITION: Water Quality

Indicator - Percent Natural Vegetation in 100-ft Shoreline Buffer: Vegetated buffers along waterways are important for maintaining several aspects of water quality and habitat viability. Vegetation sequesters nutrients, stabilizes soils thereby reducing erosion, delivers organic material to be used as aquatic energy sources, and provides shade to moderate water temperatures. Available guidance suggests that 100-ft-wide vegetated buffers are typically effective at maintaining water quality and shading stream environments (Klapproth and Johnson 2000, Baird and Wetmore 2006).

Table 6 summarizes ranking criteria for assessing potential water quality condition as it may be influenced by land use within the freshwater estuary buffer zone.

Table 6. Ranking criteria for percent land-cover as natural vegetation in upland buffers adjacent to freshwater bodies (rivers/streams, open waters, wetlands).

	poor	fair	good
Percent of upland areas directly adjacent to water edge that is in some form of natural cover type (types other than roads, developed, agriculture, barren).	<75%	75-90%	>90%

Current Condition – Fair: An analysis of the land-cover types (National Land Cover Database 2001) within a 100-ft buffer established at the edge of the freshwater estuary (Figure 10) reveals that developed, agricultural and barren land uses comprise 8%, 9% and 4%, respectively, of the buffer area (total 21%). The balance (79%) is in some form of natural cover type (forest, scrub/shrub, grassland, wetland). The freshwater estuary is well buffered along its south shore adjacent to Selkirk Shores State Park. Development and agriculture occur along the north and southeast shores of the freshwater estuary. The land-cover on the barrier dune was mapped as scrub-shrub, but substantial development of seasonal homes exists there.

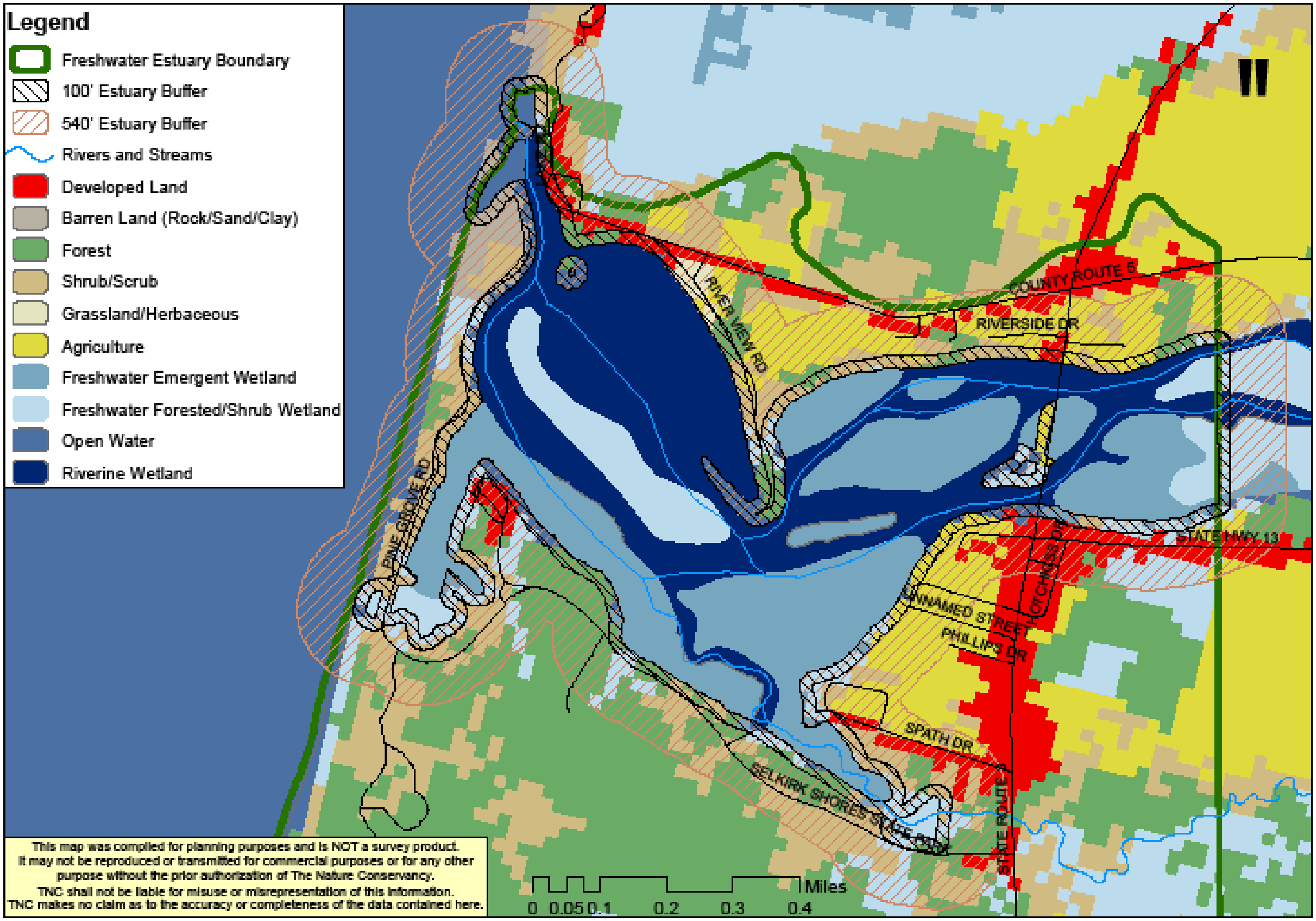


Figure 10. Analysis of land cover-types in 100- and 540-ft-wide buffers of the Salmon River freshwater estuary. Data are from the National Land Cover Database (2001).

Indicator: Phosphorus (P) Concentrations: Phosphorus is a naturally occurring mineral nutrient that is frequently the single-most important limiting resource for biological productivity in freshwater systems. It typically occurs in freshwaters in low concentrations owing to its low solubility. High P concentrations in water bodies are normally due to human activities (septic waste disposal, agricultural waste and fertilizer runoff), and typically result in high rates of productivity by algae and plants (eutrophication). The benthic (bottom) zones of eutrophic water bodies often become depleted in oxygen when large amounts of organic matter accumulate and undergo bacterial decomposition. Oxygen depletion, in turn, results in mortality of fish and other aquatic invertebrates.

No national standards have been set for phosphorus compounds in surface waters, but the USEPA has issued guidelines suggesting that to reduce eutrophication, total phosphates in streams entering lakes or reservoirs should not exceed 0.05 mg/L (Mueller and Helsel 1996).

Current Condition – Good: No data were available to specifically quantify phosphate concentrations in the water column of the freshwater estuary. However, Harman et al. (2000) subjectively describe the freshwater estuary as a mesotrophic system, suggesting low to only moderate concentrations of elemental nutrients.

Indicator – Carlson Trophic State Index: The Carlson TSI index (USEPA 2007a) synthesizes related data associated with indicators of trophic condition: chlorophyll *a* concentration (an indirect, but practical, measure of algal biomass); total phosphorus concentration (important limiting nutrient in freshwater systems); and Secchi disk transparency (depth to which one can see into the water). TSI is calculated separately for each respective measurement:

TSI = 60 – 14.41 ln Secchi disk (meters)
TSI = 9.81 ln Chlorophyll *a* (ug/L) + 30.6
TSI = 14.42 ln Total Phosphorus (ug/L) + 4.15

Ranges of TSI values can be assigned trophic state classifications:
TSI < 40: oligotrophic (low productivity)
TSI 40-50: mesotrophic (moderate productivity)
TSI >50: eutrophic (high productivity).

For instance TSI based upon concentration of P=0.5 mg/L (maximum suggested P concentration by Mueller and Helsel 1996) yields a TSI=61=eutrophic.

Current Condition – Unranked: No data are available for Secchi disk, chlorophyll *a* or total P in the freshwater estuary.

Indicator: Summertime Water Temperature: Temperature is an important regulator of partial pressure (solubility) of gases, particularly oxygen, in water. Cold water can maintain higher concentrations of oxygen than warm water. Furthermore, cellular respiration rates tend to increase with temperature, so rates of biotic activities increase. Importantly, bacterial decay of organic material increases, leading to more rapid oxygen depletion under warm conditions. The freshwater estuary naturally experiences diurnal fluctuations in temperature – warming by day and cooling by night – especially during the summer months and in the shallower reaches with slow water velocity. Because the freshwater estuary is isolated from Lake Ontario, wave action is minimized and mixing of the water column is limited. The freshwater estuary is classified as a "warm water fishery" and therefore will naturally not support certain fish requiring colder water temperatures. Even still, baseflow from the Salmon River is important for regulating water temperatures during the summer. Maximum temperature thresholds, at which many aquatic organisms begin to experience adverse physiological effects, must be considered by both temperature and duration.

Optimal temperature ranges for common warm water fish species (Michigan DNR 2007) inhabiting the freshwater estuary are:

80-82 ºF for largemouth bass;
68-70 ºF for smallmouth bass;
66-70 ºF for yellow perch.

Current Condition – Good: Limited available data (Table 7) suggest summertime high water temperatures in the freshwater estuary fall within the range of tolerance for common warm water fish species. No summer fish kills associated with lethal temperatures in the freshwater estuary have been reported.

Table 7. Summary of seasonal water quality parameters in the Salmon River freshwater estuary. Data are average temperatures taken during 1- to 2-day long sampling activities over the years reported. Average temperatures for the sampling activities are organized by season. (Source: J. McKenna, unpublished data).

	Temp. ºF	Dissolved Oxygen (mg/L)	pH
Autumn ('95,'96,'97)	68.4	10.1	8.1
Spring ('96,'97,'98,'99)	54.3	11.6	7.2
Summer ('96,'97)	72.9	8.8	7.5

Indicator – Sediment Load/Turbidity: Excessive sedimentation by silt within the slow reaches of the Salmon River can have substantial negative consequences. Siltation can smother spawning beds of several resident fish species. Silt load in the water column leads to greater absorption of light, thereby increasing water temperature.

Current Condition - Unranked: No information was obtained with which to rank this indicator for the freshwater estuary.

2.2.2.7. KEA – CONDITION: Pathogens

Several pathogens of concern to wildlife, fisheries and human health occur in or near the watershed. Table 8 presents ranking criteria used to assess current condition of pathogen occurrences in fish and wildlife populations.

Table 8. Ranking criteria for pathogen occurrences in freshwater bodies (rivers/streams, open waters, wetlands).

	Good	Fair	Poor
Percent of population within or in the vicinity of the Salmon River freshwater estuary that displays disease symptoms.	0 %	1-5%	>5%

Indicator – Type E Botulism Occurrence: Botulism is a disease caused by a neurotoxin that is produced by a bacterium and that leads to paralysis. The disease is spread by consumption of infected meat and has been known to affect fish-eating shore birds in the Great Lakes since 1999 (NYSDEC 2006b).

Current Condition – Fair: In autumn, 2006, an outbreak of Type E Botulism occurred in gulls, grebes and loons along the southern and eastern shores of Lake Ontario. This was the first occurrence in Lake Ontario (NYSDEC 2006b). No birds within the freshwater estuary were known to have been infected.

There are six viral and bacterial pathogens that are being monitored by NYSDEC for the salmonine fishery management (A. Noyes, NYSDEC Aquatic Pathologist, personal communication).

Indicator – Bacterial Kidney Disease Occurrence: BKD is caused by a gram-positive bacterium (*Renebacterium salmoninarum*) that survives in and causes extensive tissue damage to kidneys (Grayson et al. 2002). The disease is widespread in the Upper Great Lakes, with symptoms occurring in ~30-40% of Coho, Chinook, and Steelhead salmon there. The disease is spread by spawning fish migrating back into the river from Lake Ontario.

Current Condition - Fair: The bacterium has occurred sporadically in the Salmon River fishery but has not been detected since 2003.

Indicator – Furnunculosis Occurrence: Furnunculosis is a bacterial disease caused by *Aeromonas salmonicida.* The bacterium causes severe blood poisoning and acute mortality. Fish affected with pathogen may swim erratically, become sluggish and stop feeding. The disease is common throughout North America and the Great Lakes. (For more information see http://www.lsc.usgs.gov/FHB/leaflets/FHB66.pdf)

Current Condition - Good: The pathogen has recently been detected in approximately 5-10% of fish in the Salmon River, but no disease symptoms have been observed.

Indicator – Infectious Pancreatic Necrosis (IPN) Occurrence: IPN is a viral disease that infects all ages and varieties of salmonines and is transmitted vertically (adults to eggs), or horizontally (consumption of infected dead fish or by fish excretions in the water). Infected fish may have swollen stomachs, swim in spiral manners, be inactive and produce white fecal casts. (For additional information see http://www.mass.gov/czm/wpfshlth.htm, http://www.disease-watch.com/documents/CD/index/html/fv035ipn.htm)

Current Condition - Good: This disease was present in the Salmon River fishery in the 1950's and 1960's but has not been detected recently. It continues to be monitored.

Indicator – Yersinia ruckeri Occurrence: This bacterium is the causative agent of enteric redmouth (ERM), referring to symptomatic red mouths of infected fish. ERM most often infects rainbow trout, but it also affects several other salmonids. Infected fish are often found at the top of the water, isolated from other fish, and they may stop eating. The bacterium is common in Appalachian and mid-Atlantic fisheries as well as in the western Great Lakes. (For more information see http://www.mass.gov/czm/wpfshlth.htm.)

Current Condition - Fair: It is present but not common in the Salmon River.

Indicator – Viral Hemorrhagic Septicemia (VHS): The IV-B strain of this virus was detected in Nova Scotia in the 1990s. Current evidence suggests this is probably an Atlantic strain of the virus that is just now being spread into the Great Lakes. This particular strain does not target salmonines as the other strains do (I, II and IV on salmonids in Europe and Asia; and IV-A in the Pacific Northwest), but rather walleye, perch, minnows and gobies. Infected fish exhibit dark color, pale gills, sluggishness and erratic swimming. (For more information see http://www.mass.gov/czm/wpfshlth.htm, http://www.dec.state.ny.us/website/dfwmr/fish/vhsv.html.)

Current Condition - Good: The virus has not yet been detected in the Salmon River.

2.2.2.8. KEA-CONDITION: Toxins

Several known toxins are of concern within the freshwater estuary, some of which reach levels to warrant health advisories.

Indicator – Game Fish Tissue Mercury Concentration: Mercury (Hg) is a naturally occurring element that has increased in abundance due to a number of human activities. Important sources of mercury into the air and water include utilities, municipal wastewater plants, and incinerators. Toxic effects include reduced reproductive success, hormonal changes and motor skill impairment (Driscoll et al. 2007). Mercury bioaccumulates through food chains and can reach levels in carnivorous fish that are hazardous to human health. It is believed that the source of mercury in the lower Salmon River is primarily from migrating salmonines returning from Lake Ontario. However, some mercury is also deposited via wet and dry deposition in the upper watershed.

The current New York State threshold for issuing specific fish consumption advisories is the USDA standard of 1 ppm. In 2001 the USEPA set the human health standards for mercury at 0.3 ppm (=300 ng/g), but USDA, rather than EPA has enforcement capacity for human food. The source of data for this viability analysis (NYSDOH 2006) indicates those water bodies where fish exceed the USDA standard, and no data are provided that report actual tissue concentrations. Piscivorous (fish-consuming) wildlife are at high risk of adverse effects from mercury if they consume forage fish with mercury tissue concentrations >77 ng/g or higher trophic-level fish with mercury tissue concentrations >300 ng/g (USEPA 1997; Loukmas et al. 2006).

Current Condition - Fair: Elevated mercury levels are known to occur in fish in the lower Salmon River, but currently there are no fish consumption advisories for mercury in game fish taken from the lower Salmon River (NYSDOH 2006). No information is available on mercury concentrations on forage fish in the watershed.

Indicator – Game Fish and Snapping Turtle Tissue PCB Concentration: PCBs are a class of organochlorides that are persistent and bioaccumulate in aquatic food chains.

Toxicity to humans include carcinogenicity, reproductive and developmental toxicity, neurotoxicity, and acute toxicity.

Two potential rating criteria were obtained for this indicator. The first rating criterion follows NY State Department of Health standards. Another indicator is a measure of contaminant levels in snapping turtle eggs (Table 9), which have been shown to be highly correlated with contaminant concentrations in liver and adipose (fat) tissue (Pagano et al. 1999). Turtles accumulate persistent contaminants in their tissues from food and water taken directly from the wetland systems they inhabit, so their contamination levels directly reflect those of their immediate environments.

Table 9. Indicator ratings for PCB and Mirex concentrations (mg/kg) in snapping turtle eggs (data are from Pagano et al. 1999). Threshold values applied here for indicator ratings are based upon empirical measurements taken in perceived uncontaminated and contaminated (USEPA Superfund sites and NY State Hazardous waste sites) environments. These values do no reflect thresholds for adverse impacts to the animals.

	Good	Fair	Poor
PCB (mg/kg)	0	≤ 2	>2
Mirex (mg/kg)	0	≤0.2	>0.2

Current Condition (Fish Advisory Indicator)- Poor: There is currently a DOH fish consumption advisory for PCBs in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006).

Current Condition (Snapping Turtle Egg Indicator) – Fair: There are no data available for snapping turtle PCB concentrations in the watershed. However, Pagano et al. (1999) reported snapping turtle egg concentrations to be 1.5 mg/kg at the nearby Rice Creek Biological Station in Oswego County.

Indicator – Mink Jaw Lesions: The occurrence of cancerous lesions in the jaws of mink appears to serve as a sensitive indicator to PCB exposure (Haynes et al. 2007). That study further concluded that mink living and feeding near the shore of Lake Ontario, were exposed to bioaccumulative compounds (e.g., PCBs) in concentrations sufficient to cause lesions (40 parts per billion).

Current Condition - Poor: There are no data available reporting the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Beckett and Haynes (2007) in the Rochester Embayment, mink feeding within the Lake Ontario system appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario rather than within the Rochester Embayment watershed.

Indicator – Game Fish and Snapping Turtle Tissue Mirex Concentration: Mirex, which was banned in the US since the 1970s, is an organochloride that was used as an insecticide and flame retardant in a number of materials. It is persistent and bioaccumulates in aquatic food webs. Toxicity to humans includes carcinogenicity, reproductive and developmental toxicity, neurotoxicity, and acute toxicity (NYSDOH 2006, PAN Database 2007).

As with PCBs this indicator will be ranked using two criteria: issuance of fish consumption advisories by NYDOH and concentrations in snapping turtle eggs.

Current Condition (Fish Advisory Indicator) - Poor: There is currently a NYSDOH fish consumption advisory for Mirex in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006).

Current Condition (Snapping Turtle Egg Indicator) – Fair: There are no data available for snapping turtle Mirex concentrations in the watershed. However, Pagano et al. (1999) reported Mirex concentrations in snapping turtle eggs to be 0.04 kg/mg at the nearby Rice Creek Biological Station in Oswego County.

2.2.2.9. KEA-LANDSCAPE CONTEXT

The condition of the freshwater estuary is influenced by factors outside the actual limit of the wetlands, such as fragmenting landscape features and land uses that may affect water quality within the freshwater estuary or influence its use or accessibility by wildlife. The local landscape surrounding the freshwater estuary is defined by projecting its eastern boundary (last riffle of the Salmon River) northward and southward to the intersection of the Salmon River watershed boundary (Figure 7).

Indicator – Percent of Land in Natural Vegetation in Local Sub-watershed: Percent of a landscape in natural vegetation indicates capacity for habitat and migration corridors for wildlife species that utilize the freshwater estuary for certain aspects of their life histories, and for ecosystem functions such as nutrient sequestration and sediment control.

Table 10 presents criteria for ranking landscape viability based upon the amount of natural vegetation land cover-types.

Table 10. Criteria for ranking landscapes based upon percent of land cover-types as natural vegetation.

	poor	fair	good
Percent of land base in some form of natural cover-type (types other than roads, developed, agriculture, barren).	<75%	75-90%	>90%

Current Condition – Poor to Fair: Analysis of the National Land Cover Database (2001) indicates that 75% of the land cover in the local sub-watershed is “natural cover types” (i.e., wetland, forest, scrub/shrub, grassland, Figure 7). A cursory ground-truth of the NLCD (2001) data indicates that the barrier dunes forming the western limit of the freshwater estuary are comprised of wooded, but developed lots. This area, however, is classified as a natural cover type (shrub/scrub) by the NLCD data. The majority of natural cover within the freshwater estuary’s sub-watershed is provided by Selkirk Shores State Park.

Indicator – Percent Natural Cover in 540-ft Shoreline Buffer: Naturally-vegetated buffers provide opportunities for wildlife species to simultaneously utilize upland and wetland habitats within their home ranges, to migrate along water features, and to disperse from wetlands into adjacent upland communities. For instance, amphibians are known to travel 1000-1800 ft, and up to 4500 ft between breeding grounds and hibernation areas (Hels and Buchwald 2001; Gibbs and Shriver 2005). Semlitsch (1998) found adults of six salamander species at an average of approximately 375 ft distance from the edge of aquatic habitats, and suggested that a buffer of ~540 ft from wetlands would capture 95% of the individuals within populations of those species.

Current Condition – Poor: An analysis of the land-cover types (National Land Cover Database 2001) within a 540-ft buffer established at the edge of the freshwater estuary reveals that developed, agricultural and barren land uses comprise 11%, 19% and 3%, respectively, of the buffer area (Figure 10). The balance (67%) is in some form of natural cover-type (forest, scrub/shrub, grassland, wetland). Therefore, the the 540-ft buffer around the freshwater estuary is ranked as “Poor” based upon criteria presented in Table 6.

Indicator – Percent of 540-ft Freshwater Estuary Buffer Isolated by Roads: Road crossings are isolating features that limit the movement of many wildlife species. For instance roads are known to be a significant source of mortality to amphibians and reptiles (Hels and Buchwald 2001; Gibbs and Shriver 2005), especially those that breed in aquatic habitats and must cross roads to travel between hibernation and breeding sites.

Table 11 presents the criteria used to rank current condition of total road intercepts within the freshwater the estuary buffer zone.

Table 11. Criteria for ranking the amount of road intercepts within the 540-ft buffer of the Salmon River freshwater estuary.

	Poor	Fair	Good
Percent of total perimeter formed by a 540-ft buffer around the freshwater estuary that is intercepted by a road.	>25%	10-25%	<10%

Current Condition – Poor: An analysis of land-cover type data (National Land Cover Database 2001) indicated that the freshwater estuary is completely surrounded and isolated by paved roads (Figure 10). Seventy-nine percent of the area falling within a 540-ft buffer around the freshwater estuary has a road passing through it.

Indicator – Percent Natural Vegetation in 100-ft Buffers of Local First Order Streams: Apart from the main branch of the Salmon River, one mapped first-order stream feeds the freshwater estuary (Mud Creek). This stream may have localized influences on water quality and habitat within the freshwater estuary. Vegetated buffers of ~100 ft widths can provide effective nutrient and sediment controls. Ranking criteria presented in Table 6 were used to assess current condition associated with land use within a 100-ft buffer along Mud Creek.

Current Condition - Poor: The Mud Creek watershed has high agricultural use, and the buffer along the length of the creek contains less than 75% natural cover (see headwaters buffer analysis, Section 2.4.2.2, Figure 26).

2.2.3 Dune Community Viability

2.2.3.1 KEA – Size

Indicator – Dune Area (ac): The area of dunes is a direct measure of their extent.

Current Condition – Good: Total dune area at the mouth of the Salmon River to the extension of the freshwater estuary's southern shore is approximately 33 acres. These dunes are contiguous with the larger dune system extending northward from the mouth of the Salmon River. The aerial extent of existing dunes within the system does not appear to be reduced by interruptions of natural dune building processes. A recent study (Woodrow et al. 2002) analyzed sediment transport processes along the eastern Ontario lake shore with the purpose of determining, in part, the extent to which the jetty and Salmon River influence long-shore sediment transport and dune building processes. The study determined that the Salmon River does not contribute sediments to the beach/dunes and that the jetty system does not inhibit long-shore transport along this section of the Ontario lakeshore. Material for the dunes was deposited when the lake levels were higher during deglaciation. The area of dunes that was lost through construction of cottages is not known.

2.2.3.2 KEA – Condition – Dune Plant Community

The barrier dunes at the mouth of the Salmon River represent the southern extent of a 17-mile long Great Lakes dune system. These communities occur in New York only along the eastern shore of Lake Ontario and have a NY Natural Heritage Program ranking of S1S2, meaning they are rare within the state (Edinger et al. 2002). Community composition varies depending on stability of a particular dune and distance from the lake. Unstable dunes occur in closer proximity to the lake and are dominated by beachgrass (*Ammophila breviligulata*) and wormwood (*Artemisia campestris* var. *caudata*). Other species with low percent cover include cottonwood (*Populus deltoides*), heartleaf sand dune willow (*Salix cordata*), sand dropseed (*Sporobolus cryptandrus*), beach-pea (*Lathyrus japonicus* var. *glaber*), and dune grape (*Vitis riparia*). With time and stability, shrub and vine communities establish that are dominated by poison ivy (*Toxicodendron radicans*), dune grape (*Vitis riparia*), and cottonwood (*Populus deltoides*), with lower abundances of red osier dogwood (*Cornus sericea*), silky dogwood (*C. amomum*), sand cherry (*Prunus pumila*), sand-dune willow (*Salix cordata*), and bittersweet (*Celastrus scandens*), along with several herbaceous species. With further stabilization and time, open forest communities establish that are dominated by red oak (*Quercus rubra*) and red maple (*Acer rubrum*). Other characteristic species of the forested dunes include sugar maple (*Acer saccharum*), striped maple (*Acer pensylvanicum*), shad bush (*Amelanchier* spp.), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), chokecherry (*Prunus virginiana*), blackberry (*Rubus allegheniensis*), red raspberry (*Rubus idaeus*), nannyberry (*Viburnum lentago*), arrowwood (*V. recognitum*), wild sarsparilla (*Aralia nudicaulis*), and wreath goldenrod (*Solidago caesia*).

Rare plant species known to occur on the dunes at the Salmon River freshwater estuary are Champlain beachgrass (*Ammophila champlainensis*), low sand-cherry (*Prunus pumila var. pumila*) and sand dune willow (*Salix cordata*).

Indicator – Total Vegetation Cover: Due to erosion from wind and wave action, front dunes are often unstable and, therefore, plant establishment is critical for eventual stabilization and maintenance of the dune formations. In high use areas, pedestrian and off-road vehicle traffic promote destabilization.

Bonanno (1992) reported average total ground cover, under high and low use, on foredunes and secondary dunes within the eastern Lake Ontario dune system. Total cover under low use averaged ~40-60% on foredunes and 80% on secondary dunes. Under high use, cover averaged 20% on foredunes and 30% on secondary dunes.

Current Condition - Unranked: No data are available on vegetation cover of dunes at the Salmon River freshwater estuary.

Indicator – Rare Species Population Densities/Cover: Long-term trends in densities/cover of Champlain beachgrass, low sand-cherry and sand dune willow should be monitored.

There is currently no guidance on expected population sizes of these species at this location with which to make a quantitative viability ranking

Current Condition – Fair to Poor: NY Natural Heritage Program (Howard 2006) has ranked the condition for both the sand-cherry and dune willow as Fair to Poor. The sand-cherry population was estimated at 500 stems in five groups that were widely distributed within an active residential development. The population of dune willow is located at the edge of the marsh amongst *Phragmites* and purple loosestrife (*Lythrum salicaria*) along the base of a degraded dune.

Indicator – Dominance by Invasive Species: Table 4 provides guidance for ranking the abundance of invasive species based upon their relative cover or frequencies.

Current Condition -Unranked: No information is available on the distribution and abundance of invasive species in this dune complex. Potential for invasives is high given the degree of development and public use of the area.

2.2.4 Salmon River Freshwater Estuary and Dunes
Viability Summary

Notes on Guidance for Current Condition:

"NG"	No guidance was obtained to rank this indicator
"SGR"	Subjective guidance and/or ranking based on professional opinion
"ND"	No data are available with which to rank this indicator

Estuary	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. - Estuary area (acre)					Good	SG; ranking based on current area
KEA-Condition -Estuary Plant Community						
Ind. - Total macrophyte cover					Good	SGR; Harman et al. (2000)
Ind. - Invasive plant frequency (% of plots)	0	<5	5-25	>25	Fair	Drake et al. (2003)
Ind. - Invasive plant cover (avg % cover)	0	<5	5-25	>25	Good	Drake et al. (2003)
KEA - Condition - Fish Community						
Ind.- Fish species richness (# species in samples)					Good	SGR, local fisheries managers
Ind. – Index of Biotic Integrity		>38	33-37	<33	Good	Carlson et al. (2006)
Ind.- Invasive fish species relative densities (sea lamprey)	0	<5	5-25	>25	Good	Drake et al. (2003)
Ind.-Invasive fish species relative densities (common carp)					Good	
KEA-Condition-Rare & Endangered Species						
Ind. – No. black tern breeding pairs					Fair	SGR, Howard (2006)
Ind. - No. pied-billed grebe breeding pairs					Good-Fair	SGR, Howard (2006)
Ind. - No. least bittern breeding pairs					Good-Fair	SGR, Howard (2006)
Ind. – No .sedge wren breeding pairs					Unranked	ND
Ind. – No. lake sturgeon		Present		absent	Poor	SGR

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition-Hydrology						
Ind. - Lake Ontario surface water level variation (m)		74.0-75.5		74.5-75.0	Fair-Poor	ISOSLR (2006)
Ind. - Freq. Salmon River summertime baseflow <25 cfs		<40%		>40%	Good	FERC license agreement (1996)
Ind. – groundwater discharge					Unranked	NG, ND
KEA-Condition-Water Quality						
Ind. - % of 100-ft buffer in natural cover types		>90	75-90	<75	Fair	SGR, Klapproth & Johnson (2000), Baird & Wetmore (2006)
Ind. - total dissolved phosphorus concentration (mg/L)		<0.05		>0.05	Good	Mueller and Helsel (1996); SGR, Harman et al (2000)
Ind. - Carlson Trophic Status (unitless)		<50		>50	Unranked	US EPA (2007); ND
Ind. - summertime water temperature (°F)		68-80		>82	Good	Michigan DNR (2007)
Ind. – sediment load / turbidity					Unranked	NG, ND
KEA-Condition-Pathogens						
Ind.– Type E Botulism occurrence (% of population w/ symptoms)		0	1-5	>5	Fair	SGR, local fisheries managers
Ind. – Bacterial Kidney Disease occurrence		0	1-5	>5	Fair	SGR, local fisheries managers
Ind. – Furnunculosis occurrence		0	1-5	>5	Good	SGR, local fisheries managers
Ind. – Infectious Pancreatic Necrosis occurrence		0	1-5	>5	Good	SGR, local fisheries managers
Ind. – Yersinia ruckeri occurrence		0	1-5	>5	Fair	SGR, local fisheries managers
Ind. – Viral Haemorrhagic Septicaemia occurrence		0	1-5	>5	Good	SGR, local fisheries managers

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition-Toxins						
Ind.– Game fish mercury concentration (ppm)		0	0-1	>1	Fair	NY State Dept. Health (2006)
Ind.– Game fish PCB concentration (ppm)					Poor	NY State Dept. Health (2006)
Ind.– Snapping turtle egg PCB concentration (ppm)		0	0-2	>2	Fair	SGR; Pagano et al. (1999)
Ind.- Game fish Mirex concentrations (ppm)					Poor	NY State Dept. Health (2006)
Ind.- PCB-induced mink jaw lesions (ppb)		0	<40	>40	Poor	Haynes et al. (2007)
Ind.- Snapping turtle egg Mirex concentrations (ppm)		0	0-0.2	>0.2	Fair	SGR; Pagano et al. (1999)
KEA-Landscape Context						
Ind. - Natural land cover of local watershed (%)		>90	90-75	<75	Fair-Poor	SGR
Ind. – Natural land cover in 540-ft buffer (%)		>90	90-75	<75	Poor	SGR
Ind. – Amount of 540-ft freshwater estuary buffer isolated by roads (%)		<10	10-25	>25	Poor	SGR
Ind. – Natural vegetation in 100-ft buffers along local first order streams (%)		>90	90-75	<75	Poor	SGR

Dunes

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. - Dune area (acre)					~33-Good	SGR; based on current estimated area
KEA-Condition -Dune Plant Community						
Ind. - Total vegetation cover (%)		40-80		<30	Unranked	Bonanno (1992); ND
Ind. - Rare species cover (%)						
Champlain beach grass					Unranked	NG; ND
Low sand-cherry					Fair-Poor	SGR, Howard (2006)
Sand dune willow					Fair-Poor	SGR, Howard (2006)
Ind. - Invasive plant frequency (% of plots)	0	<5	5-25	>25	Unranked	Drake et al. (2003); ND
Ind. - Invasive plant cover (avg % cover)	0	<5	5-25	>25	Unranked	Drake et al. 2003; ND

2.3 Main Branch Salmon River & Major Tributaries

2.3.1 Main Salmon River & Major Tributaries Target Definition

The main branch/major tributaries target reflects the definition of "confined rivers" (*sensu* Edinger et al. 2002). These waters represent fast flowing sections of relatively large streams having moderate to gentle gradients. These streams are characterized by well-defined segments of riffles, pools and runs that occur within confined valleys. Stream velocity is great enough to cause lateral erosion, thereby creating braids, bars and channel islands; and to create coarse-rocky to sandy substrates. Biotic energy is typically generated within the streams. Confined rivers have high water clarity and are well oxygenated.

Howard (2006) generated an element distribution model for confined rivers within the Salmon River watershed, and this model roughly matches the occurrence of 3rd-order and higher streams (mapped at 1:100,000 scale). For simplicity, this target has been mapped as 3rd-order and higher streams (Figure 11) to distinguish it from the headwaters target (1st- and 2nd-order streams).

The Salmon River Falls represents a natural migration barrier within this drainage system. Currently the hydroelectric dam at the Light House Hill Reservoir (just below the falls) functions as the first barrier to migration upstream of the freshwater estuary along the main branch of the Salmon River. Consequently the fish communities differ markedly above and below the Light House Hill Reservoir/Salmon River Falls reach. Furthermore, land uses within the watershed differ along a line roughly delineated by the Oswego Sandstone escarpment, at which the Salmon River Falls form. Agriculture and urban development are more prevalent west of the escarpment/falls, while more intact, primary and secondary forests exist east of and above the escarpment. Since there are natural differences in the biotic communities and prevailing land uses (and concomitant stresses to the biotic communities) above and below the Reservoir/Falls, the sub-watersheds within the drainage have been divided into "lower" and "upper" sub-watersheds (Table 1). Specifically, the "lower" sub-watersheds are Beaverdam Brook-Meadow Creek-Reservoir, Lower Salmon River-Main Stem, Orwell-Pekin and Trout Brook. The remaining eleven are the "upper" sub-watersheds. Several indicators presented in this and subsequent sections have received separate treatment for the upper and lower portions of the watershed.

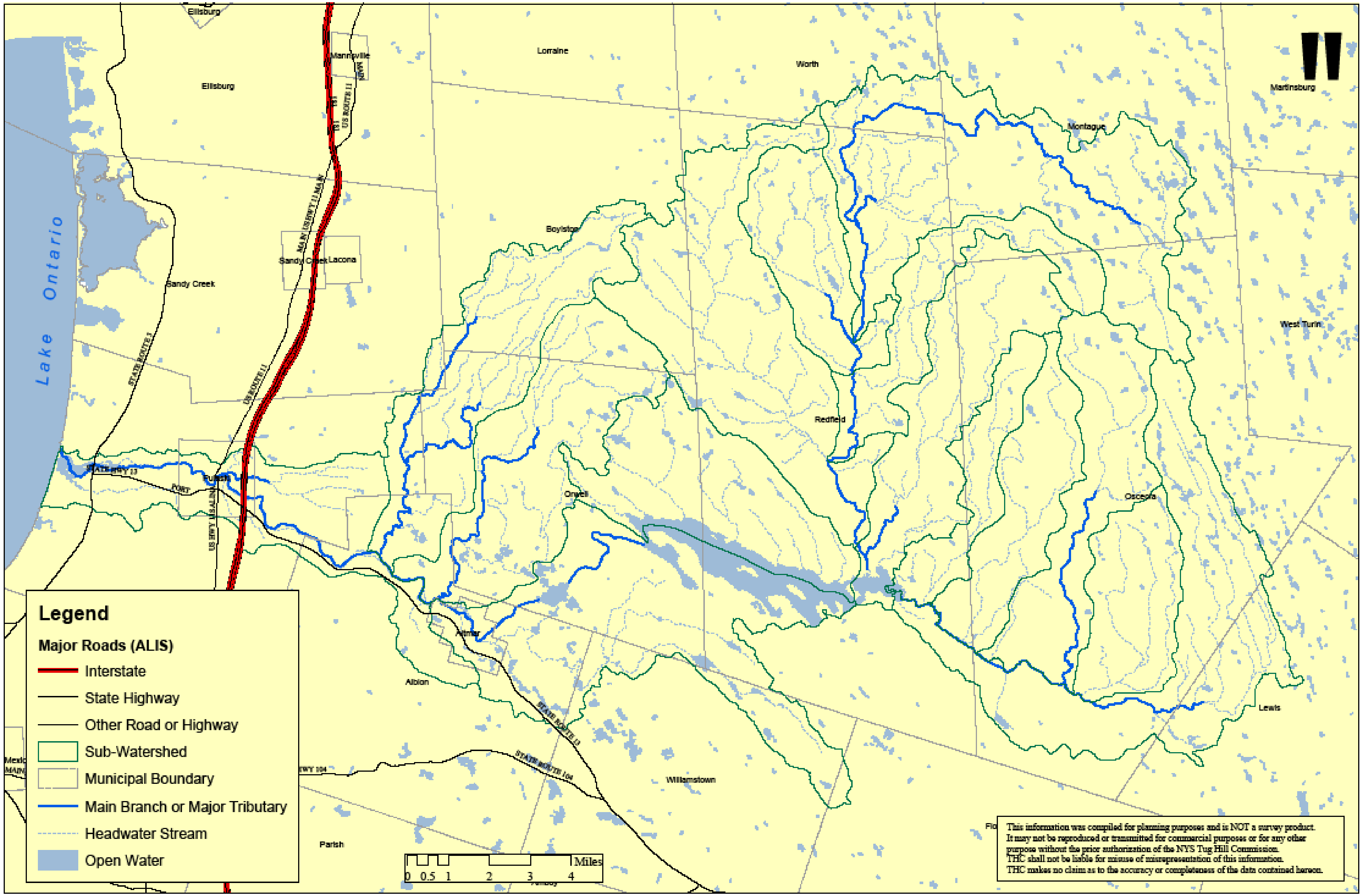


Figure 11. The Main Branch of the Salmon River and its major tributaries.

2.3.2. Main Branch / Major Tributaries Target Viability

2.3.2.1. KEA - AREA

The total area of in-stream habitat is a function of stream flow, and maintaining adequate baseflow during dry summer conditions provides greater within-channel habitat for aquatic organisms. As flow decreases, elevated areas of the channel will dry up, forcing fish and other aquatic organisms to move to remaining available submerged habitat.

The Tug Hill Aquifer (Figure 4) is a potentially important factor regulating summertime baseflow in the Trout Brook, Orwell-Pekin, and Lower Salmon River –Main Stem sub-watersheds. This aquifer is one of the largest and most productive groundwater reserves in New York. Although the aquifer is known to recharge cool, mineral enriched water to spring-fed headwaters and stream channels during baseflow periods in late summer (Miller et al. 1989), the extent to which it controls surface water flow and quality is not known. This water source is potentially very important to maintaining summertime flows in the Trout Brook and Orwell-Pekin sub-watersheds since the baseflows of these two largest tributaries in the lower watershed are not regulated by the Lighthouse Hill Reservoir.

Indicator – Volume Flow (cubic feet per second – cfs): Water flow in the lower reaches of the Salmon River is regulated by the Federal Energy Regulatory Commission (FERC) in accordance with the Salmon River Hydroelectric Project licensing agreement (FERC 1996). This license requires that continuous baseflow be maintained from the reservoirs under the following schedule:

January 1 – April 30	285 cfs
May 1 through August 31	185 cfs
September 1 through December 31	335 cfs.

<u>Current Condition - Good</u>: The flow schedule outlined in the FERC licensing agreement represents a compromise among several interests, and appears to provide adequate baseflow to maintain critical habitat in the Salmon River at different times of the year (Figure 12). The volumes were intended to maintain sufficient cover during dry summer months, provide necessary flow to sustain salmon spawning runs in the autumn and to cover and protect eggs during the winter. Under average historic flow levels, the Salmon River would experience summertime flows less <200 cfs approximately 50% of the time, and flows <25 cfs 40% of the time (Figure 9). With current regulation, summer flows do not drop below 185 cfs. The average baseflow in the regulated lower Salmon River is greater than in Sandy Creek, which can experience very low flow during the summer (Hallock 2003). No information is available to assess baseflow levels in the major tributaries of the lower watershed. It is believed that flow within streams of the upper subwatersheds do not vary from natural regimes.

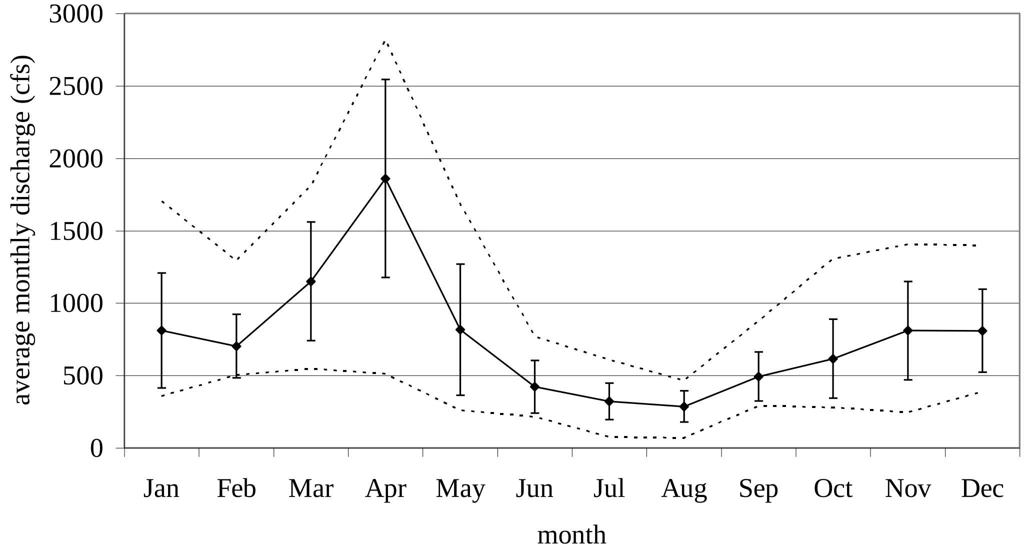


Figure 12. Average (1 std dev), maximum and minimum monthly discharges of the Salmon River at USGS Pineville station for the period December 1992 to September 2005. (Source: http://cfpub.epa.gov/surf/huc.cfm?huc_code=04140102.)

2.3.2.2 KEA: CONDITION - Water Quality

A number of indicators reflect the ecologically important physical and chemical conditions of the river. The river, along with its tributaries Trout Brook, Orwell Brook and Beaverdam Brook, and with the exception of the freshwater estuary, is classified by NYSDEC as Class C(t) -- a designation for fishing, recreational use, and fish propagation and survival (FERC 1996).

Indicator - Percent Natural Cover in 100-ft Wide Stream Reach Buffer: Vegetated buffers along waterways are important for maintaining several aspects of water quality and habitat viability. Vegetation sequesters nutrients; stabilizes soils, thereby reducing erosion; delivers organic material to be used as aquatic energy sources; and provides shade to moderate water temperatures. Available guidance suggests that 100-ft-wide vegetated buffers are typically effective at maintaining water quality and shading stream environments (Klapproth and Johnson 2000, Baird and Wetmore 2006).

Criteria used for ranking current condition of the watershed with regard to natural land cover-types within 100 ft-wide buffers are provided in Table 6.

Current Condition: Upper watershed, Good; Lower watershed, Fair: A stream buffer analysis was conducted by constructing 100-ft wide buffers along each edge of mapped stream segments (mapped at 1:100,000 scale) to calculate the percent unnatural cover (developed, roads, crops and hayfield, barren) occurring within the buffers. The analysis was conducted by stream reach (between mapped stream confluences) and presented by cover classes defined in Table 6. This analysis (Figure 13) reveals that the vast majority of stream reaches within the watershed are well-buffered by natural vegetation. No stream reaches in the watershed were ranked as "poor" with regard to natural vegetation in the 100-ft buffer. All streams within the upper sub-watersheds achieved "good" rankings (>90% natural cover). Four stream reaches, all occurring in the lower sub-watersheds (Beaver Dam Brook-Meadow Creek-Reservoir, Lower Salmon River-Main Stem, Trout Brook, Orwell-Pekin) were ranked as "fair" (75-90% natural cover).

Indicator – Embeddedness: Embeddedness describes the degree to which fine sediments surround coarse substrates in a streambed. This measurement has been used to assess fish spawning and macroinvertebrate habitat. Increased embeddedness is caused by excessive levels of siltation, and therefore it is often used as a measure of water quality. Embeddedness is a widely used substrate measurement, but its applicability is limited by the non-standardized methods applied to quantify it, and by the lack of published guidance for applying it (Sylte and Fischenich 2002).

No available guidance was obtained with which to rank this indicator. Few measurements have been made of this parameter within the watershed; these are provided for reference.

<u>Current Condition – Unranked:</u> Bode et al. (1997) reported 32 ± 11 (average ± 1 SD) embeddedness values for the main branch of the Salmon River above the freshwater estuary.

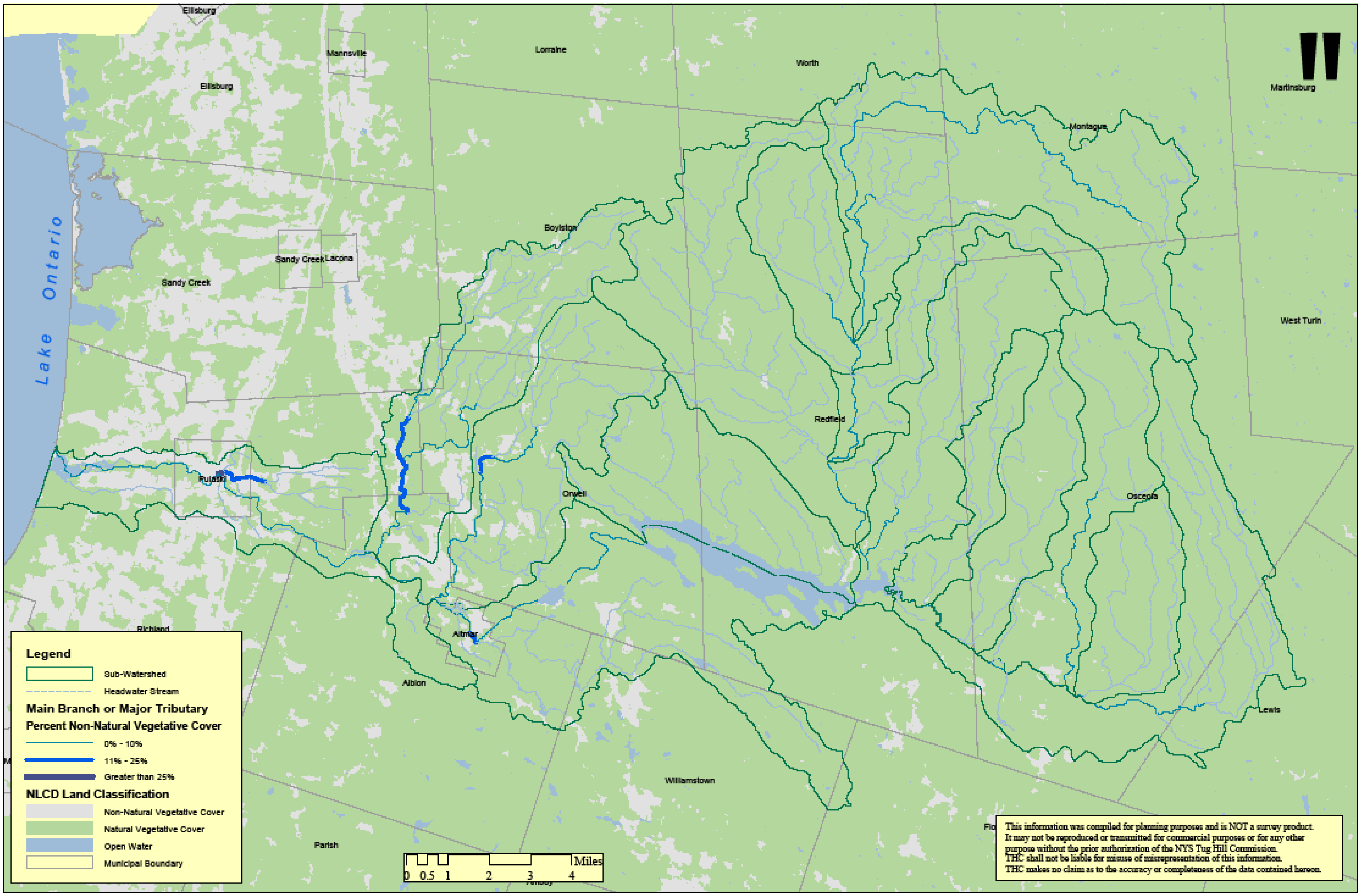


Figure 13. Analysis of land-cover types in 100-ft buffers of the Main Branch of Salmon River and its major tributaries. Data are from the National Land Cover Database (2001).

Indicator - Summertime High Temperatures: Temperature is an important regulator of partial pressure (solubility) of gases, particularly oxygen, in water. Colder water can hold higher concentrations of dissolved oxygen than warmer water. Maximum temperature thresholds, at which many aquatic organisms begin to experience adverse physiological effects, must account for both temperature and duration. Increased temperatures also are known to predispose fish to effects of various pathogens (A. Noyes, NYSDEC Pathologist, personal communication). Many salmonines are intolerant of temperatures greater than 70°F (21°C).

Due to lack of complete canopy cover, mid-reach streams such as the Salmon River and its major tributaries naturally experience diurnal fluctuations in temperature – warming by day and cooling by night – especially during the summer months. Temperature is influenced by a number of factors that act cumulatively at any particular location; these include:

- water flow and depth: the amount of water flowing over solid substrate reduces warming of that substrate;
- riparian cover: shade provided by overhanging trees and shrubs reduces warming;
- groundwater input: groundwater recharge through springs helps to maintain low temperatures of surface waters;
- discharge from impoundments: standing water in the reservoirs will heat up during the summer. Shallow water in lakes (epiplimnion) heats faster than deep water (hypolimnion). The depth from which water is discharged from impoundments, therefore influences downstream water temperature. Water released from the dams on the Salmon River is drawn from upper layers of the reservoirs, resulting in higher water temperatures below the dams than above them.

<u>Current Condition – Lower sub-watersheds, Good/Fair; Upper sub-watersheds, Good:</u> Several studies have reported temperatures at various locations within the Salmon River main stem and its major tributaries over a variety of time frames. These studies are summarized in Table 12.

Table 12. Summary of summertime water temperatures in the Salmon River watershed. Values (°F) are averages and maxima (in parentheses).

		------------------Location----------------			
Source	Sample period	Lower Salmon	E Branch Salmon	N Branch Salmon	Mad River
Hallock 2003	Summer 2000	68 (79)	59 (68)		
Bode et al. 1996	August 1996	70 (72)			
NYSDEC unpublished	Repeated July/ August samples			61(65)	67(75)
Everitt 2006	July 2005	68 (71)			

Summer temperatures are generally cooler in the upper reaches of the Salmon River compared to the lower Salmon River. In all years for which data were obtained, summertime temperatures in the lower Salmon River surpassed tolerance thresholds for salmonids (70 °F) for at least one day. No information is available to describe the duration of time for which temperatures surpass tolerance thresholds.

A GAP analysis was performed for this study (J. McKenna, unpublished data) to predict mid-summer water temperature within respective reaches of the watershed. This analysis (Figure 14) reveals that most of the higher-order stream reaches in the watershed are predicted to reach 70-73 °F, even in upper sub-watersheds. Lower order streams are predicted to be generally cooler in upper sub-watersheds, compared to lower sub-watersheds (particularly the Trout Brook and Orwell-Pekin sub-watersheds).

No data were obtained to assess the degree to which groundwater discharge moderates temperatures within the watershed.

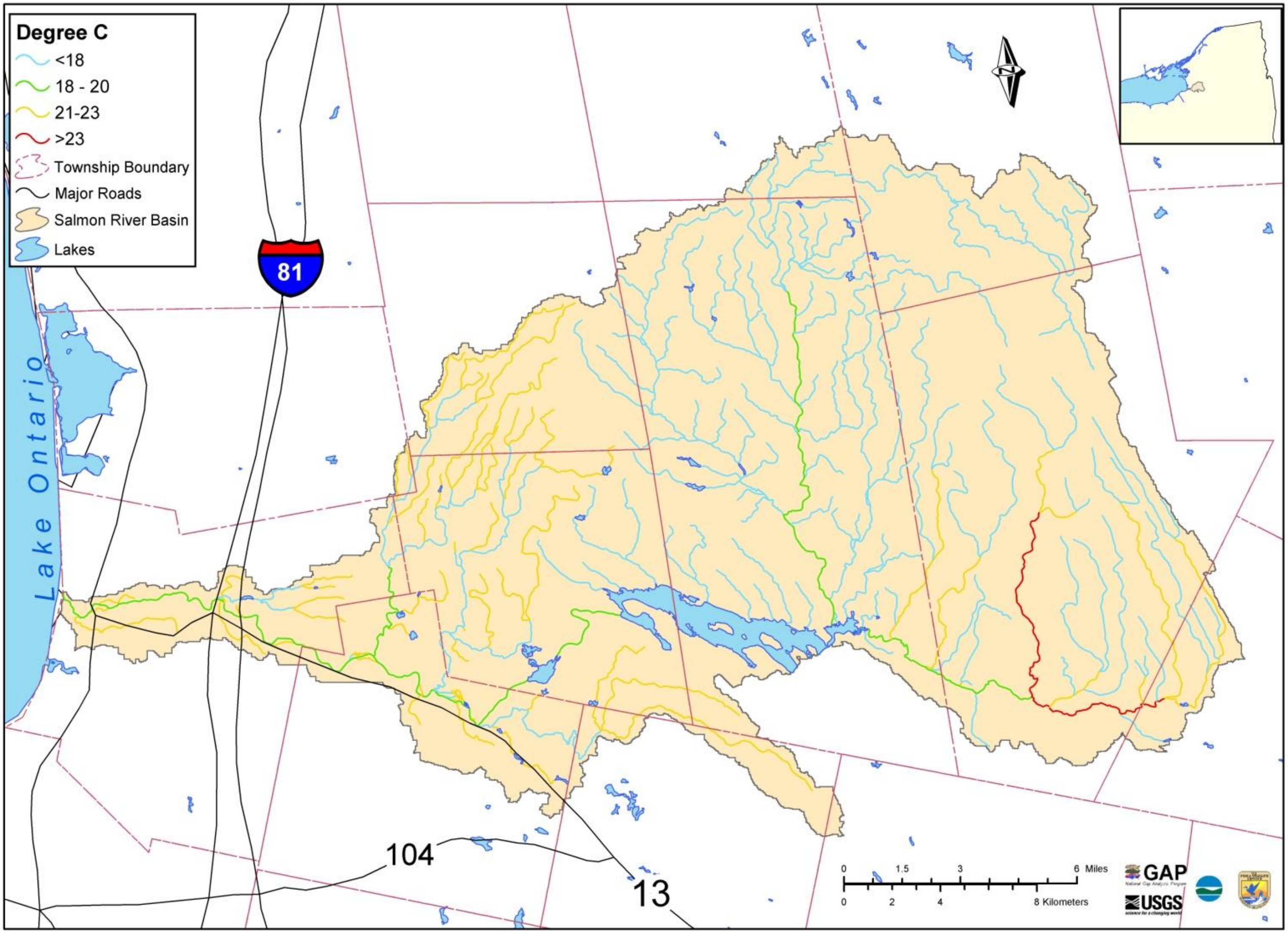


Figure 14. Predicted summer temperatures for the Salmon River watershed (J. McKenna, unpublished).

Indicator: pH: Acidity is a measure of hydrogen ion (H^+) concentration of a solution, and is frequently reported on the pH scale. The higher the concentration of H^+, the more "acidic" a solution is said to be (corresponding to low pH values). Hydrogen ions are chemically active and are readily exchanged from soils and sediments with other positively charged ions (cations) such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+), sodium (Na^+) and other naturally occurring metals. Acidified waters typically impact aquatic biota by increasing the solubility of aluminum (Al^{n+}) to toxic levels. Surface waters with pH <6.0 or having Al^{n+} concentrations > 2 μmol/L place aquatic biota at risk (Driscoll et al. 2001). In the absence of continuous monitoring, measuring pH and Al^{n+} during spring high flows and summer base flows provide information on the potential range of conditions. Acidification events are most likely during spring snowmelt when water has limited time to be buffered by soils and bedrock.

Table 13 presents viability rankings for surface water pH.

Current Condition – Good: Faigenbaum (1940) reported pH of the Salmon River at Pulaski in June 1939 was 8.6. Hallock (2003) provides the most comprehensive, seasonal reporting of pH in high order streams throughout the watershed. Springtime pH values ranged from 6-7 in 2000, while under summer baseflow conditions, pH values ranged from 7-8 (Figure 15). Summertime pH values reported by NYSDEC (unpublished) and Bode et al. (1997) are consistent with those of Hallock. Average pH of the river from 1989-1990 was 7.1 (Kozuchowski et al. 1994). NYSDEC Division of Water indicates no water bodies in the Salmon River drainage are impaired by acidification (NYSDEC 2006c).

Indicator – Total Alkalinity: Alkalinity refers to the ability of water to neutralize acids or resist changes in pH, and is a measure of the concentrations of three ions (carbonates (CO_3), bicarbonates (HCO_3), and hydroxides (OH)) expressed as mg/L $CaCO_3$.

Table 13 presents viability rankings for alkalinity, based upon susceptibility of waters of given alkalinity to further acidification.

Current Condition - Good: Hallock (2003) provides seasonal variation in total alkalinity for the high-order streams in the watershed. In early March, 2000, alkalinity measures were <60 mg/L for all sampled river segments (Figure 15). Alkalinity increased during summer baseflow periods that year. Orwell and Trout Brooks attained alkalinity values >100 mg/L. Summertime values of total alkalinity for the Mad River and N. Branch Salmon River were 67 and 61 mg/L (averaged over 1-3 years of sampling; source - R. Klindt), which are consistent with Hallock.

Table 13. Criteria for ranking surface water quality for total alkalinity (mg/L $CaCO_3$) and pH (Driscoll et al. 2001; Stoddard et al. 2003; Schreiber 2007). Indicator rankings for this assessment are indicated above the data columns. Summaries of critical pH thresholds for various aquatic organisms are provided in the second part of the table.

	Poor	Fair	Good	Excellent
Alkalinity	<0	0-2.5	2.5-100	>100
pH	<5	5.0-6.5	6.5-8.5	6.5-8.5
	Acidified	Sensitive	Not Sensitive	Well Buffered

Critical minimum pH tolerance thresholds for some common aquatic organisms (USEPA 2007b; Driscoll et al. 2003a).

snails	6.0
stoneflies, mayflies, crayfish, minnows, dace	5.5
trout, walleye, bass, salamanders	5.0
perch	4.5
frogs	4.0

Indicator: Dissolved Oxygen (mg/L): Cold water fish such as trout and salmon generally require dissolved oxygen concentrations > 6 mg/L (Kozuchowski et al 1994).

Current Condition - Good: Hallock (2003) reported that dissolved oxygen concentrations in the Salmon River and its major tributaries never dropped below 8 mg/L during spring peak or summer baseflow periods in 2000 (Figure 15). Bode et al. (1997) reported dissolved oxygen concentrations ranging from 7.7-9.2 mg/L in August 1996. Kozuchowski et al. (1994) reported DO concentrations at River Mile 6 (County Rt. 2A) on the Salmon River ranged between 8 and 14 mg/L in 1989-1990, with the exception of one date (5/22/90) when DO dropped to 0 mg/L. That study suggested that DO levels at Pulaski appear to have improved since 1939 (7.7 mg/L, Faigenbaum 1940).

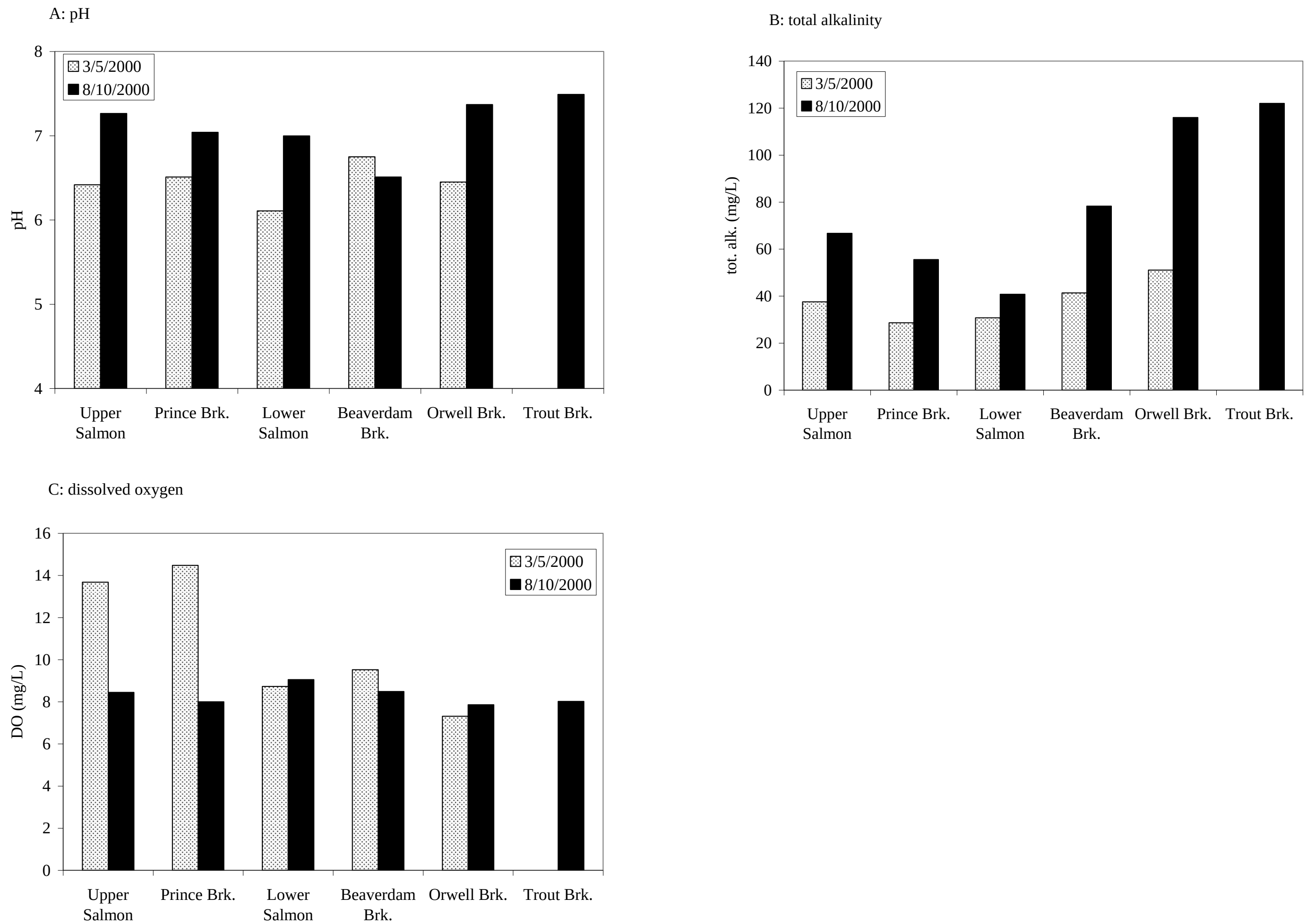
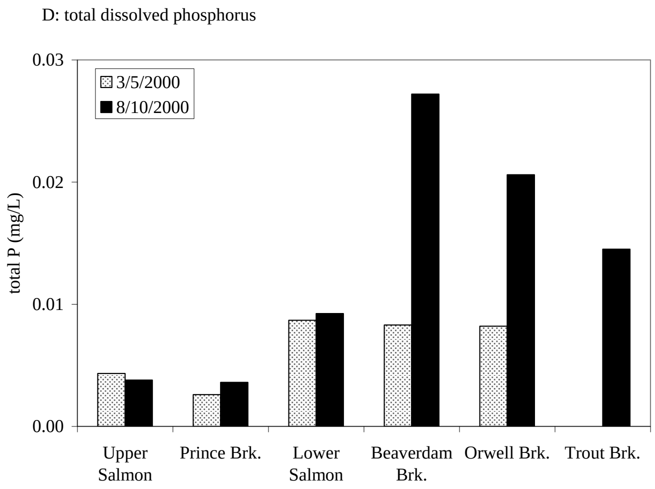


Figure 15. Water chemistry summaries for the Main Branch of the Salmon River and select major tributaries. Data are A- pH; B-Total Alkalinity; C-Dissolved Oxygen. Source: Hallock 2003.



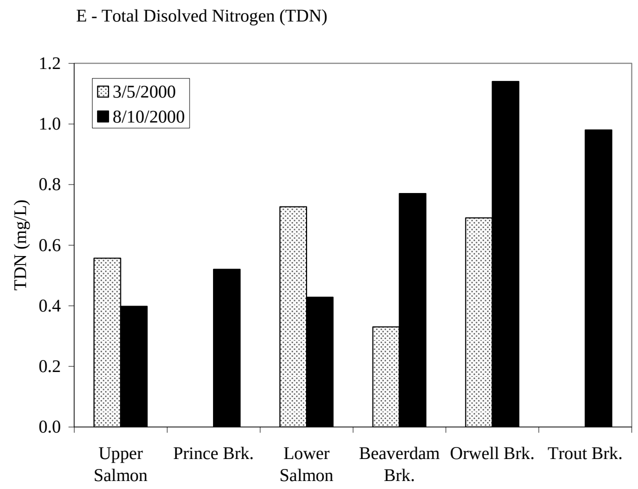


Figure 15, continued. D- Phosphorus; E-Total Dissolved Nitrogen

Indicator: Phosphorus Concentration: Phosphorus is a naturally occurring mineral nutrient that is frequently the single-most important limiting resource for biological productivity in freshwater systems. It naturally occurs in freshwaters in low concentrations (< 0.01 mg/L) owing to its low solubility. High P concentrations in water bodies are normally due to human activities (septic waste disposal, agricultural waste and fertilizer runoff), and typically result in high rates of productivity by algae and plants (eutrophication). The benthic (bottom) zones of eutrophic water bodies often become depleted in oxygen when large amounts of organic matter accumulate and undergo bacterial decomposition. Oxygen depletion, in turn, results in mortality of fish and other aquatic invertebrates.

No national standards have been set for phosphorus compounds in surface waters, but the USEPA has issued guidelines suggesting that to reduce eutrophication, total phosphates in streams not discharging directly to lakes or reservoirs should be less than 0.10 mg/L (Mueller and Helsel 1996).

Current Condition – Upper sub-watersheds, Good; lower sub-watersheds, Fair: Hallock (2003) reported seasonal variation in total dissolved phosphorus for the high-order streams in the watershed (Figure 15). Segments of the upper watershed and the Main Branch of the lower watershed consistently have low P concentrations (<0.01 mg/L). Summertime P concentrations in Orwell and Trout Brooks are elevated, but not above the USEPA guideline of 0.1 mg/L.

Indicator – Nitrogen Concentrations: Nitrogen (N) is a naturally-occurring, essential, nutrient, but it is naturally available in low supplies. Human activities such as the use of nitrogen fertilizers and burning of fossil fuels have increased the availability of N in terrestrial and aquatic systems. Nitrogen loads in excess of natural levels have been shown to alter aquatic and terrestrial plant communities and reduce biodiversity. When N exceeds biological demands of terrestrial organisms, it is usually leached from the soil in the soluble form of nitrate (NO_3^-) (Vitousek et al. 1997). In unpolluted forested landscapes, total dissolved N (TDN) in streams is usually less than 0.35 mg/L, while TDN may frequently reach 0.7-2.1 mg/L in streams draining agricultural landscapes. In extremely high concentrations (>10 mg/L), nitrogen, as NO_3^-, can have adverse human health effects (Driscoll et al. 2003).

Current Condition - Fair: Hallock (2003) provides seasonal variation in total dissolved nitrogen (TDN) for high-order streams in the watershed for 2000 (Figure 15). Stream water N concentrations in upper sub-watersheds and in the lower Main Branch of the Salmon River exhibit a seasonal effect for TDN (higher concentrations in spring) that probably reflects pollution inputs with the melting snowpack, and concentrations remain above the anticipated levels for unpolluted forest landscapes. The lower sub-watersheds (Beaverdam, Orwell-Pekin and Trout Brooks) exhibit higher TDN concentrations during summer baseflow than during spring snowmelt. Agriculture may be the source of N in these subwatersheds. Even still, N concentrations remain well below USEPA drinking water standards.

2.3.2.3 KEA – CONDITION – Macroinvertebrate Communities

Macroinvertebrates are important components of stream ecosystems. Many serve as primary consumers of plant (algal) and detrital biomass, and therefore serve as the lower links of aquatic food chains that eventually support predatory fish, birds and mammals. Macroinvertebrate communities can be used as monitors of water quality and overall ecosystem health. Some invertebrates are intolerant of water conditions having low oxygen concentration and high organic content – these indicators of good water quality include mayflies, stoneflies, caddisflies, and many water beetles. Other invertebrates are able to tolerate low oxygen concentrations, and/or feed on bacteria that grow on suspended organic matter (such as that associated with sewage and agricultural wastes). These indicators of poor water quality include various midges (fly larvae), bloodworms, aquatic earthworms, leeches, sowbugs, and some black fly larvae. Many species of mayflies, stoneflies and caddisflies are "shredders" that feed upon small particles of plant material suspended in the water column. Other species are filter feeders that consume single-celled algae. Large populations of such filter feeders can indicate eutrophic (excessive nutrient concentrations) conditions that support high levels of algal and plant production (Bode et al. 1997).

Indicators – Indices of Biotic Integrity: A combination of indices have been used in past efforts to assess biotic integrity and water quality of stream systems (e.g., Bode et al. 1997).

Richness is the total number of species (or discernible taxa) found in a sample. Richness is influenced by sample effort (the greater the sampling effort, the greater the likelihood of finding additional species) and therefore is typically standardized to number of species per 100-specimen collection. In New York, >26 species suggests non-impacted waters of excellent quality; 19-26, slightly impacted; 11-18, moderately impacted; and <11 species indicates severely impacted systems of poor water quality.

EPT Value is the percentage of individuals in a sample that are species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). These groups are considered indicators of high water quality. Expected ranges for streams in New York are: >10%, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and <2, severely impacted.

Hilsenhoff Biotic Index measures overall tolerance of an invertebrate sample for organic pollution and low oxygen concentration. It is a weighted average that is found by multiplying the number of individuals of each species by that species' tolerance rating (following Bode et al., 1996 for New York), summing the products, and dividing by the total number of individuals in the sample. Tolerance values range from 0 (intolerant) to 10 (tolerant). Biotic index values of 0-4.50 indicate non-impacted, high-quality water; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.0, severely impacted.

Percent Model Affinity measures the similarity of a sample to a model, non-impacted community made up of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta and 10% others (Novak and Bode 1992). If a sample community is >65% similar to this model composition, it is considered non-impacted; 50-64% similar, slightly impacted; 35-49% similar, moderately impacted; and <35% similar, severely impacted.

Current Condition - Good: Bode et al. (1997) reported that macroinvertebrate communities at all sites along a 25-mile reach of the Salmon River from below Pulaski to above the Redfield Reservoir were diverse and well-balanced (Figure 16). Two sites, directly below the Lighthouse Hill Reservoir, showed evidence of nutrient enrichment and it was believed this was an effect of the reservoir. However, invertebrate communities still indicated excellent water quality. Hallock (2003) also detected an effect of the reservoirs on the abundance and diversity of some functional groups of aquatic invertebrates, and suggested that the dams are inhibiting the movement of organic debris required by shredding organisms; and that high and maintained summer discharges may be removing some types of invertebrates from the substrate and flushing them through the system.

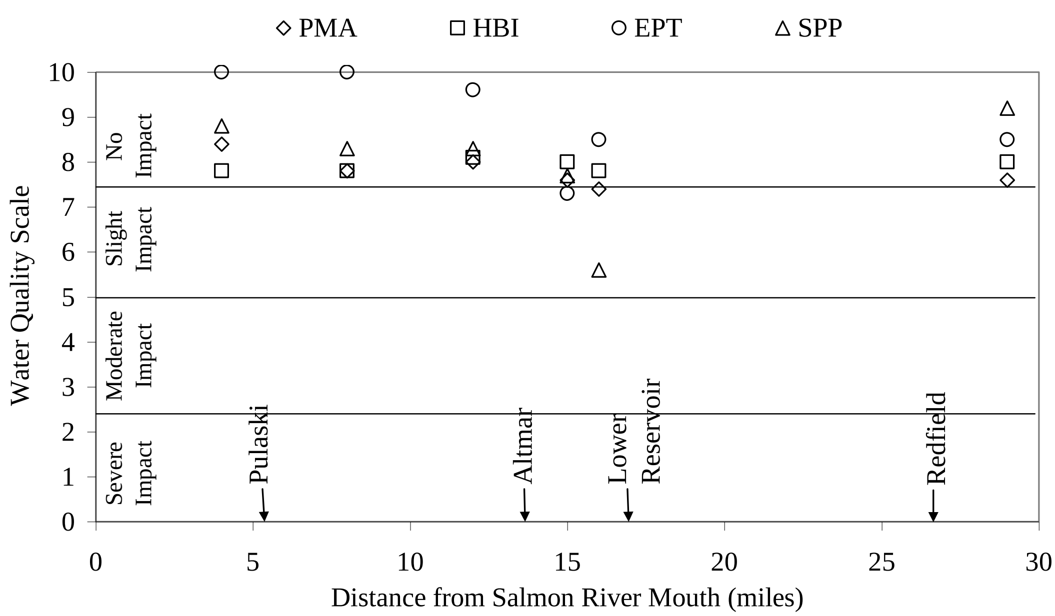


Figure 16. Profile of index values for Salmon River biotic assessment (Bode et al. 1997). Values for species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), and percent model affinity (PMA) have been normalized to a 0-10 scale.

2.3.2.4 KEA: CONDITION – Fish Communities

Historic Context

The Salmon River was purportedly among the most productive native salmon-producing tributaries to Lake Ontario prior to the late 19th century, but abuses occurring in both the lake and within the watershed greatly altered the fishery resource of the river prior to the 1900s. Lake Ontario originally supported two top predatory fish species; the Atlantic salmon (*Salmo salar*) and the lake trout (*Salvelinus namaycush*). A number of factors led to the collapse of these species' populations, including over-fishing, loss or alteration of spawning habitat within the tributaries (for migratory Atlantic salmon), and inhibition of spawning migrations by dam construction. For instance, on the Salmon River, the fishery showed a record of decline between 1810 and 1900, and especially following the 1837 construction of a dam just west of Pulaski (New York Conservation Department 1939). Another factor causing the decline of Atlantic salmon was the introduction of alewife (*Alosa pseudoharengus*) to Lake Ontario. Alewives are rich in the enzyme thiaminase, which breaks down thiamine; when Atlantic salmon feed on this species they experience thiamine deficiencies, which result in reproductive failure of developing embryos. The eventual loss of predatory fish in the Great Lakes led to an overpopulation of alewives and rainbow smelt (*Osmerus mordax*), and in order to reestablish predatory control in Lake Ontario, Pacific salmon (Chinook, *Oncorhynchus tshawytscha*; coho salmon, *Oncorhynchus kisutch*) were stocked in the late 1960s and early 1970s (see Coughlin 2004 and Everitt 2006 for reviews).

The Pacific salmonines have shown excellent growth and reproductive capacity in some tributaries of the Great Lakes, including the Salmon River. By the early 1980s, natural reproduction of Pacific salmonines was documented in the Salmon River system (Johnson 1978; Johnson and Ringler 1981), and within a decade this system was estimated to be the leading Lake Ontario tributary for naturally spawned salmon (Wildridge 1990).

Excellent juvenile habitat and barrier-free spawning routes within the Salmon River watershed would permit reintroduction of Atlantic salmon. Based on a recent analysis using introduced rainbow trout (*Oncorhynchus mykiss*), which has similar habitat requirements as Atlantic salmon, as a surrogate, abundant spawning and juvenile habitat exist for Atlantic Salmon within the watershed (McKenna and Johnson 2005). Furthermore, some experimental evidence indicates that Atlantic salmon are more competitive than rainbow trout under slightly warmer water temperatures (>20 °C), while rainbow trout are more competitive in slightly colder waters. Therefore, potential may exist for co-occurrence of these species within the watershed (Coughlin 2004). However, the continued presence of alewife within the Great Lakes system would likely continue to limit the ability of Atlantic salmon to establish a self-sustaining population.

Although NYSDEC frequently samples river sections within the watershed to obtain data on target game species, widespread sampling that yields accurate and complete descriptions of the watershed's fish assemblages (richness, abundance, spatial distributions) is lacking. Recently efforts have been made to predict habitat condition, along with accompanying fish community composition (McKenna et al. 2006) within the Great Lakes and their major tributaries. This methodology was tested on the Genesee River drainage (McKenna et al. 2006) and analyses were recently applied to the Salmon River for the purpose of this viability analysis (McKenna, unpublished data). The results of these analyses are presented below for illustration purposes. No guidance other than professional opinions of fisheries managers is currently available to interpret these results.

Indicator – Species Richness:

Current Condition – Unranked: Local fisheries managers and research scientists believe that species richness within the watershed is very good. However, no guidance is available with which to objectively rank this indicator for the watershed. Available data from several recent sampling efforts have been compiled in Table 14. Most of these samples are not exhaustive for determining species richness, and different methods were applied to different tributaries. Therefore, data are not readily comparable among the reaches described. These data are provided for baseline information. Forty-two species have been sampled from the lower reaches of the Salmon River. Available data account for only 8 and 12 species in Orwell and Trout Brooks, respectively. In the upper portions of the watershed, 20, 17 and 13 species have been sampled from the Mad River system, North Branch of the Salmon River, and upper Salmon River, respectively.

Modeled estimates of species richness are presented in Figure 17. This analysis predicts greatest species richness (>78 species in some reaches) in the lowest reaches of the Main Branch, with generally decreasing trends in richness toward the headwaters of the various sub-watersheds.

Table 14. Fish community data for the Salmon River and its major tributaries. Data are species' relative densities (percents of total sample catch) for respective river reaches. Methodology varied by reach (see notes) so data may not be directly comparable among reaches.

	Orwell Brook[1]	Trout Brook[1]	Lower Salmon River[3A]	Lower Salmon River[4B]	Lower Salmon River[6C]			N.Br. Mad River[2]	Mad River[2]	N.Br. Salmon River[2]	Upper Salmon River[5]	Upper Salmon River[2]
Sample date	9/97	9/97	6/93 10/93 11/93 9/96	7/90 8/99	spring	summer	autumn	8/99	7/97 8/93	7/92	6/95	7/95
Total fish in samples	794	661	1208	908	75	49	77	295	728	2845	76	406
bass, largemouth	0	0	0.83	0	0.26	0.80	0	0	0	0	0	0.25
bass, rock	0	0	4.97	2.97	1.02	0	1.29	0	0	0.56	0	1.23
bass, smallmouth	0.13	0.15	3.39	2.75	0.75	0	0.65	0	0	0	0	0
Bluegill	0	0	0	0	0.46	0	0.65	0	0	0	0	0
bullhead, brown	0	0	0	0.33	1.33	0	4.18	0	0	0.60	0	0
carp, common	0	0	0.58	0	0	0	0	0	0	0	0	0
chubsucker, creek	0	0	0	0	0.54	0	1.73	0	0	0	0	0
chubsucker sp.	0	0	0	0	0	0	0.42	0	0	0	0	0
chub, creek	0	0	0	0.55	0	0	0	13.90	10.30	13.60	2.63	0.49
dace, eastern blacknose	37.78	26.48	0	0.77	0.04	0	0	27.12	61.81	46.57	7.89	29.56
dace, longnose	0	1.06	0	8.59	0	0	0	5.08	5.49	2.39	5.26	13.55
dace, redside	0	0	0	0	0	0	0	20.34	6.87	0.53	0	0
darter, fantail	12.59	26.48	0	44.38	4.51	0	0	0	1.37	6.15	7.89	19.70
darter, rainbow	0	0	0	0	0	0	0	0	0	7.03	0	0
darter, tessellated	0	0	6.21	0.11	3.74	25.19	3.98	0	0	0.42	0	0
Fallfish	0	1.51	3.06	6.17	31.59	10.00	5.46	0	0	0	0	0
minnow sp.	0	0	0	0	0	0	1.82	0	0	0	0	0
minnow, bluntnose	0	0	41.39	2.20	3.62	0.80	10.52	0	0	0	0	0.49
minnow, cutlip	0	7.56	0.83	19.49	3.84	0	0.42	2.71	2.20	11.25	0	0
minnow, fathead	0	0	0	0	0	0	6.45	0	0	0	0	0

Table 14, continued

	Orwell Brook[1]	Trout Brook[1]	Lower Salmon River[3A]	Lower Salmon River[4B]	Lower Salmon River[6C] spring	summer	autumn	N.Br. Mad River[2]	Mad River[2]	N.Br. Salmon River[2]	Upper Salmon River[5]	Upper Salmon River[2]
mudminnow, central	0	0	0	0	0.38	0	5.77	0	0	0	0	0
perch, log	0	0	0	0.22	0	0	0.29	0	0	0	0	0
perch, yellow	0	0	9.52	0	0.42	0	7.33	0	0	0	0	0
pickerel, chain	0	0	0	0	2.25	0	2.20	0	0	0	0	0
pike, northern	0	0	2.32	0	0	0	0	0	0	0	0	0
pumpkinseed	0	0	0.83	0.22	2.81	0	0.60	1.02	0	0.14	0	0
redhorse, silver	0	0	5.38	0	0	0	0	0	0	0	0	0
salmon, Atlantic	0	0.30	0	1.65	0	0	0	0	0	0	0	0
salmon, chinook	0.13	6.05	0.25	3.52	0	22.76	7.94	0	0	0	0	0
salmon, coho	0.25	0.30	0.33	0.44	0	0	0.96	0	0	0	0	0
sculpin, mottled	0	0	0	0	0	0	0	0	0.14	0	0	30.79
sculpin, slimy	0	0	0	0	0	0	0	0	0	0.91	7.89	0
shiner, bridle	0	0	0	0	0	0	0	0	0	0.35	0	0
shiner, blacknose	0	0	0	0	0	0	0	8.47	0	0	0	0
shiner, common	0	0.91	0	0.77	18.62	26.38	13.41	20.34	4.12	6.75	0	0
shiner, golden	0	0	2.07	0	1.65	0	22.11	0	0	0	0	0
shiner, spottail	0	0	0	0	0	0	0	0	3.43	0	0	0
shiner, notropis sp.	0	0	0	0	0	1.60	0	0	0	0	0	0
stickleback, brook	0	0	0	0.11	0	0	0	0	0	0	0	0
Stonecat	0	0	0	0.55	0	0	0	0	0	0	0	0
Stoneroller, central	0	0	0	0.11	0	0	0	0	0	0	0	0
sucker, northern hog	0	0	0	2.53	0	0	0	0	0	0	0	0
sucker, hognose	0	0	2.15	0	1.02	11.67	0	0	0	0	0	0
sucker, white	0	0	4.14	0.66	4.40	0.80	1.41	0	0	1.97	0	2.46
sucker sp	0	0	0	0	0	0	0.42	0	0	0	0	0
sunfish	0	0	0	0	9.62	0	0	0	0	0	0	0
trout, brook	0.13	0	0	0	7.14	0	0	1.02	4.26	0.67	68.42	0

Table 14, continued

	Orwell Brook[1]	Trout Brook[1]	Lower Salmon River[3A]	Lower Salmon River[4B]	Lower Salmon River[6C] spring	Lower Salmon River[6C] summer	Lower Salmon River[6C] autumn	N.Br. Mad River[2]	Mad River[2]	N.Br. Salmon River[2]	Upper Salmon River[5]	Upper Salmon River[2]
trout, brown	0.50	0.76	1.41	0	0	0	0	0	0	0.11	0	0.49
trout, lake	0	0	0.41	0	0	0	0	0	0	0	0	0
trout, rainbow	48.49	28.44	9.93	0.88	0	0	0	0	0	0	0	0.99

Sample Methods: 1-NYDEC, Population estimate; 2-NYDEC, CROTS survey; 3-NYDEC, STMP collection; 4-NYDEC, other; 5-NYDEC, General Biological & CROTS; 6- J. McKenna sampled in repeated years over three seasons using a combination of large(1.5") and small seines (1/8").

Lower River Sample Reaches: A-immediately above Salmon River estuary; B above estuary to Lower Reservoir; C above estuary to Pineville

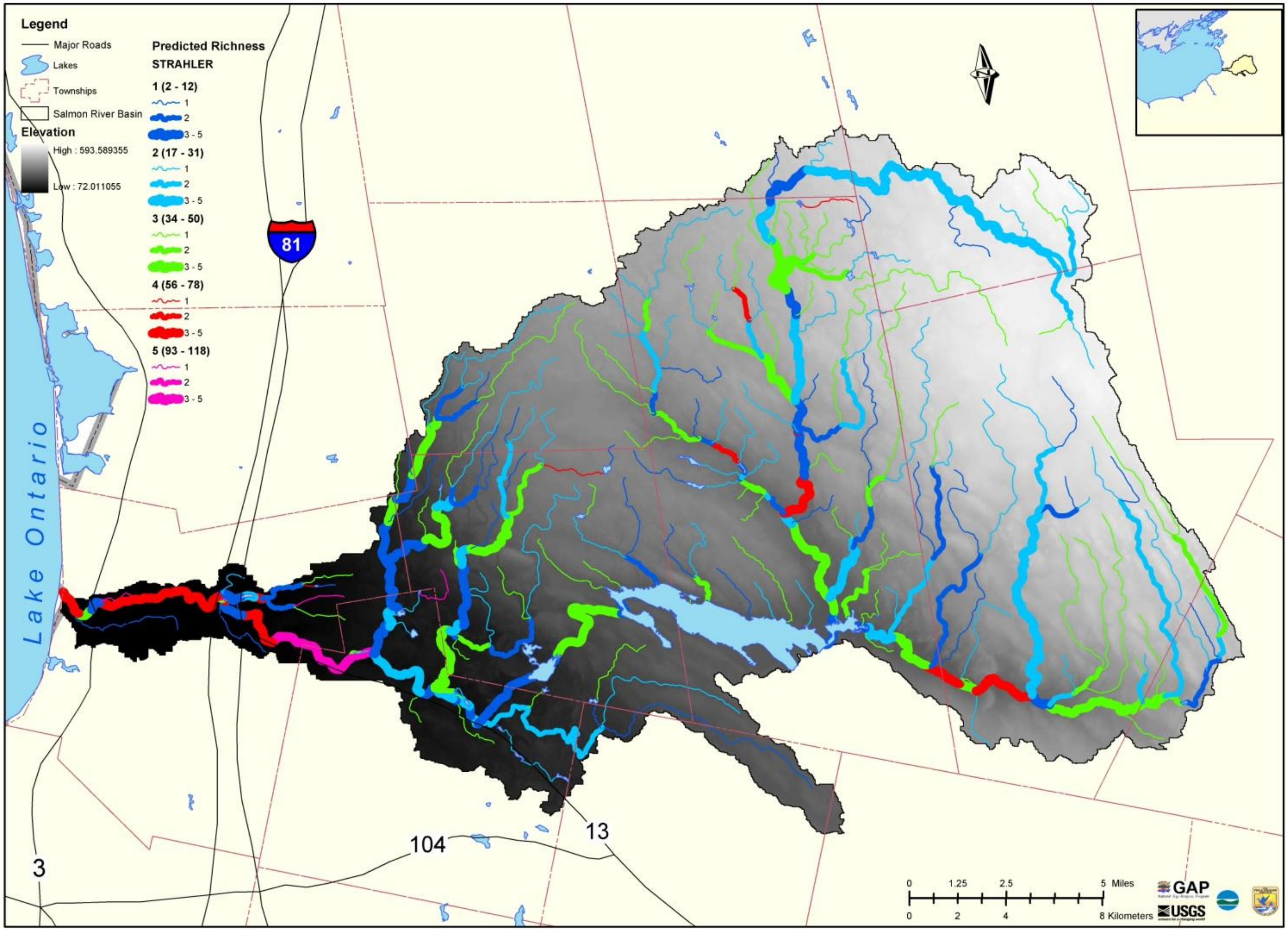


Figure 17. Predicted fish species richness in the Salmon River Watershed. Stream reaches are plotted by Strahler order: 1st and 2nd order streams are headwater streams (thin lines); 3rd-5th order streams are the Main Branch and major tributaries (thick lines). Richness (#species) categories are indicated by color (Source: J. McKenna).

Indicator – Fish Species Distributions:

Current Condition – Common Species – white sucker and blacknose dace: Several common species such as white suckers (*Catostomus commersonii*) and blacknose dace (*Rhinichthys atratulus*) are widely distributed across the watershed (Figures 18 and 19).

Current Condition – Uncommon Species – fantail darter and mottled sculpin: Cutlip minnow (*Exoglossum maxillingua*) and mottled sculpins (*Cottus bairdi*) are widely distributed, but occur in low densities across the watershed (Figure 20).

Current Condition – Exotic Species – common carp: Common carp (*Cyprinus carpio*) are native to Asia and their escape in North America has led to degradation of several water bodies. Carp have been observed in the lower watershed, and this GAP analysis reveals that suitable habitat exists throughout the watershed, although this model predicts densities would remain low if they are introduced or eventually migrate throughout the watershed (Figure 21).

Current Condition – Game Species – brown and brook trout: Brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) are two common game species that are both stocked and naturally reproducing within the watershed. Brown trout are an introduced species that have been widely stocked in North America, and which have similar habitat requirements as the native brook trout. However, brown trout can tolerate warmer temperatures and are therefore capable of inhabiting larger streams. In the presence of brown trout, brook trout tend to retreat to colder, headwater streams. The GAP analysis shows they are both common throughout the watershed, and that brown trout are generally predicted to occur in greater numbers, especially in the lower sub-watersheds (Figure 22).

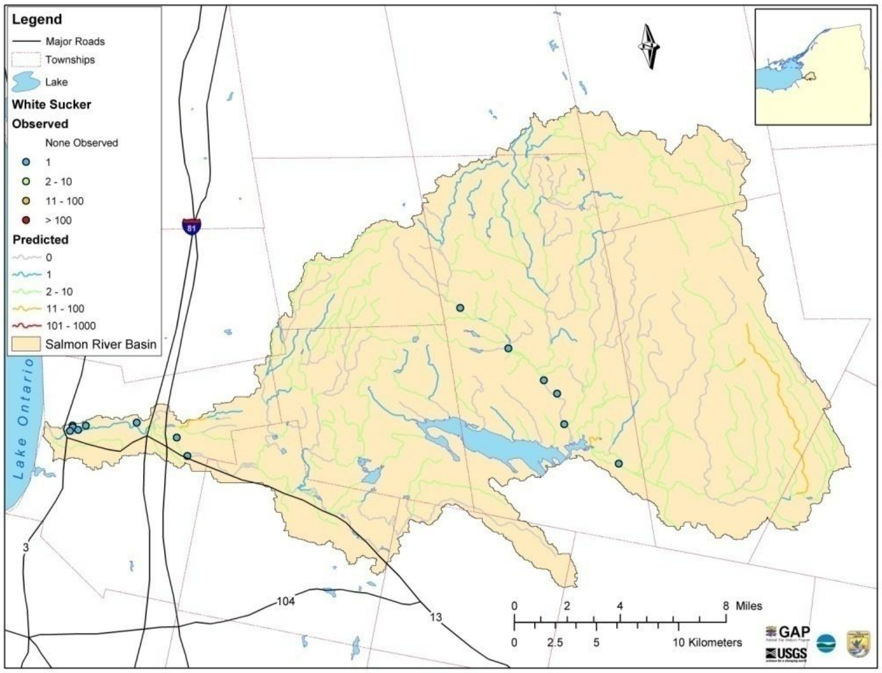


Figure 18. Observed and predicted distribution of white suckers, a common species in the Salmon River watershed.

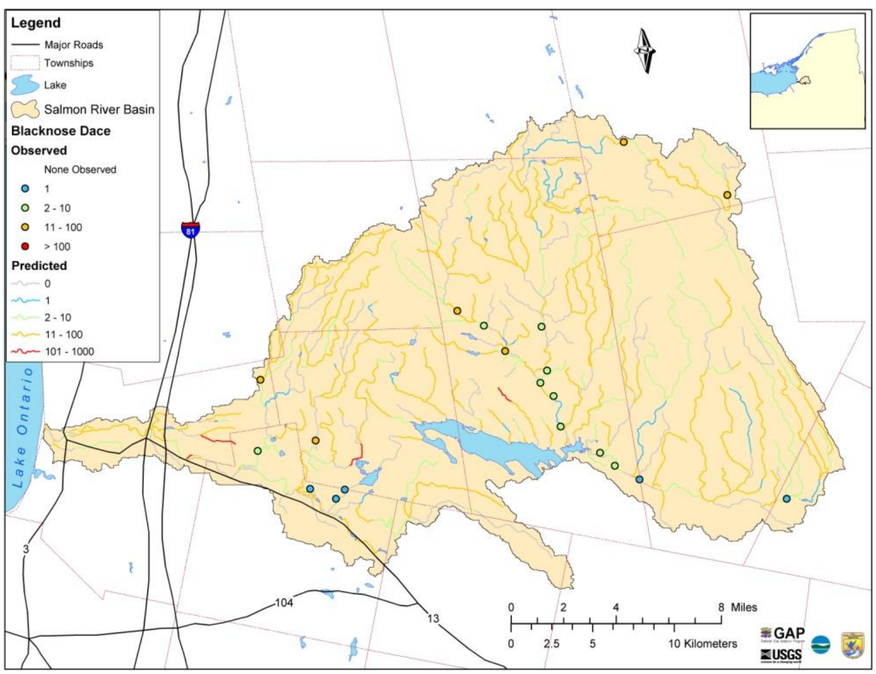


Figure 19. Observed and predicted distribution of blacknose dace, a common species in the Salmon River watershed.

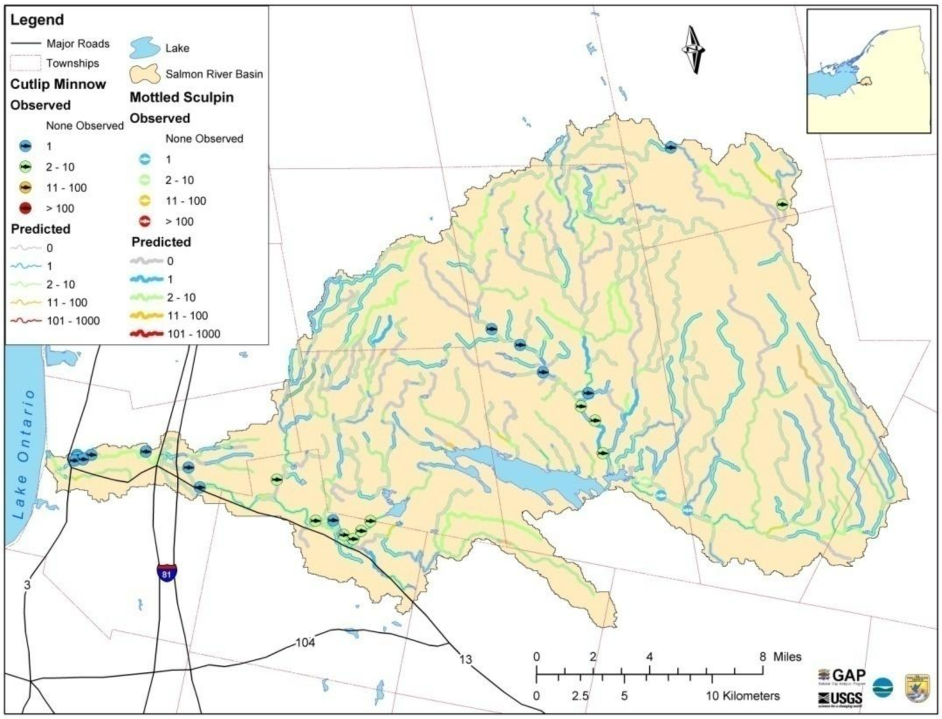


Figure 20. Observed and predicted distribution of cutlip minnow and mottled sculpin, two uncommon species in the Salmon River watershed.

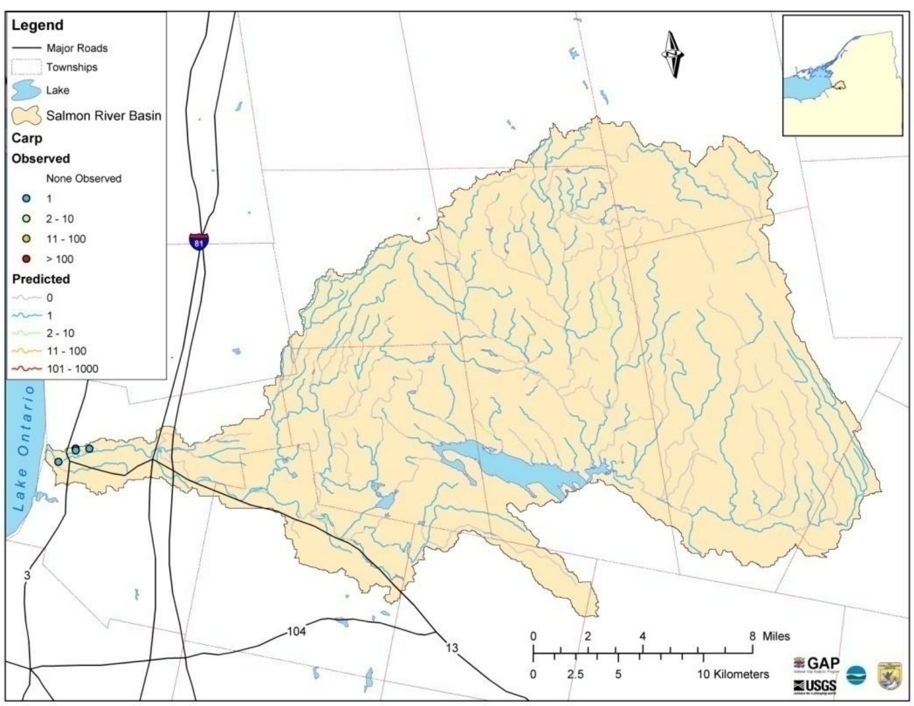


Figure 21. Observed and predicted distribution of common carp, an exotic species that occurs within the Salmon River watershed.

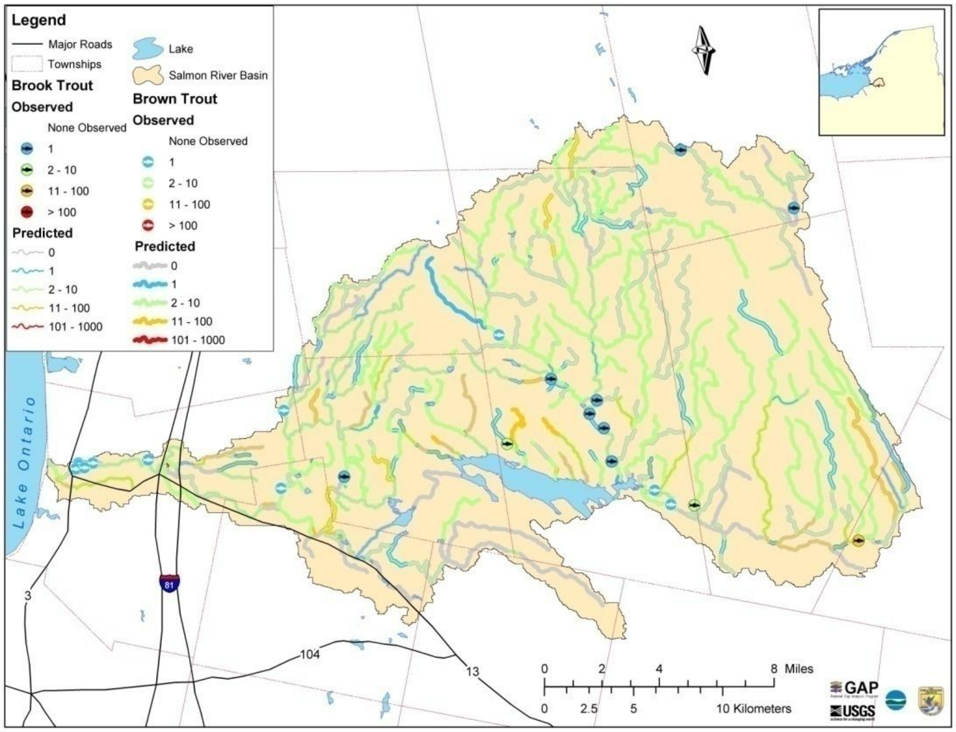


Figure 22. Observed and predicted distribution of brown trout and brook trout, two common game species of the Salmon River watershed.

Indicators of Natural Salmonine Reproduction: The level of natural salmonine production within the watershed is an integrative indicator of the number of returning adults from Lake Ontario that are available to reproduce, spawning habitat availability, and juvenile habitat and food availability. Information available for ranking these indicators in the watershed exists only for certain life history segments of Chinook salmon and rainbow trout.

Indicator – Salmonine Spawning Habitat (Proportion of Available Area): The capacity for the watershed (below the Lighthouse Hill dam) to sustain self-reproducing populations of salmonines is related, in part, to available spawning habitat along the stream beds during spawning. Chinook salmon have specific requirements for substrate size in which to create redds (nests), as well as for water depth and velocity during spawning.

<u>Current Condition - Good</u>: Everitt (2006) estimated approximately 1,900 and 2,900 redds within the lower Salmon River in 2004 and 2005. Of the total river area available (199 hectares), 15% had suitable combinations of spawning substrate, water depth and water velocity.

Indicator – Adult Escapement and Egg Production Estimate (#/yr): Adults contributing to the naturally reproducing population are those that able to survive spawning runs, and escape anglers and hatchery harvest operations.

<u>Current Condition - Good</u>: Everitt (2006) estimated the returning populations Chinook salmon into the Salmon River during 2004 and 2005 to be 48,300 and 61,900. Of these, approximately 24,400 (± 2,800, 95% CI) and 26,000 (± 3,900) were harvested by anglers in 2004 and 2005; and 10,100 and 8,100 were harvested at the hatchery in 2004 and 2005. Accounting for natural mortality during the run, an estimated 5,900 (± 2,900, 95% CI) and 11,100 (± 2,600) adults escaped the 2004 and 2005 runs and were available for natural spawning. Average egg production was approximately 5,300 and 5,000 eggs/individual female in 2004 and 2005. The total estimated number of eggs deposited by females was approximately 14.6 million (±7.1 million) in 2004 and 41.4 million (± 9.8 million) in 2005. Assuming that if only 1% of the fertilized eggs successfully yield a smolt that returns to the lake (414,000 in 2005 and 146,000 in 2004), this level of natural reproduction is comparable to that of the hatchery (~300,000).

Indicator – Salmonine Juvenile Recruitment: Estimations of juvenile recruitment have been made only for rainbow trout.

<u>Current Condition – Good:</u> Rainbow trout utilize mid-reach stream sections of the Orwell and Trout Brook systems for spawning. A recent study of natural reproduction in these streams, along with Sandy Creek, estimated 2,000-4,000 "year 0" rainbow trout per kilometer of stream, and 450-900 "yr 1+" per kilometer of stream (McKenna and Johnson 2005). Wildridge (1990) classified Orwell Brook, Trout Brook and Little Sandy Creek as the only excellent salmonine producing

streams in the Lake Ontario basin (31 total). Another study reported wide annual variation in relative abundance of naturally reproducing Chinook and coho salmon within Orwell and Trout Brooks, and Little Sandy Creek (Kennen et al. 1994).

2.3.2.5 KEA – CONDITION – Toxins

A number of environmental pollutants and toxins are capable of impairing ecological integrity of freshwaters. Toxins of current concern within the Salmon River watershed are mercury, PCBs and Mirex.

Indicator – Game Fish Tissue Mercury Concentration: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for mercury.

Current Condition – Lower sub-watersheds - Fair: Elevated mercury levels are known to occur in fish in the lower Salmon River, but currently there are no fish consumption advisories for mercury in fish taken from the lower Salmon River (NYSDOH 2006).

Current Condition – Upper sub-watersheds – Unranked: In 2006 the NYSDEC listed the Salmon River Reservoir as a Section 303(d) Impaired Water due to mercury contamination in some fish (NYSDOH 2006). It is likely that the mercury source for the reservoir is internal loading from sediments due to water fluctuations. Therefore conditions within the reservoir should not be extrapolated beyond the reservoir. No other information exists with which to rank this indicator for upper sub-watersheds.

Indicator – Game Fish Tissue PCB Concentration: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for PCBs in the watershed.

Current Condition – Lower sub-watersheds - Poor: There is currently an NYSDOH fish consumption advisory for PCBs in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006).

Current Condition – Upper sub-watersheds – Unranked: There are currently no fish consumption advisories for sport fish above the Redfield Reservoir, but no data are available that provide an actual indication of contaminant concentrations in fish inhabiting these waters.

Indicator - Indicator – Mink Jaw Lesions: Section 2.2.2.8 presents background on ranking criteria for PCBs based upon occurrence of cancerous lesions in mink jaws.

Current Condition – Lower sub-watersheds – Poor: There are no data available reporting the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Beckett and Haynes (2007) in the Rochester Embayment, mink feeding within the Lake Ontario system appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario.

Current Condition – Upper sub-watersheds – Unranked: No data are available that suggest exposure of mink to PCB concentrations sufficiently high to cause cancerous lesions in waterways where prey species are isolated from Lake Ontario.

Indicator – Game Fish Tissue Mirex Concentration: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for Mirex in the watershed.

Current Condition – Lower subwatersheds - Poor: There is currently a NYSDOH fish consumption advisory for Mirex in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006). Although no guidance exists for ranking Mirex concentrations in forage fish, samples of longnose dace, cutlip minnow and fantail darter in the lower Salmon River averaged 0.008, 0.014 and 0.019 ppm wet weight, respectively in 1988 (L. Skinner, NYSDEC, unpublished data).

Current Condition – Upper subwatersheds – Good: Mirex concentrations were below detection limits in forage fish above the Redfield Reservoir in 1988 (L. Skinner, NYSDEC, unpublished data).

Indicator – Permitted Point Source Discharges: There are currently four facilities with National Pollution Discharge Elimination System (NPDES) water discharge or USEPA Toxic Release Inventory (TRI) discharge permits in the watershed (Figure 23). Information on permits and release reporting for these facilities can be obtained from the USEPA website http://cfpub.epa.gov/surf/huc.cfm?huc_code=04140102. Indicator rankings are based here on available information regarding permit compliance histories.

	Good	Fair	Poor
Number of violations w/in last 5 years	0	1	>1

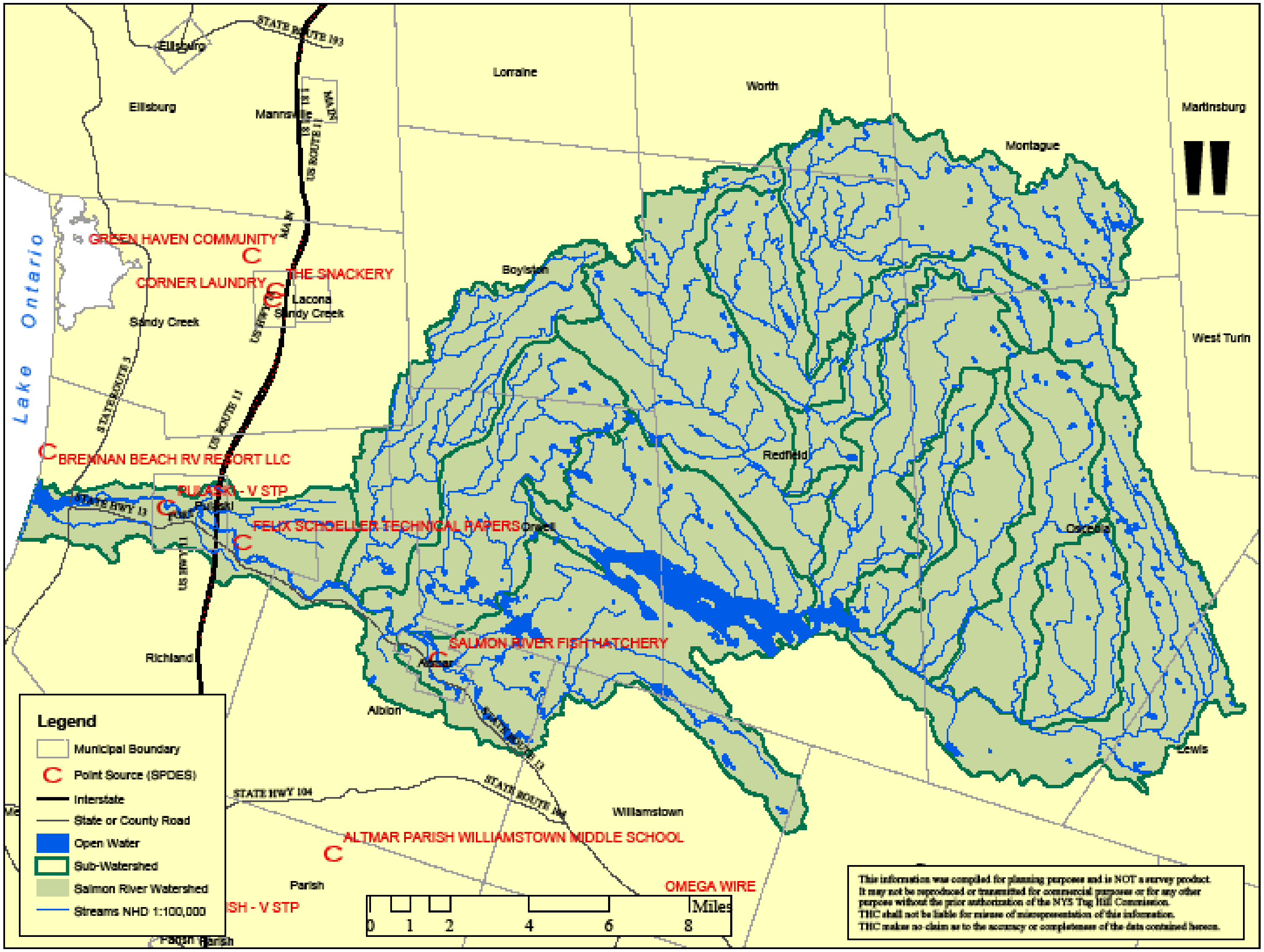


Figure 23. Location of facilities with National Pollution Discharge Elimination System (NPDES) or USEPA Toxic Release Inventory (TRI) discharge permits in the Salmon River watershed.

Current Condition - Felix Schoeller Technical Papers, Pulaski – Good: Total aggregate toxic releases from this facility have declined from 976,580 lb in 1987 to 380 lb in 2005 (the last year for which reporting is available). The only permitted toxic release from this facility in 2005 was 380 lb of N-butyl alcohol. The facility also has an NPDES permit (NY0000515) to discharge wastewater and must comply with permitted parameters for the following pollutants: temperature, turbidity, biological oxygen demand (BOD), pH, total suspended and settleable solids, phosphorus, and aluminum. The facility has not been out of compliance with discharge schedules since 1991.

Current Condition - Pulaski Sewage Treatment Plant, Pulaski – Fair: This facility has an NPDES permit (NY0020257) for discharge of wastewater and must comply with permitted parameters for the following pollutants: temperature, BOD, pH, total suspended solids, settleable solids, phosphorus, chlorine, and fecal coliform. The last violation of NPDES permit requirements for this facility was December 2002.

Current Condition - Pulaski Ford and Mercury, Pulaski: This facility has an NPDES permit (NYU700534) for discharge of wastewater. No permit documents were found through the USEPA web database for this facility.

Current Condition - New York State Fish Hatchery, Altmar - Fair: This facility has an NPDES permit (NY0109053) for discharge of wastewater and must comply with permitted parameters for the following pollutants: hydrogen peroxide, terramycin, formalin, diquat product, chloramine, chloride, pH, BOD, temperature, suspended and settleable solids, ammonia, phosphorus, potassium permanganate. The last violation of NPDES permit requirements for this facility was May 2004.

2.3.2.6 KEA: CONDITION-Pathogens

Several pathogens of concern to fisheries and human health exist in or near the watershed that are monitored for health and fisheries management. There are six viral and bacterial pathogens that are being monitored by NYSDEC for the salmonine fishery management (A. Noyes, NYSDEC Aquatic Pathologist, personal communication). Guidance for pathogen indicator rankings is provided in Table 8.

Indicator – Bacterial Kidney Disease Occurrence: BKD is caused by a gram-positive bacterium (*Renebacterium salmoninarum*) that survives in and causes extensive tissue damage to kidneys (Grayson et al. 2002). The disease is widespread in the Upper Great Lakes, with symptoms occurring in ~30-40% of Coho, Chinook, and Steelhead salmon there. The disease is vectored by spawning fish migrating back into the river from Lake Ontario.

Current Condition - Fair: The bacterium has occurred sporadically in the Salmon River fishery but has not been detected since 2003.

Indicator – Furnunculosis Occurrence: Furnunculosis is a bacterial disease caused by *Aeromonas salmonicida.* The bacterium causes severe blood poisoning and acute mortality. Fish affected with pathogen may be found swimming erratically, appear sluggish and stop feeding. The disease is common throughout North America and the Great Lakes. (For more information see http://www.lsc.usgs.gov/FHB/leaflets/FHB66.pdf)

Current Condition - Good: The pathogen has recently been detected in approximately 5-10% of fish in the Salmon River, but no disease symptoms have been observed.

Indicator – Infectious Pancreatic Necrosis (IPN) Occurrence: IPN is a viral disease that infects all ages and varieties of salmonids and in transmitted vertically (adults to eggs), or horizontally (consumption of infected dead fish or by fish excretions in the water). Infected fish may have swollen stomachs, swim in spiral manners, be inactive and produce white fecal casts. (For additional information see http://www.mass.gov/czm/wpfshlth.htm, http://www.disease-watch.com/documents/CD/index/html/fv035ipn.htm)

Current Condition - Good: This disease was present in the Salmon River fishery in the 1950's and 1960's, but has not been detected recently. It continues to be monitored.

Indicator – Yersinia ruckeri *Occurrence:* This bacterium is the causative agent of enteric redmouth (ERM), referring to symptomatic red mouths of infected fish. ERM most often infects rainbow trout, but it also affects several other salmonids. Infected fish are often found at the top of the water, isolated from other fish, and they may stop eating. The bacterium is common in Appalachian and mid-Atlantic fisheries as well as in the western Great Lakes. (For more information see http://www.mass.gov/czm/wpfshlth.htm.)

Current Condition - Fair: It is present but not common in the Salmon River.

Indicator – Viral Haemorrhagic Septicaemia (VHS): The IV-B strain of this virus was detected in Nova Scotia in the 1990s. Current evidence suggests this is probably an Atlantic strain of the virus that is just now making its way into the Great Lakes. This particular strain does not target salmonids as the other strains do (I, II and IV on salmonids in Europe and Asia; and IV-A in the Pacific Northwerst), but rather walleye, perch, minnows and gobies. Infected fish show the following symptoms: dark color, pale gills, sluggishness, erratic swimming. (For more information see http://www.mass.gov/czm/wpfshlth.htm, http://www.dec.state.ny.us/website/dfwmr/fish/vhsv.html.)

Current Condition - Fair: The virus has been detected in the Great Lakes and nearby Skaneateles Lake, but not yet in the Salmon River.

2.3.2.7 KEA – LANDSCAPE CONTEXT – Barriers to Migration

Structures such as dams and culverts can inhibit the migration of fish and other aquatic organisms through the watershed. Therefore, some segments of the river system, although suitable for habitat, may not be accessible to organisms that would utilize them.

Indicator – Dam Density (#dams/stream mile):
Current Condition - unranked: Twenty-four dams are currently known to be present within the watershed; 19 within the lower sub-watersheds, and five within the upper sub-watersheds. Seven sub-watersheds (all above the reservoir) have no impoundments (Table 15, Figure 24). No guidance was obtained with which to rank this indicator. However, these data suggest that migration capacities of aquatic organisms are more impaired by dams at the lower sub-watersheds (average of BBMC, LSRM, ORPE, TRBR dam density = 0.07/mile) than at the upper sub-watersheds (average = 0.03/mile).

Indicator – Road Crossing Density (# road crossings/stream mile):
Current Condition - unranked: There are 314 road-stream crossings within the entire watershed (Table 15, Figure 24). Crossings within sub-watersheds range from 6 (Cold Brook) to 46 (Beaverdam Brook-Meadow Creek-Reservoir), and crossing densities range from 0.14/mile (Upper Salmon River) to 0.96/mile (Lower Salmon River – Main Stem). It should be noted that these data do not differentiate the types of stream crossing (culvert versus bridge span). No guidance was obtained with which to rank this indicator, and the degree to which culverts serve as barriers to migration varies with species and life stage animal being considered, dimensions and internal roughness of the culvert, and the height at which the culvert is seated above the stream bed (USDA Forest Service 2002). However, these data suggest that migration capacities of aquatic organisms are more impaired at the lower sub-

watersheds (average road crossing density of lower sub-watersheds = 0.72/mile) than at the upper sub-watersheds (average = 0.35).

Table 15. Dam and stream crossing densities within the sub-watersheds of the Salmon River drainage (data are from Howard 2006). These values apply to both main branch & major tributaries, and headwater streams.

Subwatershed	total stream length (miles)	number of dams	dam density (no. per stream mi)	number of road crossings	road crossing density (no. per stream mi)
Beaver-Gillmore-Willow-McDougal	32.6	0	0	8	0.25
Beaverdam Brk-Meadow Crk-Reservoir	69.5	11	0.16	46	0.66
Cold Brook	32.0	0	0	6	0.19
Fall Brook-Twomile-Threemile	32.1	1	0.03	19	0.59
Grindstone-Mill-Muddy	56.6	0	0	14	0.25
Keese-Smith-Finnegan	24.7	2	0.08	10	0.41
Lower Salmon River-Main Stem	40.5	8	0.20	39	0.96
Mad River	98.5	0	0	15	0.15
North Branch	69.3	1	0.01	33	0.48
Orwell-Pekin	50.6	1	0.02	32	0.63
Pennock-Coey-Kenny	44.0	1	0.02	29	0.66
Prince-Mulligan-Little Baker	28.2	0	0	13	0.46
Stoney Brook-Lime Brook	22.2	0	0	7	0.32
Trout Brook	55.5	3	0.05	35	0.63
Upper Salmon River	58.3	1	0.02	8	0.14

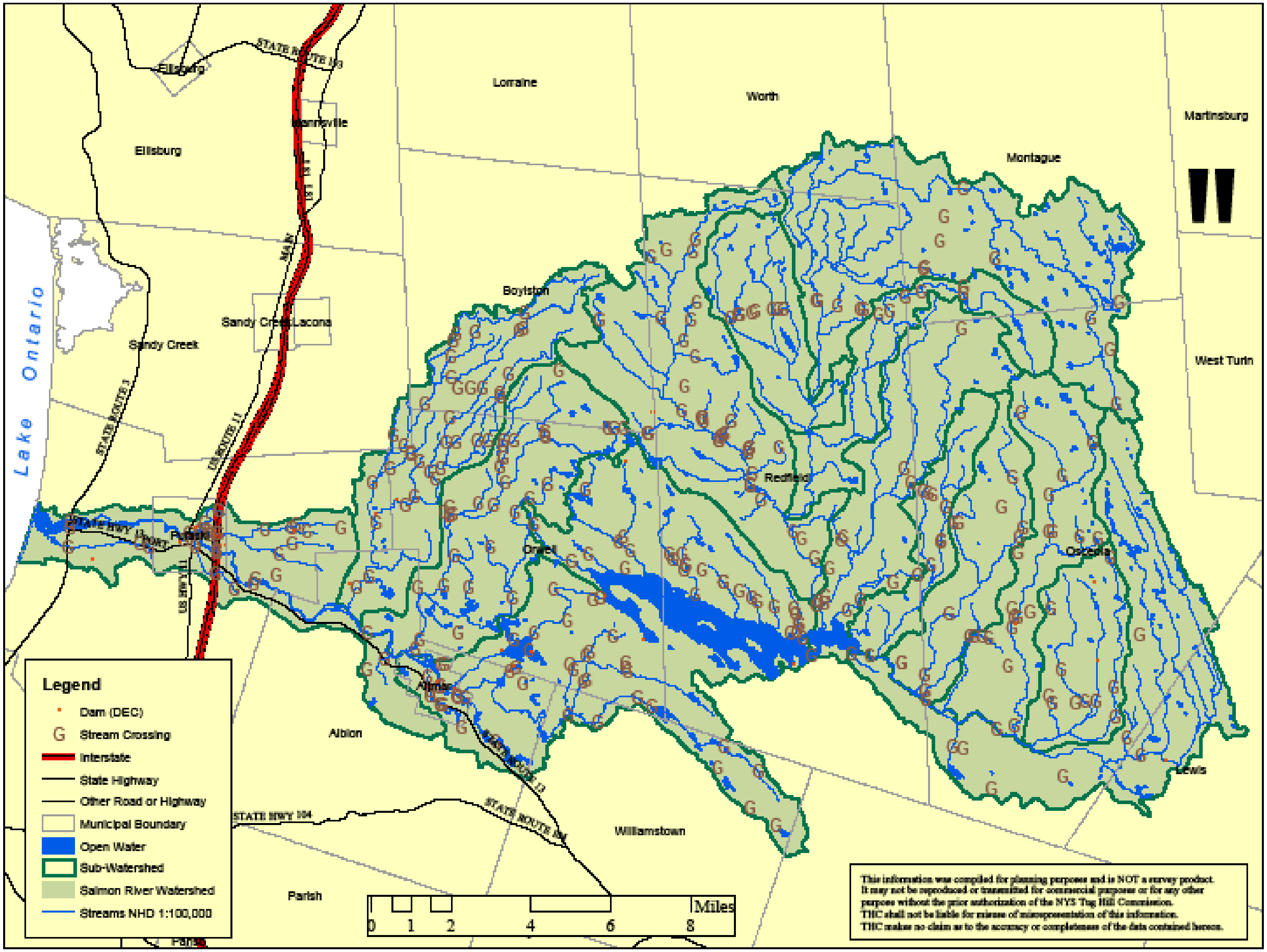


Figure 24. Locations of dams and stream crossings within the Salmon River watershed.

Indicator – Percent Natural Cover in 540-ft buffer. Naturally-vegetated buffers provide opportunities for wildlife species to simultaneously utilize upland and wetland habitats within their home ranges, to migrate along water features, and to disperse from wetlands into adjacent upland communities. For instance, amphibians are known to travel 1000-1800 ft, and up 4500 ft between breeding grounds and hibernation areas, (Hels and Buchwald 2001; Gibbs and Shriver 2005). Semlitsch (1998) found adults of six salamander species at an average of approximately 375 ft distance from the edge of aquatic habitats, and suggested that a buffer of ~540 ft from wetlands would capture 95% of the individuals within populations of those species.

Ranking criteria for this indicator are presented in Table 6.

<u>Current Condition: Upper sub-watersheds, Good; Lower sub-watersheds, Fair-Poor:</u> A stream buffer analysis was conducted by constructing 540-ft wide buffers along each edge of mapped stream segments (mapped at 1:100,000 scale) to calculate the percent unnatural cover (developed, roads, crops and hayfield, barren) occurring within the buffers. The analysis was conducted by stream reach (between mapped stream confluences) and presented by cover classes defined in Table 6.

This analysis (Figure 25) reveals that the vast majority of stream reaches within the upper sub-watersheds are well-buffered by natural vegetation (>90% cover of natural vegetation types) and only one stream reach ranked fair for this indicator (75-90% natural vegetation cover). The majority of stream reaches in the lower sub-watersheds ranked fair or poor (<75% natural cover) with regard to natural vegetation cover in the 540-ft buffers.

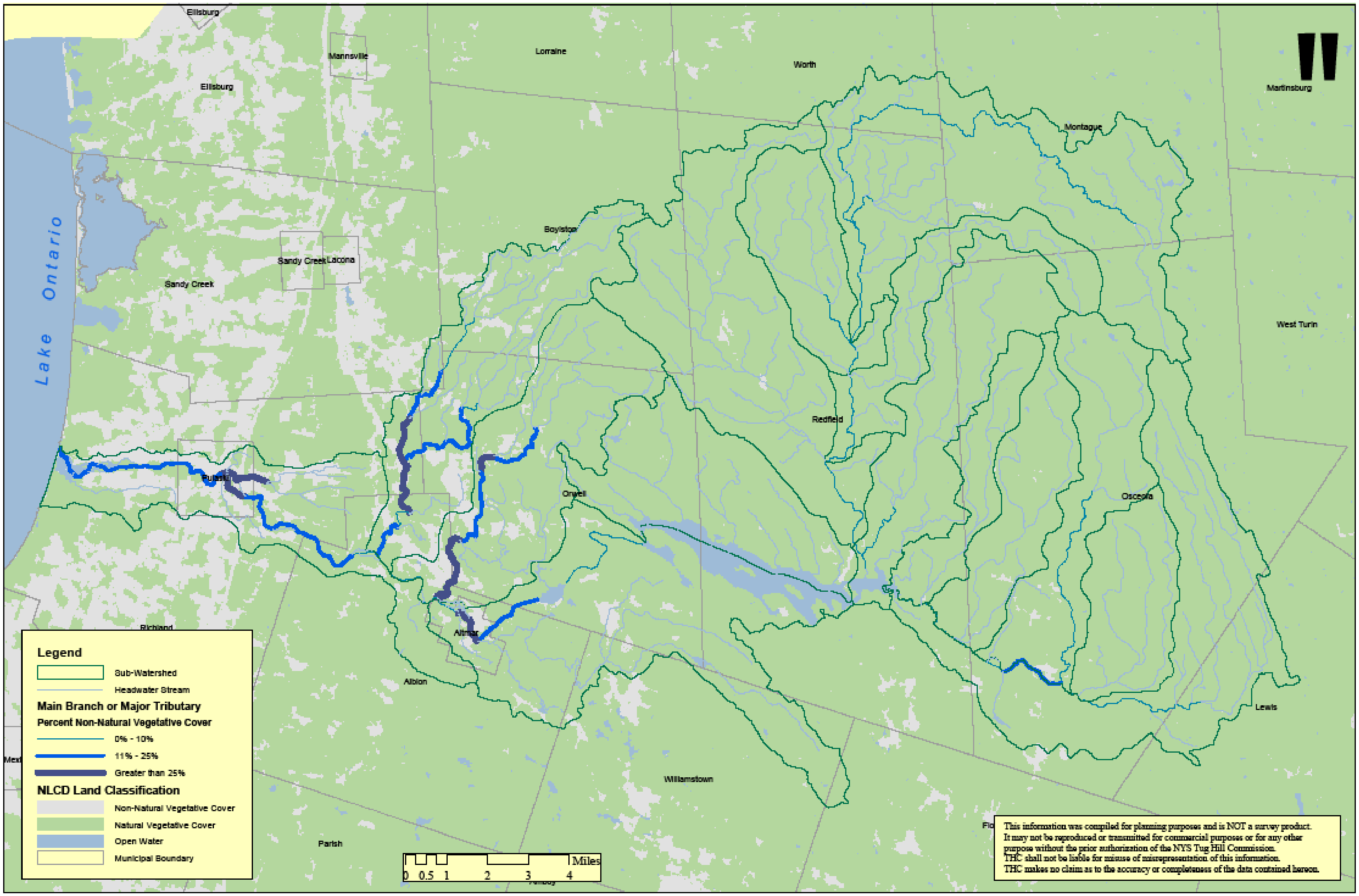


Figure 25. Analysis of land-cover types in 540-ft buffers of the Main Branch of Salmon River and its major tributaries.

2.3.3 Main Branch Salmon River & Major Tributaries

Viability Summary

Notes on Guidance for Current Condition:	"NG"	No guidance was obtained to rank this indicator
	"SGR"	Subjective guidance and/or ranking based on professional opinion
	"ND"	No data are available with which to rank this indicator

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. - Freq. Salmon River summertime flow <200 cfs		0%	1-50%		Good	SGR, FERC (1996)
KEA-Condition-Water Quality						
Ind. - % natural cover-types within 100-ft buffer		>90	75-90	<25		SGR, Klapproth & Johnson (2000), Baird & Wetmore (2006)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	
Ind. - embeddedness					Unranked	NG, ND
Ind. - summertime high temperatures (°F)		<70		>73		Eastern Brook Trout Joint Venture (2005)
Upper sub-watersheds					Good	
Lower sub-watersheds					Good-Fair	
Ind. – pH		>6.5	5.0-6.5	<5	Good	Driscoll et al. (2001), Stoddard et al. (2003), Shreiber (2007)
Ind. - Alkalinity (mg/L CaCO3)	>100	2.5-100	0-2.5	<0	Good	Driscoll et al. (2001)
Ind. - Dissolved oxygen (mg/L)		>6		<6	Good	Kozuchowski et al. (1994)
Ind. - Total phosphorus concentration (mg/L)		<0.01	.01-0.1	>0.1		Mueller and Helsel (1996)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	
Ind. - Total nitrogen concentration (mg/L)		<0.35	.35-10	>10	Fair	Driscoll et al. (2003)

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition-Macroinvertebrate Communities						
Ind. - Richness	>26	19-26	11-18	<11	Excellent	Bode et al. (1997)
Ind. - EPT	>10	6-10	2-5	<2	Excellent	Bode et al. (1997)
Ind. - Hilsenhoff Biotic Index	0-4.50	4.51-6.50	6.51-8.50	8.51-10.0	Excellent	Bode et al. (1997)
Ind. - Percent Model Affinity	>65	50-64	35-49	<35	Excellent	Bode et al. (1997)
KEA-Condition-Fish Communities						
Ind. - Observed richness					Unranked	NG
Ind. - Predicted richness					Unranked	NG
Ind. – Fish species distributions (modeled)						
Common species, white sucker & blacknose dace					Unranked	NG
Uncommon species, fantail darter & mottled sculpin					Unranked	NG
Exotic species, common carp					Unranked	NG
Game species, brown trout & brook trout					Unranked	NG
KEA-Condition-Natural Salmonine Reproduction						
Ind. – salmonine spawning habitat						
Number Chinook redds		1900-2900			Good	SGR-Everett (2006)
Percent substrate acceptable for Chinook redds		15%			Good	SGR-Everett (2006)
Ind. - Natural Chinook egg production		15-41 x 10^6			Good	SGR-Everett (2006)
Ind. - Rainbow trout recruitment (no. "yr1+" per km)		450-900			Good	SGR-Wildridge (1990)
KEA-Condition-Toxins						
Ind.– Game fish mercury concentration (ppm)		0	0-1	>1		
Upper sub-watersheds					Poor	NYS Dept. Health (2006)
Lower sub-watersheds					Fair	
Ind.– Game fish PCB concentration (ppm)						
Upper sub-watersheds					Unranked	NYS Dept. Health (2006)
Lower sub-watersheds					Poor	
Ind. – PCB-induced mink jaw lesions (ppb)		0	<40	>40		Haynes et al. (2007)
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Poor	

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
Ind.- game fish Mirex concentrations (ppm)						
Upper sub-watersheds					Good	NYS Dept. Health (2006)
Lower sub-watersheds					Poor	
KEA-Condition-Point Sources of Pollution						
Ind. - NPDES&Toxic Discharge violations last 5 yrs		0	1	>1		SGR
Schoeller					Good	
Pulaski Sewage					Fair	
Pulaski Ford/Mercury					Unranked	
NY Fish Hatchery					Fair	
KEA-Condition-Pathogens						
Ind. - % of population displaying disease symptoms		0	1-5	>5		SGR
Bacterial Kidney Disease occurrence					Fair	
Furnunculosis occurrence					Good	
Infectious Pancreatic Necrosis occurrence					Good	
Yersinia ruckeri occurrence					Fair	
Viral Haemorrhagic Septicaemia occurrence					Fair	
KEA-Landscape Context						
Ind. - No. dam per stream mile					Unranked	NG
Ind. - No. road crossings per stream mile					Unranked	NG
Ind. – Percent natural cover in 540-ft buffer		>90	75-90	<75		SGR, Semlitsch (1998)
Upper sub-watershed					Good	
Lower sub-watershed					Faur-Poor	

4 Headwaters

2.4.1 Headwaters Target Definition

This target represents 1st- and 2nd-order perennial streams described by Edinger et al. (2002). Following the same rationale outlined in section 2.3.1, the headwaters target will frequently consider aspects of the upper and lower watershed separately. The following generalized community descriptions are derived from Edinger et al. (2002).

-Intermittent streams: These are communities associated with small, ephemeral streambeds in the uppermost reaches of stream systems where surface water flows only during the spring or following heavy rains. These streams often have a moderate to steep gradient and hydric soils. Streambeds may be covered with emergent or submergent bryophytes including *Bryhnia novae-angliae, Bryum pseudotriquetrum, Chiloscyphus polyanthus, Hygrohypnum ochraceum, H. eugyrium ,Hygroamblystegium tenax, Fontinalis spp., Brachythecium rivulare, B. plumosum, Eurhynchium ripariodes, Mnium affine, Scapania nemorosa and S. undulata*. Characteristic vascular plants are hydrophytic and may include water-carpet (*Chrysosplenium americanum*) and pennywort (*Hydrocotyle americana*). The potential fauna are limited to species that do not require a permanent supply of running water, that inhabit the streambed only during the rainy season, or that are pool specialists. Characteristic fauna include amphibians such as green frog (*Rana clamitans*) and northern two-lined salamander (*Eurycea bislineata*), and macroinvertebrates such as water striders (*Gerris* sp.), water boatman (Corixidae), caddisflies (Trichoptera), mayflies (Ephemeroptera), stoneflies (Plecoptera), midges (Chironomidae), blackflies (Simulidae) and crayfish (*Cambarus bartoni*). Ecoregional variants occur throughout the state, which differ in dominant and characteristic bryophytes and insects, as well as water chemistry and temperature, underlying substrate type, and surrounding forest type.

-Headwater Streams: These community types (Figure 26) include both “rocky” and “marsh” headwaters, which share the characteristics of being small- to moderate-sized perennial, 1st- to 2nd-order streams, with biotic energy derived from adjacent terrestrial systems (leaf litter and other organic matter).

> -*Rocky headwaters* are typically shallow and narrow, and possess moderate to steep gradients, with cold water flowing over bedrock, boulders and cobbles. They contain alternating riffles and pools. High gradients lead to downward erosion with minimal deposition of sediments. They are typically surrounded by upland forest and are situated in confined valleys. Water has high levels of clarity and oxygenation.
>
> -*Marsh headwaters* are small, shallow brooks with very low gradient and slow flow rates occurring within marshes, fens or other swamps. The streams normally have well defined meanders and are in unconfined, broad, shallow valleys. They are dominated by runs with interspersed pools with substrates dominated by gravel or sand, but sometimes with silt, muck or peat. These streams may have high turbidity and varying color and sometimes be somewhat poorly oxygenated.

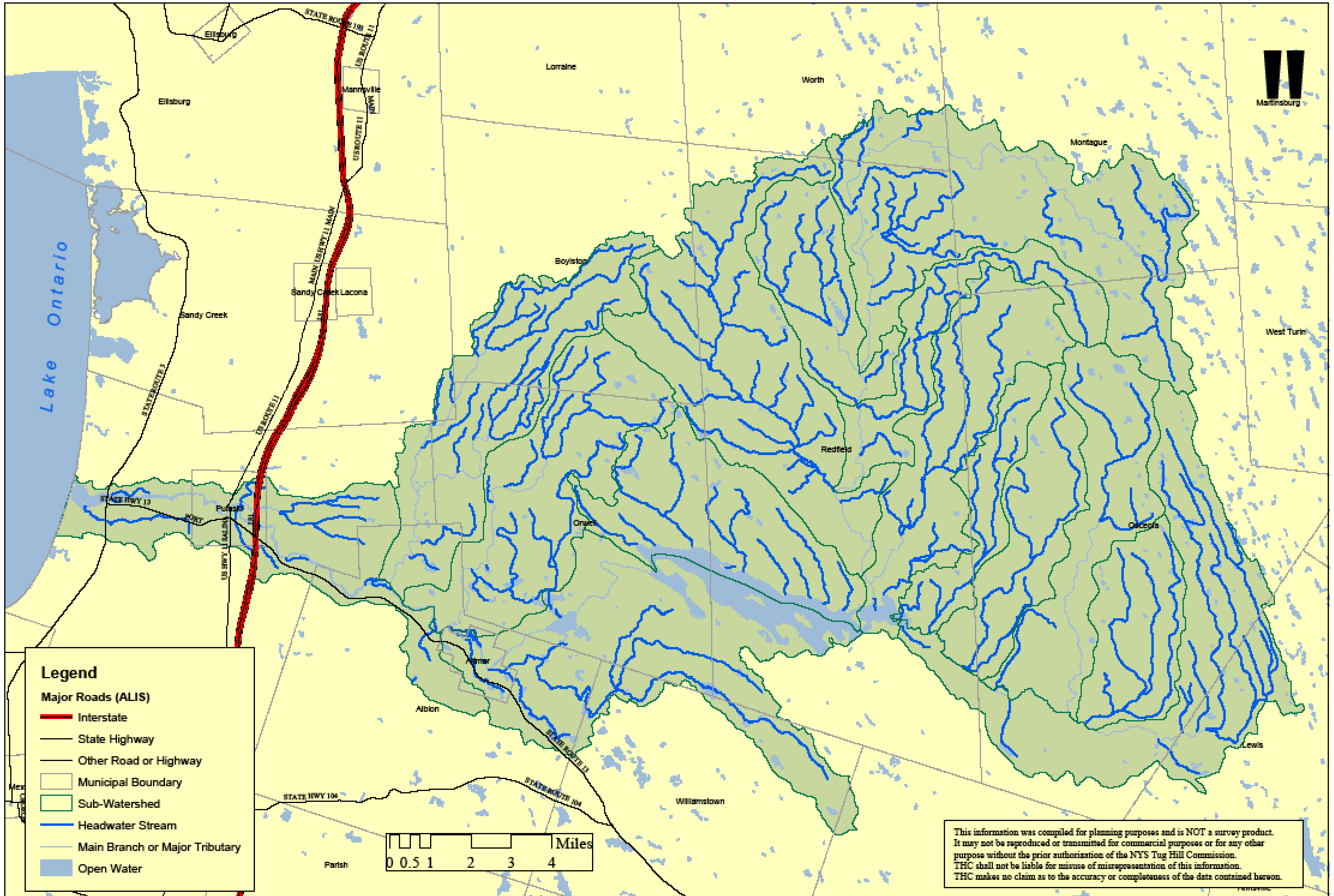


Figure 26. First- and second-order, perennial headwater streams of the Salmon River watershed.

2.4.2 Headwaters Viability Analysis

2.4.2.1 KEA-AREA

Headwater habitat availability is a function of the total length and width of 1st and 2nd order streams, and ephemeral streams within the watershed. Area of within stream aquatic habit varies annually and seasonally with hydrologic recharge by overland flow and groundwater. Groundwater recharge becomes the primary source of water during summer low-flow periods.

Indicator – Total Stream Length (mi) and Stream Density (mi. stream/mi.^{2} area): Total available aquatic habitat within an area can be quantified as total length of stream. This measure is often standardized to a per-unit-area basis (mi. steam/mi.^{2} area). Stream lengths vary with size of watershed considered, and stream density is relatively constant for a given ecoregion, given long-term climatic and hydrologic conditions. This indicator is not ranked, but is provided for baseline information.

Current Condition –Unranked: Table 16 summarizes total stream length and stream densities for the subwatersheds of the Salmon River watershed. Note that these calculations are based on stream segments mapped at the scale of 1:100,000, and therefore do not include many smaller perennial streams or any ephemeral streams. Mid-reach streams are also included in these estimates. Stream densities for the watershed average 2.1-3.2 mi/mi^2, and are consistent with stream densities mapped in the Catskill/Delaware watersheds (Mehaffey et al. 2001).

Table 16. Stream densities within the Salmon River watershed. Data are from Howard (2006) and are based upon all stream segments mapped at 1:100,000 scale.

	area (mi^2)	total stream length (mi)	stream density (mi/mi^2)
Upper Subwatersheds			
Beaver-Gillmore-Willow-McDougal	10.9	32.6	3.0
Cold Brook	10.2	32.0	3.1
Fall Brook-Twomile-Threemile	15.4	32.1	2.1
Grindstone-Mill-Muddy	17.5	56.6	3.2
Keese-Smith-Finnegan	10.0	24.7	2.5
Mad River	32.8	98.5	3.0
North Branch	28.1	69.3	2.5
Pennock-Coey-Kenny	17.0	44.0	2.6
Prince-Mulligan-Little Baker	11.3	28.2	2.5
Stony Brook-Lime Brook	7.2	22.2	3.1
Upper Salmon River	25.6	58.3	2.3
		average	2.7
Lower Subwatersheds			
Beaverdam Brook-Meadow Creek-Reservoir	30.8	69.5	2.3
Lower Salmon River-Main Stem	18.0	40.5	2.2
Orwell-Pekin	20.3	50.6	2.5
Trout Brook	20.2	55.5	2.7
		average	2.4

2.4.2.2. KEA-CONDITION-Water Quality

Indicator - Percent Natural Cover in 100-ft Buffer: Background and ranking for this indicator are presented in section 2.3.2.2 (Table 6).

Current Condition: Upper sub-watersheds, Good; Lower sub-watershed, Fair to Poor: An analysis of land-cover types occurring within 100-ft-wide buffers of headwater streams (Figure 27) revealed that only two headwater stream reaches in the upper sub-watersheds exhibited 75-90% natural cover, while all others contained >90% cover of natural vegetation. However in the lower sub-watersheds this indicator received a ranking of poor (<75% natural cover) to fair (75-90%) for numerous stream reaches.

Indicator – Summertime High Temperatures: Background and ranking stream temperature is provided in Section 2.3.2.2.

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair: No data reporting actual stream temperature measurements are available for the headwaters of the Salmon River watershed or for the greater Tug Hill region. Predicted summertime temperatures were estimated through a GAP model (J. McKenna, unpublished data). This model (Figure 14) predicts summer temperatures remain below 64 °F for the majority of headwater streams in the upper sub-watersheds. Headwaters of all the lower sub-watersheds (Beaverdam Brook-Meadow Creek-Reservoir, Lower Salmon River-Main Stem, Orwell-Pekin, and Trout Brook) have predicted summertime temperatures ranging from 70-73 °F, which is beyond the optimal range of some cold-water fish species (e.g., brook trout), and approaches their limits of tolerance. Brook trout thrive in water temperatures < 65 °F and tolerate brief periods of up to 72 °F; optimum growth occurs between 55 °F and 65 °F. Exposure to temperatures of °75 F for only a few hours is usually lethal (reviewed by Eastern Brook Trout Joint Venture 2005).

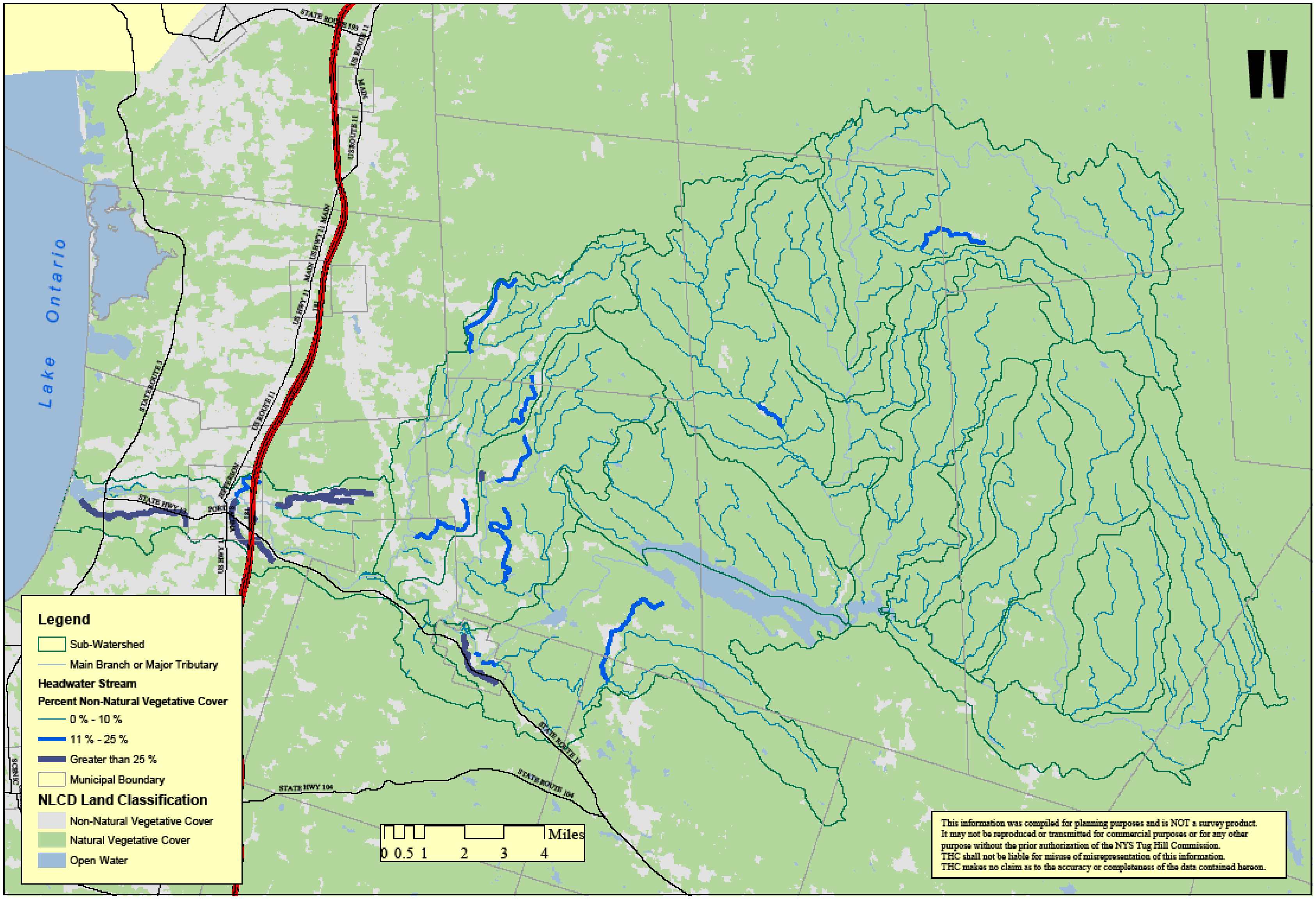


Figure 27. Analysis of land-cover types in 100-ft-wide buffers along headwaters of the Salmon River watershed.

Indicator – pH: Background and ranking criteria for surface water pH is provided in Table 13.

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Unranked: No water quality data are available for headwater reaches in the lower subwatersheds, but based upon the rankings for the main branch target (section 2.3.2.2), pH values are probably good for the lower sub-watersheds. Ranking for upper sub-watersheds is based on data provided for several headwater streams across the Tug Hill, including some within the Salmon River watershed westward to approximately Redfield, that were sampled under springtime high flow and summertime base flow conditions in 2005 and 2006. Springtime average pH averaged approximately 6.4 in both sample years. Summertime averages were approximately 7.2 across the Tug Hill (Figure 28).

Indicator – Total Alkalinity: Background and ranking criteria for surface water alkalinity is provided in Table 13.

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Good: No water quality data are available for headwater reaches in the lower sub-watersheds, but based upon the rankings for the main branch target (section 2.3.2.2), alkalinity values are probably good for the lower sub-watersheds. Ranking for upper sub-watersheds is based on data provided for several headwater streams across the Tug Hill, including some within the Salmon River watershed westward to approximately Redfield, that were sampled under springtime high flow and summertime base flow conditions in 2005 and 2006. Total alkalinity ranged from approximately 6-12 mg/L $CaCO_3$ during spring snowmelt, and approximately 35 mg/L during summer baseflow conditions (Figure 28), indicating that the headwater streams of the upper sub-watersheds are not currently sensitive to acidification.

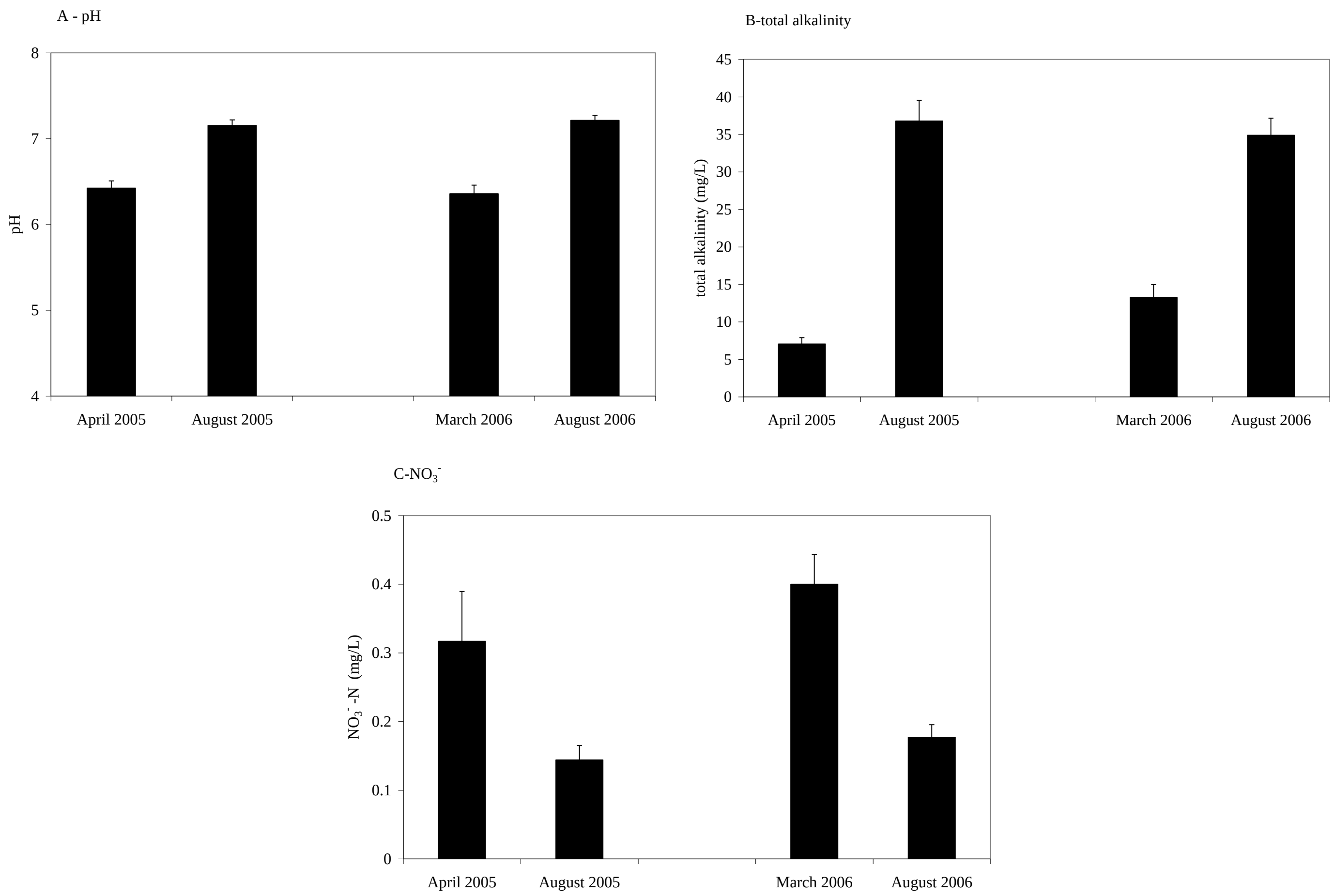


Figure 28. Stream chemistry of headwater streams on the Tug Hill, including some within the Salmon River watershed, east of the Redfield Reservoir. Values are averages (1SE) for replicate samples collected during peak snowmelt and summer baseflow conditions in 2005 and 2006. Panels are A-pH, B-total alkalinity, C-nitrate. (Source: McGee, unpublished data).

Indicator: Dissolved Oxygen (mg/L): Background and ranking criteria for surface water total dissolved oxygen concentrations are provided in section 2.3.2.2.

<u>Current Condition – Unranked:</u> No data are available on headwater stream oxygen concentrations within the watershed. Based upon the rankings of the main stem target (section 2.3.2.2), it is likely that oxygen concentrations are good within the rocky headwater streams throughout the watershed, but this extrapolation cannot be applied to marsh headwater streams.

Indicator: Phosphate Concentration: Background and ranking criteria for surface water total phosphate concentrations are provided in section 2.3.2.2.

<u>Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair:</u> There are currently no data available with which to rank this indicator for the headwaters of the watershed. However, given the condition of the main branch and major tributaries target, it is likely that phosphorus concentrations in the upper subwatersheds are good, while those of the lower subwatersheds are fair.

Indicator – Nitrogen Concentrations: Background and ranking criteria for surface water total nitrogen concentrations are provided in section 2.3.2.2.

<u>Current Condition - Fair</u>: Average stream water nitrate (NO_3^-) concentrations in the headwaters of the upper sub-watersheds averaged approximately 0.35 mg NO_3-N/L during spring snowmelt periods in 2005 and 2006, and approximately 0.15 mg NO_3-N/L during summer baseflow conditions (Figure 28). These values underestimate the total N in these waters because they do not report dissolved organic nitrogen. The springtime values of 0.35 mg/L are approaching lower limits of conditions signaling polluted forest conditions (0.37 mg/L for <u>total</u> N). No data are available for headwaters of the lower sub-watersheds, but headwater conditions are probably consistent with those of the main branch and major tributaries, which exhibited elevated total N concentrations during summer baseflow periods. N concentrations remain well below USEPA drinking water standards.

2.4.2.3. KEA – CONDITION – Trout Habitat

Indicator – Trout Habitat – Native trout populations are good indicators of stream quality. Apart from requiring cold to cool water temperatures and high dissolved oxygen concentrations, trout habitats are correlated with (a) abundant cobble and gravel substrate for spawning; (b) fast flow; (c) abundant riffles; (d) abundant coarse woody debris (Hunt et al. 2005); and (e) upwellings of groundwater into gravel substrate for suitable spawning habitat. For instance, Brabrand et al. (2002) determined that high density spawning areas (>100 redds/ha) used by brown trout received groundwater influx of 1200 ml/m^2/min, while low density spawning areas (5-10 redds/ha) received an average influx of 113 ml/m^2/min. No guidance was obtained to rank specific substrate quality, stream velocity, riffle occurrence or coarse woody debris volume for this indicator.

Current Condition – Unranked: Hunt et al. (2005) reported that the cobble/gravel substrate, fast flow and riffle habitats occur within rocky headwater stream communities and that these features occurred in all of the exemplary headwater streams they described (no quantitative estimates were provided). Furthermore, these conditions occur in approximately 5-10% of the reaches in exemplary marsh headwater streams that Hunt et al (2005) studied. However, no information is available on the range of habitat conditions within the watershed or greater Tug Hill region.

Indicator – Trout Densities: No data were obtained that describe observed densities of brook (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) in the headwaters of the watershed. Section 2.3.2.4 describes the application of a GAP analysis, developed for the entire Great Lakes basin, and tested within the Genesee River drainage, to predict distributions of fish species within the watershed (J. McKenna, unpublished). This model has been applied to both headwater and mid-reach stream segments of the Salmon River watershed.

Current Condition – Game Species – brown and brook trout - Unranked: This analysis does not permit a ranking of this indicator, but rather is presented to provide an overview of conditions within the various sub-watersheds of the Salmon River drainage. Results of the analysis (illustrated in Figure 22) indicate that both trout species occur in headwaters throughout the watershed. When the predicted densities of these species differ within a given headwater reach, brook trout tend to occur in higher densities in the upper sub-watersheds, while brown trout tend to occur in higher densities in the lower sub-watersheds.

2.4.2.4 KEA – CONDITION – Macroinvertebrate Communities

Indicator – Indices of Biotic Integrity: Section 2.3.2.3 describes several indices that have been developed to assess mid-reach stream water quality using information describing the community composition of stream macroinvertebrates (Bode et al. 1997). These indices of biotic integrity could be applied to headwater streams only with caution since they were developed for aquatic invertebrate communities inhabiting riffles of streams with gravel/cobble streambeds and moderate velocity (M. Novak, NYSDEC, personal communication). The indices should not be applied to marsh headwater streams, which due to the abundance of wetlands and beaver flows in the Tug Hill region, may represent a substantial proportion of the watershed's headwaters. Furthermore, headwaters generally support lower densities of invertebrates due to down-stream drift of these organisms.

Current Condition – Unranked: No data describing stream invertebrate communities were obtained that could readily be used to calculate indices of biotic integrity in the headwater streams of the watershed.

Indicator – Macroinvertebrate Abundance (#/m^2): This indicator provides general information regarding the potential ecosystem productivity of stream communities (amount of energy being transferred up the food chain). Headwater streams will typically exhibit lower macroinvertebrate abundance than mid-reach (3rd-4th order) streams.

Hunt et al. (2005) reported macroinvertebrate abundances only for headwater streams that they considered exemplary in the Tug Hill region, including sites in the Salmon River watershed (Table 17).

Table 17. Estimated macroinvertebrate abundance in exemplary streams of the Tug Hill region (from Hunt et al. 2005).

	invertebrate abundance (no. per m^2)		
Stream system	midreach	rocky headwater	marsh headwater
East Branch Fish Creek	3000	2500	2000
East Branch Salmon River	3000	1500	2500
N. Br. Salmon River – Mad River	--	2000	--
Deer River	1500	800	1000
Average	~2500	~1600	~1800

Current Condition – Unranked: Data presented in Table 17 are provided for baseline information on exemplary streams. No similar data were obtained for streams of lower sub-watersheds, or for streams representing the range of conditions within the watershed.

Indicator – Macroinvertebrate Species Richness: Species richness is influenced by stream water quality as well as the availability of diverse substrates and energy sources to support a wide range of species. Hunt et al. (2005) reported macroinvertebrate richness only for headwater streams that they considered exemplary in the Tug Hill region, including sites in the Salmon River watershed (Table 18).

<u>Current Condition – Unranked</u>: Data presented in Table 18 are provided for baseline information. No similar data were obtained for streams in the lower sub-watersheds, or for streams representing the range of conditions within the watershed. Comparisons of species richness among studies are hindered by differences in sampling procedures and effort.

Table 18. Macroinvertebrate species richness of exemplary Tug Hill stream systems (from Hunt et al. 2005).

	--------Biotic richness (minimum number of species)-------									
Community/Stream System	M	P	E	T	Di	C	O	De	Hi	He
Midreach Streams										
E. Branch Fish Creek	2	3	11	19	3	3	-	2	-	-
E. Branch Salmon River	-	7	7	17	4	2	-	-	-	-
Mad River	2	3	6	10	2	-	-	-	-	-
Deer River	2	6	9	12	4	2	3	-	-	-
Average	*2*	*5*	*8*	*15*	*3*	*2*	*1*	*1*	*0*	*0*
Rocky Headwater Streams										
E. Branch Fish Creek	3	8	7	17	3	4	-	-	-	-
W. Fork Salmon River	-	5	7	13	4	4	4	2	-	-
Mill Stream	3	3	6	12	3	3	-	-	-	-
E. Branch Deer River	3	6	9	14	3	4	3	-	-	-
Average	*2*	*6*	*7*	*14*	*3*	*4*	*2*	*1*	*0*	*0*
Marsh Headwater Streams										
E. Branch Fish Creek	5	-	4	7	2	2	-	-	-	-
W. Fork Salmon River	2	-	2	12	2	2	3	-	2	-
W. Branch Deer River	2	-	5	8	3	3	4	-	3	-
Average	*3*	*0*	*4*	*9*	*2*	*2*	*2*	*0*	*2*	*0*

M: Mollusca, P: Plecoptera, E: Ephemeroptera, T:Trichoptera, Di:Diptera, C:Coleoptera, O:Odonata, De:Decapoda, He:Hemiptera, Hi:Hirudinea, - not assessed (<=1).

2.4.2.5 KEA – CONDITION – Fur-Bearing Animals
Animals such as beaver and river otters utilize headwater stream habitats. Their respective abundance provides an indicator of habitat quality and food availability within headwaters.

Indicator – Beaver and Otter Population Densities: No population estimates were obtained for these species within the Salmon River watershed. The only data available are NYSDEC fur-bearer trapping records, which are assembled on a town-by-town basis. Trapping records for Jefferson, Oswego, Lewis and Oneida counties were provided by J.E. Kautz, NYSDEC Bureau of Wildlife. Records specific to towns within the watershed were insufficient to adequately illustrate population trends for these species. Therefore, data from the entire four-county area were used to illustrate trends for the greater region. These data cannot be used to estimate populations, and therefore are of limited value for ranking this indicator. They are provided here to illustrate general, regional population trends over the last forty years.

Current Condition - Unranked: Figure 29 illustrates the number of trapped beaver and otter that were reported to NYSDEC between 1958 and 2005 in the area encompassing Jefferson, Lewis, Oneida and Oswego counties. These data indicate increasing levels of trapped beaver between 1960 and the mid-1980s. The recent leveling of the beaver trend may reflect real population dynamics or the influence of market forces on trapping effort. These data also indicate a slight increase in the number of trapped otter throughout the period of the record.

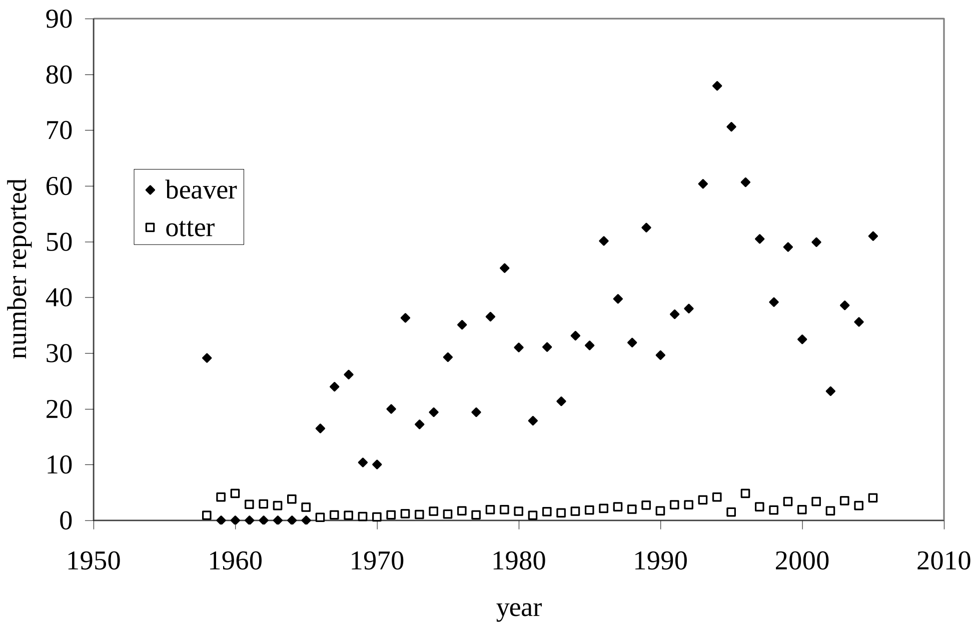


Figure 29. Average numbers (per town) of trapped beaver and otter reported to NYSDEC in Jeferson, Lewis, Oneida and Oswego Counties, New York. (Source: NYSDEC).

2.4.2.6 KEA – LANDSCAPE CONTEXT – Barriers to Migration

Structures such as dams and culverts can inhibit the migration of fish and other aquatic organisms through the watershed. Therefore, some segments of the river system, although suitable for habitat, may not be accessible to organisms that would utilize them.

Indicator – Dam Density (#dams/stream mile):

Current Condition - Unranked: Viability ranking of this indicator was conducted for the Headwaters target together with the Main Branch Salmon River & Major Tributaries target, and is outlined in section 2.3.2.7 (including Table 15, Figure 24).

Indicator – Road Crossing Density (# road crossings/stream mile):

Current Condition - Unranked: Viability ranking of this indicator was conducted for the Headwaters target together with the Main Branch Salmon River & Major Tributaries target, and is outlined in section 2.3.2.7 (including Table 15, Figure 24).

Indicator – Percent Natural Cover in 540-ft Buffer: Discussion regarding the ecological importance of natural vegetation cover in wide buffers strips along streams and other water bodies is provided in Section 2.3.2.7 and ranking criteria for this indicator is presented in Table 6.

Current Condition: Upper sub-watersheds, Good; Lower sub-watersheds, Fair-Poor: A stream buffer analysis was conducted by constructing 540-ft wide buffers along each edge of mapped headwater stream segments (mapped at 1:100,000 scale) to calculate the percent unnatural cover (developed, roads, crops and hayfield, barren) occurring within the buffers. The analysis was conducted by stream reach (between mapped stream confluences) and presented by cover classes defined in Table 6.

This analysis (Figure 30) reveals that the vast majority of stream reaches within the upper sub-watersheds are well-buffered by natural vegetation (>90% cover of natural vegetation types). Three stream reaches ranked fair for this indicator (75-90% natural vegetation cover) and one was ranked as poor (<75% natural cover). In the lower sub-watersheds, 29 headwater stream segments received a ranking of fair (18) or poor (11) with regard to the natural vegetation cover in the 540-ft buffers.

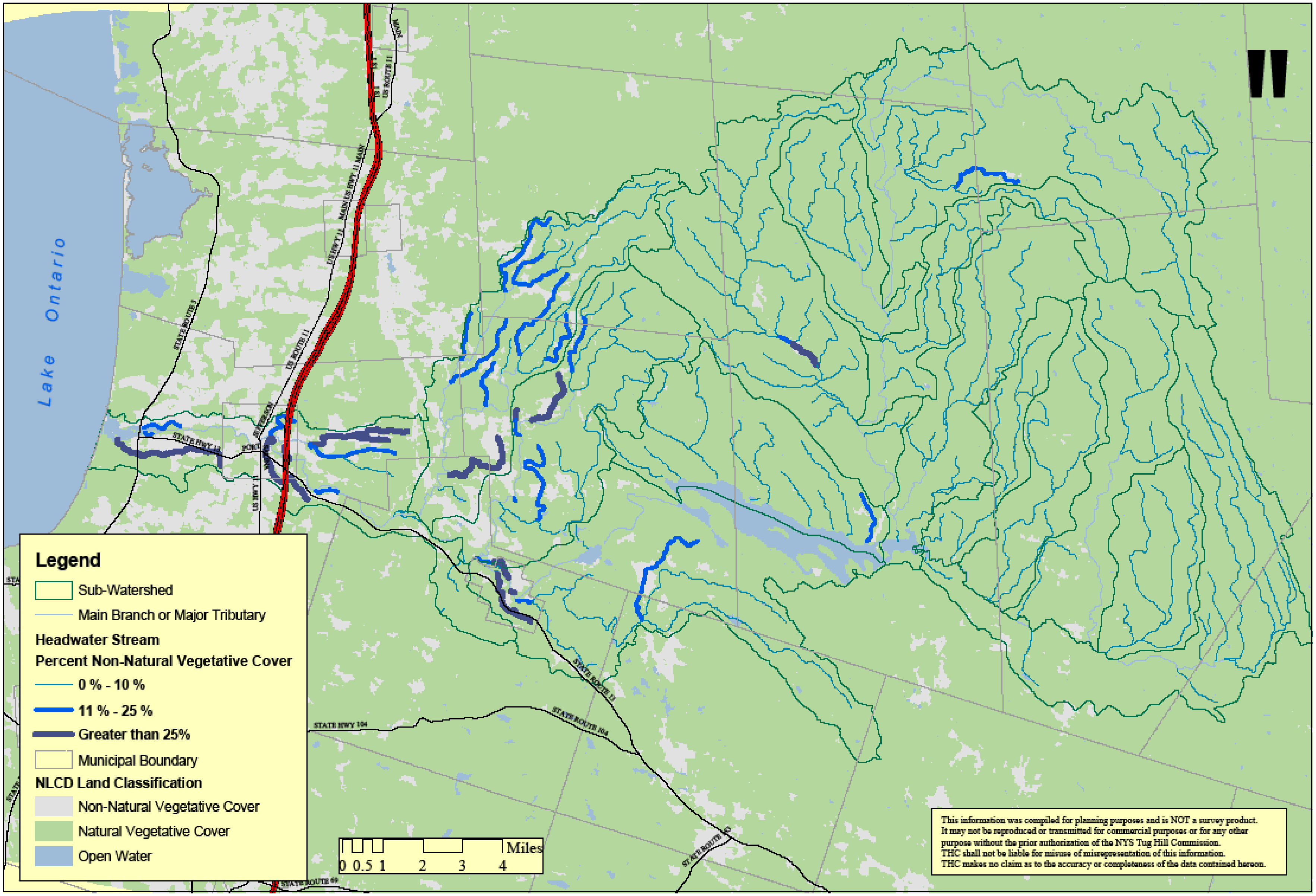


Figure 30. Analysis of land-cover types in 540-ft-wide buffers of headwater streams (1st- and 2nd-order) of the Salmon River watershed.

2.4.3 Headwaters
Viability Summary

Notes on Guidance for Current Condition:

"NG"	No guidance was obtained to rank this indicator
"SGR"	Subjective guidance and/or ranking based on professional opinion
"ND"	No data are available with which to rank this indicator

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. - Stream density (stream mi / mi^2)					Unranked	NG
KEA-Condition-Water Quality						
Ind. – % natural cover types within 100-ft buffer		>90	75-90	<75		SGR, Klapproth & Johnson (2000), Baird & Wetmore (2006)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair-Poor	
Ind. - Summertime high water temperature (°F)		<65	72	>72		Eastern Brook Trout Joint Venture (2005)
Upper sub-watersheds (predicted)					Good	
Lower sub-watersheds (predicted)					Fair	
Ind. – pH		>6.5	5.0-6.5	<5		Driscoll et al. (2001), Stoddard et al. (2003), Shreiber (2007)
Upper sub-watersheds					Good	
Lower sub-watersheds					Unranked	
Ind. - Alkalinity (mg/L CaCO3)	>100	2.5-100	0-2.5	<0		Driscoll et al. (2001); lower sub-watersheds, ND - extrapolated from main branch target
Upper sub-watersheds					Good	
Lower sub-watersheds					Good	

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
Ind. - Dissolved oxygen (mg/L)		>6		<6	Unranked	ND, Kozuchowski et al. (1994)
Ind. - Total phosphorus concentration (mg/L)		<0.01	.01-.1	>0.1		Mueller & Helsel (1996)
Upper sub-watersheds					Good	ND, ranking extrapolated from main branch target
Lower sub-watersheds					Fair	ND, ranking extrapolated from main branch target
Ind. - Total nitrogen concentration (mg/L)		<0.35	.35-10	>10		Vitousek et al. (1997), Driscoll et al. (2003)
Upper sub-watersheds					Fair	
Lower sub-watersheds					Fair	ND, ranking extrapolated from main branch target
KEA-Condition-Trout Habitat						
Ind. - Gravel substrate					Unranked	NG, ND, Hunt et al. (2005)
Ind. - Stream flow					Unranked	NG, ND, Hunt et al. (2005)
Ind. - Riffle habitat					Unranked	NG, ND, Hunt et al. (2005)
Ind. - Coarse woody debris					Unranked	NG, ND, Hunt et al. (2005)
Ind. - Groundwater discharge (ml/m^2/min)		1200	100		Unranked	ND, Brabrand et al. (2002)
Ind. - Trout densities (observed or predicted)					Unranked	NG, ND
KEA-Condition-Macroinvertebrate Communities						
Ind. - Richness	>26	19-26	11-18	<11	Unranked	ND, Bode et al. (1997)
Ind. - EPT	>10	6-10	2-5	<2	Unranked	*Note: indices developed*
Ind. - Hilsenhoff Biotic Index	0-4.50	4.51-6.50	6.51-8.50	8.51-10.0	Unranked	*for mid-reach streams and should not be applied*
Ind. - Percent Model Affinity	>65	50-64	35-49	<35	Unranked	*to marsh headwaters*

Ind. - Bacroinvertebrate abundance (#/m2)	1600-1800				Unranked	ND, Hunt et al. (2005)
Ind. – Macroinvertebrate species richness					Unranked	ND, Hunt et al. (2005)
KEA - Condition - Furbearer Populations						
Ind. - NYSDEC trapping reports (#/town/yr)						NG
Beaver					Unranked	
Otter					Unranked	
KEA-Landscape Context						
Ind. – Number of dams/stream mile					Unranked	NG
Ind. – Number of road crossings/stream mile					Unranked	NG
Ind. - % natural cover in 540-ft buffer		>90	75-90	<75		SGR, Semlitsch (1998)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair-Poor	

2.5 Open Waters

2.5.1 Open Waters Target Definition

Open waters include lakes, ponds and reservoirs. The Salmon River watershed contains no large, naturally occurring lakes or ponds. However several small open ponds occur naturally within the watershed resulting from impeded surface flow by glacial deposits and beaver dams. In addition numerous farm ponds and two notable impoundments (the Lighthouse Hill and Redfield Reservoirs) exist in the watershed (Figure 31).

2.5.2. Open Waters Viability Analysis

2.5.2.1. KEA-SIZE

Indicator – Open Water Area (acres): Total area is a direct indicator of open water habitat availability. The component of total open water area most subject to change over time may be the numerous, small beaver dams that exist in the watershed, while the areas Lighthouse Hill and Redfield reservoirs will remain regulated at a relatively static level. Therefore, rankings for this target will be based upon total area of open waters other than the two reservoirs in order to provide a measure that is most sensitive to potential future changes within the watershed.

No historic estimation of open water exists for the watershed, and this was probably a dynamic level that fluctuated with local cycles in beaver populations. Viability rankings for open water area will be based upon current conditions since beaver populations have recovered across northern New York from historic lows in the 19th century (Brocke and Zarnetske 1974). Therefore, open waters may currently be near expected natural levels, at least in some subwatersheds. Viability rankings for this indicator are presented in Table 19.

Table 19. Ranking criteria for open water habitat area in the Salmon River watershed. Baseline open water area is based upon the National Land Cover Database (2001).

	poor	fair	good
Percent of the baseline 2001 total open water area in watershed (excluding Lighthouse Hill and Redfield Reservoirs).	<75%	75-90%	>90%

<u>Current Condition – Good:</u>

Analyses conducted using National Wetland Inventory data provide an estimate of approximately 4,300 acres of open waters within the watershed (Table 20). Note that for the Beaverdam Brook-Meadow Creek, Keese-Smith-Finnegan, Fall Brook-Twomile-Threemile and Upper Salmon River sub-watersheds, NWI data were incomplete, and therefore area of open waters in these sub-watersheds are underestimated.

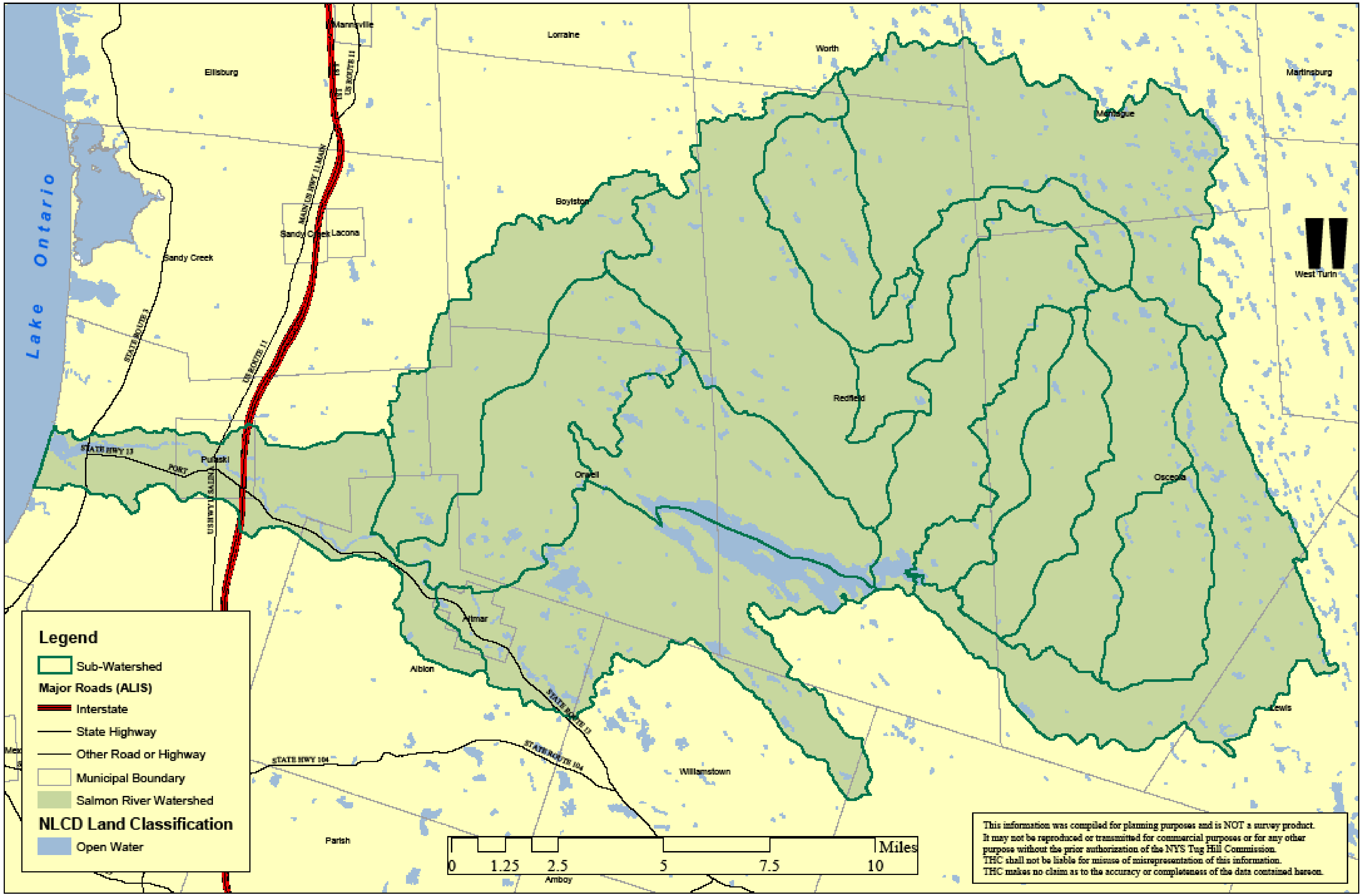


Figure 31. Open waters of the Salmon River watershed.

The areas of the Redfield and Lighthouse Hill Reservoirs are 2,660 and 150 acres, respectively. Together they account for 65% of the total open waters in the watershed. Note that for the purpose of the sub-watershed analyses (presented in Table 20) it was necessary to partition the area of the Redfield Reservoir between the Beaverdam Brook-Meadow Creek-Reservoir and Pennock-Coey-Kenny sub-watersheds.

A total of 454 water bodies (excluding the two reservoirs) were identified in the entire watershed, collectively accounting for approximately 1,520 acres. Of these non-reservoir water bodies, 92% are smaller than 10 acres (accounting for 45% of the total open water area). Three water bodies (accounting for <1% of the total number and 18% of the total area) are greater than 100 acres in size.

Table 20. Estimated numbers and areas of open waters in sub-watersheds of the Salmon River Watershed. Sub-watersheds for which data were incomplete are indicated with an asterisk. For the purpose of the sub-watershed total, open waters occurring at the confluence of streams draining two different sub-watersheds were necessarily partitioned between those two sub-watersheds. (Data Source: National Wetland Inventory).

Subwatershed	sub-watershed area (ac)	area open water (ac)	percent open water
Beaverdam Brook-Meadow Creek-Reservoir *	19,720	2,193	11.1
Pennock-Coey-Kenny	10,880	957	8.8
Grindstone-Mill-Muddy	11,183	293	2.6
Mad River	21,013	228	1.1
Orwell-Pekin	12,992	127	1.0
Stony Brook-Lime Brook	4,623	43	0.9
Upper Salmon River*	16,365	145	0.9
Cold Brook	6,558	51	0.8
Beaver-Gillmore-Willow-McDougal	6,962	48	0.7
Fall Brook-Twomile-Threemile*	9,862	57	0.6
North Branch	17,993	82	0.5
Trout Brook	12,938	54	0.4
Lower Salmon River-Main Stem	11,544	31	0.3
Prince-Mulligan-Little Baker	7,245	17	0.2
Keese-Smith-Finnegan*	6,419	6	0.1
TOTAL	176,298	4,332	2.5

*Available NWI data are incomplete for these sub-watersheds, resulting in expected underestimations of open water area.

2.5.2.2 KEA – CONDITION - Beaver Dams

The treatment of beaver-influenced communities is included in this section on open water (rather than wetlands) due to the analytical methods available for detecting and quantifying them. Using the National Wetland Inventory (NWI) database it is possible to discern open waters of beaver origin. These open waters are accompanied by a variety of wetland types that are given consideration in Section 2.6. Beaver (*Castor canadensis*) are recognized as important ecosystem "engineers" whose presence and activities contribute to maintaining diverse and variable natural communities. Wright et al. (2002) determined that beaver activities increase vascular plant diversity in Adirondack riparian zones by more than 33%.

Indicator – Proportion of Total Open Waters as Beaver-Influenced:

Current Condition – Unranked: Figure 32 illustrates the beaver-influenced open waters of the watershed. Beaver-influenced open waters are quantified in Table 21. No guidance is available for estimating expected, natural beaver populations in the watershed or areas of wetlands within the watershed expected to be influenced by beaver activities. The data in Table 21 are provided as baseline data for comparisons among sub-watersheds and to facilitate future comparisons. The analysis summarized in Table 21 indicates that approximately 11% of the watershed's water body area is influenced by beaver, with beaver influence ranging from 0 (Lower Salmon River sub-watershed) to 28% (Beaver-Gilmore-Willow-McDougal sub-watershed).

Table 21. Summary of beaver-influenced wetland and open water areas in the Salmon River Watershed.

Subwatershed	wetland area (ac)	open water area (ac)	total area (ac)	beaver-influenced area (ac)	beaver-influenced percent
Beaverdam Br.-Meadow Cr.-Reservoir*	1,639	2,193	3,831	268	7
Beaver-Gilmore-Willow-McDougal	1,104	48	1,152	319	28
Cold Brook	1,117	51	1,167	184	16
Fall Brook-Twomile-Threemile*	1,674	57	1,731	209	12
Grindstone-Mill-Muddy	1,338	293	1,632	223	14
Keese-Smith-Finnegan*	442	6	448	52	12
Lower Salmon River – Main Stem	1,345	31	1,376	0	0
Mad River	4,848	228	5,077	701	14
North Branch	3,061	82	3,143	213	7
Orwell-Pekin	1,623	127	1,750	279	16
Pennock-Coey-Kenny	1,272	957	2,228	157	7
Prince-Mulligan-Little Baker	847	17	864	85	10
Stony Brook – Lime Brook	468	43	511	35	7
Trout Brook	1,065	54	1,120	20	2
Upper Salmon River*	1,148	145	1,292	269	21
TOTAL	22,991	4,332	27,323	3,012	11

*Available NWI data are incomplete for these sub-watersheds, resulting in expected underestimations of open water and wetland area, and additional error in estimating areas of beaver-influenced water bodies.

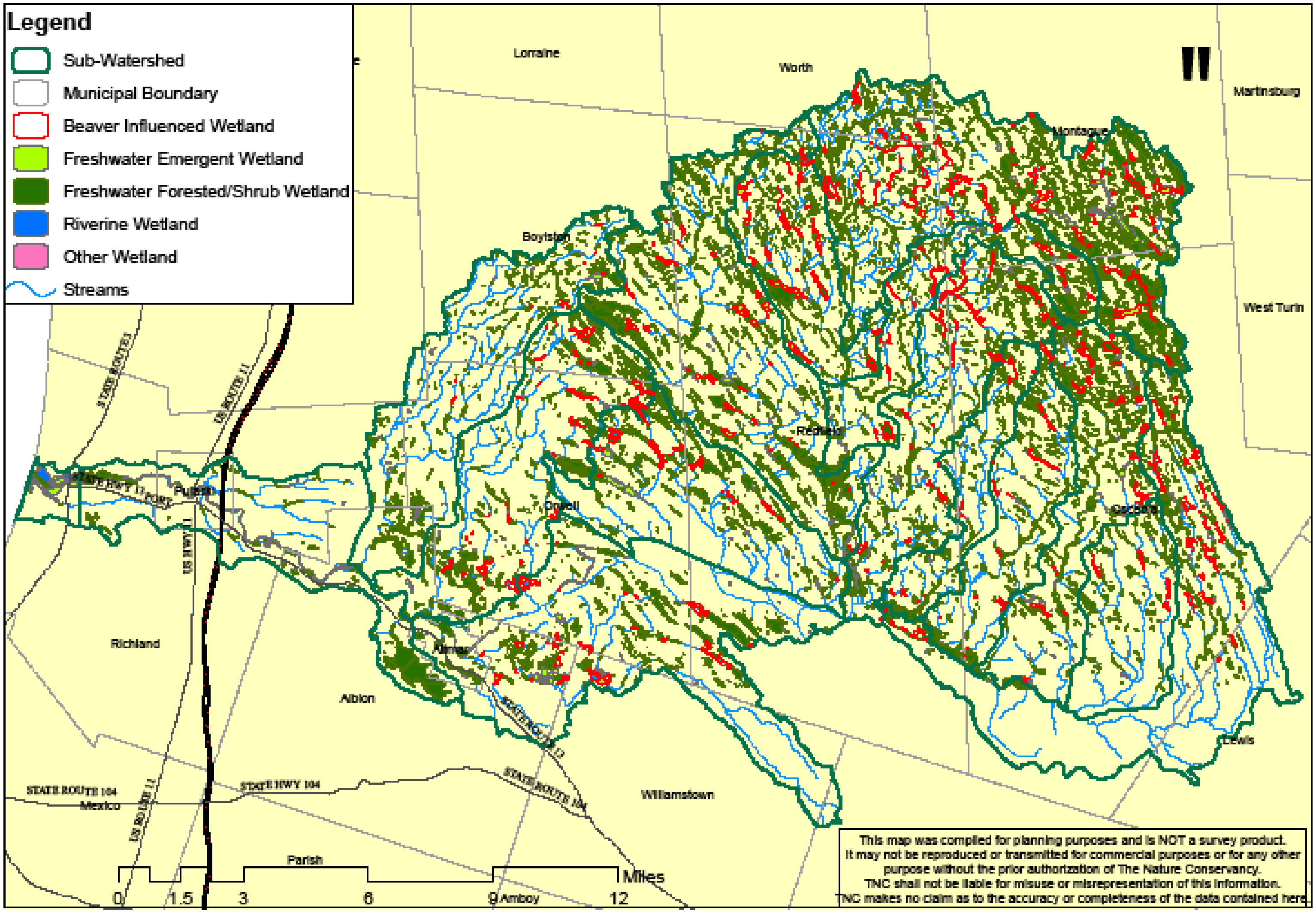


Figure 32. Beaver-influenced wetlands of the Salmon River watershed.

2.5.2.3 KEA – CONDITION – Water Quality

Indicator - Percent Natural Vegetation in 100-ft-wide Buffer: Section 2.2.2.6 provides background and rationale for this indicator. Ranking criteria for this indicator are provided in Table 6. Buffer analyses were conducted only for the large open waters of the watershed (Lighthouse Hill and Redfield Reservoirs).

Current Condition – Lighthouse Hill Reservoir, Good; Redfield Reservoir, Good: Figure 33 illustrates land-cover types surrounding the Lighthouse Hill and Redfield reservoirs. Natural vegetation represents 91% and 98% of the land-cover types within the 100-ft buffers of the Lighthouse Hill and Redfield reservoirs, respectively.

Indicator - Carlson Trophic State Index: The Carlson TSI index (USEPA 2007a) synthesizes related data associated with indicators of trophic condition. This index is described in section 2.2.2.6.

Current Condition – Unranked: No data are available for chlorophyll *a* or total P in any of the ponds or lakes of the sub-watershed. Harman et al. (2000) classified the Redfield Reservoir as oligotrophic. They reported Secchi disk measurements of 2.2 m at the west end near the dam (with disk site limitation due to water color), and 1.5 m (depth to bottom) on the east end, and noted that nutrient loading does not appear to be substantial enough to support planktonic algal blooms. The potential for eutrophication in farm ponds in the western sub-watersheds is high.

Indicator – pH: pH is a measure of acidity, which may vary naturally across the watershed based upon the acid buffering capacity of soils and bedrock. Table 13 summarizes viability rankings for surface water pH.

Current Condition- Good: Available data (NYSDEC, Bureau of Fisheries, unpublished data) report the pH of the Redfield Reservoir in June 2003 to be 7.0 (neutral). No information is available for pH of the watershed's other open waters, but they probably do not vary greatly from those of other surface waters in the watershed (Sections 2.4 and 2.5).

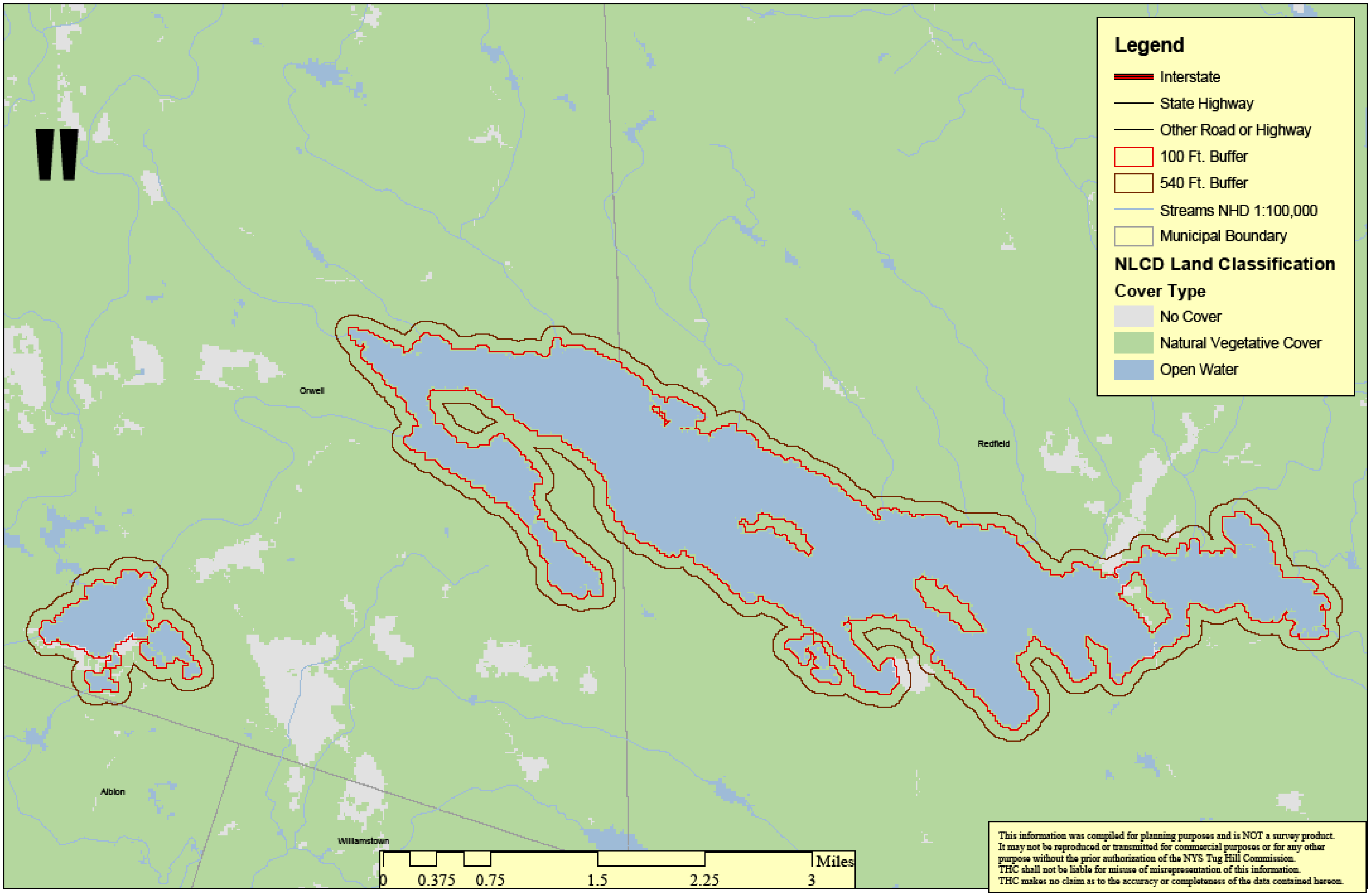


Figure 33. Analysis of land cover-types in 100- and 540-ft-wide buffers of the Lighthouse Hill and Redfield Reservoirs.

Indicator – Total Alkalinity: Table 13 presents viability rankings for surface water alkalinity, based upon susceptibility of waters of given alkalinity to acidification.

Current condition – Good: Available data (NYDEC unpublished data) indicate total alkalinity of the Redfield Reservoir in June 2003 to be 68.4 mg/L $CaCO_3$. No information is available for alkalinity of the watershed's other open waters, but they probably do not vary greatly from those of other surface waters in the watershed (Sections 2.4 and 2.5).

2.5.2.4 KEA – CONDITION - Toxins

A number of environmental toxins are of concern in the watershed, several of which are described in Section 2.2.2.8 along with viability ranking criteria using game fish health advisories and snapping turtle egg concentrations (Table 9). Conditions for toxins are ranked separately for waters below and above the Lighthouse Hill Reservoir due to the migration barrier imposed by the dam on fish returning from Lake Ontario, and for the Redfield Reservoir in the case of mercury. The Great Lakes are important sources of Mirex and PCBs and contaminated salmonines returning from Lake Ontario are believed to be a major source for these contaminants within the lower Salmon River watershed.

Indicator – Game Fish Tissue Mercury Concentration:

Current Condition – Redfield Reservoir - Poor: In 2006 the NYSDEC listed the Redfield Reservoir as a Section 303(d) Impaired Water due to mercury contamination in some game fish (NYSDOH 2006). It is likely that that mercury is being liberated from the reservoir sediments due to effects of fluctuating water levels on sediment chemistry (Evers et al. 2007).

Current Condition – Upper sub-watersheds - Unranked: Although the Redfield Reservoir was listed as an Impaired Water in 2006 due to mercury contamination, it is likely that that mercury is being liberated from the reservoir sediments. This mercury source is not expected to affect other water bodies upstream of the reservoir. However, it is also possible that mercury may be liberated from the extensive wetland systems, including small open waters, in the upper sub-watersheds due to similar interactions of fluctuating water chemistry on mercury liberation from sediments (Evers et al. 2007). No information is available on mercury contamination for other open water bodies of the upper watershed.

Current Condition – Lower sub-watersheds - Fair: Mercury is present in game fish below the dam, but no fish consumption advisories are currently in effect for mercury below the reservoir. It is not known whether mercury advisories are appropriately applied to other open water bodies in the lower watershed.

Indicator – Game Fish Tissue and Snapping Turtle Egg PCB Concentrations:

Current Condition – Upper sub-watersheds - Unranked: No information was available on PCB concentration in game fish above the Redfield Reservoir. There is currently no PCB fish consumption advisory for the Reservoir (NYSDOH 2006). No information is available on snapping turtle eggs in sections of watersheds that are isolated from Lake Ontario (available data are from Rice Creek Biological Station).

Current Condition - Lower sub-watersheds – Poor to Fair: There is currently a fish consumption advisory for PCBs in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006). It is not known whether PCB advisories are appropriately applied to other open water bodies in the lower watershed. In applying snapping turtle egg criteria, Pagano et al. (1999) reported snapping turtle egg concentrations to be 1.5 mg/kg at the nearby Rice Creek Biological Station in Oswego County, indicating the presence of PCBs in aquatic systems linked to Lake Ontario.

Indicator – Game Fish Tissue and Snapping Turtle Egg Mirex Concentrations:

Current Condition – Upper sub-watersheds – Good: Data made available by NYSDEC (J. Skinner, unpublished data) indicate that Mirex concentrations in fish taken above the Salmon River reservoir were below detection limits in 1988. Given that Mirex has shown a declining trend in the environment over the last few decades (J. Skinner, personal communication), and that Mirex appears to originate from sources in the Great Lakes, it is not believed that Mirex poses a threat to water bodies above the Lighthouse Hill Reservoir.

Current Condition - Lower sub-watersheds – Poor: There is currently a fish consumption advisory for Mirex in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006). It is not known whether fish consumption advisories for Mirex are appropriately applied to other open water bodies in the lower watershed. Pagano et al. (1999) reported Mirex concentrations in snapping turtle eggs to be 0.04 kg/mg at the nearby Rice Creek Biological Station in Oswego County.

2.5.2.5. KEA-CONDITION – Aquatic Plant Communities

Plant and algal communities will vary among the lakes and ponds of the watershed based upon water depth and trophic status of the water bodies. Guidance regarding the expected communities in small ponds of the region has not been obtained. The following considerations apply to the Redfield Reservoir.

Indicator – Total Macrophyte Cover: No information on the anticipated natural range of variation in aquatic vegetation of the reservoir could be located to serve as a quantitative baseline for estimating viability. Viability is ranked based upon the professional judgment of local researchers.

Current Condition – Good: Harman et al. (2000) conducted a survey of aquatic macrophytes in the Redfield Reservoir in 1999. They reported that most of the shoreline is emergent or shrub wetland, and that the lake supports little true aquatic vegetation. The submerged flora is diverse, but comprises little biomass within the reservoir. They concluded that cobble substrate, varying water levels, tea-colored water that precludes light penetration, and low nutrient status of the water combine to limit the production of aquatic macrophytes (including invasives) and algae. An earlier survey by (Petreszyn 1990) indicated the presence of no aquatic plants in the reservoir in 1990. Table 22 reports the Harman et al. (2000) data on macrophyte patches within the reservoir.

Table 22. Average cover (percent) of aquatic plant species at given depths in macrophyte beds of the Salmon River Reservoir in 1999 (Harman et al 2000). Data are averages of cover class midpoints from replicate transects placed systematically through macrophyte beds. Invasive species are indicated with an asterisk (*). These data do not estimate overall cover in the Reservoir.

	------water depth (m)-----			
Species	0.5	1	2	3
sedge (*Carex* spp.)	3			
knotweed (*Polygonum* sp.)	3			
broadleaf arrowhead (*Sagittaria latifolia*)	3			
bur-reed (*Sparaganium* sp.)	3			
*purple loosestrife (*Lythrum salicaria*)	3			
needle spikerush (Eleocharis acicularis)	3	3		
*Eurasian milfoil (*Myriophyllum spicatum*)		3		
wild celery (*Vallisneria americana*)		3		
bladderwort (*Utricularia* sp.)		15		
ribbonleaf pondweed(*Potamogeton epihydrus*)		3		
variableleaf pondweed (*Potamogeton gramineus*)	3	15		
Sago pondweed (*Potamogeton pectinatus*)	3	3	3	
small pondweed (*Potamogeton pusillus*)		3	3	
nodding water nymph (*Najas flexilis*)		37	3	
muskgrass (*Chara* sp.)		3		
total cover	24	88	9	0

Indicator – Invasive Species Dominance (% of total cover): Table 4 provides guidance for ranking macrophyte communities relative to invasive species dominance.

Current Condition – Good to Fair: Two potentially invasive macrophyte species (purple loosestrife and Eurasion milfoil, were observed in the Reservoir in 1999 (Harman et al. 2000), but when they were encountered, these species occurred in low relative abundance (Table 22). Purple loosestrife represented 12% of the total cover at 0.5 m depths, and milfoil accounted for 3% of total cover at 1 m depths. Milfoil was not thought to be a threat since it tends to occur in disturbed, eutrophic environments. This reservoir has a cobble bottom, with varying water levels and dark water color, which limits light penetration. All these variables limit milfoil.

2.5.2.6 KEA – CONDITION – Fish Community Composition

Fish communities of ponds, beaver dams and reservoirs will be dominated by warm water fish species, and will also reflect species that are introduced through stocking or by naturally reproducing species that are able to migrate to these waterbodies. Fish species frequently found in farm ponds include bluegill (*Lepomis macrochirus*) and yellow perch (*Perca flavescens*). Larger reservoirs support species such as chain pickerel (*Esox niger*), and other pikes (*Esocidae*); brown bullhead (*Ictalurus nebulosus*), yellow bullhead (*I. natalis*), bluegill (*Lepomis macrochirus*), pumpkinseed *L. gibbosus*), golden shiner (*Notemigonus crysoleucas*), and fathead minnow (*Pimephales promelas*). Reservoirs are often stocked with rainbow trout (*Salmo gairdneri*) (Edinger et al. 2002).

No information is available on fish communities inhabiting the smaller ponds of the watershed. The following information is specific to the Redfield and Lighthouse Hill Reservoirs.

Indicator – Fish Species Richness and Community Composition: This indicator is ranked based upon current management objectives for the Reservoir and the opinions of local fisheries managers.

Current Condition – Good: The Redfield Reservoir is a warm/cool water fishery that is managed by NYSDEC for game fish species. An NYSDEC survey was conducted in June 2003 using electroshocking techniques (Table 23). Certain biases are introduced to fish community composition data based upon season and methodology of sampling. This sample underestimates forage fish (minnows, young-of-year perch and panfish) which provide food base for other piscivores. The reservoir currently contains at least 16 species, including six game fish species. Stocking for walleye began in the reservoir in 2005 and therefore this species does not appear in the 2003 sample data. Tributaries to the reservoir are stocked with rainbow and brook trout. Bass were introduced in 1960s and these have flourished without additional stocking (F. Verdoliva, NYSDEC, personal communication). NYSDEC fisheries managers believe the Redfield Reservoir fishery to be in good condition.

The Lighthouse Hill Reservoir is managed as a cool water fishery, and is stocked with rainbow trout (~4000/yr). It was previously stocked with brown trout until 1991 (F. Verdoliva, NYSDEC, personal communication).

Table 23. Fish community composition of the Redfield Reservoir. Data are relative abundance of fish species in June 2003 electroshocking survey. (Source: R. Klindt, D. Bishop, NYSDEC, Region 7 Fisheries).

Species	Total
yellow perch	252
pumpkinseed	212
largemouth bass	120
smallmouth bass	92
rock bass	54
common shiner	10
golden shiner	5
white sucker	5
bluntnose minnow	3
rainbow trout	3
black crappie	1
brown bullhead	1
centeral mudminnow	1
creek chub	1
Etheastoma sp.	1

2.4.2.7 KEA – LANDSCAPE CONTEXT – Barriers to Migration

Indicator – Proportion of 540-ft Buffer in Natural Cover. Discussion regarding the ecological importance of natural vegetation cover in wide buffers strips along streams and other water bodies is provided in Section 2.3.2.7 and ranking criteria for this indicator is presented in Table 6. Buffer analyses were conducted only for the Lighthouse Hill and Redfield reservoirs.

Current Condition – Lighthouse Hill Reservoir, Fair; Redfield Reservoir, Good: Figure 33 illustrates land-cover types surrounding the Lighthouse Hill and Redfield reservoirs. Natural vegetation represents 87% and 98% of the land-cover types within the 540-ft buffers of the Lighthouse Hill and Redfield reservoirs, respectively.

2.5.3 Open Waters
Viability Summary

Notes on Guidance for Current Condition:

"NG"	No guidance was obtained to rank this indicator
"SGR"	Subjective guidance and/or ranking based on professional opinion
"ND"	No data are available with which to rank this indicator

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. -% of total current open waters (excluding reservoirs)		>90	75-90	<75	Good	SGR
KEA - Condition - Beaver Dams						
Ind. - % open waters beaver-influenced					Unranked	NG
KEA-Condition-Water Quality						
Ind. - % of 100-ft buffer in natural cover types		>90	75-90	<75		SGR, Klapproth & Johnson (2000), Baird & Wetmore (2006)
Redfield Reservoir					Good	
Lighthouse Hill Reservoir					Good	
Ind. - Carlson Trophic State Index		<50		>50	Unranked	ND - USEPA 2007
Ind. – pH		>6.5	5.0-6.5	<5		Driscoll et al. (2001), Stoddard et al. (2003), Shreiber (2007)
Redfield Reservoir					Good	
Other open waters					Good	extrapolated from headwaters

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
Ind. - Alkalinity (mg/L CaCO3)	>100	2.5-100	0-2.5	<0		Driscoll et al. (2001)
Reservoirs					Good	
Other open waters					Good	extrapolated from headwaters
KEA-Condition-Toxins						
Ind.– Game fish mercury concentration (ppm)			0-1	>1		NYSDOH (2006) fish consumption advisories
Redfield Reservoir					Poor	
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Fair	
Ind.– Game fish PCB concentration						NYSDOH (2006) fish consumption advisories
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Poor	
Ind.- Snapping turtle egg PCB concentrations		0	0-2	>2		Pagano et al. (1999)
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Poor-Fair	
Ind.- Game fish Mirex concentrations (ppm)						NYSDOH (2006) fish consumption advisories
Upper sub-watersheds					Good	
Lower sub-watersheds					Poor	
Ind.- Snapping turtle egg Mirex concentrations		0	0-0.2	>0.2		Pagano et al. (1999)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition-Aquatic Plant Communities						
Ind. - Macrophyte percent cover (for Redfield Reservoir)					Good	SGR, Harman et al. (2000)
Ind. - Invasive plant cover (avg % cover – Redfield Reservoir)	0	<5	5-25	>25	Good-Fair	Drake et al. (2003)
KEA-Condition-Fish Communities						
Ind. - Observed Richness (Redfield Reservoir)					>16 Good	SGR
KEA-Landscape Context-Barriers to Migration						
Ind. - % of 540-ft buffer in natural cover types		>90	75-90	<75		
Redfield Reservoir					Good	SGR
Lighthouse Hill Reservoir					Fair	SGR

2.6 Non-Estuarine Wetlands

2.6.1 Non-Estuarine Wetlands Target Definition

This target is intended to reflect the palustrine (wetlands containing emergent vegetation, i.e., not open water) systems of the watershed, with the exception of the Salmon River estuary, which was treated separately (Section 2.2) because of its transitional role between the Salmon River and Lake Ontario, and its linkage to larger dune/wetland complexes along the lake's eastern shore. Palustrine wetlands are those that are permanently saturated by seepage; permanently flooded; or are seasonally or intermittently flooded if the vegetative cover is dominated by species that are tolerant of saturated soils (hydrophytes), the soils display physical and chemical features of being saturated, and a hydrologic regime exists that leads to seasonally flooded or saturated conditions (Cowardin et al. 1979).

The Salmon River watershed, along with the greater Tug Hill region, contains extensive and diverse wetland communities (Figure 34). The abundance of wetlands within the region is due to the abundance of precipitation (Section 2.1); and to glacial deposition of compacted till materials on this landscape of limited topographic relief, which together impede drainage of soil water. The variety of wetland types reflects the complexity and interaction of soils, bedrock and flowpaths of soil solution and groundwater.

Wetlands provide a number of important ecological and societal functions to the watershed (NYSDEC 2007a, NRCS 2007). They store surface and subsurface waters thereby providing natural flood abatement within this watershed that receives and distributes up to 50" of annual precipitation. They sequester nutrients and sediment that enter aquatic systems from upland habitats, thereby preventing downstream transport and loading of sediments and nutrients that would eutrophy lakes and streams. They provide unique and necessary habitat for a number of plant and animal species, many of which are rare or endangered, and provide spawning habitat for fish.

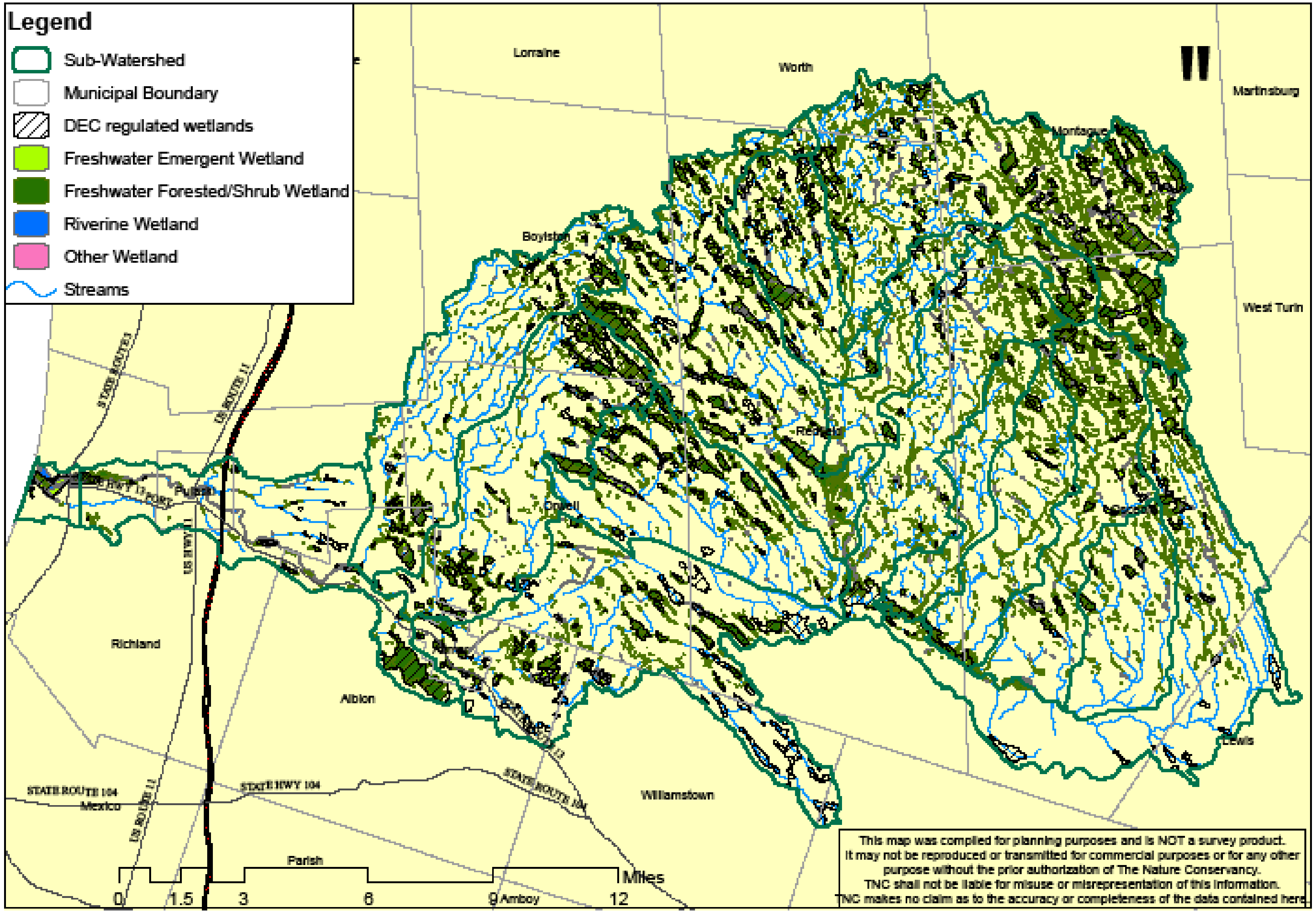


Figure 34. Non-estuarine wetlands of the Salmon River watershed.

2.6.2 Non-Estuarine Wetland Viability

2.6.2.1 KEA: SIZE – Wetland Area

The ability of wetland systems to provide ecosystem services is related to both the absolute area of wetlands (i.e., habitat availability for unique communities and rare species) and the proportion of land area occupied by wetlands (efficiency of nutrient retention and hydrologic regulation in watershed).

Indicator – Total Surface Area of Wetlands (ac): This indictor provides an estimated current baseline of wetland area for each of the sub-watersheds. There are no historic estimates of wetland area for the watershed. Future levels of wetland area can be assessed as deviations from existing levels. Potential sources of information to quantify wetland conversion rates include NYSDEC and US Army Corps of Engineers permitting programs, however, not all activities are permitted. Still, permit records may provide insight to areas of the watershed where conversion pressures are greatest. Another source of information would be photo interpretation of ASCS aerial imagery, which is currently obtained on two-year increments.

<u>Current Condition - Unranked:</u> Total palustrine (excluding lakes and ponds) wetland area within the watershed is approximately 23,000 acres (Table 24). Note that the data layers utilized in making this estimate include the NYSDEC Regulated Wetlands, which only maps wetlands ≥12.4 acres, and the US Fish and Wildlife Service National Wetlands Inventory (NWI), which is derived from air photo analysis. Both data sources likely under-represent total wetland area because the smallest wetland are not included or detected. A recent estimate suggests that approximately 1/3 of New York's fens remain unmapped due to their small size or non-jurisdictional status (Bedford and Godwin 2003). It should also be noted that no digital NWI data were available for portions of some sub-watersheds (see Table 24). Therefore, reported areas are underestimated for these sub-watersheds.

Indicator – Percent of Total Land Area as Wetlands: There are no historic records of wetland area or proportion of land base as wetland in the watershed and its respective sub-watersheds. The following data are provided for comparisons among sub-watersheds and for baseline information to facilitate future comparisons.

<u>Current Condition – Good:</u> The total 23,000 acres of wetland within the watershed represents approximately 13% of the watershed's land base. Forested and scrub/shrub wetlands consistently are the most abundant wetland category in all sub-watersheds. For those sub-watersheds with complete data, wetland coverage ranged from 23% (Mad River drainage) to 8% (Trout Brook drainage). No baseline information is available on preexisting wetland acreage and cover in the watershed. It is possible that some wetlands were drained for agriculture in the lower sub-watersheds and that those losses persist (e.g., in the Trout Brook sub-watershed, which has 8% wetland area, and is among the most heavily farmed, see Figure 5). If

wetlands were originally drained for agriculture in the upper sub-watersheds it is likely that sufficient time has passed to permit wetland hydrology and vegetation in impacted areas to return to natural conditions since the wide-scale abandonment of agriculture around the turn of the 20th century. Given the lack of development pressures in the upper sub-watersheds, it is not believed that wetland losses to development have been great there.

Table 24. Estimated area of wetland types in sub-watersheds of the Salmon River Watershed. Sub-watersheds highlighted with an asterisk were lacking digital National Wetland Inventory data, and therefore area is underestimated in these sub-watersheds.

	*BBMC	BGWM	COBR	*FBTT	GRMM	*KESF	LSRM	MARI
Wetland Occurrences								
Freshwater Emergent Wetland	43	31	32	50	52	20	27	67
Freshwater Forested/Shrub Wetland	320	259	201	277	344	96	90	654
Riverine	7	0	4	1	9	0	4	0
Other	2	0	0	0	0	0	0	0
Total Wetland Area (acres)								
Freshwater Emergent Wetland	187	187	161	196	158	48	144	547
Freshwater Forested/Shrub Wetland	1347	917	938	1477	1153	394	854	4301
Riverine	84	0	18	1	27	0	346	0
Other	20	0	0	0	0	0	0	0
Total	***1639***	***1104***	***1117***	***1674***	***1338***	***442***	***1345***	***4848***
Percent of Subwatershed	***8***	***16***	***17***	***17***	***12***	***7***	***12***	***23***
Avg. Size of Wetlands (acres)								
Freshwater Emergent Wetland	4	6	5	4	3	2	5	8
Riverine	12	0	4	1	3	0	87	0
Freshwater Forested/Shrub Wetland	4	4	5	5	3	4	9	7
Other	10	0	0	0	0	0	0	0

Table 24, continued

	NOBR	ORPE	PECK	PMLB	SBLB	TRBR	*UPSR	*TOTAL*
Wetland Occurrences								
Freshwater Emergent Wetland	89	49	32	15	21	35	37	**585**
Freshwater Forested/Shrub Wetland	523	307	239	202	128	268	213	**3880**
Riverine	5	2	0	1	0	1	2	**31**
Other	0	0	0	0	0	0	0	**2**
Wetland Area (acres)								
Freshwater Emergent Wetland	221	159	151	60	24	103	157	***2503***
Freshwater Forested/Shrub Wetland	2828	1434	1121	784	444	956	990	***19938***
Riverine	13	30	0	3	0	7	1	***529***
Other	0	0	0	0	0	0	0	**20**
Total	***3061***	***1623***	***1272***	***847***	***468***	***1065***	***1148***	***22991***
Percent of Subwatershed	***17***	***12***	***12***	***12***	***10***	***8***	***7***	***13***
Avg. Size of Wetlands (acres)								
Freshwater Emergent Wetland	2	3	5	4	1	3	4	***4***
Riverine	3	15	0	3	0	7	1	***5***
Freshwater Forested/Shrub Wetland	5	5	5	4	3	4	5	***17***
Other	0	0	0	0	0	0	0	***10***

2.6.2.2 KEA-CONDITION –Wetland community types

A number of wetland community types are known to occur within the Salmon River watershed. Type descriptions are provided by Edinger et al. (2002), and detailed descriptions of exemplary occurrences within the watershed are provided by Howard (2006). Species composition has also been documented in several other area wetlands (A. Nelson, in Dru Associates 2001). Generalized descriptions (taken from Edinger et al. 2002) of wetland community types occurring within the watershed are included in section 2.6.2.11. Wetland community types (and NY Natural Heritage Rankings) occurring in the watershed are:

-*Black spruce – tamarack bog (G4G5 S3)*
-*Floodplain forest (G3G4 S2S3)*
-*Hemlock-hardwood swamp (G4G5 S4)*
-*Red maple – hardwood swamp (G5 S4S5)*
-*Spruce-fir swamp (G3G4 S3)*
-*Vernal Pool (G4 S3S4)*
-*Dwarf Shrub Bog (G4 S3)*
-*Inland poor fen (G4 S3)*
-*Shrub swamp (G5 S5)*
-*Sedge meadow (G5 S4)*
-*Shallow emergent marsh (G5 S5)*

Indicator – Area (ac) of Wetland Community Types: Area of respective community types is a direct measure of habitat availability and ecosystem functions.

Current Condition – Unranked: There is currently no accurate quantitative estimation for the amount of different wetland community types, or for the historic abundance of these community types in the watershed. Recent efforts have been made to apply GIS models to predict the occurrence of these communities, but several local wetland scientists concluded that the accuracy of these predictive models currently suffers from a lack of data.

2.6.2.3 KEA – CONDITION – Invasive Species

Indicator – Frequency of Invasive Plant Occurrence in Wetlands: Table 4 presents the criteria used to rank community viability in relation to occurrence and/or dominance of invasive species.

Current Condition – Good: There are currently no monitoring efforts for invasive plant species in the watershed, so no quantitative data are available with which to rank this indicator. However, several local wetland scientists agreed that there is a remarkable lack of invasive plant species in the wetlands they have visited in the watershed. Species such as purple loosestrife and *Phragmites* tend to occur at lower elevations, and glossy buckthorn (*Rhamnus frangula*) has been observed in some peatlands.

2.6.2.4 KEA – CONDITION – Rare Species Populations

Several species of concern are known to inhabit wetland communities within the watershed. Species reported by Howard (2006) include:

Jacob's-ladder (*Polemonium vanbruntiae*) – G3G4 S3
Lesser bladderwort (*Utricularia minor*) – G5 S3
Pied-billed grebe (*Podilymbus podiceps*) – G5 S3B,S1N
Pitcher plant borer moth (*Papaipema appassionata*) – G4 SU

The following viability ratings are based upon NY Natural Heritage reports of known occurrences within the watershed. Element distribution models for predicting additional occurrences of these species have been developed but require verification.

Indicator – Jacob's-ladder Population Density:
Current Condition – Excellent: The New York Natural Heritage program rated the occurrence of this plant in the town of Montague as excellent (Howard 2006). This report indicated thousands of plants in an 8-acre site.

Indicator – Lesser Bladderwort Population Density:
Current Condition – Fair: The New York Natural Heritage program rated the occurrence of this plant in the town of Albion as fair (Howard 2006). This report indicated a small colony in a 1-acre, undisturbed area.

Indicator – Pied-billed Grebe Occurrence:
Current Condition – Fair to Poor: The New York Natural Heritage (Howard 2006) program reported the sighting in 2005 of one territorial male in a marsh in Orwell.

Indicator – Pitcher Plant Borer Moth Occurrence:
Current Condition – Excellent: The New York Natural Heritage program reported the occurrence of 40 acres of required habitat at a bog in Albion (Howard 2006).

2.6.2.5 KEA – CONDITION – Pests and Pathogens

There are few pests and pathogens of concern currently influencing wetland community composition in the watershed.

Indicator – Viburnum Leaf Beetle Occurrence: The viburnum leaf beetle (*Pyrrhalta viburni*) is native to most areas of Europe and was first observed in Ontario in 1947 and in New York in 1996. Symptoms of infestation are skeletonized leaves in the spring (May-June), heavily chewed leaves in the summer (July-September), and terminal twigs with characteristic egg "caps" arranged in straight rows, seen throughout the summer months. Host plants include many *Viburnum* species (e.g., arrow-wood, cranberry bush). For more information see: http://www.ceris.purdue.edu/napis/pests/vlb/news/fs-vlb.html.

Viability ranking for this indicator is provided in Table 4.

Current Condition - Poor: No quantitative data exist for viburnum beetle infestations in the watershed, however local botanists have reported recent widespread defoliation and mortality of arrow-wood throughout the Tug Hill region.

2.6.2.6 KEA- Condition - Sentinel Group Abundance (Migratory Birds, Amphibians)

Certain groups, or guilds, of wildlife require wetlands for some aspects of their life histories, and therefore the populations of these groups may serve as "sentinels" of wetland viability in the watershed.

Indicator – Amphibian and Reptile Densities and/or Frequencies: There are no sources of data specific to the watershed indicating expected abundance of amphibians and reptiles in different wetland types. The only available information on amphibian populations is derived from the New York Amphibian and Reptile Atlas database (NYSDEC 2007). This database lists presence/absence of species throughout New York on the scale of a USGS 7-1/2" quadrangle, and can be used to infer the frequency of occurrence of certain species across the region relative to the whole of New York. It should be noted that this approach, which is based on relative frequencies in New York, is not sensitive to negative effects of global amphibian and reptile declines that would influence populations across New York.

Viability rankings for this indicator are presented in Table 25.

Table 25. Viability ranking for frequencies of occurrence of widespread amphibian and reptile species within the Salmon River watershed relative to the whole of New York based upon NY Amphibian and Reptile Atlas data (NYSDEC 2007b).

	Good	Fair	Poor
percent of widespread amphibian and reptile species occur in Salmon River watershed with greater frequencies than the whole of New York	>90%	75-90%	<75%

Current Condition - Good: Twenty-six amphibian and reptile species that utilize wetlands, and that are distributed equitably throughout New York (i.e., no regional patterns of distribution), occur in the Salmon River watershed (Table 26). Of these, 24 species (92%) occur with equal or greater frequency in the watershed than the whole of New York.

Table 26. New York Amphibian and Reptile (Herp) Atlas data for amphibians and reptiles that inhabit or utilize wetland communities, and that have natural ranges that are equitably distributed across New York and include the Salmon River watershed. Data are percentage of USGS quads in the watershed (n=10) and New York (n=979) in which a species has been reported. (Data available at: http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/).

	% of watershed	% of NY
Salamanders		
Common mudpuppy (*Necturus maculosus*)	10	4
Blue-spotted salamander complex (*Ambystoma laterale x jeffersonianum*)	20	12
Spotted salamander (*Ambystoma maculatum*)	40	50
Red-spotted newt (*Notophthalmus v. viridescens*)	80	63
Northern dusky salamander (*Desmognathus fuscus*)	40	36
Northern redback salamander (*Plethodon c. cinereus*)	90	73
Northern spring salamander (*Gyrinophilus p. porphytriticus*)	50	27
Northern two-lined salamander (*Eurycea bislineata*)	100	59
Snakes		
Northern water snake (*Nerodia s. sipedon*)	40	36
Northern brown snake (*Storeria d. dekayi*)	30	23
Northern redbelly snake (*Storeria o. occipitomaculata*)	40	31
Common garter snake (*Thamnophis sirtalis*)	100	84
Eastern ribbon snake (*Thamnophis sauritus*)	10	8
Northern ringneck snake (*Diadophis punctatus edwardsii*)	30	25
Smooth green snake (*Liochlorophis vernalis*)	30	15
Toads and Frogs		
Eastern American toad (*Bufo a. americanus*)	100	83
Gray tree frog (*Hyla versicolor*)	60	53
Northern spring peeper (*Pseudacris c. crucifer*)	100	88
Bullfrog (*Rana catesbeiana*)	100	74
Green frog (*Rana clamitans melanota*)	100	93
Wood frog (*Rana sylvatica*)	100	69
Northern leopard frog (*Rana pipiens*)	70	49
Pickerel frog (*Rana palustris*)	100	50
Turtles		
Common snapping turtle (*Chelydra s. serpentina*)	40	65
Wood turtle (*Clemmys insculpta*)	20	19
Painted turtle (*Chrysemys picta*)	70	69

Indicator – Numbers of Breeding or Migratory Waterfowl: Personnel at NYSDEC Bureau of Wildlife indicate that no quantitative data exist for migratory waterfowl use of wetlands within the watershed or in NYSDEC wildlife management units of the greater Tug Hill region. Furthermore, there is no guidance with which to rank expected levels of use, except to provide long-term trend data for the wetland systems of the watershed.

Current Condition - Unranked:

2.6.2.7 KEA-Condition-Hydrology

Different wetland types develop through variations in quantity and quality of surface and groundwater flow. For instance, fen communities require nutrient-enriched groundwater discharge in order to develop, and their categorization into "rich," "medium," and "poor" fen types reflects nutrient levels of the water sources. For other wetland communities the stage and duration of flooding dictates community assemblage, and year-to-year variation in water levels may serve as a source of disturbance that maintains a diverse species mix. Within a given wetland complex diversity of community types reflects, in part, the combinations and location of water sources feeding the system (Drexler and Bedford 2002). Hydrologic alterations that would negatively influence wetland community occurrence include declines in surface water flow; ditching or tiling of wetland areas; breaching of impoundments; filling of wetlands above prevailing surface water or groundwater levels; and lowering of groundwater levels.

Indicator – Regional Annual Water Surplus (inches): The abundance of wetlands in the greater Tug Hill region is due, in large part, to the high levels of precipitation that sustain wetland hydrology. Annual water surplus is the measure of excess precipitation (surplus = precipitation minus losses by evaporation and plant transpiration) that eventually contributes to surface waters and groundwater. Deviations in annual water surplus from natural levels of variation would indicate potential for region-wide disruptions of wetland hydrology.

Average water surplus values range from 40" of surplus water at the highest elevations of the Tug Hill Plateau to approximately 16" at Lake Ontario (Eschner et al. 1974). No data were obtained with which to analyze the historic range of variation in these levels for the region.

Current Condition – Good: Prevailing water surplus levels currently sustain widespread and diverse wetlands within the watershed.

Indicator – Source Alteration (% from groundwater and surface water): The source and quality of water supply to individual wetland systems dictates wetland community type and condition. Viability ranking for this indicator requires hydrologic information for each wetland community type, and these relationships have been established in other areas supporting similar communities. However, to make this a useful indicator for this watershed assessment, distributions of respective community types must first be known.

Current Condition – Unranked: A group of local wetland scientists suggested that no reliable information currently exists to accurately characterize the distribution of respective wetland types within the watershed, and therefore, to infer localized hydrologic regimes that support those wetlands.

2.6.2.8 KEA- Condition - Toxins

A number of toxins may bioaccumulate in aquatic foodwebs and therefore may adversely affect wetland biota. These include PCBs, DDT, Mirex and mercury. Substantial monitoring for these compounds is conducted for game fish due to the potential for human consumption. Contamination of non-game species has received far less consideration with which to draw inference regarding the viability of natural resource targets in the Salmon River watershed. Furthermore, with the exception of game fish, no monitoring programs of toxins are known to exist for game or non-game species of the watershed.

Indicator – Game Fish Tissue Mercury Concentration: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for mercury.

Current Condition – Lower sub-watersheds - Fair: Elevated mercury levels are known to occur in fish in the lower Salmon River, but currently there are no fish consumption advisories for mercury in fish taken from the lower Salmon River (NYSDOH 2006). It is possible that the sources of mercury contamination in fish of the lower watershed also impact other wetland fauna due to migrations of salmonines.

Current Condition – Upper sub-watersheds – Unranked: In 2006 the NYSDEC listed the Redfield Reservoir as a Section 303(d) Impaired Water due to mercury contamination in some fish (NYSDOH 2006). It is likely that the mercury source for the reservoir is internal loading from sediments due to water fluctuations. Therefore conditions within the reservoir should not be extrapolated beyond the reservoir. However, mercury is liberated from soils and sediments in the toxic methyl form under conditions that are common in wetlands (Evers et al. 2007). Given the extensive wetland systems within the watershed, it is possible that mercury contamination may be problematic here. No other information exists with which to rank this indicator for upper sub-watersheds.

Indicator – Snapping Turtle Egg PCB Concentrations: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for PCB.

PCB contamination threats in wetlands have recently been addressed using snapping turtle eggs (Table 9), which have been shown to be highly correlated with contaminant concentrations in liver and adipose (fat) tissue (Pagano et al. 1999). Turtles accumulate persistent contaminants in their tissues from food and water taken directly from the wetland systems they inhabit, so their contamination levels directly reflect those of their immediate environments.

<u>Current Condition – Upper sub-watersheds, Unranked; Lower sub-watersheds, Fair:</u> There are no data available for snapping turtle PCB concentrations in the watershed. However, Pagano et al. (1999) reported snapping turtle egg concentrations to be 1.5 mg/kg at the nearby Rice Creek Biological Station in Oswego County. The regional source for PCB contamination is believed to be Lake Ontario, with migratory salmonines serving to disperse PCBs when they move inland from the lake. Therefore, sub-watersheds above the Lighthouse Hill Reservoir are isolated from this source. PCB concentrations in sport fish are known to be lower in the Redfield Reservoir compared to the lower reaches of the Salmon River (Section 2.5.2.4). Therefore, it is probable that PCB concentrations in wetland fauna will be lower in the upper sub-watersheds than in the lower sub-watersheds.

Indicator - Indicator – Mink Jaw Lesions: Section 2.2.2.8 presents background on ranking criteria for PCBs based upon occurrence of cancerous lesions in mink jaws.

<u>Current Condition – Lower sub-watersheds – Poor:</u> There are no data available reporting the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Beckett and Haynes (2007) in the Rochester Embayment, mink feeding within the Lake Ontario system appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario.

<u>Current Condition – Upper sub-watersheds – Unranked:</u> No data are available that suggest exposure of mink to PCB concentrations sufficiently high to cause cancerous lesions in waterways where prey species are isolated from Lake Ontario.

Indicator – Snapping Turtle Egg Mirex Concentrations: Section 2.2.2.8 presents background on toxic effects, sources of contamination and viability ranking criteria for Mirex.

As with PCBs this indicator will be ranked using criteria based on snapping turtle eggs (Table 9).

<u>Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair:</u> There are no data available for snapping turtle Mirex concentrations in the watershed.

However, Pagano et al. (1999) reported Mirex concentrations in snapping turtle eggs to be 0.04 kg/mg at the nearby Rice Creek Biological Station in Oswego County. As with PCBs, the regional source for Mirex contamination is believed to be Lake Ontario, with sub-watersheds above the Lighthouse Hill Reservoir being isolated from this source. Mirex concentrations in sport fish are known to be lower in the Redfield Reservoir compared to the lower reaches of the Salmon River (Section 2.5.2.4). Therefore, it is probable that Mirex contamination of wetland fauna will be lower in the upper sub-watersheds than in the lower sub-watersheds.

2.6.2.9 KEA-Condition-Eutrophying Nutrients (Nitrogen and Phosphorus)

Wetlands play key roles in cycling of nitrogen (N) and phosphorus (P). Nutrient cycling processes in wetlands are complex and are influenced by a number of factors including pH and oxidation-reduction capacity (Osmond et al. 1995) and the local abundance of nitrogen-fixing organisms (e.g., speckled alder, Hurd et al. 2005). In general, however, wetlands tend to remove these nutrients from ground and surface waters. For instance, wetland buffers in agricultural areas have been shown to reduce the amount of N and P reaching streams by approximately 60% and 20-50% respectively (Illinois Groundwater Consortium 1995). Phosphorus is typically removed by sedimentation of plant litter or formation of insoluble precipitates with calcium and iron (Osmund et al. 1995). Nitrogen is removed from soil and surface water through sedimentation of plant litter and through the microbe-mediated process of denitrification (Saunder and Kalff 2001), which forms gaseous N_2 that is then released to the atmosphere.

Although wetlands are capable of long-term sequestration and removal of N and P, high inputs of these nutrients are known to reduce wetland biodiversity. Potential sources of excess P in wetlands include agriculture runoff (e.g., Illinois Groundwater Consortium 1995; Drexler and Bedford 2002) and point sources such as sewage treatment plants. Excess N inputs are derived from agriculture runoff, atmospheric deposition (Hurd et al. 2005), and, when present, N-fixing plants (Hurd et al. 2005). Inputs traced to elevated N deposition include linkages to N-saturated upland forests (see Section 2.7), and these may be significant to the Salmon River watershed because of the high level of atmospheric N deposition to the Tug Hill region (Figure 35).

Drexler and Bedford (2002) found that P concentrations in wetland soils were strongly and negatively correlated with vascular plant and bryophyte richness in a fen in central New York. Plant species with the genetic capacity to increase growth rates in response to elevated N and P availability are able to competitively displace other slow-growing species. These competitive interactions can reduce biodiversity and lead to local problems of weedy or invasive species such as *Phragmites* (Rickey and Anderson 2004) and possibly *Typha* (Drexler and Bedford 2002).

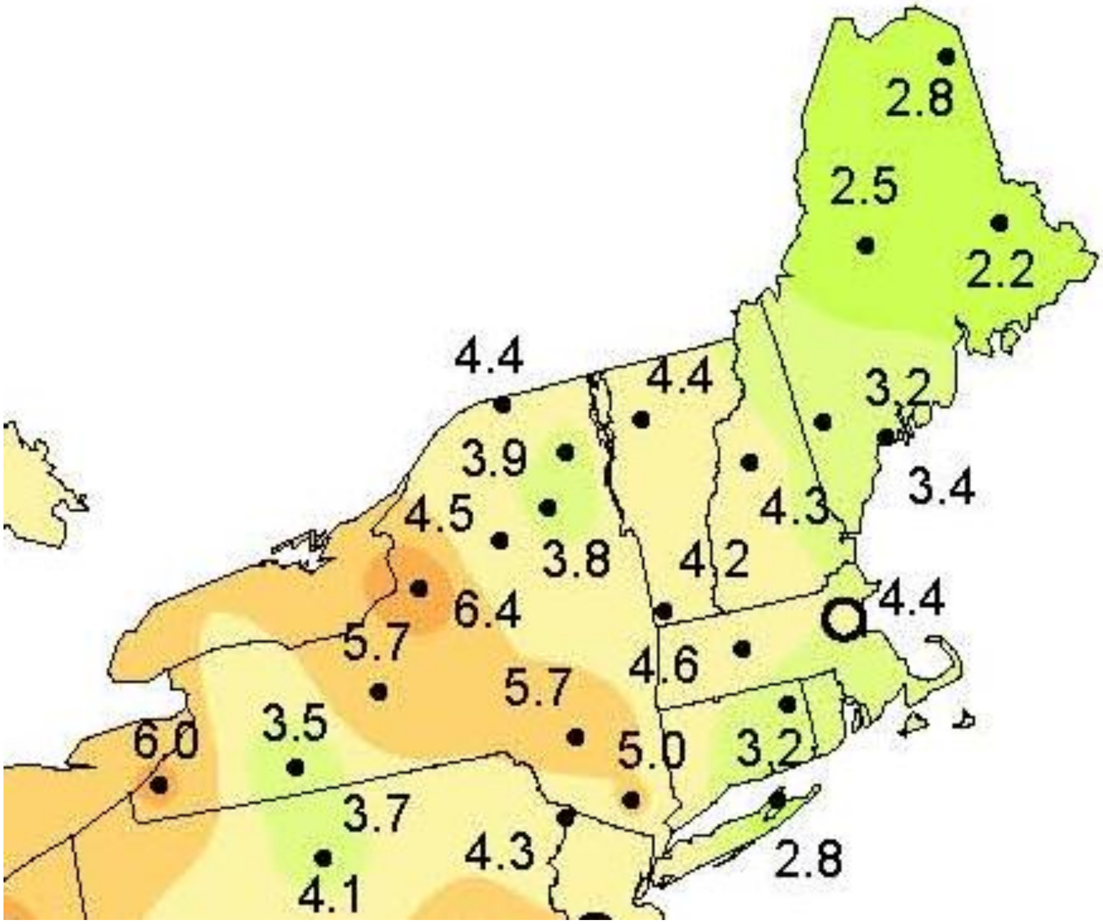


Figure 35. Annual (2005) total wet nitrogen (kg/ha as NO_3^- and NH_4^+) deposition in the northeastern US. Source: NADP 2007.

Indicator – Soil Nutrient Concentrations and Plant Richness: Available guidance for assessing N and P loading on wetland biodiversity (Table 27) comes from Drexler and Bedford (2002) who measured relationships between soil nutrient concentrations and plant diversity in different locations across a fen embedded within an agricultural landscape of central New York.

Table 27. Indicator rankings for soil nutrient concentrations and plant richness in fens (From Drexler and Bedford 2002).

	Soil Total P (mg/cm^3)	Soil extractable NO_3^- ($\mu g/cm^3$)	Vascular plant richness (# sp./m^2)	Bryophyte richness (# sp/m^2)
Good	.01	<dl	>20	>8
Poor	> 0.3	>0.02	<10	<5

Current Condition – Unranked: No data were obtained on soil or surface water nutrient concentrations for wetlands in the watershed, or on vascular plant and bryophyte species richness at the scale necessary to apply the ranking criteria.

Indicator – Percent Natural Land Cover-Types in 100-ft Wetland Buffer: Upland buffers containing natural vegetation may serve to reduce phosphorus and nitrogen loading to wetlands, which is known to negatively impact unique plant communities (Drexler and Bedford 2002). Additional background and guidance for ranking 100-ft buffers along water bodies are provided in Section 2.2.2.6 and Table 6.

Current Condition - Good: An analysis of land-cover types within 100-ft buffers of NYDEC regulated wetlands was conducted to assess current condition of this indicator. All sub-watersheds received a viability ranking of "good" (>90% cover as natural land-cover types, Table 28). In general, the lower, western sub-watersheds (Lower Salmon River-Main Stem, Trout Brook, Orwell-Pekin) have the most non-natural cover types within the 100-ft wetland buffers. Note that this analysis was conducted only on NYSDEC-regulated wetlands (> 9.4 acres).

Table 28. Summary of land-cover type analysis in 100-ft buffers of wetlands in the sub-watersheds of the Salmon River watershed. Non-natural cover types include: developed, agricultural, barren.

Subwatershed	% of 100-ft buffer with non-natural cover type
Beaverdam Brk-Meadow Crk-Reservoir	2
Beaver-Gillmore-Willow-McDougal	<1
Cold Brook	0
Fall Brook-Twomile-Threemile	1
Grindstone-Mill-Muddy	0
Keese-Smith-Finnegan	1
Lower Salmon River-Main Stem	7
Mad River	<1
North Branch	<1
Orwell-Pekin	3
Pennock-Coey-Kenny	<1
Prince-Mulligan-Little Baker	2
Stony Brook-Lime Brook	<1
Trout Brook	7
Upper Salmon River	<1

2.6.2.10 KEA-Landscape Context – Migration Barriers

Indicator –Percent Natural Land Cover-Types in 540-ft wetland buffers: Background and guidance for ranking 540-ft buffers along water bodies are provided in Section 2.2.2.9 and in Table 6.

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair: An analysis of land-cover types within 540-ft buffers of NYSDEC regulated wetlands was conducted to assess current condition of this indicator. All but two sub-watersheds received a viability ranking of "good" (>90% cover as natural land-cover types, Table 29) for this indicator. Most sub-watersheds had <5% of the 540-ft buffer in non-natural land-cover types. Two sub-watersheds, both in the lower, western portion of the watershed, ranked "fair" for this indicator (Lower Salmon River-Main Stem, 14% non-natural cover; Trout Brook, 13% non-natural cover). Non-natural land-cover types occur in 9% of the 540-ft buffer around wetlands in the Orwell-Pekin sub-watershed, which is also located in the western portion of the watershed. Note that this analysis was conducted only on NYSDEC-regulated wetlands (> 9.4 acres).

Table 29. Summary of land-cover type analysis in 540-ft buffers of wetlands in the sub-watersheds of the Salmon River watershed. Non-natural land cover types include: developed, agriculture, barren.

Subwatershed	% of 540-ft buffer with non-natural cover types
Beaverdam Brk-Meadow Crk-Reservoir	4
Beaver-Gillmore-Willow-McDougal	<1
Cold Brook	<1
Fall Brook-Twomile-Threemile	2
Grindstone-Mill-Muddy	<1
Keese-Smith-Finnegan	<1
Lower Salmon River-Main Stem	14
Mad River	<1
North Branch	<1
Orwell-Pekin	9
Pennock-Coey-Kenny	1
Prince-Mulligan-Little Baker	2
Stony Brook-Lime Brook	2
Trout Brook	13
Upper Salmon River	<1

Indicator – Length of Road Bisecting 540-ft Wide Wetland Buffers:

Road crossings have been shown to be a significant source of mortality to amphibians and reptiles (Hels and Buchwald 2001; Gibbs and Shriver 2005), especially those that breed in aquatic habitats and must cross roads to travel between hibernation and breeding sites.

No guidance is currently available to suggest quantifiable ratings related to road densities and mortality risks in amphibian/reptile populations. Subjective ranking criteria for this indicator are provided in Table 11 using the criterion of Semlitsch (1998) in which an estimated 95% of salamander populations occur within 540 ft of wetlands.

Current Condition – Unranked: An analysis was conducted of total road length intersecting 540-ft wide buffers around NYSDEC-regulated wetlands as a preliminary estimate of road densities within wetlands buffers in the watershed (Figure 36). Note that this analysis was conducted using only the mapped NYSDEC wetlands (>9.2 acres). Due to the fact that dirt and gated roads were not discerned from paved roads in this analysis, the results may overstate the potential for amphibian and reptile mortality by vehicles since traffic volume and speed are expected to be substantially lower on many road segments. However, it should also be noted that many of the dirt roads and gated paths are open to ATV traffic and therefore may still pose threats to migrating reptiles and amphibians. No determinations were made of viability for this indicator. Data are presented as a baseline for future analyses.

Results of the analysis are presented in Table 30. An estimated total of ~107 miles of road segments (~33%) occur in the watershed within 540 ft of NYSDEC-regulated wetlands. On a sub-watershed basis, road segments in wetland buffers ranged from 0.6 to 19.7 miles. Sub-watersheds with the greatest length of road within 540-ft buffers are North Branch (19.7 miles, 67% of total road length), Beaverdam Brook-Meadow Creek-Reservoir (17.4 miles, 40%), Orwell-Pekin (15.6 miles, 52%) and Lower Salmon River-Main Stem (14.7 miles, 24%).

Table 30. Summary of road segment lengths occurring within 540-ft buffers of NYSDEC-regulated wetlands in the Salmon River watershed. Note that road segments used in this analysis included paved, gravel and gated roads.

Sub-watershed	total road length (mi.)	road length in 540-ft buffer (mi.)	% of road length in 540-ft buffer
Beaverdam Brk-Meadow Crk-Reservoir	43.7	17.4	40
Beaver-Gillmore-Willow-McDougal	2.4	2.1	87
Cold Brook	3.5	1.2	34
Fall Brook-Twomile-Threemile	18.7	4.4	24
Grindstone-Mill-Muddy	12.3	1.7	14
Keese-Smith-Finnegan	8.8	0.8	9
Lower Salmon River-Main Stem	60.4	14.7	24
Mad River	19.9	7.5	38
North Branch	29.5	19.7	67
Orwell-Pekin	30.0	15.6	52
Pennock-Coey-Kenny	22.2	5.2	24
Prince-Mulligan-Little Baker	14.0	2.8	20
Stony Brook-Lime Brook	5.7	0.6	11
Trout Brook	31.9	8.7	27
Upper Salmon River	19.9	4.8	24
Total Salmon River Watershed	323.1	107.4	33

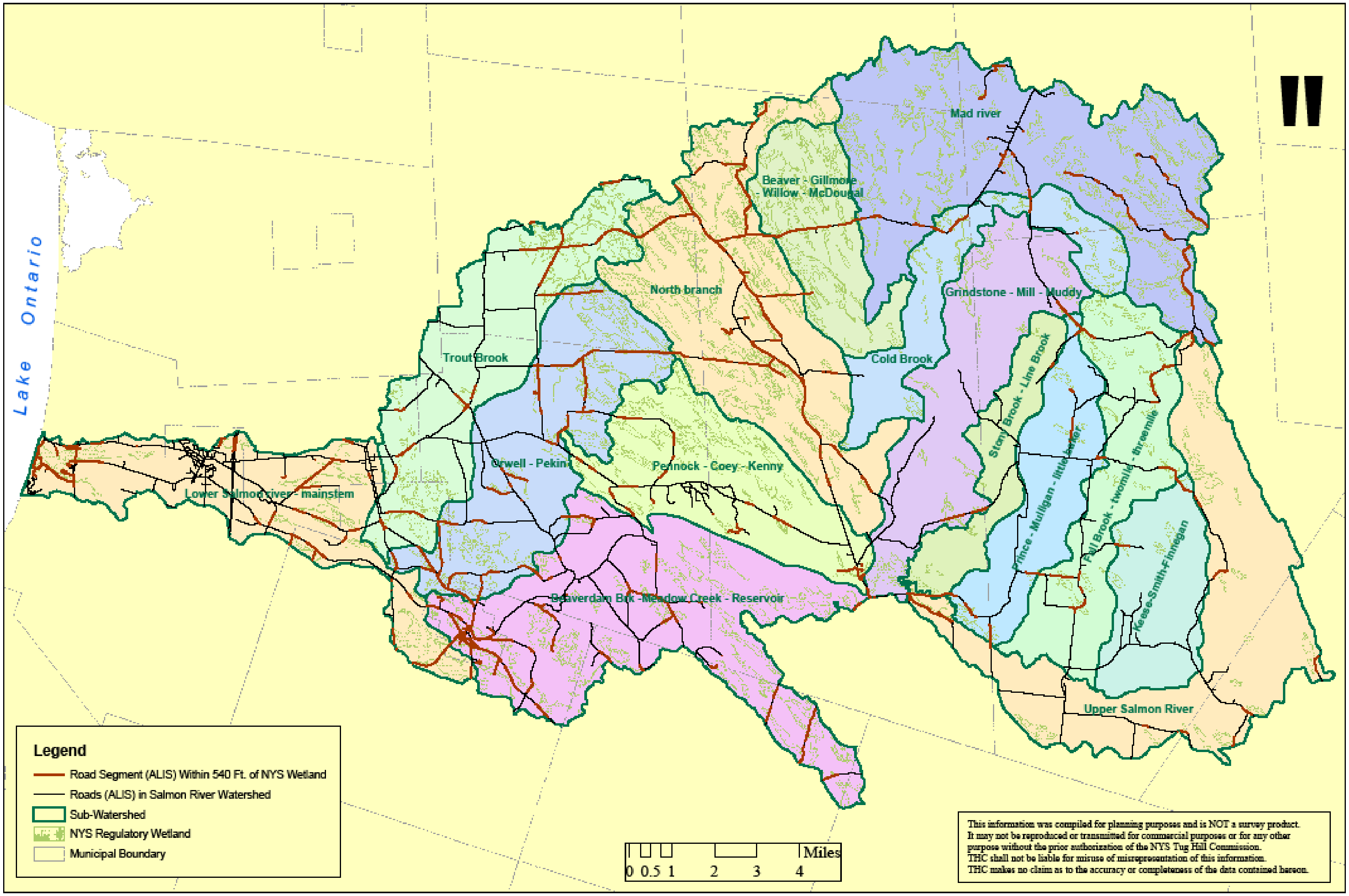


Figure 36. Road segments occurring within 540 ft of NYSDEC-regulated wetlands in the Salmon River watershed.

2.6.2.11 Generalized descriptions of wetland communities occurring in the watershed (from Edinger et al. 2002).

-Black spruce – tamarack bog (G4G5 S3)

These conifer-dominated wetlands occur on acidic peatlands in cool, poorly drained depressions throughout upstate New York but are most common in the Adirondacks ecozone. Characteristic trees are black spruce (*Picea mariana*) and tamarack (*Larix laricina*). Canopy cover is quite variable, ranging from open canopy woodlands with as little as 20% cover of evenly spaced canopy trees to closed canopy forests with 80 to 90% cover. In the more open canopy stands there is usually a well-developed shrublayer characterized by several shrubs typical of bogs: leatherleaf (*Chamaedaphne calyculata*), sheep laurel (*Kalmia angustifolia*), highbush blueberry (*Vaccinium corymbosum*), Labrador tea (*Rhododendron groenlandicum*), mountain holly (*Nemopanthus mucronatus*), and wild raisin (*Viburnum nudum* var.*cassinoides*). In closed canopy stands the shrublayer is usually sparse, but species composition is similar. The dominant groundcover consists of several species of *Sphagnum* moss, with scattered sedges and forbs. Characteristic herbs are the sedge *Carex trisperma*, cotton grass (*Eriophorum* spp.), pitcher plant (*Sarracenia purpurea*), bunchberry (*Cornus canadensis*), and cinnamon fern (*Osmunda cinnamomea*). In shady areas where the canopy is dense, gold thread (*Coptis trifolia*) and creeping snowberry (*Gaultheria hispidula*) may be found. Vascular plant diversity is usually low in these forested peatlands, but bryophyte and epiphytic lichen flora may be diverse. Characteristic animals include three-toed woodpecker (*Picoides tridactylus*), black-backed woodpecker (*Picoides arcticus*), olive-sided flycatcher (*Contopus borealis*), gray jay (*Perisoreus canadensis*), Lincoln's sparrow (*Melospiza lincolnii*), white-throated sparrow (*Zonotrichia albicollis*), golden-crowned kinglet (*Regulus satrapa*), spruce grouse (*Dendragapus canadensis*), and four-toed salamander (*Hemidactylium scutatum*).

-Floodplain forest (G3G4 S2S3)

This is a broadly defined hardwood forest type that occurs throughout upstate New York north of the coastal lowlands on mineral soil deposits of low floodplain terraces and river deltas. These sites are annually flooded in spring, and high areas are flooded irregularly. Some sites may be quite dry by late summer. The most abundant trees include silver maple (*Acer saccharinum*), ashes (*Fraxinus pensylvanica, F. nigra,F. americana*), cottonwood (*Populus deltoides*), red maple (*Acer rubrum*), box elder (*Acer negundo*), elms (*Ulmus americana, U. rubra*), hickories (*Carya cordiformis, C. ovata, C. laciniosa*), butternut and black walnut (*Juglans cinerea, J. nigra*), sycamore (*Platanus occidentalis*), oaks (*Quercus bicolor, Q. palustris*), and river birch (*Betula nigra*). Other less frequently occurring trees include hackberry (*Celtis occidentalis*), tulip tree (*Liriodendron tulipifera*), basswood (*Tilia americana*), and sugar maple (*Acer saccharum*). Introduced trees, such as white willow (*Salix alba*) and black locust (*Robinia pseudo-acacia*), have become established in some floodplain forests. The most abundant shrubs include spicebush (*Lindera benzoin*), ironwood (*Carpinus carolinianus*), bladdernut (*Staphylea trifoliata*), speckled alder (*Alnus incana* spp. *rugosa*), dogwoods *(Cornus sericea, C.foemina* spp. *racemosa, C. amomum*), viburnums (*Viburnum cassinoides, V.*

prunifolium, V. dentatum, V. lentago), and sapling canopy trees. Invasive exotic shrubs that may be locally abundant include shrub honeysuckles (*Lonicera tatarica, L. morrowii*), and multiflora rose (*Rosa multiflora*). Other less frequently occurring shrubs include meadowsweet (*Spiraea alba* var. *latifolia*) and winterberry (*Ilex verticillata*). The most abundant vines include poison ivy (*Toxicodendron radicans*), wild grapes (*Vitis riparia, Vitis* spp.), Virginia creeper (*Parthenocissus quinquefolia*), virgin's bower (*Clematis virginiana*), and, less frequently, moonseed (*Menispermum canadense*). The most abundant herbs include sensitive fern (*Onoclea sensibilis*), jewelweeds (*Impatiens capensis, I. pallida*), ostrich fern (*Matteuccia struthiopteris*), white snakeroot (*Eupatorium rugosum*), wood nettle (*Laportea canadensis*), false nettle (*Boehmeria cylindrica*), goldenrods (*Solidago gigantea, S. canadensis, Solidago* spp.), lizard's tail (*Saururus cernuus*), and jumpseed (*Polygonum virginianum*). Invasive exotic herbs that may be locally abundant include moneywort (*Lysimachia nummularia*), garlic mustard (*Alliaria petiolata*), dame's rockets (*Hesperis matronalis*), and stilt grass (*Microstegium vimineum*). Characteristic birds include yellow-throated vireo (*Vireo flavifrons*), tufted titmouse (*Parus bicolor*), redbellied woodpecker (*Melanerpes carolinus*), and pileated woodpecker (*Dryocopus pileatus*).

-Hemlock-hardwood swamp (G4G5 S4):
These common and widespread communities occur throughout upstate New York north of the coastal lowlands on mineral soils and deep muck in depressions that receive groundwater discharge. Some occurrences are very small (1 to 2 acres). Water levels in these swamps typically fluctuate seasonally; they may be flooded in spring and relatively dry by late summer. Forest canopies are normally closed (70 to 90%). Shrub layers are sparse and species diversity low. Canopies are dominated by hemlock (*Tsuga canadensis*), and co-dominated by yellow birch (*Betula alleghaniensis*) and red maple (*Acer rubrum*). Other less frequently occurring trees include white pine, (*Pinus strobus*), black gum (*Nyssa sylvatica*), and green ash (*Fraxinus pennsylvanica*). Characteristic shrubs include highbush blueberry (*Vaccinium corymbosum*), various viburnums (*Viburnumcassinoides, V. lentago,*and *V. lanatanoides*), winterberry (Ilex verticillata), and mountain holly (*Nemopanthus mucronatus*). Characteristic herbs are cinnamon fern (*Osmunda cinnamomea*) and sensitive fern (*Onoclea sensibilis*), sedges *(Carex trisperma, C. folliculata*, and *C. bromoides*), goldthread, (*Coptis trifolia*), Canada mayflower (*Maianthemum canadense*), mountain sorrel (*Oxalis montana*), foamflower (*Tiarella cordifolia*), and sarsparilla (*Aralia nudicaulis*).

-Red maple – hardwood swamp (G5 S4S5)
These swamps occur throughout New York in poorly drained depressions, usually on inorganic soils. This is a broadly defined community with many variants. Red maple (*Acer rubrum*) is either the only canopy dominant, or it is codominant with one or more hardwoods including ashes (*Fraxinus pennsylvanica, F. nigra*, and *F. americana*), elms (*Ulmus americana* and *U. rubra*), yellow birch (*Betula alleghaniensis*), and swamp white oak (*Quercus bicolor*). Other tree species include butternut (*Juglans cinerea*),bitternut hickory (*Carya cordiformis*), black gum (*Nyssa sylvatica*), ironwood (*Carpinus carolinianus*), and white pine (*Pinus strobus*). The shrub layer is usually well-developed and may be quite dense. Characteristic shrubs are winterberry (*Ilex verticillata*),

spicebush (*Lindera benzoin*), alder (*Alnus incana* ssp. *rugosa*), viburnums (*Viburnum recognitum*, and *V. cassinoides*), highbush blueberry (*Vaccinium corymbosum*), common elderberry (*Sambucus canadensis*), and various shrubby dogwoods (*Cornus sericea*, *C. racemosa*, and *C. amomum*). The herbaceous layer may be quite diverse and is often dominated by ferns, including sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), and marsh fern (*Thelypteris palustris*), with much lesser amounts of crested wood fern (*Dryopteris cristata*), and spinulose wood fern (*Dryopteris carthusiana*). Characteristic herbs include skunk cabbage (*Symplocarpus foetidus*), white hellebore (*Veratrum viride*), sedges (*Carex stricta*, *C. lacustris*, and *C. intumescens*), jewelweed (*Impatiens capensis*), false nettle (*Boehmeria cylindrica*), arrow arum (*Peltandra virginica*), tall meadow rue (*Thalictrum pubescens*), and marsh marigold (*Caltha palustris*). Examples of wetland fauna include wood duck (*Aix sponosa*), American black duck (*Anas rubripes*), northern water thrush (*Seiurus noveboracensis*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*), and mink (*Mustela vison*). These swamps provide breeding habitat for many wetland-dependent species, such as spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), wood frog (*Rana sylvatica*), and spotted salamander (*Ambystoma maculatum*).

-Spruce-fir swamp (G3G4 S3):

Spruce-fir swamps are found primarily in the Adirondacks, Tug Hill, and Catskills in basins or along edges of open waters. In the Adirondacks and the Tug Hill these swamps are often found in drainage basins occasionally flooded by beaver (*Castor canadensis*). These communities typically have a closed canopy (80 to 90% cover). The dominant tree is usually red spruce (*Picea rubens*). Codominant trees include balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), and black spruce (*Picea mariana*) . Other tree species include yellow birch (*Betula alleghaniensis*), white pine (*Pinus strobus*), and hemlock (*Tsuga canadensis*). The shrublayer is often sparse and includes mountain holly (*Nemopanthus mucronatus*), alders (*Alnus viridis* ssp. *crispus*, *A. incana* ssp. *rugosa*), blueberries (*Vaccinium corymbosum*, *V. myrtilloides*), wild raisin (*Viburnum cassinoides*), mountain ash (*Sorbus americana*), and winterberry (*Ilex verticillata*). Characteristic herbs are cinnamon fern (*Osmundacinnamomea*), sedges (*Carex trisperma*, *C. folliculata*), gold thread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), starflower (*Trientalis borealis*), wood sorrel (*Oxalis acetosella*), creeping snowberry (*Gaultheria hispidula*), and dewdrop (*Dalibarda repens*). The non-vascular layer is often dominated by *Sphagnum* species (*S. girgensohnii*, *S. centrale*,and *S. angustifolium*) along with *Bazzania trilobata* and *Pleurozium schreberi*. A characteristic bird of spruce-fir swamps is the northern water thrush (*Seiurus noveboracensis*).

-Vernal Pool (G4 S3S4):

Vernal pools are aquatic communities associated with intermittently to ephemerally (springtime) ponded, small, shallow depressions within upland forests (or other terrestrial communities). Vernal pools are typically flooded in spring or after heavy rains but are usually dry during summer. Vernal pools typically occupy a small, confined basin (i.e., a standing waterbody without a flowing outlet) but may be associated with intermittent streams. Several hydrologic types of vernal pools have been identified and 5-7 ecoregional variants have been identified in New York that differ in dominant vascular plants, amphibians and invertebrates, as well as water chemistry, water temperature, substrate type, and surrounding forest type. *Note: Several foresters who contributed to this Salmon River watershed assessment indicate that vernal pool communities are frequently created in managed woodlands when machinery causes the formation of localized depressions.* Vernal pool communities include a diverse group of invertebrates and amphibians that depend upon temporary pools as breeding habitat. Since vernal pools cannot support fish populations, there is no threat of fish predation on amphibian eggs or invertebrate larvae. Characteristic animals of vernal pools include species of amphibians, reptiles, crustaceans, mollusks, annelids. Obligate vernal pool amphibians include spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*A. laterale*), Jefferson's salamander (*A. jeffersonianum*), marbled salamander (*A. opacum*) and wood frog (*Rana sylvatica*). Fairy shrimp (Anostraca) are obligate vernal pool crustaceans, with *Eubranchipus* spp. being the most common. Facultative vernal pool amphibians include four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), gray tree frog (*Hyla versicolor*), green frog (*Rana clamitans*), American toad (*Bufo americanus*), and Fowler's toad (*B. woodhousei fowleri*). Facultative vernal pool reptiles include painted turtle (*Chrysemys picta*), spotted turtle (*Clemmys guttata*), and snapping turtle (*Chelydra serpentina*). Facultative vernal pool mollusks include freshwater fingernail clams (*Sphaerium* sp., *Musculium* sp., and *Pisidium* sp.) and aquatic amphibious snails (*Physa* sp., *Lymnaea* sp., and *Helisoma* sp.). Facultative vernal pool insects include diving beetles (Dytiscidae), whirligig beetles (Gyrinidae), dobsonflies (Corydalidae), caddisflies (Trichoptera), dragonflies (Anisoptera), damselflies (Zygoptera), mosquitoes (Cuculidae), springtails (Collembula) and water striders (*Gerris* sp.). Leeches (Hirudinea) are a facultative vernal pool annelid. Characteristic vascular plants may include mannagrass (*Glyceria* sp.), spikerush (*Eleocharis acicularis*), water purslane (*Ludwigia palustris*), naiad (*Najas* sp.), duckweed (*Lemna minor*), and water hemlock (*Cicuta maculata*). Characteristic bryophytes may include *Brachythecium rivulare*, *Calliergon* sp. and *Sphagnum* spp.

-Dwarf Shrub Bog (G4 S3):

These communities occur throughout upstate New York north of the coastal lowlands on peat soils where surface and soil water is nutrient-poor and acidic. Communities are dominated by low-growing (<1 m tall), evergreen, ericaceous shrubs and peat mosses (*Sphagnum* spp.). The surface of the peatland is typically a mosaic of hummock/hollow microtopography. The hummocks tend to have a higher abundance of shrubs than the hollows; however, these bogs have more than 50% cover of low-growing shrubs. The dominant shrubs are leatherleaf (*Chamaedaphne calyculata*), sheep laurel (*Kalmia angustifolia*), bog laurel (*K. polifolia*), Labrador tea (*Rhododendron groenlandicum*), and cranberry (*Vaccinium oxycoccos, V. macrocarpon*). Dominant graminoids are the sedge *Carex trisperma* and tawny cottongrass (*Eriophorum virginicum*). Other characteristic, but less common, plants are round-leaf sundew (*Drosera rotundifolia*), pitcher plant (*Sarracenia purpurea*), bog rosemary (*Andromeda glaucophylla*), huckleberry (*Gaylussacia baccata*), black chokeberry (*Aronia melanocarpa*), highbush blueberry (*Vaccinium corymbosum*), water-willow (*Decodon verticillatus*), meadow sweet (*Spiraea alba* var. *latifolia*, *S. tomentosa*),, marsh St. John's-wort (*Triadenum virginicum*), and the sedges *Carex canescens*, *Carex pauciflora*, and *Rhynchospora alba*. Scattered stunted trees may be present, including black spruce (*Picea mariana*), tamarack (*Larix laricina*), and red maple (*Acer rubrum*). Characteristic peat mosses that form a nearly continuous carpet under the shrubs include *Sphagnum magellanicum*, *S. rubellum*, *S. fallax*, *S. fuscum*, *S. papillosum*, and *S. angustifolium*. Characteristic animals include common yellowthroat (*Geothlypis trichas*), song sparrow (*Melospiza melodia*), savannah sparrow (*Passerculus sandwichensis*), masked shrew (*Sorex cinereus*), meadow jumping mouse (*Zapus hudsonius*), southern bog lemming (*Synaptomys cooperi*), and wood frog (*Rana sylvatica*).

-Inland poor fen (G4 S3):

These communities occur throughout upstate New York north of the coastal lowlands on peat (*Sphagnum*) soils that are fed by water with low mineral concentrations and pH values (3.5-5.0). The dominant species are *Sphagnum* mosses, with scattered sedges, shrubs, and stunted trees. Characteristic mosses include *Sphagnum rubellum*, *S. magellanicum*, *S. papillosum*, *S. cuspidatum*, *S. fuscum*, *S. angustifolium*, *S. fallax*, and *S. russowii*. Characteristic herbs include sedges (*Carex oligosperma, C. exilis, C. limosa, C. trisperma, C.utriculata, C. paupercula, C. canescens*), white beakrush (*Rhynchospora alba*), cottongrasses (*Eriophorum vaginatum* ssp. *spissum, E. virginicum*), round-leaf sundew (*Drosera rotundifolia*), and pitcher-plant (*Sarracenia purpurea*). Shrubs and dwarf shrubs usually have less than 50% cover (i.e., not dominated by shrubs as in dwarf shrub bogs). Characteristic shrubs include cranberry (*Vaccinium oxycoccos, V. macrocarpon*), bog laurel (*Kalmia polifolia*), sheep laurel (*K. angustifolia*), sweet-gale (*Myrica gale*), black chokeberry (*Aronia melanocarpa*), leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and Labrador tea (*Rhododendron groenlandicum*). Scattered, stunted trees such as tamarack (*Larix laricina*), black spruce (*Picea mariana*) or red maple (*Acer rubrum*) may be present.

-Shrub swamp (G5 S5):

Shrub swamps are broadly defined communities that occur throughout New York on mineral soil or muck. They are dominated by tall shrubs that occur along lake shores and river banks, in wet depressions, or in transition zones between marshes and upland communities. In northern New York many shrub swamps are dominated by alder (*Alnus incana* ssp. *rugosa*). Other characteristic shrubs include meadow-sweet (*Spiraea alba* var. *latifolia*), steeple-bush (*Spiraea tomentosa*), gray dogwood (*Cornus foemina* ssp. *racemosa*), swamp azalea (*Rhododendron viscosum*), highbush blueberry (*Vaccinium corymbosum*), maleberry (*Lyonia ligustrina*), smooth alder (*Alnus serrulata*), spicebush (*Lindera benzoin*), willows (*Salix bebbiana, S. discolor, S. lucida, S. petiolaris*), wild raisin (*Viburnum cassinoides*), and arrowwood (*Viburnum recognitum*). Birds that may be found in shrub swamps include common species such as common yellowthroat (*Geothlypis trichas*); and rare species such as American bittern (*Botaurus lentiginosus*), alder flycatcher (*Empidonax alnorum*), willow flycatcher (*E. trallii*), and Lincoln's sparrow (*Passerella lincolnii*).

-Sedge meadow (G5 S4):

Sedge meadows are scattered throughout upstate New York north of the coastal lowlands and are common in the Adirondack ecozone. They occur on organic soils (muck or fibrous peat) that are permanently saturated and seasonally flooded. Peats are usually fibrous, not sphagnous, and are usually underlain by deep muck. The dominant herbs must be members of the sedge family (Cyperaceae), typically of the genus *Carex*. Sedge meadows are dominated by peat and tussock-forming sedges such as tussock-sedge (*Carex stricta*), with at least 50% cover. They are often codominated by bluejoint grass (*Calamagrostis canadensis*) with less than 50% cover, and other sedges (*Carex* spp., including *C. utriculata*, *C. vesicaria*, and *C. canescens*). Other frequently occurring plants with low percent cover include marsh cinquefoil (*Potentilla palustris*), sensitive fern (*Onoclea sensibilis*) manna grasses (*Glyceria* spp., *G. canadensis*), swamp loosestrife (*Lysimachia terrestris*), hairgrass (*Agrostis scabra*), marsh St. John's-wort (*Triadenum virginicum*), water horsetail (*Equisetum fluviatile*), tall meadow-rue (*Thalictrum pubescens*), spike rushes (*Eleocharis acicularis, E. obtusa*), sweetflag (*Acorus americanus*), spotted joe-pye-weed (*Eupatorium maculatum*), purple-stem angelica (*Angelica purpurea*), three-way sedge (*Dulichium arundinaceum*), and bulrushes (*Scirpus* spp.). Sparse shrubs may be present, such as meadow sweet (*Spiraea alba* var. *latifolia, S. tomentosa*), leatherleaf (*Chamaedaphne calyculata*), sweet gale (*Myrica gale*), and alder (*Alnus* spp.).

-Shallow emergent marsh (G5 S5):

Shallow emergent marshes occur throughout New York, typically in lake basins and along streams. They often intergrade with deep emergent marshes, shrub swamps and sedge meadows, and they may occur together in a complex mosaic in a large wetland. These communities occur on mineral or deep muck soils (rather than true peat) that are permanently saturated and seasonally flooded. Water depths may range from 6 in to 3 ft during flood stages, but the water level usually drops by mid to late summer and the substrate is exposed during an average year. The most abundant herbaceous plants include bluejoint grass (*Calamagrostis canadensis*), cattails (*Typha latifolia, T. angustifolia, T. x glauca*), sedges (*Carex* spp.), marsh fern (*Thelypteris palustris*), manna grasses (*Glyceria pallida, G. canadensis*), spikerushes (*Eleocharis smalliana, E. obtusa*), bulrushes (*Scirpus cyperinus, S. tabernaemontani, S. atrovirens*), threeway sedge (*Dulichium arundinaceum*), sweetflag (*Acorus americanus*), tall meadow-rue (*Thalictrum pubescens*), marsh St. John's-wort (*Triadenum virginicum*), arrowhead (*Sagittaria latifolia*), goldenrods (*Solidago rugosa, S. gigantea*), eupatoriums (*Eupatorium maculatum, E. perfoliatum*), smartweeds (*Polygonum coccineum, P. amphibium, P. hydropiperoides*), marsh bedstraw (*Galium palustre*), jewelweed (*Impatiens capensis*), and loosestrifes *(Lysimachia thyrsiflora, L. terrestris, L. ciliata*). Frequently in degraded examples, reed canary grass (*Phalaris arundinacea*) and/or purple loosestrife (*Lythrum salicaria*) may become abundant. Sedges (*Carex* spp.) may be abundant in shallow emergent marshes, but are not usually dominant. Marshes must have less than 50% cover of peat and tussock-forming sedges such as tussock sedge (*Carex stricta*), otherwise it may be classified as a sedge meadow. Characteristic shallow emergent marsh sedges include *Carex stricta, C. lacustris, C. lurida, C. hystricina, C. alata, C. vulpinoidea, C. comosa, C. utriculata, C. scoparia, C. gynandra, C. stipata,* and *C. crinita*. Other plants characteristic of shallow emergent marshes (most frequent listed first) include blue flag iris (*Iris versicolor*), sensitive fern (*Onoclea sensibilis*), common skullcap (*Scutellaria galericulata*), beggerticks (*Bidens* spp.), water-horehounds (*Lycopus uniflorus, L. americanus*), bur-weeds (*Sparganium americanum, S. eurycarpum*), swamp milkweed (*Asclepias incarnata*), water-hemlock (*Cicuta bulbifera*), asters (*Aster umbellatus, A. puniceus*), marsh bellflower (*Campanula aparinoides*), water purslane (*Ludwigia palustris*), royal and cinnamon ferns (*Osmunda regalis, O. cinnamomea*), marsh cinquefoil (*Potentilla palustris*), rushes (*Juncus effusus*, *J. canadensis*), arrowleaf (*Peltandra virginica*), purple-stem angelica (*Angelica atropurpurea*), water docks (*Rumex orbiculatus, R. verticillatus*), turtlehead (*Chelone glabra*), waterparsnip (*Sium suave*), and cardinal flower (*Lobelia cardinalis*). Shallow emergent marshes may have scattered shrubs including rough alder (*Alnus incana* ssp. *rugosa*), water willow (*Decodon verticillatus*), shrubby dogwoods (*Cornus amomum, C. sericea*), willows (*Salix* spp.), meadow sweet (*Spiraea alba* var. *latifolia*), and buttonbush (*Cephalanthus occidentalis*). Areas with greater than 50% shrub cover are classified as shrub swamps. Amphibians that may be found in shallow emergent marshes include frogs such as eastern American toad (*Bufo a. americanus*), northern spring peeper (*Pseudoacris c. crucifer*), green frog (*Rana clamitans melanota*), and wood frog (*Rana sylvatica*); and salamanders such as northern redback salamander (*Plethodon c. cinereus*) (Hunsinger 1999). Birds that may be found include red-winged blackbird (*Agelaius phoeniceus*), marsh wren (*Cistothorus palustris*), and common yellowthroat (*Geothlypis trichas*).

2.6.3 Non-Estuarine Wetlands
Viability Summary

Notes on Guidance for Current Condition:

"NG"	No guidance was obtained to rank this indicator
"SGR"	Subjective guidance and/or ranking based on professional opinion
"ND"	No data are available with which to rank this indicator

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Size						
Ind. – Total surface area (acres) as wetland					Unranked	NG
Ind. - % of total area					Good	SGR
KEA-Condition -Wetland Community Types						
Ind. - Abundance of wetland community types (acres)					Unranked	ND, NG
KEA-Condition-Invasive Species						
Ind. - Frequency of Invasive Plant Occurrences	0	<5	5-25	>25	Good	Drake et al. (2003)
KEA-Condition-Rare Species Populations						
Ind. – Jacob's ladder population occurrence and density					Good	SGR, Howard (2006)
Ind. – Lesser bladderwort					Fair	SGR, Howard (2006)
Ind. – Pied-billed grebe					Fair-Poor	SGR, Howard (2006)
Ind. – Pitcher plant borer moth					Excellent	SGR, Howard (2006)
KEA-Condition-Pests & Pathogens						
Ind. - Viburnum beetle (frequency of infestation)	0	<5	5-25	>25	Poor	SGR
KEA-Condition-Sentinel Wildlife Groups						
Ind. - Amphibian species frequency in watershed relative to whole of NY state (Herp Atlas Quads)		>90	80-90	<80	Good	SGR
Ind. - Breeding and migratory bird densities (#/acre)					Unranked	NG, ND

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition-Hydrology						
Ind. - Regional water surplus (inches)						
sub-watersheds		40			Good	SGR, Eschner et al. (1974)
Lower sub-watersheds		16			Good	SGR, Eschner et al. (1974)
Ind. - Source alteration (% ground vs. surface water)					Unranked	NG, ND
KEA-Condition-Toxins						
Ind.– Game fish mercury concentration (ppm)			0-1	>1		NYSDOH (2006) fish consumption advisories
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Fair	
Ind.- Snapping turtle egg PCB concentrations		0	0-2	>2		Pagano et al. (1999)
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Poor-Fair	
Ind. – PCB-induced mink jaw lesions (ppb)		0	<40	>40		Haynes et al. (2007)
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Poor	
Ind.- Snapping turtle egg Mirex concentrations		0	0-0.2	>0.2		Pagano et al. (1999)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	
KEA-Condition-Nutrient Loading						
Ind. - Soil P (mg/cm^3)		0.01		>0.3	Unranked	ND (Drexler & Bedford 2002)
Ind. - Soil extractable NO3- (ug/cm^3)		<dl		>0.02	Unranked	ND (Drexler & Bedford 2002)
Ind. - Vascular plant richness (#sp./m^2)		>20		<10	Unranked	ND (Drexler & Bedford 2002)
Ind. - Bryophyte richness (#sp./m^2)		>8		<5	Unranked	ND (Drexler & Bedford 2002)
Ind. - % of 100-ft buffer in natural cover types		>90	75-90	<75	Good	SGR
KEA-Landscape Context						
Ind. - % of 540-ft buffer in natural land cover-types		>90	75-90	<75	Good	SGR
Ind. – Length of road bisecting 540-ft' wetland buffers					Unranked	NG

2.7 Matrix Forest

2.7.1 Matrix Forest Target Definition

The matrix forest includes the majority of land cover in the watershed and represents the mix of upland, terrestrial forest cover of varying composition and successional stages, including early successional shrub and herbaceous vegetation types. The incorporation of early-successional shrub/sapling and grasslands in this target reflect the realization that many agricultural grasslands and abandoned fields provide habitat for a variety of wildlife species that would have naturally been uncommon in the Northeast. Purposeful management of these grasslands will perpetuate the occurrence of many species that are currently declining in the Northeast. Also, although wetland forest types are embedded within this matrix, for the purpose of this analysis, the wetland forest types are considered within the non-estuarine wetland target.

The forests of the Salmon River Watershed span two broad ecoregional subsections (Figure 37). The Eastern Lake Ontario Lake Plain Subsection of the Great Lakes Ecoregion occurs at the lowest elevations of the watershed. This intergrades with forests at higher elevations to the east that are included in the Tug Hill Plateau Subsection of the Northern Appalachian – Boreal Forest Ecoregion (USDA Forest Service 2004, 2005).

> Tug Hill Plateau Subsection – The upper elevations of the interior Tug Hill Plateau represent the extreme western limit of this ecoregional unit. Forests are dominated by boreal red spruce-balsam fir types at high elevations and in areas of poor soil drainage. Lower elevations and better drained soils are dominated by sugar maple, yellow birch and American beech, with an admixture of eastern hemlock and red spruce. Natural disturbances include severe wind events (frontal and cyclonic), winter ice storms, and several insect pests and diseases.
>
> Eastern Lake Ontario Lake Plain Subsection – This ecoregional unit is characterized by relatively flat topographic relief and shallow drainages associated with rolling glacial till-plains and glacial lake deposits (including clays, silt, marl, peat and muck, beach ridges and dunes). Sedimentary rocks (Ordovician, Silurian and Devonian) underlie the glacial deposits. Potential natural vegetation types include beech-maple mesic forests with a mixture of oaks and hickories, and aspen. Climatic-induced disturbances include winter ice storms and frontal and cyclonic wind events.

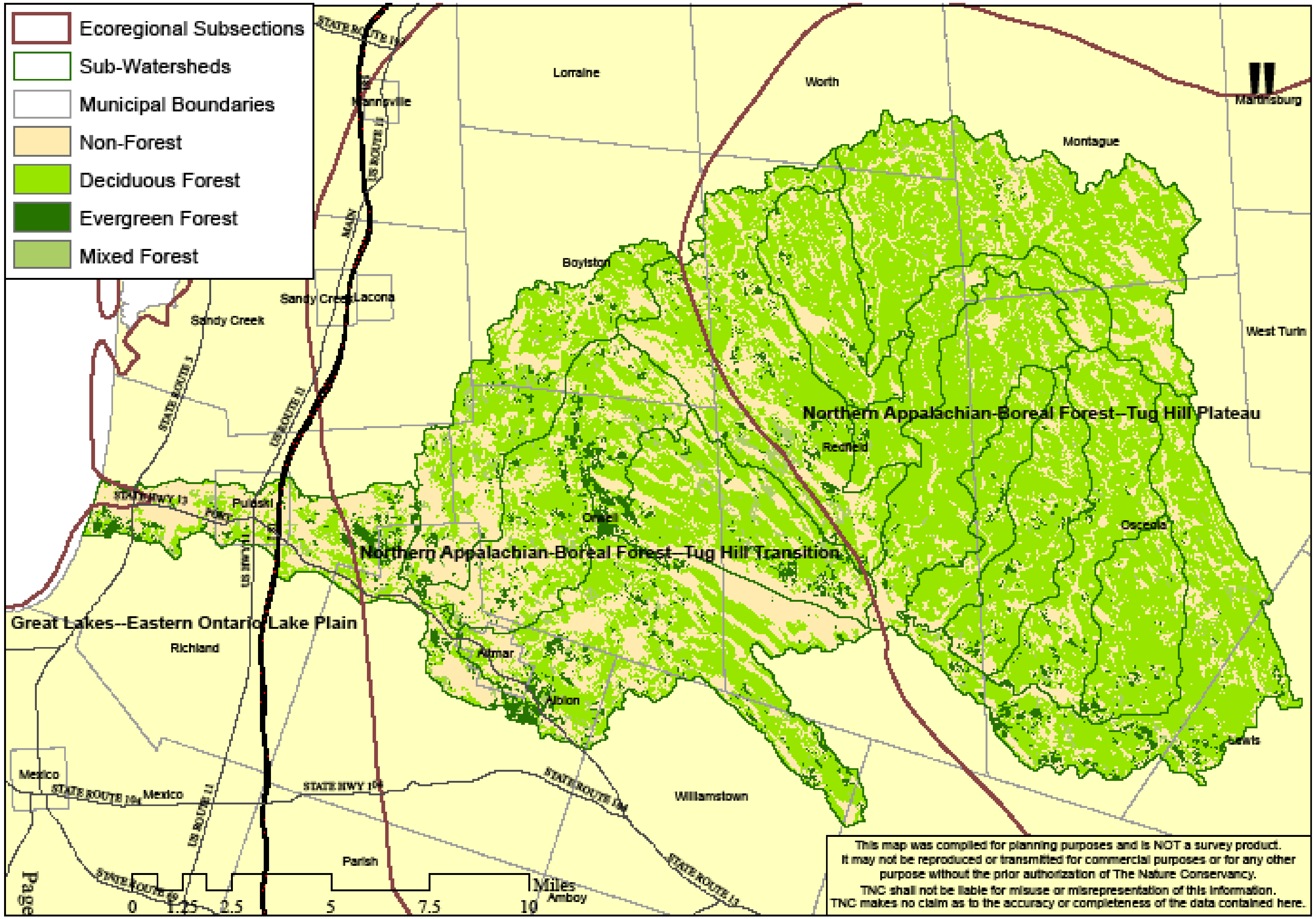


Figure 37. Matrix forests and ecoregional subsections of the Salmon River watershed.

The current structure and composition of forests in the Salmon River watershed, like most forest landscapes across the Northeast, have resulted from agricultural land use, logging and settlement of the past century. Stout (1958) and Hotchkiss (1932) report that forest composition at the time of European settlement was characterized by northern hardwoods (American beech, sugar maple, yellow birch) with an abundant mix of red spruce, eastern white pine, eastern hemlock, balsam fir and tamarack (primarily on lower slopes and swamp edges). In the transitional Tug Hill fringe, northern hardwoods dominated with hemlock, white pine, and some spruce restricted to stream sides and ravines. Logging for softwoods began late in the 19th century and, as transportation capacity improved (e.g., Glenfield & Western Railroad), hardwoods began to be extracted. At the turn of the 20th century, widespread abandonment of marginal agricultural sites around the Tug Hill fringe resulted in the establishment of successional hardwood stands (primarily red maple and cherry), while conifer plantations were created through reforestation efforts on several NY State Forests (Stout 1958). Heavy selective cutting across the Tug Hill in the past has resulted in poorly stocked stands with low proportions of high quality timber (Temporary State Commission on the Tug Hill 1976:40) and increased dominance of red maple (Stout 1958).

2.7.2. Matrix Forest Viability

2.7.2.1. KEA: SIZE – Forest Area and Cover

Indicator – Total Area of Contiguous Forest Cover (ac): Forest area provides an estimator of total gross forest ecosystem and social functions (e.g., carbon sequestration capacity; supply of raw materials for renewable forest products industry; and recreational opportunities such as hunting, fishing, hiking, skiing and snowmobiling). Furthermore, some ecosystem functions cannot be realized until forests reach a minimum size threshold (e.g., habitat for numerous forest-dwelling organisms including many animals that require large home ranges or interior forest conditions). Current guidance on forest reserve size suggests that at least 25,000 acres of contiguous forest are required to permit natural ecosystem processes to occur unabated, and to support viable populations of all forest-dwelling organisms native to northeastern forest types (Anderson et al. 2004).

<u>Current Condition: Upper sub-watersheds, Good; Lower-subwatersheds, Fair:</u> Forests of the upper sub-watersheds are contiguous with those of the greater Tug Hill region, and together they occupy the western extreme of the Tug Hill “Core Forest” (Figures 6 and 37). The Core Forest is a large (~150,000 acres) complex of forest and wetlands that has remained unfragmented by large roads, utility rights-of-way, heavily-used water bodies, agriculture and other cultural features. It represents the third largest intact forest landscape in New York (after the Adirondacks and Catskills), and the westernmost portion of the Northern Forest, which spans northern portions of New York, Vermont, New Hampshire and Maine. Forests of the extreme western portions of the lower sub-watersheds, and all of the Lower Salmon River

Main Stem sub-watershed, are highly fragmented and do not form any forested blocks >25,000 acres.

Indicator – Percent Forest Cover: Percent of a landscape in forest cover is a better approximation of capacity for forests to provide localized ecosystem services regardless of total forest cover. These localized functions include nutrient sequestration, hydrologic and sedimentation control, and riparian buffers that help to sustain healthy aquatic communities throughout the watershed. Ranking criteria for percent of upland cover-types in forest are:

	Poor	Fair	Good
% of upland cover-types	<75%	75-90%	>90%

<u>Current Condition: Upper sub-watersheds, Good; Lower sub-watersheds, Poor:</u> The Salmon River watershed is heavily forested, with the matrix forests (excluding forested wetlands) occupying approximately 86% (~131,800 acres) of the watershed's total upland land base. As a percentage of upland (non-wetland) cover-types, forests comprise 94% of the land area in the upper, eastern sub-watersheds. All of the upper sub-watersheds possess ≥90% forest cover in uplands. Forest cover in the uplands of the lower, western sub-watersheds ranged from 48-79% and averaged 69% (Table 31).

Table 31. Total acreage of land cover types by sub-watershed in the Salmon River watershed. Sub-watersheds have been segregated into "upper" and "lower" positions at approximately the west end of the Redfield Reservoir, corresponding with the approximate transition to Lake Plain forest types. Forested wetlands are included with the wetland cover type. This information is based on the 2001 National Land Cover Data for the area.

					----------------------forest----------------------				total forest as % of total
	developed	agriculture	grassland	shrub	deciduous	conifer	mixed	*Total*	upland (non-wetland) cover-types
Lower Sub-watersheds									
LSRM	1063	2362	142	1411	2990	1130	453	*4573*	48
BBMC	263	921	173	1642	9624	1375	552	*11551*	79
TRBR	149	2104	281	1002	6783	567	510	*7860*	69
ORPE	127	1466	291	902	6287	965	416	*7667*	73
Lower totals	**1601**	**6853**	**887**	**4956**	**25684**	**4036**	**1931**	***31652***	**69**
Upper Sub-watersheds									
BGWM	0	2	1	100	5243	148	27	*5417*	98
COBR	4	0	1	194	5178	47	51	*5276*	96
FBTT	22	79	159	374	7268	234	76	*7577*	92
GRMM	12	29	9	346	8945	95	113	*9154*	96
KESF	1	1	12	279	5182	194	106	*5483*	95
MARI	2	11	63	232	15551	77	258	*15886*	98
NOBR	50	181	62	951	10903	766	562	*12232*	91
PECK	1118	78	80	565	5971	9870	539	*16380*	90
PMLB	14	28	74	284	5560	204	91	*5855*	94
SBLB	0	10	1	135	3844	54	28	*3926*	96
UPSR	19	128	96	974	11762	869	403	*13034*	91
Upper Totals	**1242**	**547**	**557**	**4434**	**85408**	**12558**	**2253**	***100219***	**94**
Watershed Totals	**2755**	**7400**	**1444**	**9390**	**111092**	**16595**	**4184**	***131871***	**86**

Indicator – Area by Forest Cover-Type: Broad forest cover-types provide habitat for a variety of different wildlife, plant and microbial species. Within the Salmon River watershed, known broad forest cover types include deciduous hardwood, conifer (natural hemlock, spruce, pine, and conifer plantations), and forests having natural mixtures of hardwoods and conifer (spruce, hemlock and pine). Historic natural abundances of forest types are not known for the watershed. However, at lower elevations, conifer-dominated stands (hemlock and pine) occurred along waterways, wetlands and wetland edges and shaded ravines. At upper elevations, conifer stands (spruce, fir, hemlock and pine) occurred along wetland edges and waterways, and upland forests contained a substantial conifer (spruce) component (Hotchkiss 1932, Stout 1958).

Current Condition – Unranked: The matrix forests of the watershed are dominated by deciduous types (Table 32). Note that this analysis does not include forested wetlands, which include a number of conifer types (spruce, fir, tamarack, hemlock). The high proportion (60%) of conifer types in the Pennock-Coey-Kenny sub-watershed reflects the large number of State reforestation areas there. The amount of mixed forest types is low given the historic accounts of spruce, hemlock and white pine admixtures in the original forests of the watershed. This likely reflects the historic level of selective cutting for conifers during the 19th century. However, it should be noted that red spruce regeneration was encountered on 41% of sampled hardwood dominated forests across the Tug Hill, including sites within the Salmon River watershed (Section 2.7.2.9). Therefore red spruce appears to be reestablishing across its range in the upper sub-watersheds.

Table 32. Forest land-cover type analysis for Salmon River sub-watersheds. Values are percent of total matrix forest cover as deciduous, conifer and mixed types. (Date Source: 2001 National Land Cover Data for the area)

	Deciduous	Conifer	Mixed
Lower Sub-watersheds			
Lower Salmon River – Main Stem	65	25	10
Beaver Brk-Meadow Crk-Reservoir	83	12	5
Trout Brook	86	7	6
Orwell-Pekin	82	13	5
Average Lower	81	13	6
Upper Sub-watersheds			
Beaver-Gillmore-Willow-McDougal	97	3	0
Cold Brook	98	1	1
Fall Brook-Twomile-Threemile	96	3	1
Grindstone-Mill-Muddy	98	1	1
Keese-Smith-Finnegan	95	4	2
Mad River	98	0	2
North Branch	89	6	5
Pennock-Coey-Kenny	36	60	3
Prince-Mulligan-Little Baker	95	3	2
Stony Brook-Lime Brook	98	1	1
Upper Salmon River	90	7	3
Average Upper	85	13	2

2.7.2.2. KEA: LANDSCAPE CONTEXT – Forest Fragmentation

Forest fragmentation is the division of large, contiguous forest tracts into smaller woodlots by alternative land uses such as agriculture, development and roads. Fragmentation increases the ratio of forest edge habitat relative to forest interior. While forest edge habitat is important for many wildlife species (primarily game species, e.g., white-tailed deer, hare, pheasant) because it maximizes the ability for such animals to simultaneously achieve cover and foraging habitat, fragmentation can lead to impairment of forest communities in other ways. Forest edges (those areas within 60-150 ft of openings) are influenced by environmental conditions and processes occurring in adjacent open areas. Light, temperature and humidity changes abruptly over several meters thereby permitting competitive, shade-intolerant and weedy species to become established. Forest edges are sites of increased bird nest predation (by jays, crows, raccoons) and brood parasitism (by the brownheaded cowbird, *Mothrus ater*), thereby reducing reproductive success of many nesting bird species (Rosenberg et al. 1999). Road corridors and utility rights-of-way also provide avenues for dispersal of invasive plants. Some evidence indicates that even relatively narrow fragmenting features, such as infrequently used truck trails, can prevent some species from crossing over them into adjoining habitat.

Some forest management practices such as clearcutting will also temporarily fragment forests, but with time, forest cover reestablishes. Additionally, these forests in early stages of development provide habitat for a variety of organisms not found in more mature forests. Therefore, fragmentation by agriculture, development, or roads has a greater impact on forest species because it is more permanent and vegetation management is more intensive.

Indicator – Edge:Area Ratio: A simple and direct measure of fragmentation is the ratio of forest perimeter to area. With increasing amount of non-forest land types that abut forest parcels of equal area, the edge:area ratio will increase, thereby indicating the degree to which edge habitat occurs within the parcels. For this study, a ratio was developed representing the total length of “non forest” edge (miles) to area of forest (ac) within each of the sub-watersheds. Note that for this analysis fragmenting features included all unnatural land cover types (development, agriculture, barren land, roads and trails) as well as some natural land cover types (wetlands, grasslands, shrub lands, open water).

No guidance was obtained for ranking this indicator. Viability rankings are subjective and based upon the range of conditions currently existing in the upper sub-watersheds, which are known to contain relatively intact forests that are naturally fragmented by extensive wetland systems.

<u>Current Condition- Upper Sub-watersheds, Good; Lower Sub-watersheds, Fair:</u> The forests of the upper sub-watersheds are largely contiguous and unfragmented by non-natural vegetation types. Edge:area ratios ranged from 0.1 to 0.3 for these sub-watersheds. Major fragmenting features in these sub-watersheds are roads and trails, as well was open wetland communities. The edge:area ratio for the lower sub-watersheds were 10- to 25-fold greater then the upper watersheds due to the prevalence of agriculture and development there (Table 33).

Table 33. Fragmentation analysis of Salmon River sub-watersheds. (Data Source: 2001 National Land Cover Data)

	non-forest edge (mi)	forest area (ac)	edge:area
Lower Sub-watersheds			
Lower Salmon River – Main Stem	11,809	4,573	2.6
Beaver Brk-Meadow Crk-Reservoir	12,751	11,551	1.1
Trout Brook	7,882	7,860	1.0
Orwell-Pekin	6,670	7,667	0.9
Upper Sub-watersheds			
Beaver-Gillmore-Willow-McDougal	632	5,417	0.1
Cold Brook	582	5,276	0.1
Fall Brook-Twomile-Threemile	2,334	7,577	0.3
Grindstone-Mill-Muddy	2,050	9,154	0.2
Keese-Smith-Finnegan	997	5,483	0.2
Mad River	3,321	15,886	0.2
North Branch	3,727	12,232	0.3
Pennock-Coey-Kenny	5,010	16,380	0.3
Prince-Mulligan-Little Baker	1,505	5,855	0.3
Stony Brook-Lime Brook	722	3,926	0.2
Upper Salmon River	3,022	13,034	0.2

Indicator – Frequencies of Forest Interior Birds: Different bird species are influenced, negatively or positively, by forest fragmentation and availability of edge. Long-term population trends in these species can indicate fragmentation effects in a forested landscape. Several "forest interior" bird species will breed only in large tracts of forests that are far from an edge. Approximately a dozen native forest bird species have been identified as forest interior habitat specialists (Rosenberg et al. 1999). Other species thrive in woodlands that are interspersed with open habitats. One such species is the brown-headed cowbird, which is native to open prairies of the Midwest and expanded eastward when the eastern forests were cleared for settlement. It now persists in fragmented agricultural landscapes with extensive forest edge. Long term, quantitative bird survey data would reveal population trends of interior bird species and cowbirds that could reflect changing levels of forest fragmentation. In the absence of such data, breeding bird survey data (species' presence/absence in a given area) can provide a useful, albeit less comprehensive, assessment of forest fragmentation.

Current Condition – Unranked: No absolute ranking can be made with this indicator; however inference can be made regarding the impacts of greater fragmentation in western portion of watershed. New York State Breeding Bird Atlas data (2000-2005) were used to determine the frequency of occurrence of “forest interior indicator species” (Rosenberg et al. 1999) within the western (more fragmented) and eastern (less fragmented) portions of the Salmon River watershed. The data from this source provide presence/absence of a species over a 5-year period within a census “block,” four of which are used to cover a 7.5’ USGS Topographic Quad Map. These data provide no measure of species abundance. This analysis (summarized in Table 34) provides some evidence suggesting less frequent distributions of forest interior species in the western, more fragmented section of the watershed. Of the twelve interior specialist species identified by Rosenberg et al. (1999), one (bay-breasted warbler) has not been observed in the watershed, and six occurred in over 90% of the blocks in both the western and eastern portions of the watershed. However, when substantial difference in frequencies (>10%) occurred between the western and eastern portions of the watershed, the eastern forests tended to have greater occurrences of the interior indicator species than the western forests, while the cowbird (edge specialist) was more frequent in the western forests.

Table 34. Frequency of occurrence of bird species identified as northern forest interior specialists (Rosenberg et al. 1999) in the western (more fragmented) versus eastern (less fragmented) portion of the Salmon River Watershed. The edge specialist and nest parasite, brown-headed cowbird is also included for comparison. Frequency data are from the NY Breeding Bird Atlas (2000-2005). Atlas data list a species' presence within a "block" (4 blocks per USGS Topographic Quad). The western portion of the watershed contained 18 blocks; the eastern contained 36 blocks.

Species	West % blocks present	East % blocks present
Forest interior specialists		
scarlet tanager (*Piranga olivacea*)	100	97
red-eyed vireo (*Vireo olivaceus*)	100	100
ovenbird (*Seiurus aurocapilla*)	100	100
black-capped chickadee (*Poecile atricapillus*)	100	100
black-and white warbler (*Mniotilta varia*)	83	83
rose-breasted grosbeak (*Pheucticus ludovicianus*)	94	100
yellow-bellied sapsucker (*Sphyrapicus varius*)	67	100
Blackburnian warbler (*Dendroica fusca*)	78	94
wood thrush (*Hylocichla mustelina*)	100	94
Canada warbler (*Wilsonia canadensis*)	78	89
black-throated blue warbler (*Dendroica caerulescens*)	56	92
bay-breasted warbler (*Dendroica castanea*)	0	0
Forest edge species		
brown headed cowbird (*Molothrus ater*)	89	58

Indicator – Presence of Wide-Ranging Forest Mammals: Several wildlife species that are native to the Tug Hill region require large home ranges of unfragmented forest for maintenance of viable breeding populations. Such species include black bear, bobcat, fisher and possibly moose (Saunders 1988, Fox 1990, Serfass and Mitcheltree 2004). No current or historic estimations of wildlife populations are available for the region. The only quantitative data that exist for such species are provided by volunteers in the New York Bowhunter Log program, who agree to keep track of the number of hours spent hunting (observing) and to report the number and location of animal sightings they make while in the field. This program was initiated in 1998 and data are available through 2005. Participation in the program is too limited to draw conclusions on populations within the limits of the Salmon River watershed, or even within the Tug Hill region. The data utilized for this analysis were taken from the whole of Jefferson, Oswego, Lewis and Oneida counties. The best information regarding other wide-ranging mammals is limited to anecdotal accounts.

Current Condition – Unranked: Available information and anecdotal evidence indicates that populations of several wide-ranging mammal species are increasing and some, whose populations were locally reduced or extirpated due to habitat loss or overhunting/trapping (bobcat, black bear, fisher), appear to be returning to the area over the last several decades (Conner 1966, McNamara 1999). Officials at NYSDEC indicate that black bears, although still uncommon and possibly transient, are known to the Tug Hill, and a few moose sightings have been reported of males that likely migrated in the autumn to the Tug Hill from the Adirondacks. Fox (1990) quantified three core population centers for bobcats in New York, one of which incorporated the western Adirondacks and eastern Tug Hill Plateau (the other two being in the Catskills and Taconics). That study suggested that most of the Tug Hill, including the Salmon River watershed was at or outside of the peripheral Adirondack bobcat population center due to intolerance for climatic conditions and for human caused population disturbances. The NYSDEC Bowhunter Log data also indicate that sightings of fisher, bobcat and bear, are frequent, although data from this source are insufficient to suggest long-term population trends for these species (Table 35). It is not known whether the recent lack of river otter represents a meaningful trend.

Table 35. Summary of NYSDEC Bowhunter Log data for Jefferson, Lewis, Oswego and Oneida Counties. Data on wildlife sightings are standardized to number per 1000 hunter*hours. The number of hours logged by participating bow hunters is also provided. For more information: http://www.dec.state.ny.us/website/dfwmr/wildlife/bowlog/

	1998	1999	2000	2001	2002	2003	2004	2005
# hunter*hrs	358	674	227	378	196	389	670	537
black bear	11	6	4	8	5	13	1	9
bobcat	8	1	4	0	5	3	1	4
fisher	25	27	18	24	41	41	34	19
river otter	3	6	13	0	0	0	0	0

Indicator – Connectivity to Regional Forest Types: Fragmentation influences forest community viability at both the patch/stand level and at the scale of large ecoregions. Many wide-ranging animals require large blocks of contiguous habitat to meet all their life-history requirements and to sustain regional dispersal for maintenance of viable, regional populations. In the presence of global climate change species migrations across broad ranges will be facilitated by connectivity among regional habitat types. The forests of the upper, eastern portion of the Salmon River watershed are components of the Northern Appalachian-Boreal Forest Ecoregion. Furthermore, these forests represent the western-most limits of this ecoregion. Biodiversity of these forests will be sustained, in part, through continued connectivity to the forest of the greater Tug Hill region, and likewise to the Adirondack and northern Appalachian forests. Similarly, forests of the lower, western portion of the watershed represent the eastern extreme of the Great Lakes Ecoregion (Figure 38), and require connectivity to other communities within that ecoregion.

Current Condition – Upper sub-watersheds, Good-Fair; Lower sub-watersheds, Poor: The upper sub-watersheds are embedded within the Tug Hill forest matrix, which represents a ~150,000-acre roadless region of forests and wetlands. However, the Tug Hill, itself, is bounded by agriculture in the Black River Valley to the north and east, and in the Mohawk Valley to the south; by development to the north (Watertown) and south (Syracuse metropolitan area); and by Oneida Lake to the south. With the exception of a narrow forested corridor, extending toward the southwestern Adirondacks, and located south of Booneville and through the Webster Hill, Jackson Hill, Buck Hill, Clark Hill and Benn Mountain State Forests, there is no connectivity between the Tug Hill and other components of the Northern Appalachian-Boreal Forest Ecoregion in the Adirondacks and New York's Southern Tier (Figure 38). Forests of the lower sub-watersheds are highly fragmented and embedded within a matrix of agricultural land use. The Great Lakes forests as a whole are highly fragmented.

2.7.2.3 KEA: CONDITION – Distribution of Forest Successional Stages

Natural and human-caused forest disturbances reduce competition for resources (soil nutrients, water, light and space) thereby permitting entry of additional species to a community. Periodic disturbances of intermediate spatial extent, intensity and return interval are key natural features in the maintenance of biodiversity. A disturbance regime consisting of frequent, extensive and intensive disturbances will lead to communities dominated by ruderal ("weedy" or "invasive") species that are capable of rapid growth and reproduction and long-distance dispersal. Disturbance regimes that are infrequent, small and mild will lead to ecosystems dominated by slow growing species that are tolerant of low resource availability. However, disturbance regimes that span intermediate conditions of these extremes permit co-occurrence of species of differing life histories.

There is virtually no guidance for a successional patch type distribution that would optimize biodiversity at a landscape scale. The current landscapes of the Tug Hill and Salmon River watershed very likely have greater diversities of forest age classes today than before European settlement when disturbance regimes were controlled primarily by natural events (wind, ice, frontal winds). Clearing for agriculture and intensive logging during the mid- to late-19th century increased the abundance of early successional community types, thereby providing opportunities for grasslands and shrub lands to establish along with the variety of birds, mammals and insects that flourish in these communities, including pheasant, woodcock, grouse, hare, cottontail rabbit, and numerous songbirds (e.g., Chambers 1983, Keller et al 2003, PADCNR 2007).

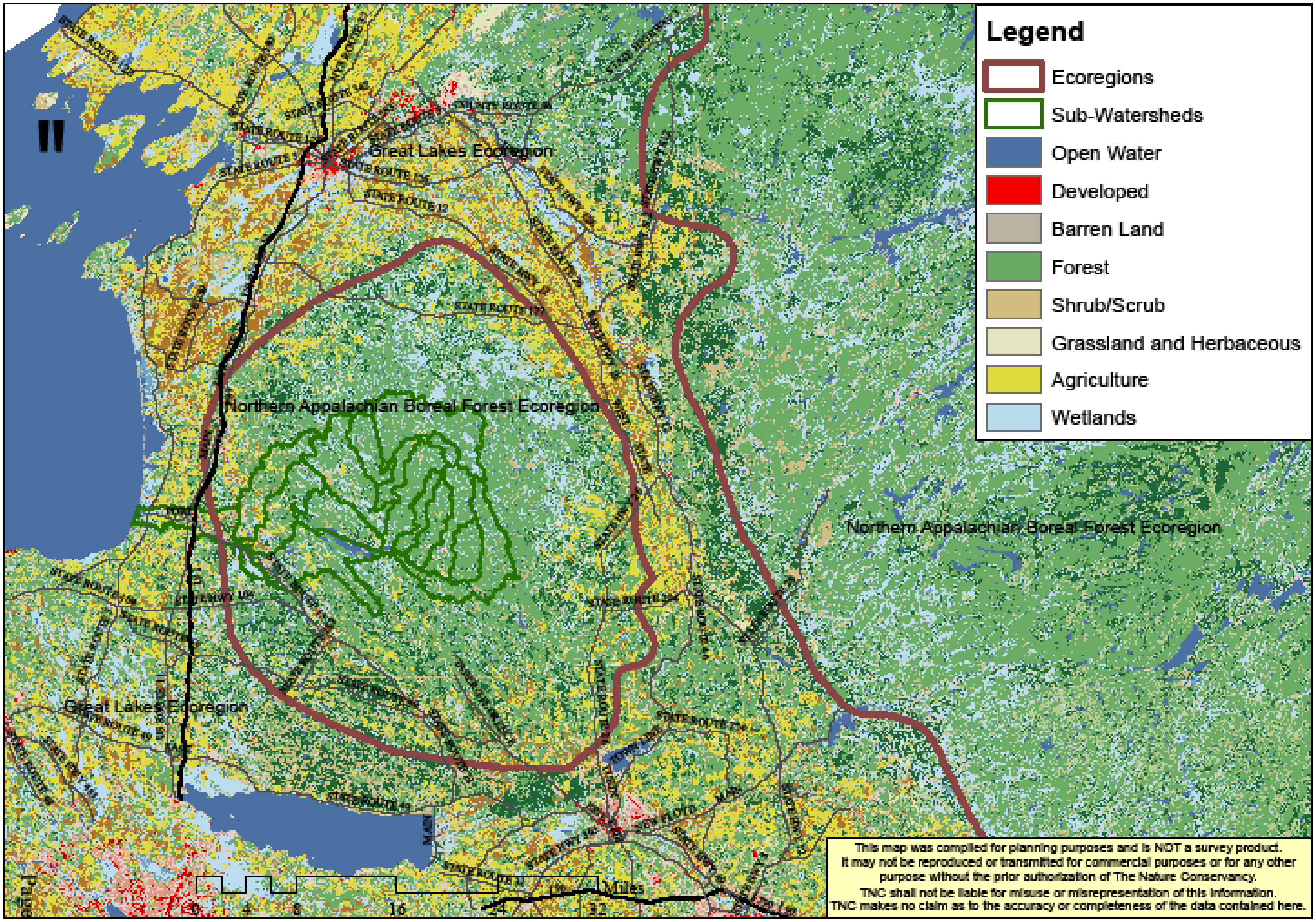


Figure 38. Regional land-cover types surrounding the Tug Hill Plateau.

Importantly, grasslands that are maintained open, but not regularly mowed, provide critical habitat for some species that are not common to the region due to the natural lack of grassland communities in the region, reversion of open fields to woodlands due to agricultural abandonment, and the fragmentation or development of those grasslands that remain.

Indicator – Forest Stand-Size Class Distributions: Forest stands are traditionally categorized into stand-size classes that can be used to provide limited guidance on developmental stage of the stand. Periodic forest monitoring of permanent plots is conducted nationally by the US Forest Service Forest Inventory and Analysis (FIA) Program (USDA Forest Service 2007). Among the data included in this inventory are those necessary to define the following forest stand-size classes (Alerich and Drake 1995):

-Sapling stand: a stand with at least half the live trees as saplings (1-4.9” diameter) or seedlings.
-Poletimber stand: a stand with half or more of the live trees as poletimber trees (5-9” for softwoods; 5-11” for hardwoods) or sawtimber trees (>9” dia for softwoods, >11” dia for hardwoods) and in which poletimber stocking exceeds that of sawtimber.
-Sawtimber stand: a stand with half or more of the live trees as poletimber or sawtimber trees, and in which stocking of sawtimber trees is equal to or greater than poletimber trees.

The sample size of FIA plots within the Salmon River watershed is not large enough to draw accurate conclusions regarding specific forest conditions there. However, assuming that conditions within the Salmon River watershed reflect those of the greater Tug Hill region, these data can be used to draw inferences regarding changes in forest developmental stages across the Tug Hill and, therefore, within the watershed. Furthermore, the current regional stand-size class distribution for the Tug Hill can be compared to that estimated about 35 years ago by Geis et al. (1974). That estimation utilized land classification data compiled on a town-wide basis through the Land Use and Natural Resource Inventory program (LUNR) of the New York State Office of Planning Services (NYSOPS 1972). By combining US Forest Service timber inventory data for “commercial forest land” reported on a county-wide level for Jefferson, Lewis, Oneida and Oswego Counties (Ferguson and Mayer 1970) with town-wide estimates of land uses falling within the definition of “commercial forest land” (mature forest, forest brushland, plantations, inactive agriculture) for those towns within the Tug Hill region, Geis et al. (1974) estimated the stand-size class distribution for the towns of the Tug Hill. Comparable county-wide timber resource data from 2004 were obtained from the US Forest Service FIA program and combined with the 2001 National Land Cover Data to provide an updated analysis similar to that of Geis et al. (1974).

Deviation from expected size class distributions provide insight to differences in extent and intensity of disturbance regimes relative to expected natural regimes. Frelich and Lorimer (1991a, 1991b) estimated that 73% of the area in northern hardwood landscapes subjected to natural disturbance regimes would be maintained as mature, multi-aged sawtimber (with 4% representing old, multi-aged forests); 20% as multi-aged, pole-size stands; 7% as even-aged sapling, pole or small sawtimber stands.

Current Condition – Unranked: The Frelich and Lorimer (1991a, 1991b) studies provide a model against which observed forest stand-size class distributions can be compared. However the FIA data are not sufficient to discern several categories such as "old, multi-aged sawtimber," "mature, multi-aged sawtimber" and "even aged small sawtimber." Even still, this analysis reveals recent (30- to 40-year), regional trends in the forest stand-size class distribution. Figure 39 illustrates the estimated 1968 and 2004 stand-size class distributions for towns in Jefferson, Lewis, Oneida and Oswego counties that fall within the limits of the Tug Hill. These data indicate that the overall amount of commercial forest land did not change appreciably during this time. However, these data illustrate an overall trend in forest maturation during this period; a trend that was initiated with widespread agricultural abandonment in the early 20th century. Substantial areas of sapling- and poletimber-size classes have advanced to sawtimber-size stands. Figure 40 presents the same stand-size class distributions from 1968 and 2004 as percentages of total available commercial forest land, and compares these distributions to the Frelich and Lorimer (1991a, 1991b) model distribution for natural northern hardwood forest landscapes. This figure illustrates that the current regional forest stand-size class distribution is closer than the 1968 distribution to one that reflects natural disturbance regimes for northern hardwood forest types.

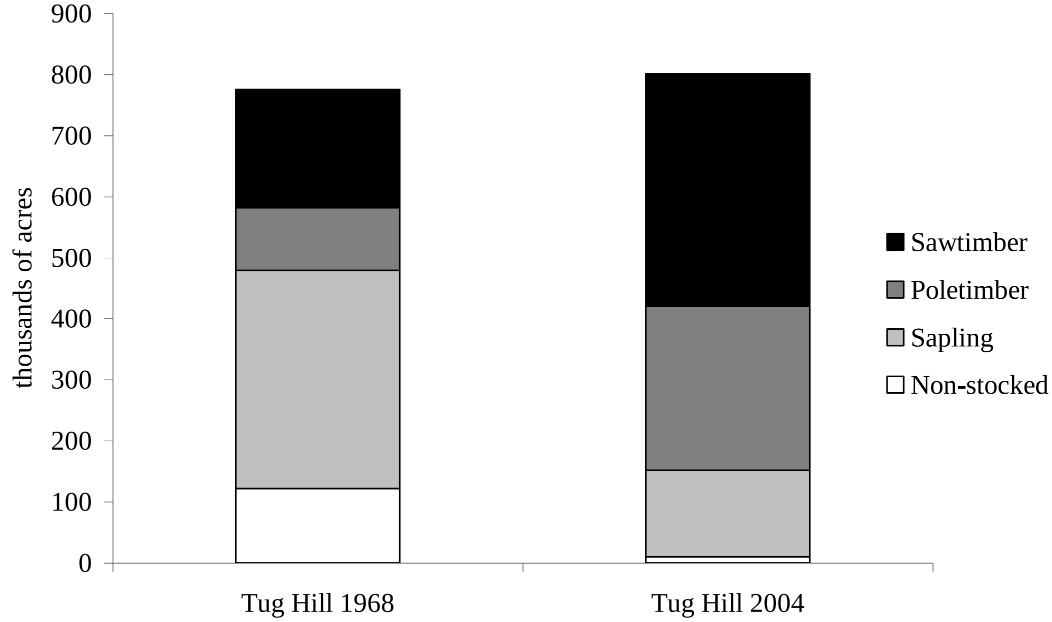


Figure 39. Area of commercial forest land by stand-size class within the Tug Hill Region

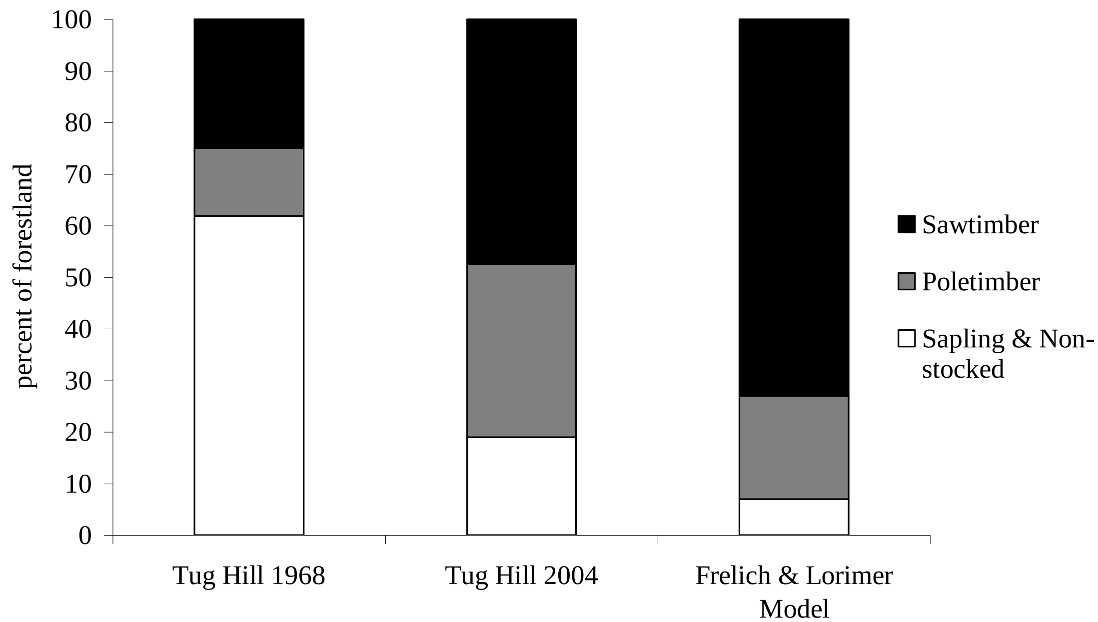


Figure 40. Percent of commercial forest land by stand-size classes within the Tug Hill Region with reference to a model northern hardwood landscape.

Indicator – Early Successional Community Cover (ac) and Percent Cover: Estimates of total and percent cover of early successional communities (inactive grassland and shrub land) is a direct measure of the abundance of these habitats in the landscape. However, there are no historic estimates of the abundance of these habitats under natural disturbance regimes for the region, nor were any records obtained that provide estimates of regional historic maximums for early successional communities at the turn of the 20th century.

<u>Current Condition – Good:</u> Shrub lands and inactive grasslands occupy approximately 11% (~5800 ac) and 4% (~5000) of the lower and upper sub-watersheds, respectively (Table 31). The current total area of early successional habitat is undoubtedly lower than the historic maximum in the late 19th and early 20th centuries when farmland was widely abandoned on marginal sites, but probably higher than conditions under natural disturbance regimes.

The USDA Grassland Reserve Program (GRP) offers landowners the opportunity to protect or rehabilitate grasslands on their property. The NYSDEC, in conjunction with the USDA, has identified critical areas within New York ("Grassland Wildlife Zones") where landowners are encouraged to manage their properties for grassland habitat. There are no Grassland Reserve Zones within the Salmon River watershed (Figure 41), indicating that the watershed has low potential for management of natural grassland habitat.

Indicator – Grassland Bird Species Occurrence: The New York State Landowner Incentive Grassland Protection Program (NYSDEC 2007c) identifies nine grassland bird species that are known to be in decline in New York since 1966, eight of which occur historically in the Salmon River watershed. No data exist on actual population sizes of these species, nor do any baseline data exist suggesting their historic abundance in the region. New York Breeding Bird Atlas census data can be used to determine their relative abundance within the watershed.

<u>Current Condition - Unranked:</u> Table 36 presents the frequency of occurrence for the eight grassland species identified by the NY Landowner Incentive Grassland Protection Program in the upper and lower portions of the watershed. Total occurrences of these species were greater in the western portion of the watershed relative to the eastern, reflecting the greater abundance of early successional communities there.

Figure 41. Locations of USDA Grassland Reserve Zones in New York.

Table 36. Frequency of occurrence of grassland bird species (NY Landowner Incentive Grassland Protection Program) in the Salmon River watershed. Data are from the New York Breeding Bird Atlas (2000-2005). Census blocks were partitioned into lower (n=18) and upper (n=36) portions of the watershed roughly at the Salmon River reservoir.

	Lower Watershed	Upper Watershed
Henslow's sparrow (*Ammodramus henslowii*)	0	0
grasshopper sparrow (*Ammodramus savannarum*)	17	8
vesper sparrow (*Pooecetes gramineus*)	28	6
horned lark (*Eremophila alpestris*)	6	0
eastern meadowlark (*Sturnella magna*)	50	11
savannah sparrow (*Passerculus sandwichensis*)	89	36
northern harrier (*Circus cyaneus*)	28	3
bobolink (*Dolichonyx oryzivorus*)	83	31

2.7.2.4 KEA: CONDITION – Forest Structural Diversity

Terrestrial and aquatic ecologists have long recognized that habitat heterogeneity is important for maintaining biodiversity. This is readily observable through the distribution of community types and individual species across a landscape such as the Tug Hill, which has complex soils and hydrologic regimes (e.g., Hotchkiss 1932, Geis et al. 1974, Howard 2006). A variety of forest "patch types" or successional stages (e.g., grasslands; shrub lands; and sapling, pole, and sawtimber forest size classes) provide intermediate-scale habitat heterogeneity that supports greater diversity of plants and animals than an equal area of a single patch type (Chambers 1983, Keller et al 2003). Finally, within patches, structural complexity associated with tree diameter distributions, decaying logs of different species and decay stages, and standing dead trees provides additional habitat heterogeneity that maintains populations of numerous organisms that rely on such structural features (e.g., Chambers 1983, Harmon et al. 1986, Hansen et al. 1991, DeGraaf et al. 1992, McGee and Kimmerer 2002, Root et al. 2007ab).

Indicator – Large Tree Densities: Large, old trees, whether they occur in natural, unmanaged forests, or in selection or reserve shelterwood stands provide unique and necessary habitat for a number of arboreal taxa such as lichens (Root et al. 2007a), oribatid mites (Root et al. 2007b), bryophytes (McGee and Kimmerer 2002), myxomycetes (Stephenson 1989), and large cavity-nesting or roosting birds and mammals (Chamber 1983, DeGraaf et al. 1992). The minimum density of large trees (i.e., >20 inches dbh) required to sustain viable populations of species that utilize them (many of which are small and dispersal limited) is not known, and is probably influenced by a variety of interacting factors. Under historic, natural disturbance regimes in northern hardwood forests (as estimated by Runkle 1982, Frelich and Lorimer 1991a), densities of large trees average approximately 20 trees/ac ≥ 20”dbh (McGee et al. 1999). Widely applied selection system cutting guides developed for northern hardwood forests recommend 8 trees/ac ≥ 20”dbh (Arbogast 1957) and northern hardwood stands in the central Adirondacks and in Cortland County have been managed under selection system for sawtimber while maintaining approximately 7-10 trees/ac ≥ 20” dbh (Bohn and Nyland 2006).

Table 37. Criteria for ranking forest structural diversity viability based upon live, large tree (>20” dbh) densities.

Large Tree Densities	Poor	Fair	Good	Excellent
Number of trees >20” dbh per acre	0-2	3-6	7-10	>10

Current Condition – Fair: The only data available on live canopy tree diameter distributions for the watershed are from 44 northern hardwood sites located across the Tug Hill region, extending into the watershed to approximately Redfield (McGee unpublished). These measurements were taken at randomly located plots on lands owned by The Nature Conservancy, NYSDEC East Branch Fish Creek Conservation Easement Lands, and NYSDEC State Forests and Wildlife Management Areas. The average live tree density (>4” dbh) is 220 trees per acre, with an average of 3 trees/acre greater than 20” dbh (Figure 42). No data were located that describe canopy structure in the Lake Plain forests in the lower sub-watersheds.

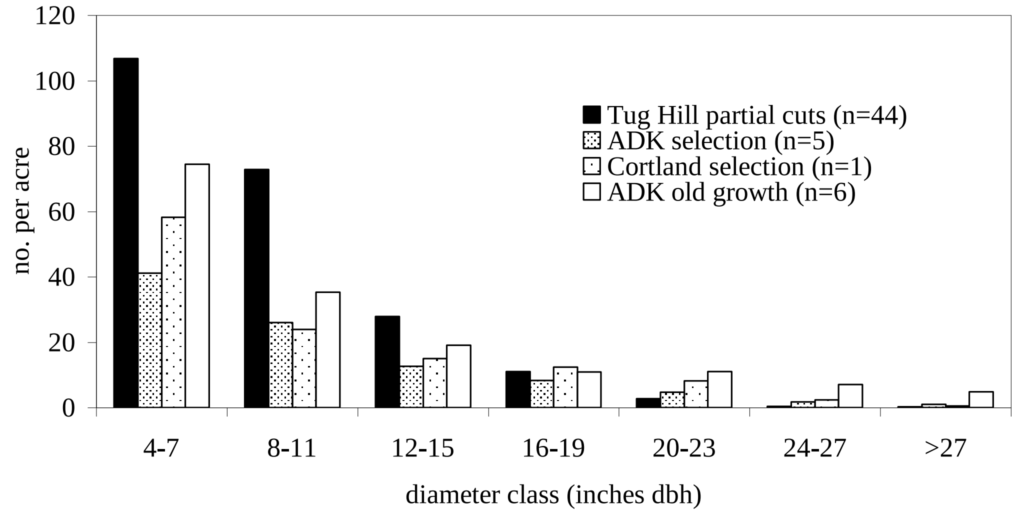


Figure 42. Tree diameter distributions in Tug Hill stands (TNC, DEC Conservation Easement Lands, State Forests and WMAs; McGee unpublished), Adirondack and Cortland selection stands (Bohn and Nyland 2006) and Adirondack old growth (McGee et al. 1999).

Indicator – Decaying Log Volume: Decaying logs provide critical habitat for a variety of birds, mammals, amphibians, fish, fungi, and plants (Harmon et al. 1986, Hayes and Cross 1987, Aubry et al. 1988, Bader et al. 1995, Flebbe and Dolloff 1995, Hanula 1996, Loeb 1996, McKenny et al. 2006). Current regional guidance on expected decaying log volumes in northern hardwood forests suggest maximum levels of approximately 100 m^3/hectare (adjusted for effects of beech bark disease mortality) while those under a variety of common selective cutting regimes approach 60 m^3/hectare (McGee et al. 1999, McGee 2000). Under intensive management regimes such as whole tree harvesting where tops are utilized, log volumes would be limited to approximately <20 m^3/hectare associated with chronic losses of branches and residual trees to wind and ice. The minimum level of CWD required to sustain various important ecosystem functions and wildlife populations is not known.

Table 38. Criteria for ranking forest structural diversity viability based upon decaying log volume

	Poor	Fair	Good
Log volume m^3/ha	0-20	21-60	>60

Current Condition – Fair: No data were available to assess volumes of decaying logs in forests of the watershed or Tug Hill region. Given the similarities between disturbance and management histories of the watershed forests with industrial forests of the Adirondacks (see McGee et al. 1999 for review), it is expected that decaying log volumes in the watershed forests would approximate 60 m^3/hectare.

2.7.2.5 KEA Condition – Nutrient Cycling Processes: Nitrogen Deposition

Nitrogen (N) is an essential, elemental nutrient that naturally occurs in such low concentrations that it frequently limits plant growth in terrestrial and agricultural systems. However, the formation of nitrous oxides (NOx) through fossil fuel combustion, and volatilization of urea (from animal waste) and ammonium (from fertilizer) from agricultural areas has led to increased deposition of N throughout much of northeastern North America. The Tug Hill region consistently receives among the highest rates of atmospheric N deposition in North America (Figure 35). Recent evidence suggests that some forested regions in the Northeast are becoming biologically “saturated” with N (Lovett et al. 2000; Driscoll et al. 2003b), whereby N availability exceeds the biotic requirements of the systems. Excessively high N availability can lead to forest decline because much of the excess N is converted from ammonium (NH_4^+) to nitrate (NO_3^-) by a microbiological process called nitrification. Nitrification is an acidifying process that liberates hydrogen ions (H^+). Therefore, as with impacts of acidic deposition, excessive N availability leads to depletion of other soil nutrients, altered nutrient ratios in plant tissues, and the liberation of aluminum (Al^{n+}) in potentially toxic levels.

Biochemical parameters useful for monitoring forest N status include: N concentration in canopy tree foliage, forest floor carbon-to-nitrogen (C:N) ratios; and seasonal patterns of streamwater NO_3^- concentrations (Aber et al. 2003). Actual threshold levels that signal the onset of nitrogen-saturated conditions are not well established. However, the results of several studies comparing soil and plant tissue responses to various N addition treatments provide some guidance for expected values under high N input levels.

Indicator-Foliar N concentration: Recent controlled experiments (Magill et al. 1997) that included nitrogen dosing of forest soils established foliar N content values for several tree species under ambient N deposition conditions (in ME and MA) and under conditions of experimentally elevated N deposition (56 kg N/ha/yr for four to six years). These control and experimentally “dosed” foliar N concentrations are presented in Figure 43.

Current Condition- Fair to Poor: Tree foliage sampled from 36 forest sites across the Tug Hill region (including 13 in the Salmon River watershed) during summer 2005 (McGee et al., unpublished) exhibited N concentrations at or above levels produced from nitrogen dosing experiments in ME and MA (Figure 43) suggesting potential onset of N-saturated conditions in regional forests.

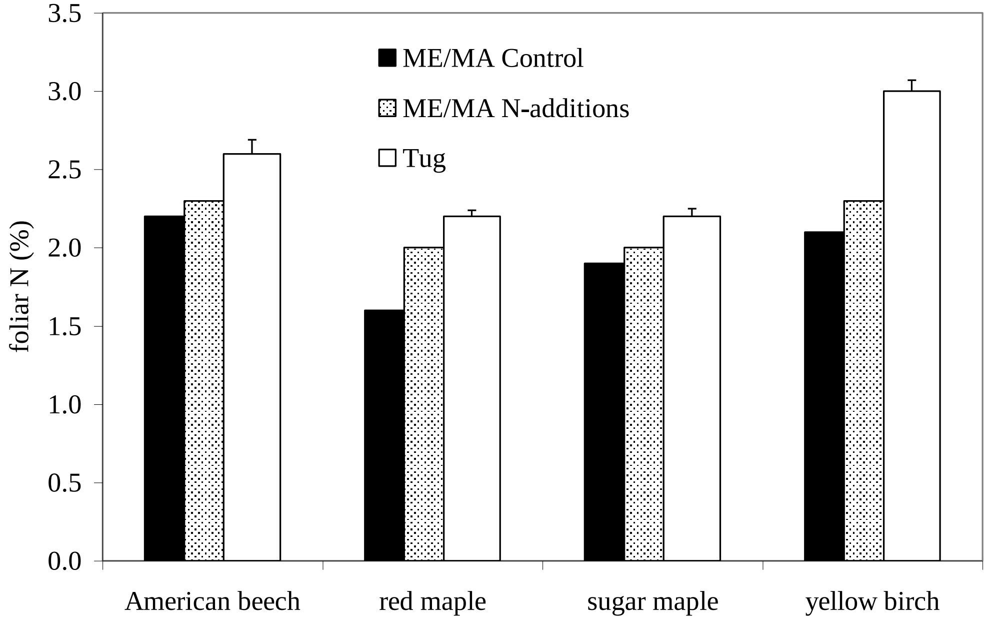


Figure 43. Mean (1SE) N content (%) of fresh foliage from the Tug Hill (2005, McGee, unpublished data), and from control and N-addition plots in less impacted forests of ME and MA (Magill et al. 1996, 1997).

Indicator-Forest Floor C:N ratio: As nitrogen accumulates in soils relative to carbon, C:N ratios will decline. Forest floor C:N ratios impose strong influences on N leaching rates. Ratios of < 22-25 have been correlated with increased nitrification and NO_3^- leaching rates (e.g., Fenn et al. 1998; Aber et al. 2003).

<u>Current Condition: Poor:</u> Forest floor samples taken from 33 Tug Hill forest stands in 2005 and 57 stands in 2006 (McGee et al., unpublished), including several from the Salmon River watershed east of the Redfield Reservoir, all exhibited C:N ratios <25, with the majority being < 20 (Figure 44). These data suggest Tug Hill forest soils may have accumulated N to levels at which high nitrification rates, nitrate leaching and soil acidification are expected to occur.

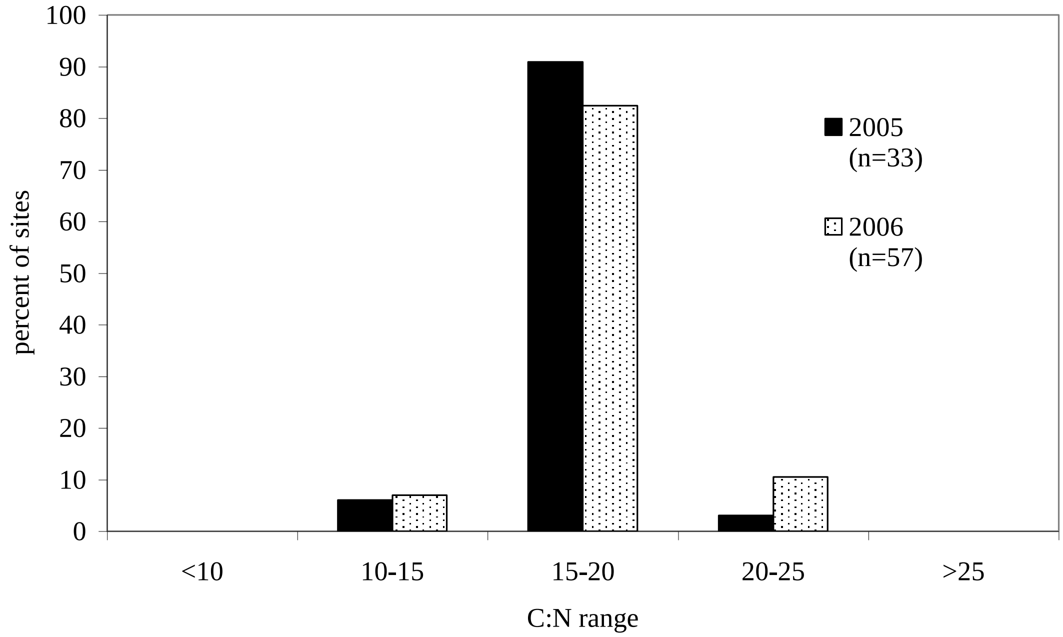


Figure 44. Frequency distribution of forest floor C:N ratios (for 2005 and 2006) in Tug Hill forests (McGee et al., unpublished data)

Indicator-Seasonal Surface Water NO_3^- concentrations: Surface water NO_3^- concentrations are one of the most sensitive indicators of the effects of atmospheric N deposition to forest ecosystems (Aber et al. 2003), and Stoddard (1994) proposed three phases of nitrogen saturation.

<u>Phase 1, unsaturated:</u> Nitrogen loss from unsaturated forests exhibit pronounced annual cycles, with high NO_3^- export during spring snowmelt (e.g., ~ 50-60 µeq/L) which reflects direct input of precipitation to surface waters in the absence of biological assimilation. Nitrogen assimilation by vegetation and soil microbes during the growing season results in very low NO_3^- concentrations in drainage waters during summer baseflow conditions (e.g., <10 µeq/L).

<u>Phase 2, early saturation:</u> With elevated, chronic N inputs summertime lows of nitrate export begin to increase (e.g., 40-50 µeq/L), reflecting the onset of soil nitrogen levels that exceed biotic demand.

<u>Phase 3, acute saturation:</u> Under conditions of exceedingly high NO_3^- deposition, both summertime and springtime NO_3^- export levels remain high (e.g., 150-250 µeq/L) indicating complete loss of biotic control on N cycling processes.

Current Condition: Good to Fair: Headwater streams in the Tug Hill region exhibited an average (± 1 SE) of 24 ± 2 μeq/L NO_3^- (range: 2-80) during spring 2006 and 12 ± 1 μeq/L NO_3^- (range: 2-39) during the summer 2006 (McGee et al., unpublished data). Somewhat elevated NO_3^- concentrations (10-40 μeq/L) in several of the summer samples suggest the potential for some headwaters within the region to be entering the early stages of N saturation.

2.7.2.6 KEA Condition – Nutrient Cycling Processes: Acidification

Acidic deposition leads to the leaching of several base cation mineral nutrients (e.g., calcium (Ca^{2+}), magnesium (Mg^{2+}) and potassium (K^+). Soil nutrient depletion, in turn, leads to foliar Mg^{2+} and Ca^{2+} deficiencies and increased solubility of Al^{n+}, which causes dysfunction to plant root systems. These conditions predispose forests to decline from multiple stresses including drought, insect defoliation and freezing damage (Bailey et al. 2004; Horsley et al. 1999; Shortle et al. 1997). Acid-induced losses of calcium from forest soils have also been implicated in the decline of forest-dwelling species with high reliance on calcium for egg shells or carapaces (e.g., terrestrial snails).

Indicator – Soil pH: Soil pH is a direct measure of soil acidity. However, soil pH is a function of base cation availability in soil parent material, and many of the regional soils are naturally acidic (ranging to extremely acidic, pH<4.5, NCSS 1981). Despite this natural acidity, pH can still be used to suggest the resilience of soils to additional acidifying processes.

Current Condition – Upper sub-watersheds, Fair; Lower sub-watersheds, Good : Upland forest and agricultural soils in the higher, eastern sub-watersheds are generally strongly to extremely acid (e.g., Worth-Empeyville, Westbury and Colton-Hinkley soil series) owing in large part to naturally low buffering capacity of the material from which the soils formed. Soils dominating the cultivated and forested uplands of the western sub-watersheds are generally better buffered, and range from strongly- and medium-acid to neutral or slightly alkaline. Therefore the soils of the lower sub-watersheds generally have better buffering capacity against detrimental impacts of acidic deposition.

Indicator-Foliar Ca:Al Ratio: With acid-induced leaching of base cations from soils and increased solubility of Al^{n+} in soil solution, foliar Ca:Al ratios will decline. Aber et al. (1995) and Magill et al. (1997) reported foliar Ca:Al ratios in northern hardwood forest sites in ME and MA on acid soils. These sites included experimental controls and plots that were further acidified through N fertilization. They found Ca:Al ratios of ~300-550 (depending on species) on control plots and ~200-450 (depending on species) on experimentally acidified plots.

Current Condition – Upper sub-watersheds, Poor; Lower sub-watersheds, Unranked: Samples of American beech, red maple and sugar maple foliage collected across the Tug Hill region during the summers of 2005 and 2006 exhibited Ca:Al ratios of ~200 in 2005 and ~50-60 in 2006. These data indicate substantial annual variation, but all levels are at or considerably below those levels of experimentally acidified forest soils suggesting the potential that forest soils of the region may be impacted by acidification, thereby causing increased solubility of Al^{n+} in soil solution (Figure 45).

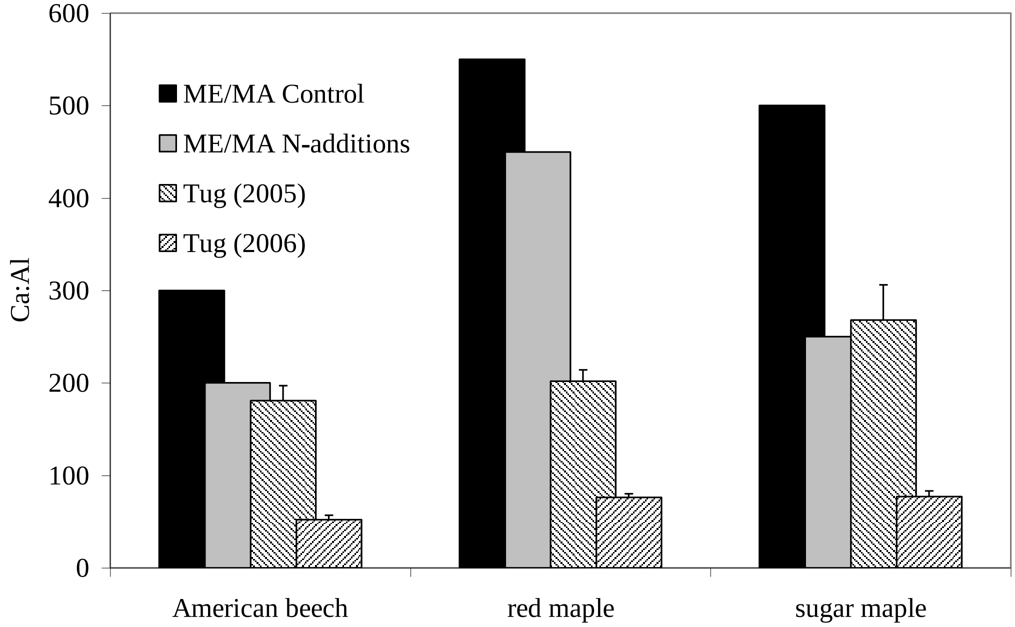


Figure 45. Mean (1SE) Ca:Al ratios of fresh foliage from Tug Hill forests (2005 and 2006) compared to less polluted areas in MA and ME on control sites and sites that were experimentally acidifiied through high doses of N (McGee, unpublished data).

2.7.2.7 KEA Condition – Toxins.
An environmental toxin of growing national interest is mercury (Hg). In its biologically active form (methyl-mercury, MeHg) this element bioaccumulates in the food chain, thereby causing greater exposure to higher-level carnvivores. Mercury is a neurotoxin that leads to reduced reproductive success and impaired motor skills in wildife and humans (Driscoll et al. 2007). Mercury enters forest ecosystems by uptake of gaseous Hg through pores in leaves, where it then passes into the food chain through decomposition of leaf litter by detritivores such as slugs, snails, woodlice and millipedes. These invertebrates are then consumed by predaceous invertebrates such as centipedes and spiders, which are in turn consumed by foraging birds, and importantly, by ground foraging birds such as the wood thrush (Evers and Duron 2006).

Indicator-Insectivorous Bird Blood Mercury Concentration: Blood mercury concentration is a direct indicator of cumulative exposure to mercury. Ground-foraging woodland species such as wood thrush are at greatest risk of exposure.

Table 39. Criteria for ranking blood mercury concentration in woodland birds (based on thresholds leading to risk of negative reproductive impacts, Evers and Duron 2006).

	good	fair	Poor
blood Hg concentration (μg/g)	<1	1	1.4
risk of negative reproductive impacts	low	likely	High

Current Condition - Good: In a survey across New York and Pennsylvania, including a site in the Tug Hill region, blood mercury concentration of wood thrushes was found to be above expected levels for uncontaminated sites, but still below levels that would cause negative reproductive impacts (Evers and Duron 2006).

2.7.2.8 KEA Condition – Forest Understory Community Composition and Diversity
A number of factors influence the composition and diversity of native forest understory vascular plants. First, site conditions (moisture and nutrient availability) importantly influence the suite of species that occupy a particular location based upon their respective tolerance for limited moisture and nutrients. Past disturbance history also influences understory plant composition. Past agricultural activities, such as cultivation and pasturing, are known to reduce the number and types of species that occur in second-growth forests that reestablish on abandoned agricultural lands. Natural and human canopy disturbances also influence the abundance and composition of understory plants by altering resource (i.e., light, soil moisture and nutrients) availability in the understory. Intense canopy disturbances or repeated low intensity disturbances favor the establishment of more competitive, shade-intolerant, and invasive species.

Indicator – Invasive Plant Species Frequencies of Occurrence: Invasive species are those non-native organisms whose introduction to an ecosystem causes or is likely to cause economic or environmental harm (NYSISTF 2005). Many invasive plant species are competitive or weedy plants that are able to displace others, thereby reducing diversity of other plants and organisms that rely on a diverse assemblage of plants. The frequency of occurrence of an invasive species within an area of interest, and/or the density or percent cover within communities when they occur are indicators of the local distribution and degree of community dominance by invasive species. Table 4 ranks community composition based upon the frequency of occurrence or dominance of invasive species.

<u>Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Unranked:</u> There is currently no comprehensive list of invasive plant species in New York, but the New York State Invasive Species Task Force and the Adirondack Park Invasive Plant Program offer guidance for some species to monitor on a local or regional basis (Table 40). There are currently no efforts to systematically monitor invasive plants within the Salmon River watershed or greater Tug Hill region, and few data sources are available with which to gauge distribution of invasives within the watershed. In an October, 2001 survey of the Salmon River greenway corridor (Dru Assoc., 2001), field biologists completed NY Natural Heritage reporting forms for 36 upland hardwood and conifer plantation sites. No invasive plant species were recorded on these Heritage reporting forms, but a few invasive species were included in the flora checklist for the corridor's study area (Table 40). McGee (unpublished data) reported no invasive plant species on 49 upland forest sites on NY State and private lands across the Tug Hill (including several in the Salmon River watershed east of the Redfield Reservoir). McGee's survey excluded sites within 100 m of a road and therefore was biased against encountering invasive species. These surveys suggest that, although terrestrial invasive plant species are present within the watershed, they are not dominant components of the forest flora. Other species are known, anecdotally, to occur within the watershed (J. Chairvolotti personal communication, Table 40) but quantitative information regarding their frequencies of occurrence or local dominance is not available. Information regarding invasive plant occurrences in forests of the lower sub-watersheds is especially lacking.

Table 40. Terrestrial invasive plants currently monitored by the Adirondack Park Invasive Plant Program (APIPP 2007). Known occurrences within the Salmon River Watershed are denoted by a letter referencing a specific source.

Common Name	Scientific Name	Present in Watershed
garlic mustard	*Alliaria petiolata*	Present[1, 2]
Russian and autumn olive	*Elaeagnus angustifolia. E. umbellata*	
fly and Tatarian honeysuckle	*Lonicera morrowii, L. tatarica*	
purple loosestrife	*Lythrum salicaria*	Present[1]
white sweet-clover	*Melilotus alba*	
common reed grass	*Phragmites australis*	Present[1]
Japanese knotweed	*Polygonum cuspidatum*	Present[2]
common and smooth buckthorn	*Rhamnus cathartica, R. frangula*	Present[2]
black locust	*Robinia pseudoacacia*	Present[1]
black swallowwort	*Vincetoxicum nigrum*	Present[2]

Sources: (1) Dru Assoc., 2001; (2) Chairvolotti, J., Oswego County District Forester, personal communication, March, 2007.

Indicator – Native Forest Herb Densities/Frequencies: A number of shade-tolerant, native forest herb species characterize the understories of the regional forests (Hotchkiss 1932, McNamara 1999). Many of these species lack resilience to extreme disturbance events due to low sexual reproductive success and slow vegetative growth rates (Bierzychudek 1982). A recent literature review indicates that, while the relative abundance of shade-tolerant forest herbs may decline relative to more competitive and weedy species directly following forest management activities, with canopy closure their abundances generally appear to return to pre-existing levels (Roberts and Gilliam 2003). However, disturbances that remove soil seed banks and kill root stock (agriculture) appear to have greater negative consequences for this suite of species (e.g., Singleton et al. 2001). Therefore, post-agricultural second-growth forests display highly reduced forest herb diversity.

<u>Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Unranked</u>: No quantitative information exists that would provide baseline conditions for forest herb species cover or frequencies in forests of the watershed or greater Tug Hill region. Hotchkiss (1932) provided a subjective rank-ordered species list for herbs commonly found in climax forests of the Tug Hill. A recent unpublished survey was conducted of forest herb species frequencies in 49 northern hardwood study sites across the Tug Hill (McGee, unpublished), including sites in the watershed westward to approximately Redfield. That study found that many of the common species listed by Hotchkiss continued to be among the most frequently encountered in the region's forests (Table 41). However, McGee also found that a number of more competitive

and weedy species (briars, hay-scented fern and New York fern) are more frequent in current forests than would be suggested by the Hotchkiss data. It should be noted that this study was conducted on sites that were generally uninfluenced by agricultural activities, and therefore does not accurately reflect conditions on the post-agricultural, second-growth forests that are common in the watershed. No information is available on herb communities in forests of the lower watershed.

Table 41. Frequencies of occurrence for dominant herbaceous species on the Tug Hill Plateau. Species are listed in a generalized rank order of abundance for Tug Hill climax forests according to Hotchkiss (1932). Current herb species occurrences are provided for McGee (unpublished data for forty-nine 800 m^2 plots in Tug Hill northern hardwood forests including sites in the Salmon River watershed east of Redfield, growing seasons 2005/2006).

Hotchkiss (1932) "rank order" of dominant species	McGee % sites
spinulose woodfern (*Dryopteris intermedia*)	90
wood sorrel (*Oxalis acetosella*)	56
sarsaparilla (*Aralia nudicaulis*)	60
bluebead lily (*Clintonia borealis*)	68
bunchberry (*Cornus canadensis*)	10
shiny clubmoss (*Lycopodium lucidulum*)	32
Canada mayflower (*Maianthemum canadense*)	84
painted trillium (*Trillium undulatum*)	38
goldthread (*Coptis trifoliata*)	29
indian cucumber root (*Medeola virginiana*)	35
starflower (*Trientalis borealis*)	27
partridgeberry (*Mitchella repens*)	35
dewdrop (*Dalibarda repens*)	0
red trillium (*Trillium erectum*)	38
foamflower (*Tiarella cordifolia*)	6
tall white violet (*Viola canadensis*)	32 (*Viola* spp.)
red baneberry (*Actea rubra*)	1
dewberry (*Rubus pubescens*)	10
beech-fern (*Thelypteris phegopteris*)	1
waterleaf (*Hydrophyllum virginianum*)	0
shinleaf (*Pyrola elliptica*)	0
rosy bells (*Streptopus roseus*)	34
McGee other dominant species	
briar (*Rubus idaeus, R. allegheniensis, R. occidentalis*)	78
hay-scented fern (*Dennstaedtia punctilobula*)	61
false Solomon's seal (*Smilacina racemosa*)	31
New York fern (*Thelyptris noveboracensis*)	31
Jack-in-the-pulpit (*Arisaema atrorubens*)	30
whorled aster (*Aster acuminatus*)	28
sessile bellwort (*Uvularia sessilifolia*)	22

2.7.2.9 KEA Condition – Forest Tree Regeneration

The maintenance of productive, well-stocked and diverse forests requires abundant and well-distributed tree regeneration to replace trees that die naturally or are removed by logging activities. Several variables influence the regeneration of ecologically and commercially desirable tree species including site conditions, herbivory, competition by herbaceous and other woody species, and, in working forests, the application of silvicultural prescriptions that ensure adequate seed production and optimal growing conditions for species and genotypes that are best suited for a given site and management objective (Nyland 1996).

Indicator – Regeneration Frequency: The proportion of sites on which seedlings of component forest species occur provides a measurement of potential for regeneration of respective species across the watershed.

Current Condition – Good: Little information is available with which to draw conclusions regarding forest tree regeneration trends in the watershed. The data currently available include only frequency of occurrence on 49 northern hardwood sites within the Tug Hill region, including some in the watershed east of the Redfield Reservoir (McGee, unpublished); and frequency of occurrence on 30 hardwood and 6 plantation sites along the Salmon River Corridor below Redfield (Dru Assoc., 2001).

Only one non-native species (Norway spruce) was listed among regeneration in these two surveys (Table 42). This species is not considered invasive in this area, and it occurred with low frequencies in existing plantations. No invasive tree species were recorded in the regeneration layer of the watershed's forests. Red maple was the most abundant seedling/sapling in the higher elevation forests (89% of sites), followed by black cherry, striped maple, American beech and yellow birch. Sugar maple and red spruce occurred on approximately 40% of sites. In lower elevation forests west of Redfield, American beech was the most abundant seedling/sapling (60% of sites), followed by maple (undetermined), striped maple, hemlock and red oak.

Indicator – Regeneration Density: Seedling and sapling densities, by height class, of component forest tree species provide the best indication of potential regeneration success.

Current Condition – Unranked: No data were obtained reporting seedling/sapling densities in the forests of the watershed.

Table 42. Frequencies of occurrence for dominant tree seedlings and woody shrubs in the Tug Hill region. Data from McGee (unpublished) are percent of 800 m^2 plots that a species was present in the herb layer (≤1 m tall) in Tug Hill northern hardwood forests (including sites in the Salmon River Watershed east of the Redfield Reservoir). Data from Dru Assoc. (2001) are the frequency of sites at which a species was recorded along the Salmon River corridor in and downstream of Redfield. Only dominant species were listed at sites of unknown area (size cutoff for understory not known). Dru included consideration of pine and spruce plantations.

	McGee (n=49)	Dru hardwood types (n=30)	Dru pine and spruce plantations (n=6)
maple		50	17
red maple (*Acer rubrum*)	89		
black cherry (*Prunus serotina*)	67		
striped maple (*Acer pensylvanicum*)	65	40	
American beech (*Fagus grandifolia*)	65	60	17
yellow birch (*Betula alleghaniensis*)	64		17
sugar maple (*Acer saccharum*)	41		17
red spruce (*Picea rubens*)	41	3	
balsam fir (*Abies balsamea*)	20		
white ash (*Fraxinus americana*)	18	13	
serviceberry (*Amelanchier arborea*)	14		
alternate-leaf dogwood (*Cornus alternifolia*)	14		
basswood (*Tilia americana*)	6		
eastern hemlock (*Tsuga canadensis*)	5	27	
eastern white pine (*Pinus strobus*)	3	13	
Norway spruce (*Picea abies*)			17
mountain maple (*Acer spicatum*)	1	3	
red oak (*Quercus rubra*)		23	17
eastern hophornbeam (*Ostrya virginiana*)	1		
American hornbeam (*Carpinus caroliniana*)		13	
hickory (*Carya* sp.)		13	
hawthorn (*Crataegus* sp.)		7	
American chestnut (*Castanea dentata*)		3	
elm (*Ulmus* sp.)		3	
witch-hazel (*Hamamelis virginiana*)		3	

2.7.2.10 KEA –CONDITION: Forest Overstory Composition

Current forest overstory reflects the cumulative effects of past disturbances on the capacity for component species to regenerate. Current overstory composition and diversity may deviate from expected due to a number of factors such as disease (beech bark disease, chestnut blight, Dutch elm disease), changes in the extent and intensity of natural or human disturbances (e.g., declining oak dominance in Appalachian forests due to changes in fire frequencies; or abundance of successional species following widespread clearing and abandonment of agricultural lands), or deliberate management decisions to favor certain species.

Indicator – Invasive Species Frequencies/Dominance: The frequency of occurrence of invasive species, and/or the density or percent cover within communities when they occur are indicators of the local distribution and degree of community dominance by invasive species. Table 4 ranks community composition based upon the frequency of occurrence or dominance of invasive species.

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Unranked: No invasive species were recorded in any of the overstory layers in 147 samples of Tug Hill forests, including sites extending to lower elevations to approximately Orwell (Table 43). It should be noted that none of the sample locations occurred in the Lake Plain forests, where growing conditions, increased development, and fragmentation may lead to increased occurrences of invasive species.

Indicator – Rank Abundance of Native Component Species: Forest species composition constantly shifts in geologic time scales due to fluctuations in climate (e.g., deglaciation) and otherwise can vary on more narrow time scales due to natural perturbations. Monitoring canopy composition (and regeneration) permits for the detection of long-term compositional trends, which may indicate meaningful environmental change. Historic considerations of the natural vegetation of the region indicate that these forests were dominated by various combinations of American beech, yellow birch and sugar maple, with an abundant admixture of conifers (red spruce, hemlock, white pine balsam fir, all of which increased in abundance near swamps and stream valleys). In the transitional Tug Hill fringe, northern hardwoods dominated with hemlock, white pine, and some spruce restricted to stream sides and ravines (Hotchkiss 1932, Stout 1958). A forest landscape in which the dominance of native species that are adapted to prevailing site conditions and historic disturbance regimes is maintained indicates no substantial, widespread perturbation. Large change in the dominance distribution of forest overstory trees on a landscape scale indicates the occurrence of some historic shift in regeneration processes.

Current Condition – Upper sub-watersheds, Fair; Lower sub-watersheds, Unranked: Table 43 summarizes available data regarding forest canopy composition (based on average relative stand basal area and frequency of occurrence across sampled stands). These data are limited primarily to the upper elevations and transitional sections of the watershed. No data were obtained for forests in the Ontario Lake Plain. Notable shifts from expected dominance by northern hardwood forest species (sugar maple, beech, yellow birch, red spruce, hemlock) include reduction of dominance for red spruce to 1% of the basal area, although it occurs on 31% of sites. This likely reflects heavy cutting of this species in the 19th century. American beech is frequent but accounts for only 7% of the average basal area, reflecting widespread effects of beech bark disease on forest structure. Red maple and black cherry, which are early- to mid-successional species, together account for 40% of the relative basal area of the region, and this may reflect their widespread establishment on abandoned post-agricultural lands throughout a portion of the watershed, and/or management decisions that favor the regeneration and growth of these species.

Table 43. Summary of forest canopy composition in Tug Hill northern hardwood forests, including sites in the Salmon River watershed east of the Redfield Reservoir. Data are averages of species relative basal areas (expressed as percent), and species frequencies of occurrence. Data are from Wink, 2002 (n=25); available stand inventory data from properties in the Salmon River watershed enrolled in the state 480A tax program (n=75 stands across ten ownerships); and McGee (unpublished, n=44).

	average relative basal area	frequency (percent of stands)
red maple	29	93
sugar maple	21	76
black cherry	11	71
yellow birch	10	78
American beech	7	64
eastern hemlock	6	26
white ash	3	33
red spruce	1	31
other	10	61

2.7.2.11. KEA – CONDITION: Forest Pests and Pathogens
A number of forest pathogens (fungi, bacteria, viruses) and insect pests are endemic to, have been introduced to, or are of potential concern to northern forest ecosystems in general, and to the matrix forests of the Salmon River watershed in particular.

Indicator – Sirex Woodwasp Distribution: Sirex woodwasp (*Sirex noctilio*) is a wood-boring pest of conifers, primarily 2 & 3-needled pines. In New York, it is a recently introduced invasive species that was first discovered near the town of Fulton in 2004. Since then, the Sirex woodwasp has been confirmed in over half of the counties in the state, including those counties which contain the Salmon River Watershed. It has also been detected in Pennsylvania, Vermont, and Ontario. Scots pine, red pine, Austrian pine, and eastern white pine are all susceptible hosts occurring in the watershed.

The female woodwasp drills a series of holes in the host tree with her ovipositor, through which she injects an egg along with a toxic mucus and a blue-stain fungus, which prepare the host tree for invasion by hatching larvae. The cumulative result of the toxin, fungus, and larval tunneling is death of the tree within 2-3 years.

At this time it is unclear what the long-term ecological impact of Sirex woodwasp will be in the watershed. The majority of trees attacked in New York have been weak, overtopped or otherwise pre-disposed hosts. However there have also been cases of dominant, vigorous trees attacked and killed, and worldwide Sirex has caused millions of dollars in timber losses, primarily within monoculture plantations. (More information is available online at http://www.na.fs.fed.us/fhp/sww/.)

Current Condition – Fair: A few specimens of *Sirex* have been trapped in Oswego County. Given the abundance of native eastern white pine and the number of NYSDEC reforestation areas in the watershed that contain white, red and Scots pines, this species poses a serious threat to the regional forests.

Indicator – Forest Tent Caterpillar Distributions: Eastern (*Malacosoma americanum*) and forest (*Malacosoma disstria*) tent caterpillars are two important tree pests in New York. These defoliators can cause widespread damage to a variety of native hardwood species. The forest tent caterpillar is the most common defoliator pest in northern hardwood forest types and, in the Northeast, sugar maple is the principle host. Outbreaks in the Lake States typically last for 3-4 years, occur at 7-12 year intervals, and can cover areas as large as 40,000 km^2 (Wink 2002; Wink and Allen 2007). Depending on the intensity and extent of defoliation, forest trees may experience diminished productivity (40-90%), direct mortality (2% of dominant and codominant sugar maples, and14% of intermediate and suppressed trees), or may be predisposed to forest decline through other contributing agents such as past disturbance or drought.

Hardwood stands in this part of New York can typically be expected to experience some "background" level of defoliation every year, and native tree species are well adapted to it. However, during outbreaks in which severe defoliation occurs in two or more consecutive years, significant mortality of one or more host tree species can be expected. When this happens, understory plants may respond rapidly to the increased availability of light beneath the canopy, so the species make-up of this understory layer becomes an important determining factor in what the future composition of the forest will be.

<u>Current Condition – Fair:</u> These species are endemic to the forests of the watershed and are known to cause periodic, extensive defoliation. A recent study found that Tug Hill forests subjected to repeated diameter-limit cutting (selective removal only of trees over a set diameter) exhibited greater mortality associated with forest tent caterpillar defoliation than forests that had received timber stand improvement cuts (Wink 2002; Wink and Allen 2007). NYSDEC aerial survey data (Figures 46, 47) illustrate the extent of damage within the watershed caused by the most recent outbreak of tent caterpillars during the period 2002-2007 and by a drought in 2007.

Indicator – Beech Bark Disease Distribution: Beech bark disease is caused by the fungi *Nectria* spp., preceded by the beech scale *Cryptococcus fagisuga* on American beech. The scale was introduced in North America around 1890 (Houston 1994) and, along with the associated fungi, has extended through Canada's maritime provinces, New England and into the mid-Atlantic states. The fungus causes extensive above-ground mortality to larger trees, but the root systems remain alive. The ability of beech to root sprout leads to establishment of extensive root-sprout thickets (Shigo 1972) that may impose heavy competition on other understory woody and herbaceous species. The disease spread through northern New York in the 1980s causing difficulties in the maintenance of desired forest stocking and composition in managed forests.

<u>Current Condition – Poor:</u> Beech bark disease has spread throughout the Tug Hill and affects stand structure and composition there. In a survey of four New York State Forest Preserve stands within the Tug Hill region that had not been actively managed for more than a century, McGee (unpublished data) found no live beech >16" diameter in stands where beech bark disease symptoms were apparent. In those same stands, several other species were frequently present with diameters from 20-28". This is a clear indication of the impact of beech bark disease; in stands that have not been harvested for over 100 years, densities of large, old beech would be comparable to those of other long-lived species such as sugar maple, yellow birch hemlock and red spruce if beech bark disease was not a factor.

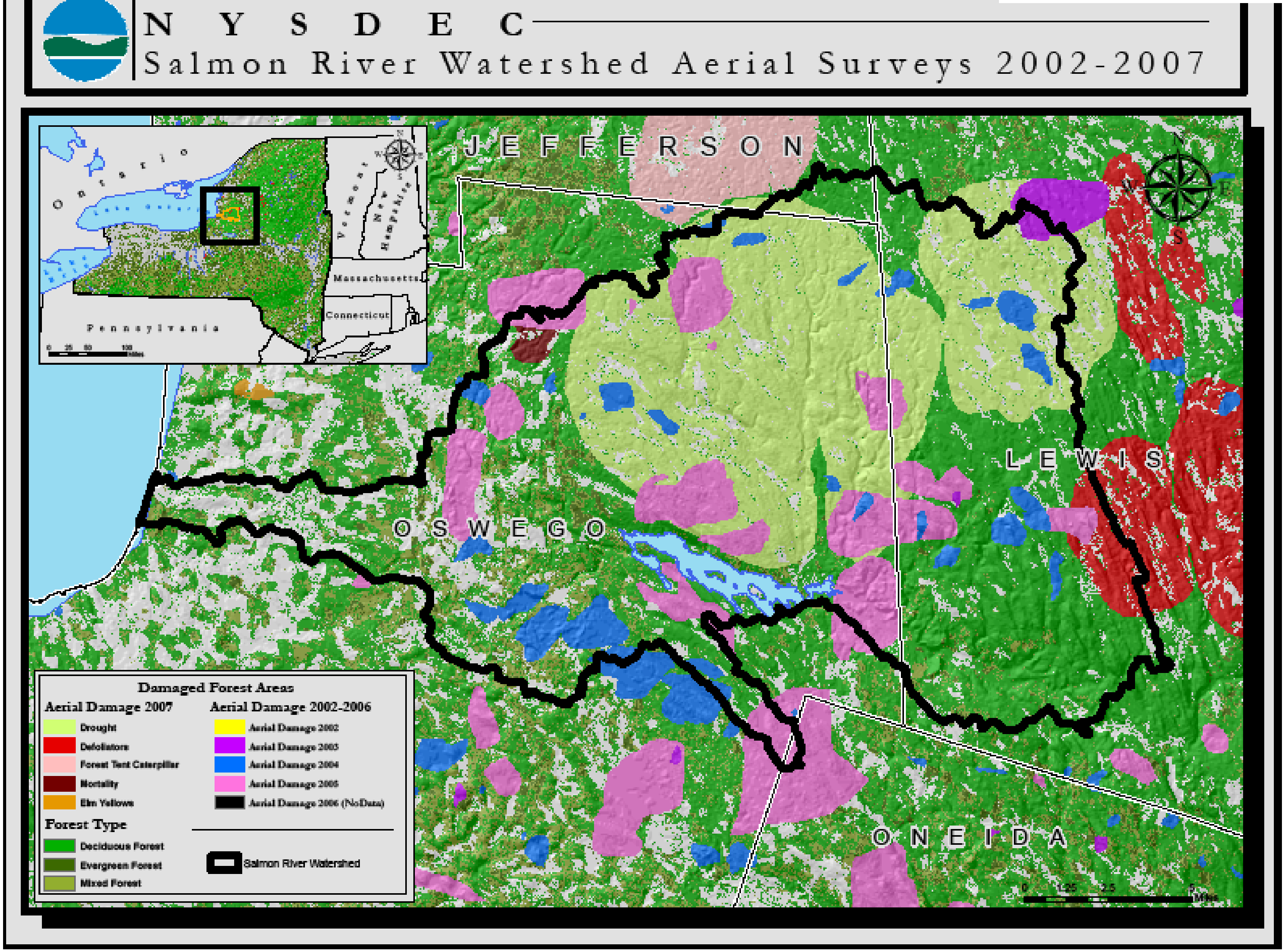


Figure 46. NYSDEC aerial survey data of forest damage in the Salmon River watershed during the period 2002-2007.

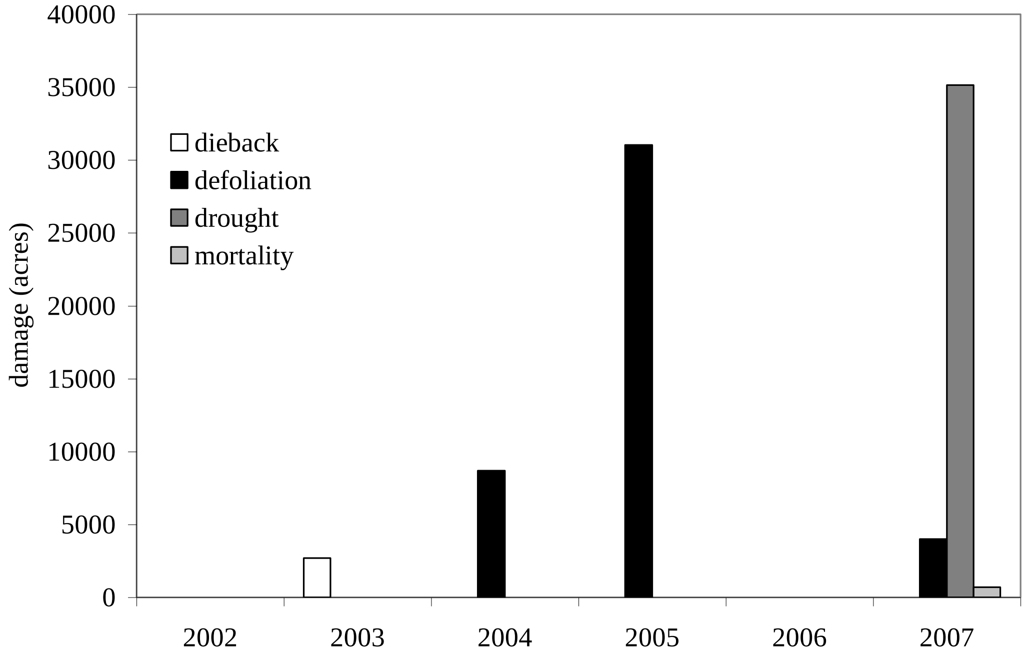


Figure 47. NYSDEC survey of Salmon River watershed forest damage (2002-2007).

There are several potential pests that are not currently known to occur in the Salmon River watershed, but which several forest managers indicate should be carefully monitored.

Emerald Ash Borer (*Agrilus planipennis*) is an exotic pest of ash trees that has been detected in MI, OH, IN, VA, WV, MD, PA and Ontario. It has not yet been detected in New York. EAB is a buprestid wood-boring beetle that attacks all species and cultivars of ash. Larvae tunnel in the cambium layer just beneath the bark, usually killing the tree by girdling within a year or two. Symptoms of infestation include: crown dieback, vigorous sprouting from the base, small D-shaped (half-moon) exit holes, and serpentine galleries beneath vertical bark splits. There is currently no effective chemical or biological control for EAB. Unless one is developed in the next few years, the long-term outlook for ash in the region seems uncertain at best. As ash is a frequently occurring though not dominant component of many hardwood stands across the state, there would almost certainly be serious (and difficult to predict) ecological impacts from the loss of these species. (More information is available online at http://www.emeraldashborer.info/.)

The Asian Long Horned Beetle (*Anoplophora glabripennis*) is a wood boring beetle native to China that attacks a variety of hardwoods including maples, elms, poplars and willows. Infestations have been found in New York City, northern New Jersey, Illinois and Ontario. (More information is available online at http://www.uvm.edu/albeetle/.) The maple-dominated forests of northern New York, including the Salmon River watershed are highly susceptible to infestation by the beetle (TNC 2007).

Hemlock Wooly Adelgid (*Adelges tsugae*) is a scale insect native to east Asia that has infested and caused extensive mortality to hemlock trees in New England, and mid-Atlantic states. It is currently restricted to the lower Hudson and Delaware Valleys in New York. Its ability to spread northward into colder climatic regions in New York is currently unclear, but given the distribution of hemlock throughout New York, the adelgid could potentially cause extensive ecological damage to New York's forests. (More information is available online at http://www.na.fs.fed.us/fhp/hwa/.)

2.7.3 Matrix Forests
Viability Summary

Notes on Guidance for Current Condition:

"NG"	No guidance was obtained to rank this indicator
"SGR"	Subjective guidance and/or ranking based on professional opinion
"ND"	No data are available with which to rank this indicator

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA - Area - Forest Cover						
Ind. – Total contiguous forest area (ac)		> 25,000	< 25,000			Anderson et al. (2004)
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	
Ind. - Upland percent forest cover		> 90	90-75	< 75		SGR
Upper sub-watersheds					Good	
Lower sub-watersheds					Poor	
Ind. – Percent cover by forest type					Unranked	NG
KEA - Landscape Context – Fragmentation						
Ind. - Forest Edge:Area Ratio		< 0.3	> 0.3			SGR based on current upper sub-watershed conditions
Upper sub-watersheds					Good	
Lower sub-watersheds					Fair	
Ind. - Frequencies forest interior birds (NY Bird Atlas)						NG
Upper sub-watersheds (avg. freq. interior species)					Unranked	
Lower sub-watersheds (avg. freq. interior species)					Unranked	
Ind. - Frequency brown-headed cowbird (NY Bird Atlas)						NG
Upper sub-watersheds					Unranked	
Lower sub-watersheds					Unranked	
					Current	

	Exellent	Good	Fair	Poor	Condition	Notes on Guidance for Current Condition
Ind. –Presence of wide-ranging forest mammals					Unranked	NG
Ind. – Connectivity to regional forest types						
Upper sub-watersheds					Good-Fair	SGR
Lower sub-watersheds					Poor	SGR
KEA-Condition - Distribution Successional Stages						
Ind. –Forest stand size-class distribution ratio						
Old : Mature/Uneven : Immature/Uneven : Sapling/Pole		*5:70:20:5*			Unranked	ND, Frelich & Lorimer (1991a,b)
Ind. - Early successional community cover (percent)						
Upper sub-watersheds					Good	SGR
Lower sub-watersheds					Good	
Ind. - Frequency grassland bird species (NY Bird Atlas)						
Upper sub-watersheds (avg. freq. grassland species)					Unranked	NG
Lower sub-watersheds (avg. freq. grassland species)					Unranked	
KEA-Condition - Forest Structural Diversity						
Ind. - Large (20+ inch) tree densities (#trees/acre)	>10	7-10	3-6	0-2	Fair	McGee et al. (1999)
Ind. - Decaying log volume (m^3/ha)		100-60	60-20	< 20	Fair	McGee et al. (1999)

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition - Nutrient Cycling Processes						
Ind. - Foliar nitrogen concentration (%)		1.6-2.2		2.0-2.4	Fair-Poor	Magill et al. (1996, 1997)
Ind. - Forest floor carbon:nitrogen ratio		> 25	25-22	< 22	Poor	Fenn et al. (1998) Aber et al. (2003)
Ind. - Summer surface water NO_3^- (μeq/L)		< 10	10-50	> 50	Good-Fair	Stoddard (1994)
Ind. - Soil pH						
Upper sub-watersheds					Fair	SGR
Lower sub-watersheds					Good	
Ind. - Foliar Ca:Al ratio		300-550		200-450		Aber et al. (1995)
Upper sub-watersheds					Poor	Magill et al. (1997)
Lower sub-watersheds					Unranked	ND
KEA-Condition - Toxins						
Ind. – Insectivorous bird blood mercury concentration		<1	1-1.4	>1.4	Good	Evers and Duron (2006)
KEA-Condition - Understory Communities						
Ind. -Frequency invasive plant species	0	<5	5-25	>25		Drake et al. (2003)
Upper sub-watersheds					Good	
Lower sub-watersheds					Unranked	ND
Ind. -Freq. native forest herb species						
Upper sub-watersheds					Good	SGR
Lower sub-watersheds					Unranked	ND
Ind. – Forest tree regeneration frequency (% sites)					Good	SGR
Ind. – Forest tree regeneration density					Unranked	ND

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Condition - Forest Overstory Community						
Ind. – Frequency Invasive Species	0	<5	5-25	>25		Drake et al. (2003)
Upper sub-watersheds					Good	
Lower sub-watersheds					Unranked	ND
Ind. - Rank Abundance Component Species: in upper sub-watersheds, beech, s. maple, y. birch, r. spruce and hemlock expected to have highest, average basal areas and frequencies		5 in top 7	4 in top 7	< 4 in top 7	Fair	SGR
Lower sub-watersheds					Unranked	ND
KEA - Condition - Forest Pests and Pathogens						
Ind. - Sirex wood wasp frequency on potential hosts	0	<5%	5-25%	>25%	Fair	SGR
Ind. - Tent caterpillars	0	<5%	5-25%	>25%	Fair	SGR
Ind. - Beech bark disease	0	<5%	5-25%	>25%	Poor	SGR
Ind. - Emerald ash borer	0	<5%	5-25%	>25%	Excellent	SGR
Ind. - Asian longhorn beetle	0	<5%	5-25%	>25%	Excellent	SGR
Ind. - Hemlock wooly adelgid	0	<5%	5-25%	>25%	Excellent	SGR

2.8 Salmon River Gorge and Steep Slope Communities

2.8.1 Gorge and Steep Slope Target Definition

One of the pronounced geologic features of the Tug Hill region is the numerous, steep and often deep gorges (or "gulfs") that have formed from the erosive actions of high-velocity streams eroding weak shale and thin-bedded sandstone bedrock (Hotchkiss 1932). Most of the Tug Hill's western fringe gulfs (Inman, Bear, Shingle, Lorraine, Totman and Mooney Gulfs) occur outside the Salmon River watershed and the only such pronounced feature within the watershed is the Salmon River Gorge, which begins at a 34-m high falls and continues downstream for approximately 1000 m. The Gorge includes 35-m high sheer cliffs and talus slopes that support unique plant assemblages and several rare plant species. The Gorge represents a unique natural resource within the Salmon River Watershed, and it emerged as a stand-alone conservation target because it was believed that its natural and cultural values, future condition, and management were independent of the Main Stem of the Salmon River and of the Matrix Forest targets.

Apart from the cultural and scenic values of the Salmon River gorge and other regional gulfs, their ecological uniqueness is due to their deep, shaded valleys, and the presence of sheer, moist cliffs, and talus slopes. It is these physical and topographic conditions of the gulfs and the Salmon River gorge that permit the unique assemblage of uncommon species there. The upper slopes and rims are dominated by conifers and successional hardwoods including white pine, eastern hemlock, northern white-cedar and aspens. Several researchers have reported on the unique plant assemblages and rare species that occur within these gulfs (Hotchkiss 1932, Geis et al. 1974).

In addition to the gorge, numerous other less prominent areas (e.g., Mad River Falls) exist along many streams in the watershed that contain sheer outcroppings or steep-slopes of more moderate relief (Figure 48). Although not as visually imposing as the region's gulfs, these geologic features may possess the combination of conditions that support unique biological elements. Therefore, these other, more modest "steep slope" communities have been included in this target to extend consideration beyond the Salmon River gorge.

The viability analyses for the gorge and the other steep slope communities will be treated separately in this section.

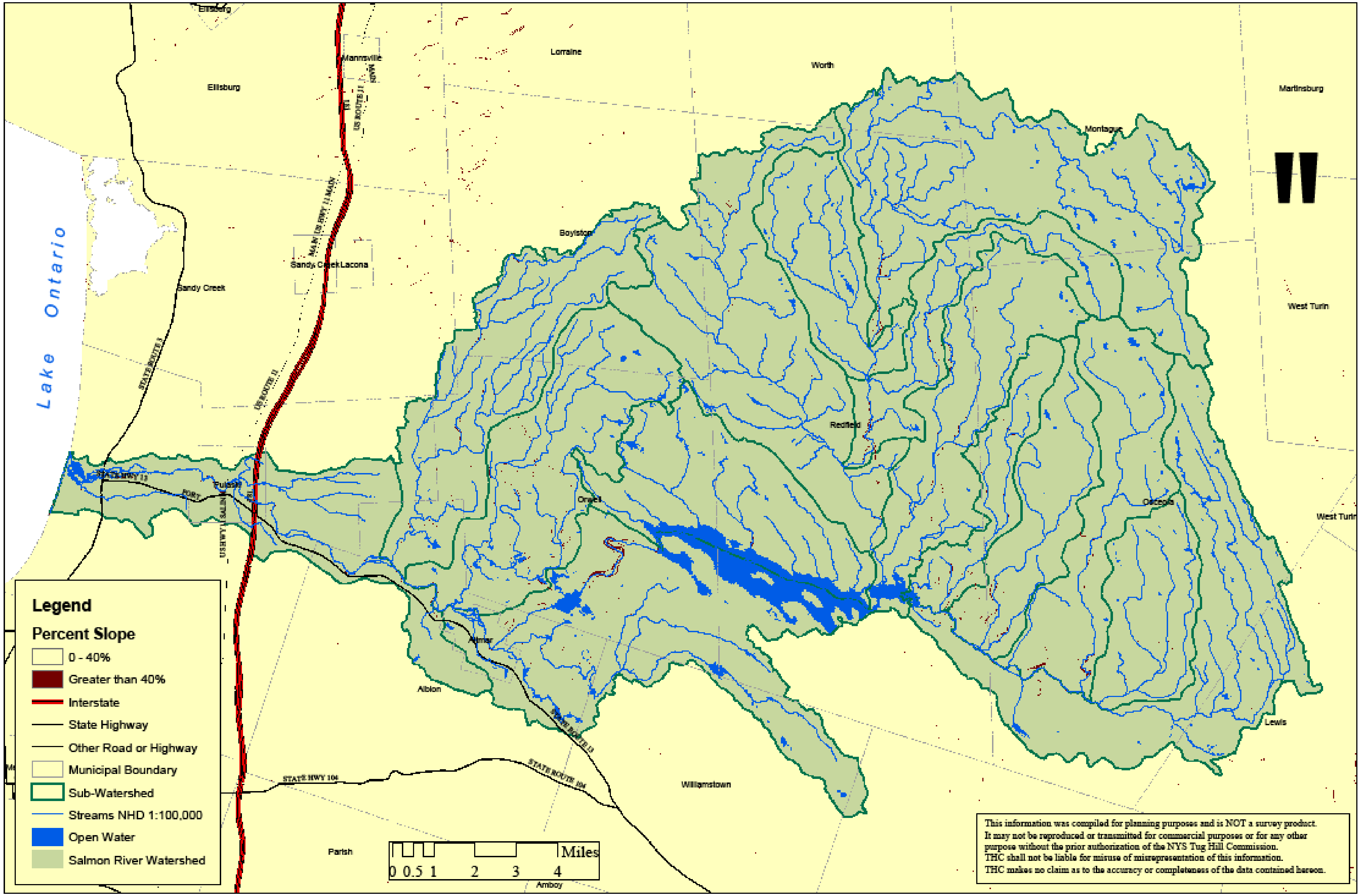


Figure 48. Steep slopes communities (>40% slope) of the Salmon River watershed.

2.8.2 Salmon River Gorge Viability Analysis

The Salmon River Gorge (Figure 49) begins at the 110-ft falls where an outcropping of Oswego sandstone overlays softer Pulaski shale deposits, thereby leading to relatively rapid erosion of the Gorge through the lower shales below the falls, which flow over the upper sandstone stratum. The Gorge continues downstream from the falls for approximately 3000 ft and is characterized by 120-ft shale cliffs and talus slopes. Sawchuck (2006) provides a detailed assessment of current condition.

The 112-acre area immediately surrounding the falls and gorge was purchased by the State of New York in 1993 and is currently managed as a Unique Area (Figure 49). An NYSDEC Unit Management Plan was recently developed for this area (Sawchuck 2006).

2.8.2.1 KEA – Water Flow

Water flow over the falls and through the gorge (the "Bypass Reach") has the potential to be quite low due to natural reduction in flow during dry summer periods (which would be approximately 60 cfs). However, current low flows are due primarily to diversions for hydropower production. Water flow from the Salmon River Reservoir is diverted from the river to a pipline in order to drive the Bennett's Bridge hydropower station. Prior to recent licensing agreements, the falls frequently experienced very low or no flow during summer dry periods due to the diversion of water to the generating plant. Currently, minimum flow rates through the Bypass Reach are set by the Federal Energy Regulatory Commission (FERC) licensing agreement to maintain the aesthetic qualities of the falls. The guidelines are:

- from July 1 – September 30, flow shall not be less than 20 cfs;
- from October 1 – June 31, flow shall not be less than 7 cfs .

High flow can exceed 10,000 cfs during emergency releases for high water levels in the Reservoir.

Minimum flow rate over the falls may also be important for a number of cliff-dwelling organisms (mosses, lichens, ferns) that require moist, humid substrate. It is not known whether the minimum flows set for aesthetic purposes are sufficient to maintain viable populations of these organisms. Furthermore, it is not known whether the historic, regulated minimum flows have caused contraction or extirpation of such organisms.

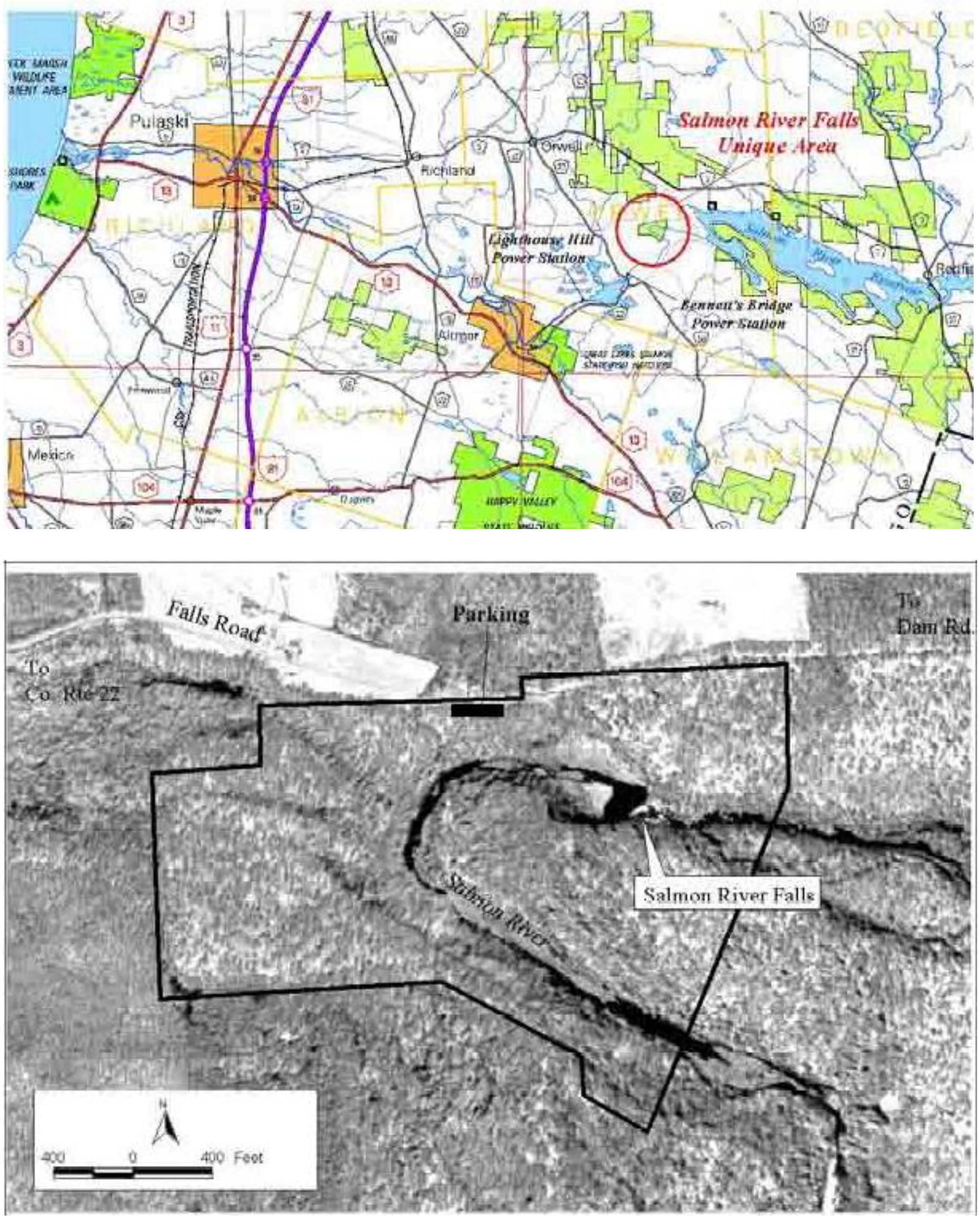


Figure 49. Site location map and aerial view of the Salmon River Gorge (From Sawchuck, 2006).

Indicator-Frequency of Low Flow Volume (cfs): Flow is a direct measure of water discharge over the falls. Minimum flows are of most concern during summer dry periods.

Current Condition-Unranked: Baseflow discharge over the falls must be maintained at a minimum of 20 cfs (July-September) or 7 cfs (October-June) according to the FERC licensing agreement. This value was set as a compromise to balance hydroelectric capacity and maintenance of aesthetic qualities of the falls and is an improvement over pre-license conditions when summertime low flow often approached 0 cfs. However, the FERC license agreement gives no consideration to the relationship between discharge over the falls and maintenance of cliff- or pool-dwelling organisms.

2.8.2.2. KEA – Fish Communities

The Salmon River Falls represents the natural upper limit of salmonine migration in the watershed. Currently the upper limit to migration is the dam at the Lighthouse Hill Reservoir, located two miles downstream. Therefore all immigrating individuals to the fish community within the Bypass Reach are from the stocked or natural populations within the lower reservoir and its tributaries. No stocking occurs within this section of river and it is not managed as a fishery.

Indicator – Fish Species Richness: This indicator will be ranked by comparison of fish species richness along the lower reaches of the Salmon River, below the Light House Hill Reservoir. The following indicator rankings will be used:

Table 44. Viability rankings for fish species richness in Salmon River Gorge (Bypass Reach).

	Good	Fair	Poor
% of total species richness present in the lower Salmon River	>90%	75-90%	<75%

Current Condition – Good: Sawchuck (2006) reported the findings of a July/August 2001 survey of the Bypass Reach by J. McKenna (Tunison Laboratory). That report indicated 19 fish species present in this reach. Fish species richness from various sampling efforts along the Lower Salmon River, between the estuary and the Lighthouse Hill Reservoir range from 9-23, and average 19 species. The range in variation in the lower Salmon River samples is likely due to the intensity, duration and methods of sampling applied in the respective surveys.

2.8.2.3 KEA – Plant Communities

Sawchuck (2006) described four distinct plant community types within the Unique Area (Figure 50):

- northern hardwood forest (67 acres);
- hemlock forest (9 acres);
- shale talus slope woodlands (19 acres);
- shale cliff and talus community (6 acres).

Of these four community types, the talus slope and the shale cliff / tallus communities have been classified by the New York Natural Heritage Program with a state ranking of S3 (typically 21-100 occurrences of limited acreage). Therefore these are not protected communities, but they are unique. Edinger et al. (2002) provide the following general descriptions of these two community types, and Howard (2006) provides specific descriptions of the communities within the gorge.

- shale talus slope woodland: These are open and closed canopy woodlands (normally <50% canopy cover) that occur on shale talus slopes throughout New York north of the coastal lowlands. Soils are unstable, shallow, and typically dry and very well-drained. Characteristic species include chestnut, red and white oak (*Quercus montana, Q. rubra, Q. alba*), pignut hickory (*Carya glabra*), white pine (*Pinus strobus*), white ash (*Fraxinus americana*), eastern red-cedar (*Juniperus virginiana*), sumac (*Rhus glabra*), scrub oak (*Q. prinoides*), poison ivy (*Toxicodendron radicans*), penstemon (*Penstemon hirsutus*), everlasting (*Antennaria plantaginifolia*), Pennsylvania sedge (*Carex pensylvanica*).

- shale cliff and talus community: These communities occur throughout upstate NY north of the Coastal Lowlands on nearly vertical outcrops of shale. The communities include ledges and small talus areas. The unstable nature of shale leads to uneven slopes and numerous rock crevices. Soil development is minimal and vegetation sparse. Communities are not well documented and vary based on exposure, aspect and moisture. Edinger et al. (2002) provide a list of characteristic species for this community type for New York including blunt-lobed woodsia (*Woodsia obtusa*), rusty woodsia (*W. ilvensis*), penstemon (*Penstemon hirsutus*), herb-robert (*Geranium robertianum*), cyperus (*Cyperus filiculmis*), little bluestem (*Schizachyrium scoparium*), panic grass (*Panicum linearifolium*), Pennsylvania sedge (*Carex pensylvanica*), and eastern red cedar (*Juniperus virginiana*).

  Sawchuck (2006) lists the following species for the Salmon River gorge shale cliff and talus community: flat-top aster (*Aster umbellatus*), grass of parnassia (*Parnassia glauca*), bladder fern (*Cystopteris*), Bigelows sedge (*Carex bigelowii*), and clearweed (*Pilea fontana*).

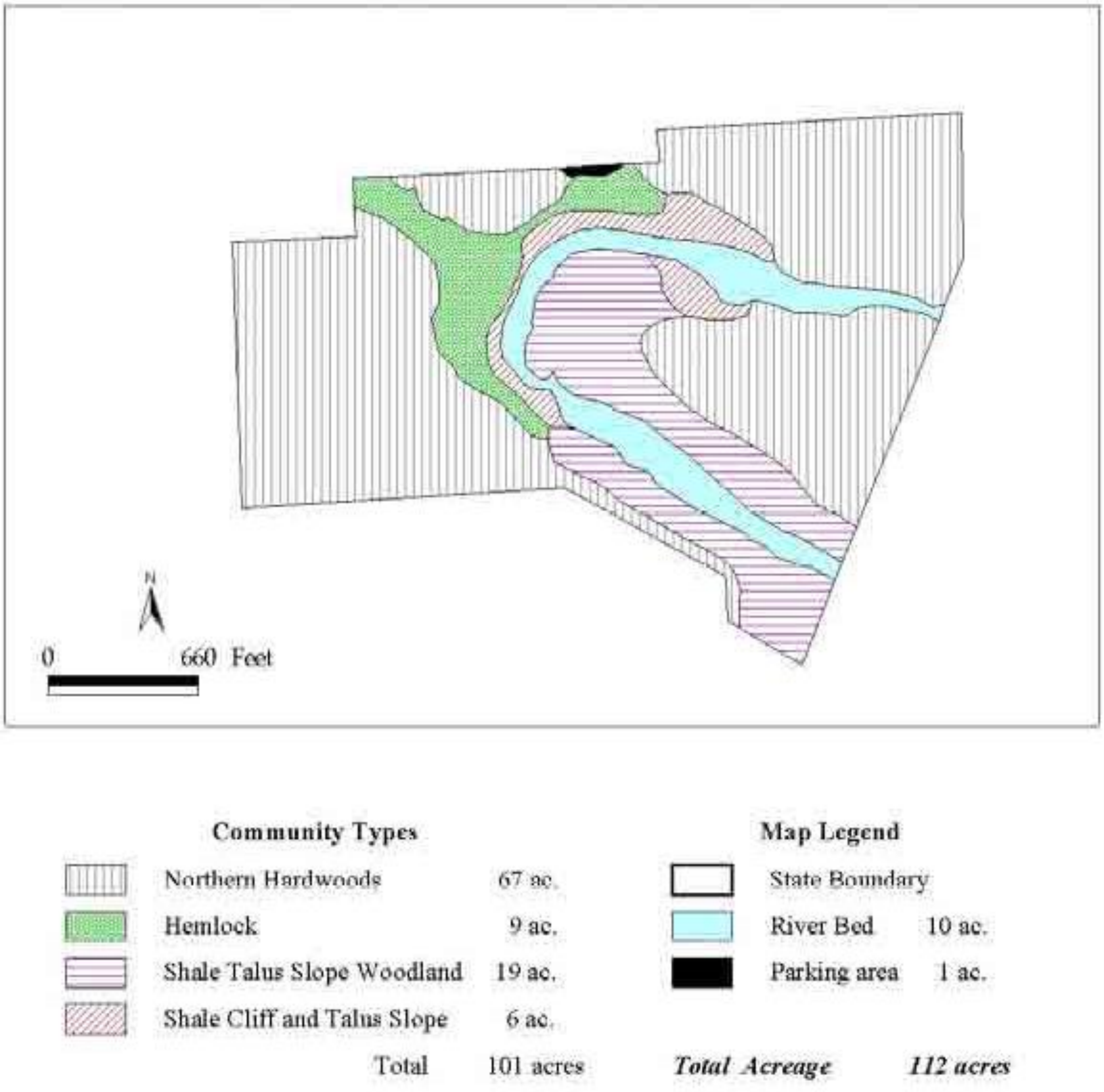


Figure 50. Salmon River Gorge plant communities (from Sawchuck 2006).

Howard (2006) described additional unique communities within the gorge.

- calcareous cliff community: This occurs along the Salmon River above the lower reservoir. Portions are shaded by trees and shrubs above the cliff. Some moist seeps occur along the outcrop. Plant species composition includes infrequent occurrence of *Alnus incana* and *Rubus odorata*. Herb layer is dominated by *Parnassia glauca, Deschampsia cespitosa, Lobelia kalmii, Primula mistassinica, Cystopteris bulbifera* and *Symphyotrichum ciliolatum.* Mosses and liverworts are common.
- calcareous shoreline outcrop: This occurs within the Salmon River gorge and at the falls. It is regularly flooded and scoured by ice and water. Vegetation is primarily in cracks of the bedrock. Common species include *Oenothera perennis, Carex flava, Danthonia spicata, Drosera rotundifolia, Equisetum sp., Erigeron sp., Eupatorium perfoliatum, Houstonia caerulea, Hypericum ellipticum, Lycopus americanus, Osmunda regalis, Parnassia glauca, Pilosella piloselloides, Prunella vulgaris, Spiranthes lucida, Symphyotrichum ontarione, Triadenum fraseri, Trichophorum alpinum Lobelia kalmii.*

Two state-protected plant species (Heritage rank S2 = demonstrably vulnerable due to few remaining occurrences) occur within the shale cliff and talus communities of the Salmon River gorge: yellow mountain saxifrage (*Saxifraga aizoides*) and birds-eye primrose (*Primula mistassinica*).

Indicator – Native plant community composition:
Current Condition
Calcareous Cliff Community – Good: These communities are small, but they occur in a contained and protected landscape (Howard 2006).
Calcareous Shoreline Outcrop – Good: These communities have high species richness and occur in a protected landscape. Some consideration should be given to range of variation in water flow over the falls and the extent to which this influences community composition (Howard 2006).
Shale Cliff and Talus Communities – Good: The community has high species richness, is in a protected landscape and is inaccessible.
Shale Talus Slope Woodland – Good: Howard (2006) rated the occurrence of this community type at this location.

Indicator – Threatened species population stability: Population densities of the saxifrage and primrose should be monitored to assess trends through time and to guide management decisions to ensure their long-term success as this site.

Current Condition – Good: No long-term data are available on these species, but monitoring is planned as part of the Unique Area Unit Management Plan. These species are known to have persisted here for several decades and given the state management of the cliff communities, there appears to be good possibilities for long-term success. Impacts of ice climbing are of potential concern for these species since ice formations occur along the shaded cliffs that these species occupy.

Indicator – Invasive Species Cover or Frequencies of Occurrence: Table 4 summarizes viability rankings for community composition based upon the frequency of occurrence or dominance of invasive species.

Current Condition – Good: No invasive plant species were reported in the Unit Management Plan to occur in the Unique Area (Sawchuck 2006) but it is unclear whether a systematic search for invasives had been conducted. The area abuts a paved road and trails are being developed in certain areas of the unit. Therefore, potential exists for the establishment and spread of invasive plants.

2.8.3 Other Steep Slope Communities Viability Analysis

In addition to the Gorge, numerous other less prominent areas are known or are likely to exist in the watershed that provide for unique combinations of habitats such as exposed bedrock (shale, sandstone or limestone), moist and shaded microenvironments, and talus slopes. Locations that have unusual or locally uncommon combinations of environmental conditions provide habitat for rare species.

Several GIS analyses were conducted in an effort to make a first approximation of the potential locations for steep slope communities or rare biological element occurrences within the watershed. At this time, these analyses have only limited data to utilize, and most have not been extensively ground-truthed. Therefore it is likely that the accuracy of these models is limited. Even still, these analyses provide a starting point for identifying potentially unique areas in watershed.

Figures 51 through 53 illustrate the results of element distribution models for the occurrence of various outcrop and steep slope communities, and rare species that utilize such locations (yellow mountain-saxifrage and birds-eye primrose, Figure 51; smooth cliff brake, Figure 52; and alpine cliff fern, Figure 53).

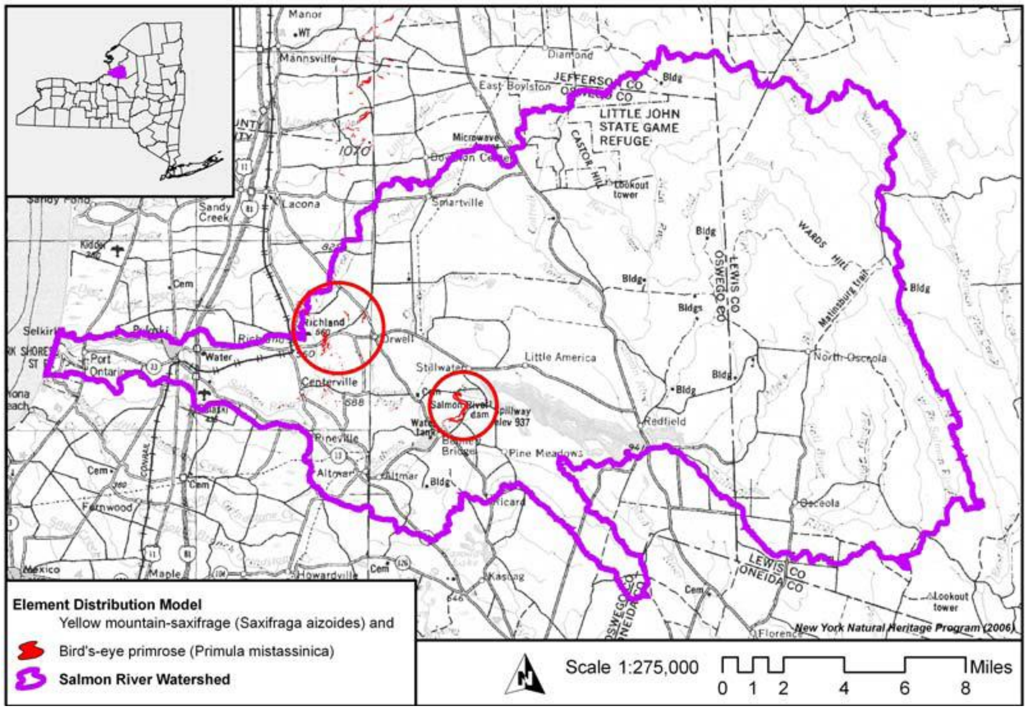


Figure 51. Element distribution model for yellow mountain-saxifrage (*Saxifraga aizoides*) and birds-eye primrose (*Primula mistassinica*) (from Howard 2006).

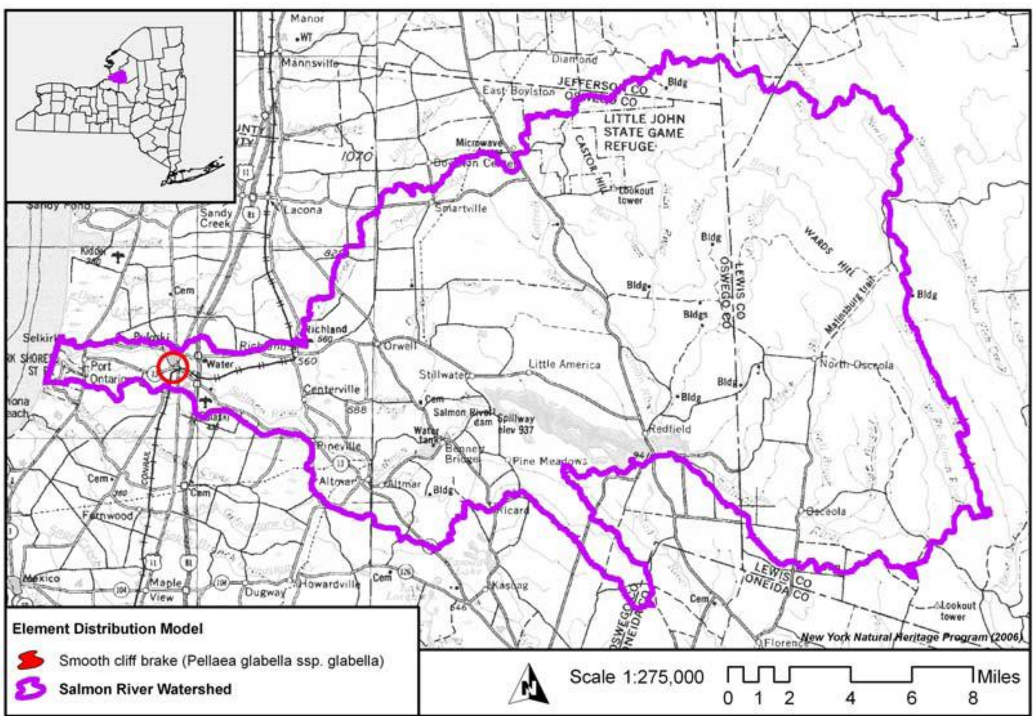


Figure 52. Element distribution model for smooth cliff brake (*Pellaea glabella* ssp. *glabella*) (from Howard 2006).

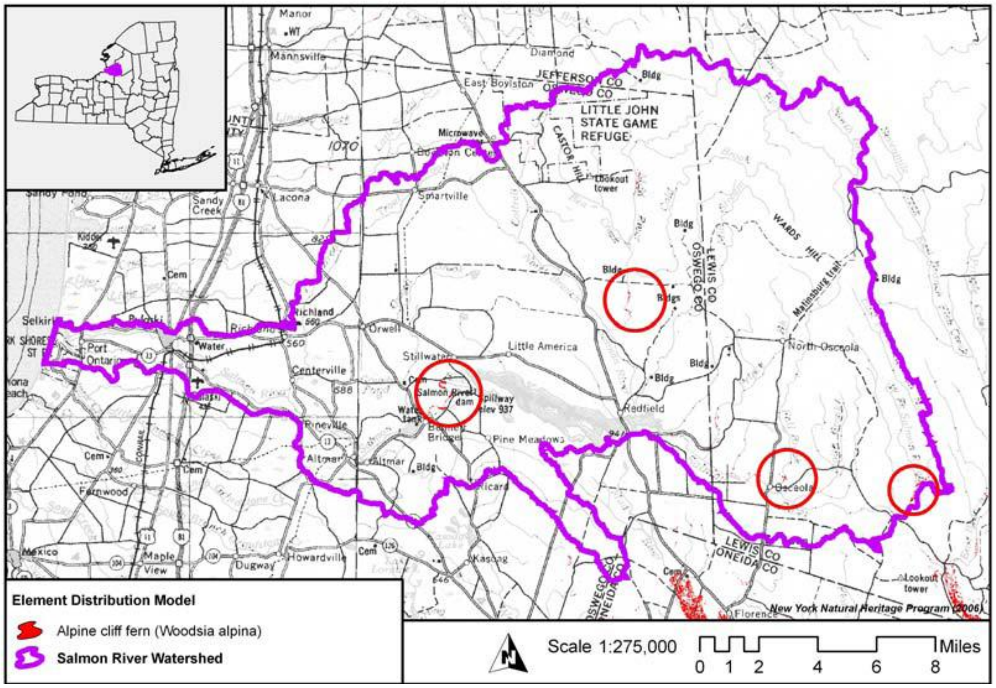


Figure 53. Element distribution model for alpine cliff fern (*Woodsia alpina*) (from Howard 2006).

Generalized descriptions of the mapped community types follow below (from Edinger et al. 2002).

- calcareous shoreline outcrop (Figure 54): Within the Salmon watershed, these communities occur within the Salmon River Gorge and at the lower river reaches near the mouth. These communities (ranked G3G4 S2) occur along shores of lakes and streams on sparsely vegetated outcrops of calcareous rocks (limestone, dolomite) throughout New York north of the coastal lowlands. Vascular plant species become rooted in rock crevices, and several moss and lichen species occur on rock faces. Vascular plant species include wild columbine (*Aquilegia canadensis*), sedges (*Carex eburnean, C. granularis*), silky and red osier dogwoods (*Cornus amomum, C. sericea*), and meadow-rue (*Thalictrum* spp.). Characteristic mosses include *Tortella tortuosa* and *T. ruralis.*

- calcareous talus slope woodland (Figure 55): Apart from the Salmon River Gorge, these communities are predicted by the NY Natural Heritage Program at the lower reaches of the Salmon River. These communities (G3G4 S3) occur on talus slopes throughout New York north of the coastal lowlands. These are open or closed canopy communities comprised of sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), eastern hophornbeam (*Ostrya virginiana*), eastern redcedar (*Juniperus virginiana*), northern white-cedar (*Thuja occidentalis*), basswood (*Tilia americana*), slippery elm (*Ulmus rubra*) and butternut (*Juglans cinerea*). Shrubs may be abundant in open canopy conditions, and include round-leaf dogwood (*Cornus rugosa*), downy arrowwood (*Viburnum rafinesquianum*), prickly ash (*Zanthozylum americanum*) and bladdernut (*Staphylea trifolia*). Vines may also be abundant in more open conditions and include bittersweet (*Celastrus scandens*), Virginia creeper (*Parthenocissus quinquefolia*), and climbing fumitory (*Adlumia fungosa*). Ferns, forbs and graminoids include bulblet fern (*Crystopteris bulbifera*), lady fern (*Athyrium filix-femina* var. *asplenioides*), oak fern (*Gymnocarpium dryopteris*), walking fern (*Asplenium rhizophyllum*), maidenhair spleenwort (*Asplenium richomanes*), bottlebrush grass (*Elymus hystrix*), herb-robert (*Geranium robertianum*), Solomon's-seal (*Polygonatum pubescens*), wild ginger (*Asarum canadense*), white baneberry (*Actaea pachypoda*), early meadow-rue (*Thalictrum dioicum*), bloodroot (*Sanguinaria canadensis*), blue-stem goldenrod (*Solidago caesia*), blue cohosh (*Caulophyllum thalictroides*), lyre-leaved rock cress (*Arabis lyrata*), white wood aster (*Aster divericatus*), and ricegrass (*Oryzopsis racemosa*). Variants of this community range from northern whitecedar-dominated to hardwood-dominanted to nonvegetated types.

- shale cliffs and talus slopes (Figure 56): These communities are described in section 2.8.2.2, above. Apart from occurring in the Salmon River Gorge, the geographic analyses indicate that these communities are known to occur, or have a high probability of occurring in the vicinity of the Mad River falls, in ravines north of the Salmon River Reservoir and in reaches of the upper Salmon River.

- <u>shoreline outcrop (Figure 57):</u> These communities (NY Heritage ranking G5 S5) are mapped at the lower reaches of the Salmon River near the mouth. They occur along shores of lakes and streams on sparsely vegetated outcrops of noncalcareous rocks throughout New York north of the coastal lowlands. These shorelines are normally exposed to wave action and ice scour. A variety of lichens and vascular plant species adapted to open conditions and shallow soils occur in these habitats including blueberries (*Vaccinium angustifolium, V. pallidum*), huckleberry (*Gaylussacia baccata*), poverty-grass (*Danthonia spicata*), hairgrass (*Deschampsia flexuosa*) along with several lichen species. More data are required on this community type.

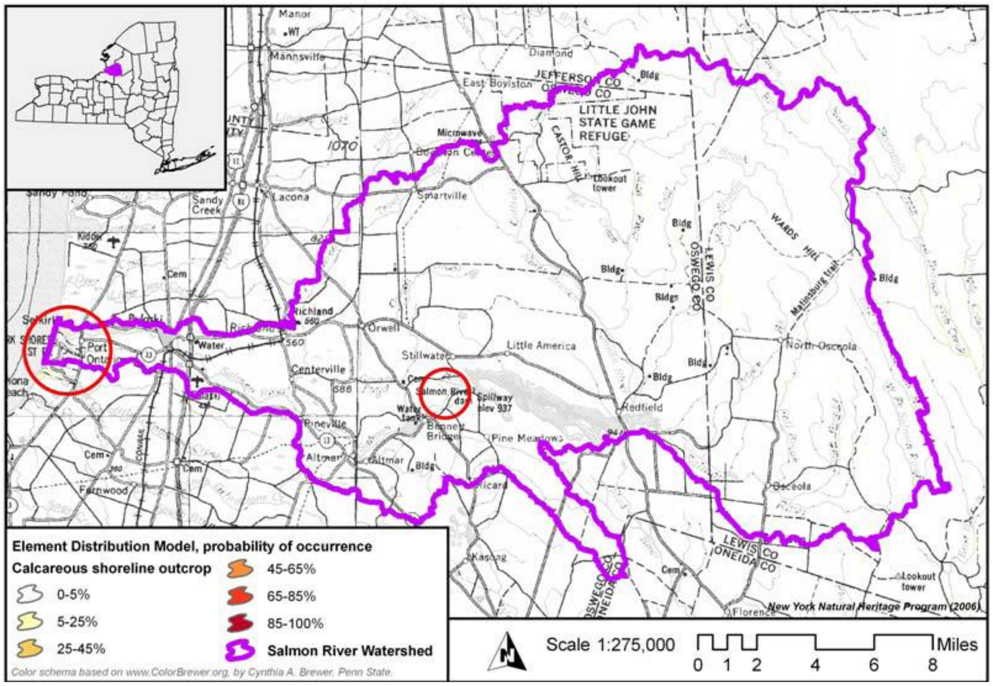


Figure 54. Element distribution model for calcareous shoreline outcrop (from Howard 2006).

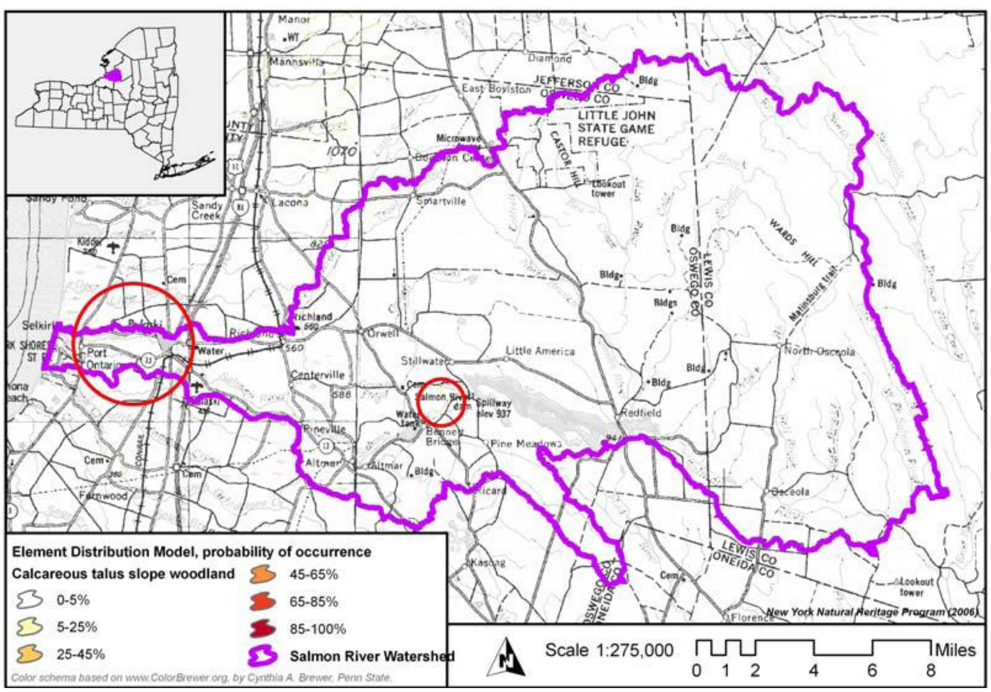


Figure 55. Element distribution model for calcareous talus slope woodlands (from Howard 2006).

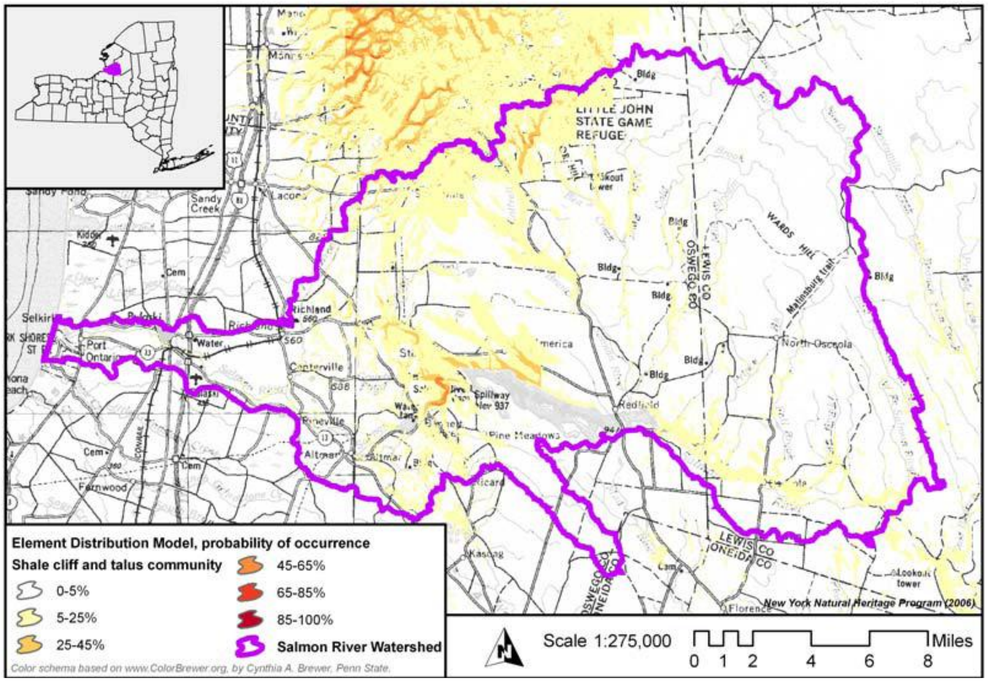


Figure 56. Element distribution model for shale cliff and talus communities (from Howard (2006).

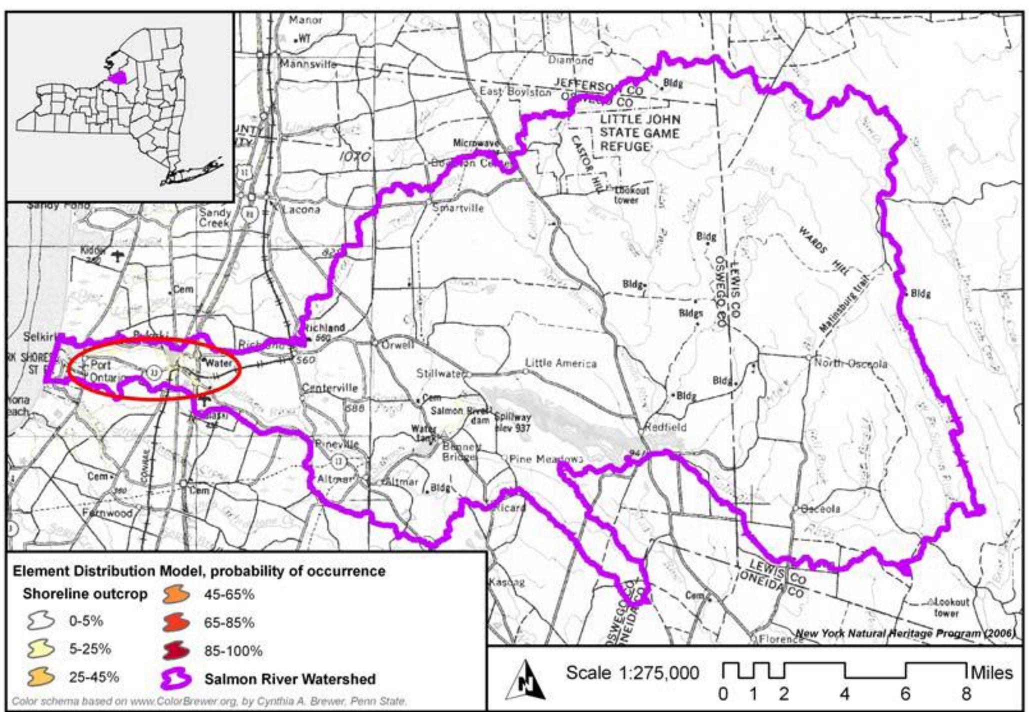


Figure 57. Element distribution model for shoreline outcrop (from Howard 2006).

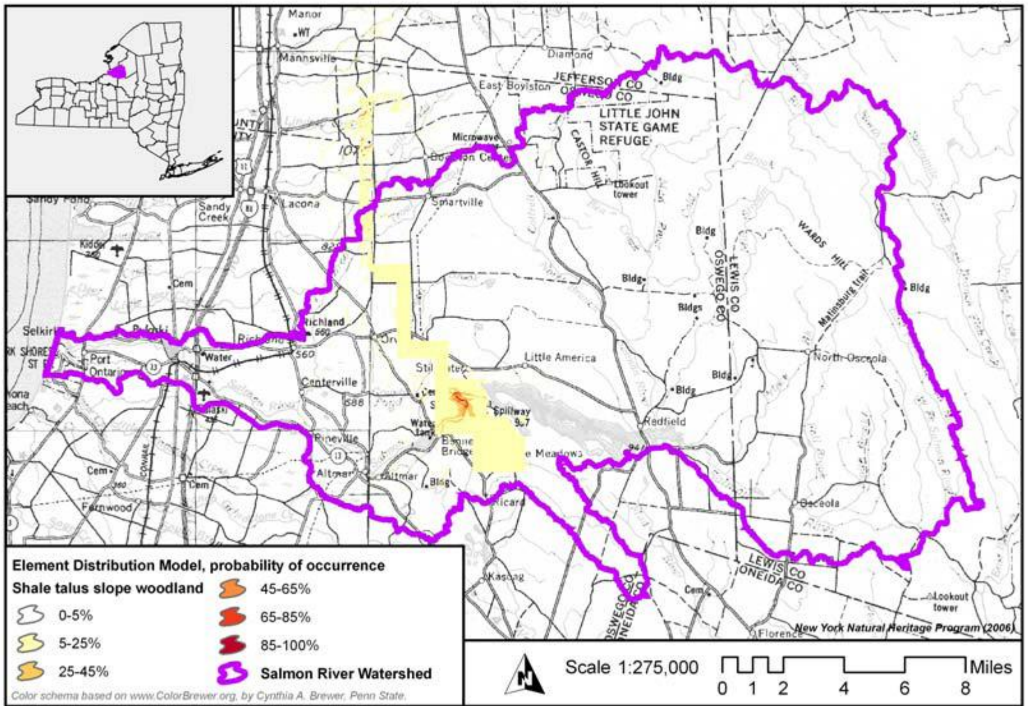


Figure 58. Element distribution model for shale talus slopes (from Howard 2006).

2.8.3.1 Key Ecological Attributes, Indicators and Viability Ranking for Steep Slope Communities and Species

There is currently no information, with the exception of the element distribution models, on the actual distribution, community composition and viability ranking of the other steep slope communities in the watershed.

2.8.4 Salmon River Gorge & Steep Slopes
Viability Summary

Notes on Guidance for Current Condition:		
	"NG"	No guidance was obtained to rank this indicator
	"SGR"	Subjective guidance based on professional opinion
	"ND"	No data available to rank this indicator, although guidance is available

Gorge	Exellent	Good	Fair	Poor	Current Condition	Notes
KEA – Condition - Water Flow						
Ind. - Frequency of Low Flow Volume					unranked	NG
KEA – Condition - Fish Community						
Ind. - Fish species richness (% of lower Main Branch)		>90	90-75	<75	100% Good	SGR
KEA – Condition - Plant Community Composition						
Ind. - Native Plant Community Composition						
Calcareous cliff community					Good	SGR, Howard (2006)
Calcareous shoreline outcrop					Good	SGR, Howard (2006)
Shale cliff and talus community					Good	SGR, Howard (2006)
Shale talus slope woodland					Good	SGR, Howard (2006)
Ind. - Threatened Species Populations						
Yellow mountain saxifrage					Good	SGR, Howard (2006)
Birds-eye primrose					Good	SGR, Howard (2006)
Ind. - Invasive Plant Species Frequency & Dominance	0	<5	5-25	>25	Good	Drake et al. (2003)

Other Steep Slopes

No quantitative information exists on the distribution, composition and viability of other steep slope communities within the watershed

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APPENDIX 1

SALMON RIVER WATERSHED
NATURAL RESOURCES ASSESSMENT

PROCEEDINGS OF WORKSHOP ONE: NATURAL RESOURCE TARGETS

Salmon River Watershed
Natural Resources Assessment

Workshop One: Natural Resource Targets

A Report of Workshop Process and Products

September 25, 2006

Prepared for:
NYSDEC, Division of Fish, Wildlife and Marine Resources
Tug Hill Tomorrow Land Trust
Oswego County Environmental Management Council
New York Natural Heritage Program
The Nature Conservancy
SUNY College of Environmental Science and Forestry
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New York Sea Grant
NYS Tug Hill Commission

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Engaging People

Contents

Introduction

On September 25, 2006, a workshop was held in the Snow Building in Pulaski, NY to begin a conservation planning process for the Salmon River Watershed as part of the Salmon River Watershed Natural Resource Assessment Project. The overall project objective is to develop a hands-on land use planning tool for the Salmon River watershed that highlights the significant natural resource assets in the area that can be used by both individual land owners and agencies when making decisions about land use and local planning.

The planning process relies on local knowledge and ecological expertise to identify important conservation targets, outline threats to those targets, and develop strategies to abate those threats. The key planning work is done in open forums (workshops) where participants of varied backgrounds can share information and perspectives. Between workshops, information is compiled by partner agencies and organizations, and shared with other participants to facilitate informed decision-making.

The objectives of this particular workshop were to:

1. Identify and prioritize conservation targets for the Salmon River watershed, and
2. Become familiar with the Conservation Action Planning process, including viability assessments.

Participants

Thirty-eight people attended the workshop (a complete list of participants is included as Appendix One). Participants represented government agencies, non-profit organizations, universities, municipalities, sportsmen, and private industry. Workshop organizers strived for a cross section of stakeholders to represent the different interest groups and knowledge within the watershed.

Conservation Target Identification

The first step in the planning process is to identify conservation targets. The targets should represent the full range of biodiversity within the watershed. They may include individual species, natural communities, or entire ecosystems.

In order to do this, workshop participants worked in small groups to select potential targets. Using index cards and a sticky board, potential targets were shared with all participants. Through discussion, participants grouped related targets. A final list of eight conservation targets was drawn up that includes:

1. Freshwater Estuary
2. Non-estuarine Wetlands

3. High Order Riverine System
4. Open Water
5. Open Terrestrial Communities
6. Forest
7. Falls/Gorge
8. Headwater Streams

A complete listing of potential targets and how they were grouped is included in Appendix Two.

Viability Analyses

A next important step in the planning process is to conduct viability analyses for each of the conservation targets. Much of this work will be done between workshops. In order to capitalize on participants' knowledge about targets and help participants become familiar with the viability assessment process, information to be included in viability analyses was collected for four of the targets. The four targets selected were large riverine systems, non-estuarine wetlands, forests, and headwater streams.

The viability analyses will focus on three key concepts: key ecological attributes (KEAs), indicators, and acceptable range of variation of those indicators. The definitions used in this process are:

Key Ecological Attributes (KEAs): Aspects of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. As such, attributes define the target's viability or integrity (e.g. water chemistry, population size).

Indicators: Measurable entities related to a specific attribute. Indicators should be measurable, precise, and sensitive (e.g. pH, spawning adults observed per hour). There may be several indicators associated with each attribute.

Acceptable range of variation: Defines the limits of variation that allow the target to persist over time. An acceptable range of variation establishes the minimum criteria for identifying a conservation target as conserved or not (e.g. pH between 6.0 and 7.5).

For each of the four selected targets, participants brainstormed key ecological attributes. They then listed indicators and acceptable ranges of variation for selected attributes. The results are included in Appendix Three.

Workshop Evaluation Results

At the conclusion of the day, participants were asked to fill out an evaluation of the workshop process and logistics. Twenty-two participants completed evaluations. The results will help organizers in planning and facilitating future workshops. The full results of the evaluation are included in Appendix Four.

Over 80% of participants generally or strongly agreed that they understood the purpose of the Salmon River Watershed Natural Resources Assessment, and that their time at the workshop was well spent. Most participants acknowledged that they understood the planning process and the concepts used during the workshop (specifically conservation target and viability analysis). While the majority of respondents felt that the target selection process was productive, two did not. Several people did not completely understand how the workshop products would be used.

The workshop logistics (advance materials, facilitation, format, room, and food and drink) were rated as “good” or better by most participants. About one quarter of the participants rated the advance materials and methods for achieving the workshop objectives as “fair.”

Next Steps

Over the next few months Greg McGee, a professor and researcher at the State University of New York College of Environmental Science and Forestry will facilitate the completion of viability analyses for each of the identified targets. He will work with professionals with specific knowledge of each of the targets and use best available data to compile the analyses.

Concurrently, members of the Tug Hill Commission will continue to raise awareness among town councils and local residents as to the methods and purpose of the Salmon River Watershed Natural Resource Assessment.

A second workshop to identify threats to the identified targets is tentatively scheduled for April 2007. It is anticipated that many of the participants of this first workshop will attend. They will be joined by additional people with knowledge of the Salmon River Watershed and its resources. The information amassed in the viability analyses, as well as feedback from the outreach efforts, will help to inform the second major step of the process.

Appendix One – Workshop Participants

Dudley Bailey
Fall Brook Club

John Bartow
NYS Tug Hill Commission

Paul Baxter
Salmon Rivers Council of Governments

Dan Bishop
NYS DEC

Michelle Brown
The Nature Conservancy

Mike Connerton
NYSDEC, Cape Vincent Fisheries Station

Patrick Crast
Harden Furniture

Ed Delaney
Village of Pulaski

Debbie Forester (facilitator)
Engaging People

Linda Garrett
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Christine Gray
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Richard Pancoe
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Mary Penney
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Gerry Smith
Self-employed

Tracey Tomajer
NYS DEC

Jessica Trump
Oswego County Dept. of Planning and Tourist

Fran Verdoliva
NYS DEC

Dave White
NY Sea Grant

Fran Yerdon
Town of Osceola

Appendix Two – Target Identification

The final identified targets are numbered. Bulleted targets were agreed to be part of the identified target. Some potential targets identified by participants were not explicitly included as they were deemed integrated into the final targets (identified as "other" below).

1. Freshwater estuary

2. Non-estuarine Wetlands
- Headwater wetlands – bogs/fens/meadows/tamarack/spruce/alder
- Fens communities along lower Salmon River (rare/endemics)

3. High Order Riverine System
- Fish biodiversity of lower reach of Salmon River
- Fish (migratory/predatory and supporting system of biotic and abiotic communities)
- Large Riverine systems

4. Open Water
- Fish communities in reservoirs
- Lakes/ponds
- N.B. include man-made impoundments

5. Open Terrestrial Communities
- Non-forested communities
    - Agriculture
    - Grasslands
- Grassland birds
- Village of Pulaski (community infrastructure)

6. Forest
- Conifer component
- Northern hardwood forest (maple, beech, birch)
- Hardwood forest on high elevation
- Unbroken forest

7. Falls /Gorge

8. Headwater Streams
- Native brook trout

Other
- Bald eagle
- Important (unique) habitat
- Unique species (salmon, mussel, eagle, lynx, moose)

- Wetlands (needs to be narrowed)
- Uncommon elements of biodiversity – fauna
- Upland habitats and associated biotic communities
- Hydrology – groundwater and sub-surface water
- Intact aquatic communities
- Riparian zones
- Riparian vegetative communities (temperature maintenance and water quality)
- Aquatic habitats
- Water quality

Appendix Three – Viability Assessments

Viability analysis information collected at the workshop for large riverine systems, non-estuarine wetlands, forests, and headwater streams is outlined below.

Target: Large Riverine Systems

Potential Key Ecological Attributes

- Water quality (turbidity)
- Water quantity (flow)
- Water temperature
- Tributary integrity
- Reservoir impacts
- Migration corridor intact
- Riparian cover
- Bank stability
- Invasive species
- Migratory fish species
- Resident fish species
- Groundwater influence
- Coldwater refuges
- Invertebrate species
- Tributary habitat – critical spawning habitat – Steelhead
    - Beaver effects
    - Angler effects
- Mainstream habitat – critical spawning habitat – Chinook
- Lake Ontario contaminants
- Cobble embededness (sedimentation)
- Public education and outreach
- Predatory bird species
    - eagles
    - ospreys
    - raptors
    - great blue heron
    - Mergansers

Key ecological attribute – Water Temperature
Indicators

- Mainstream and tributaries
    - Mean temperature
    - Minimum temperatures
    - Maximum temperatures

Range of variation for salmonids, for maximum temperature (°F)

	poor	fair	good	very good
Mainstem of Salmon River	76	74	72	70
Tributaries	75	72	70	68

Key ecological attribute – Migratory Species (salmonids)
Indicators

	poor	fair	good	very good
#fish count	30k	50k	90k	150k
# fish harvested				
Angler hours				
# returns to hatchery				
# spawning beds				
≥year of young density in mainstream – Chinook	100	200	300	400
Density year of young and older steelhead tribs	0.3	0.7	1.0	1.2

Target: Non-estuarine wetlands

Swamps

Marshes/Emergent wetlands

Peatlands
- bogs
- fens

Beaver Impoundments

Vernal Pools

Potential Key Ecological Attributes

- Intact hydrology
- Species composition
- Upland buffer
- Exotic/invasive species
- Geochemistry
- Connectivity -> to a mix of wetland types and to the broader landscape
- Amount of wetlands edge
  - Change over time
- Rare species – herps, plants, insects
- Indicator species – herps, plants
- Migratory birds
- Wetland usage patterns (heritage uses)
- Nutrient load (point and non-point)
- Toxins
- Maintain diversity of types

Key ecological attribute – Nutrient load
Indicators

- Nitrogen – trates – trites
- Phosphorus
- pH
- dissolved oxygen (water or soil characteristics
- conductivity

** range of variability will depend on specific wetland type

Key ecological attribute – Buffer/Wetland edge
Indicators

- proportion of natural vs. non-natural cover -> change over time (ASCS air photos every two years or NYS air photos)
- wetland size (loss or expansion)
- disturbance -- % of area, type
- roads in buffer

Range of variability – Wetland buffer Indicators

	poor	fair	good	very good
% natural cover w/i 500 (?)m buffer	≤ 80%		80-95%	95-100%

Key ecological attribute – Intact hydrology
Indicators

- water source (surface, subsurface, comb.)
    - source alteration (% from different sources)
- flow reduction (look for blockages, i.e. road, stuffed culvert) – surface flow
- wetland water level -> minimum and variability
- pool longevity for vernal pools -> 2-3 weeks

** The group thought that priority should be given to isolated wetlands, which might be more susceptible to changes in hydrology

Target: Forest

Potential key ecological attributes

1. Condition
    - composition
        - woody plants
        - conifer hardwood
        - understory
        - bird communities
    - structure

    - canopy diameter distribution
    - cwd
    - successional stage
- "forest health"
    - pH, N loading

2. Size

3. Landscape context
    - connectivity/fragmentation

Threats
Adelgid
Sirex (wood wasp)

Key ecological attribute – Structure
Indicators

- density #trees/acre
- diameter distribution #trees/dia class
- tree quality
    - % AGS
    - % UGS
- snags #snags/acre
- downed coarse woody debris ft^3/acre
- canopy closure
- indicator species
- regeneration
- shrub/herb layer #/m^2 composition

Key ecological attribute – Composition
Indicators

- bird indicator species
    - abundance
        - #birds/hr
        - #birds/mile
- amphibian
- % invasives
- herb layer composition

Target: Freshwater Estuary

Notes for future use:
Freshwater estuary target can roughly be mapped as the area west of Route 3
Private ownership (development opportunity) is one of the largest threats
The freshwater estuary target is the target most heavily impacted by recreation

- boat launch motorized
- heavily used

Potential key ecological attributes

- water quality
- accessibility of passage: aquatic system
- habitat and freshwater estuarine processes
- water level – quantity (flow)
- coastal wetland integrity
- black tern populations integrity
- flooding regime
- riparian zone
- hydrology
- seasonal abundance of game fish
- resident assemblage of fish and other organisms
- index of species diversity

Key ecological attribute – Water quality
Indicators

- pH * village of Pulaski collecting data
  * hatchery – Brookfield Power collecting data
- dissolved oxygen
- total suspended solids
- metals
- PCBs
- Temperature

** as far as we know, water quality is ok

Key ecological attribute – Black tern population integrity (specific nesting habitat) ** ask Gerry Smith
Indicators

- # of birds
- # of nests
- # of fledglings
- amount of appropriate habitat (grass in wetlands)

Key ecological attribute – Hydrology regime
Indicators

- water level
- flow volume*
- flow timing*
- miles of natural channel
- ground water/water table

*ask Dan Bishop/Dan Sawchuk/Fran Verdoliva
specific information available/needed:
How does the lake impact the freshwater estuary target? – IJC
How much of the freshwater estuary was included in FERQ relicensing?

Target: Headwater streams

Potential key ecological attributes
- cold water
- forest cover/alder swamp mix
- macroinvertebrate community
- spawning habitat
- springs/seeps/interaction with groundwater
- beavers
- low road density
- presence of large woody debris in stream
- low level of vehicle disturbance
- one or more species of trout present
- beginning of stream system
- presence of fur-bearing animals
- clear water
- low nutrient levels
- presence of mussels

Key ecological attribute – Water conditions
Indicators
- 65-70°F maximum
- pH 05-08
- conductivity 45-200
- turbidity
- dissolved oxygen (5-9)
- phosphorus < 10ppl

Key ecological attribute – Vegetative cover
Indicators
- % cover – 75% minimum in riparian zone

Key ecological attribute – Indicator species
Indicators
- macroinvertebrates

presence of (see Bob Bode) –
- salamanders/amphibians
- mussels – need to know baseline (ask Fran Y.)
- fur-bearing mammals – otter, beaver, mink, muskrat

Key ecological attribute – Spawning habitat
Indicators
- gravel in stream bed – 65% minimum
- stream sediment
- turbidity (need low)

Key ecological attribute – Interaction with groundwater
Indicators
- Darcy Flow modeling
- Presence of trout spawn indicates presence of seep/spring

Key ecological attribute – Level of disturbance
Indicators
- Road density
  - Take cue from elk/lynx measurements
  - Karen Murray – USGS – road crossing/water/stream quality
- Distance to nearest parking area
- Evidence of vehicles in stream (low to no needed)
- Salt and sand chloride levels

Key ecological attribute – Fishery
Indicators
- Presence/absence of trout
- Density of spawning adults ->go to literature
- Presence of woody debris
- Presence of winter habitat

Key ecological attribute – Stream system/structure
Indicators
- Geographic location
- Stream order – 1st or 2nd only
- # of 1st order streams – range?
- # of dam/dam-like barriers

Appendix Four – Workshop Evaluation Results

Salmon River Watershed Natural Resources Assessment
Workshop 1—Targets
September 25, 2006

Evaluation of Workshop Content

•Twenty two workshop participants completed evaluations.•

Please mark your level of agreement with the following statements.

	Strongly Agree	Generally Agree	Partially Agree	Mostly Disagree	Strongly Disagree
My personal goals for participating in this workshop were met	18%	59%	23%		
I understand what the **purpose** of the SRWNRA* is	36%	45%	18%		
I understand the SRWNRA* **process**	24%	62%	14%		
I understand what a **target** is	18%	59%	23%		
The process of selecting the targets was productive	23%	36%	32%	9%	
I understand what **viability analysis** is	14%	86%			
I understand how the products of the workshop will be used	18%	41%	36%	5%	
Participating in this workshop increased my knowledge of conservation in the Salmon River Watershed	27%	36%	32%	5%	
My participation in this workshop was valuable to the process	9%	64%	27%		
My time today was well spent	32%	50%	18%		

*Salmon River Watershed Natural Resources Assessment

How might you and/or your organization use the information shared during this workshop?

- Raising awareness; best vehicle may be a draft summary and updates through a newsletter
- Future agency planning
- Talking to town government and sportsman organizations
- Contributing data and identifying targets
- As an example of a collaborative planning process, and for use in an open space course taught at SUNY ESF
- Management plans
- Information, data, and recommendations can be used in the DEC's UMP process
- Identify needed research
- Natural resource management
- Later in the process the information can be used in outreach

What do you see as the most significant challenge to the success of conservation in the Salmon River Watershed?

- Getting all significant parties involved in the planning process and helping them to gain buy-in to the plan
- Acceptance by residents (5)
- Acceptance from management agencies
- Acceptance by local government
- Local participation
- Reconciling major economic aspects of recreational fishing and habitat preservation goals
- Working with snowmobilers and ATVers
- Development, recreation, and economic pressure
- Money
- Resolving conflicting resource use
- Need more integration of terrestrial and aquatic management
- Citizen and government interest

Can you recommend others who might benefit from, or be able to contribute towards, this natural resource assessment process? Please provide names, organization, and any other contact information you might have. Or ask us to send you an email next week reminding you to send us this information!

- Brookfield Power
- Oswego County Planning researcher did a plan south of Salmon River Corridor
- Jeff Devine, Executive Director, Save the County Land Trust
- Representative from Trust for Public Lands
- NYC is interested in this whole region
- Stakeholder groups: conservation fishing, landowners

Evaluation of Workshop Logistics

Please fill in the blank in each sentence by checking the appropriate box.

	Excellent	Very Good	Good	Fair	Poor	Comments
Advance Materials						
In general, the materials sent prior to the workshop were _____.		35%	45%	20%		__________
The advance materials gave me a(n) ________ understanding of the scope of the workshop, including the goals.	5%	20%	50%	25%		__________
The advance materials did a(n) ______ job of explaining new concepts.		25%	40%	30%	5%	__________
Workshop						
The facilitators did a(n) _____ job of keeping to the agenda.	15%	50%	25%	10%		__________
The workshop was ______ for achieving the objective of identifying conservation targets.	5%	40%	30%	25%		__________
The workshop was ______ for becoming familiar with the process of viability assessments	10%	35%	30%	25%		__________
Logistics						
The meeting room was ______ for this workshop.	20%	40%	30%	10%		__________
The food and drink was _________.	25%	45%	30%			__________

APPENDIX 2

The following individuals participated on the working groups and/or contributed substantially to data acquisition and analyses during the development of the Salmon River Watershed Viability Analysis.

Forest Target:
Tom Bell, NYSDEC
Art Brooks, Brooks Forestry Associates
Pat Crast, Harden Lumber
Jim Farquhar, NYSDEC
Ed Kautz, NYSDEC
John Mueller, Gutchess Lumber
Fred Munk, NYSDEC
Michelle Peach, TNC
Dave Riehlman, NYSDEC
Dan Sawchuck, NYSDEC
Charles Smith, Cornell University
Jerry Smith
Fran Verdoliva, NYSDEC

Wetlands:
Sandy Bonanno
Linda Gibbs, THC
Sandy Doran, US Fish & Wildlife Service
Andrew Nelson, SUNY-Oswego
Michelle Peach, TNC
Peter Rosenbaum, SUNY-Oswego
Rich Smardon, SUNY-ESF

Aquatics:
Dan Bishop, NYSDEC
Mike Connerton, NYSDEC
Frank Flack, NYSDEC
Michelle Henry, USGS, Tunison Laboratory
Jim Johnson, USGS, Tunison Laboratory
Roger Klindt, NYSDEC
Amy Mahar, NYSDEC
Dick McDonald, NYSDEC
Jim McKenna, USGS, Tunison Laboratory
Andy Noyes, NYSDEC
Neil Ringler, SUNY-ESF
Larry Skinner, NYSDEC
Fran Verdoliva, NYSDEC

APPENDIX 3
SOURCE DATA FOR MAP PRODUCTION AND GIS ANALYSES

The geographic mapping and analyses prepared specifically for this report include data from the following sources.

Notes on GIS maps and analyses in this report:

1. Unless otherwise indicated on the map or figure description, all maps were created by NYS Tug Hill Commission or The Nature Conservancy expressly for the Salmon River Watershed Natural Resources Assessment and associated Viability Analysis.
2. The following list of data sources applies to maps and analyses conducted by NYS Tug Hill Commission and/or The Nature Conservancy for this project, which includes figures 1-7, 10, 11, 13, 23-27, 30-34, 36-38, and 48. The source of all other maps and figures included in this report is indicated in the description of those maps and figures, and the original authors can be contacted for additional information about the data sources they used.
3. GIS software used: ArcGIS 9.1 and 9.2

I. Basemaps and Background Layers
Layer: Municipal Boundary
Data Type: polygon
Source: NYS Office of Cyber Security and Critical Infrastructure Coordination
Description: Union of Tug Hill communities by the Tug Hill Commission
Use in this report: Used as a location and background dataset in many maps

II. Boundaries
Layer: Salmon River Watershed and Subwatershed
Data Type: polygon
Source: A cooperative effort by US Department of Agriculture Natural Resources Conservation Service (USDA NRCS), NYS Department of Environmental Conservation (NYS DEC) - Division of Water, and US Geological Survey (USGS) - Water Division. Adapted by NY Natural Heritage Program (NYNHP).
Description: This is the definition datalayer of the study area and analysis units for the project. This dataset was developed by NYNHP in-house by beginning with 11 digit Hydrologic Unit Coverage (HUC) watersheds, and then custom-delineating smaller watershed using the 1:24,000 USGS topographic quadrangle basemaps and the stream hydrology layer to define water flow.
Use in this report: Used as a location and background dataset in many maps and to do analyses by subwatershed within the Salmon River watershed.

Layer: TNC Ecoregions or “Subsections”
Data Type: polygon
Source: The Nature Conservancy (TNC)
Description: Developed by TNC’s ecoregional planning teams. Written justification for each modification is available through TNC’s Ecoregional Planning Office. Scale is 1:7,500,000.
Use in this report: Used in Figures 5 and 6 to show the Salmon River Watershed in relation to ecoregions.

III. Datalayers used in target mapping and viability assessment
Layer: Stream Crossing
Data Type: point
Source: NYNHP
Description: Road features (ALIS) were intersected with stream features (Hydrography Source: NYS DEC, USGS, and adapted by NYNHP. Hydrography Description: These data were being developed by the DEC - Division of Water and the Habitat Inventory Unit of the Division of Fish and Wildlife, as digital versions of the water features in the USGS 1:24,000 quadrangle maps. They are still in development stages. Points were generated where these two features intersected.
Use in this report: Appears on Figure 24 showing the locations of dams and stream crossings within the Salmon River watershed.

Layer: Dam (DEC)
Date Type: point
Source: NYS DEC - Dam Safety Section, Division of Water
Description: Metadata for this data set are not available at this time (2006). Point locations of dams located by DEC though out the study area. Field descriptions are available from the NYS Department of Water.
Use in this report: Appears on Figure 24 showing the locations of dams and stream crossings within the Salmon River Watershed.

Layer: State Pollution Discharge Elimination System (SPDES) point sources
Data Type: point
Source: NYS DEC - Division of Water/GIS Unit Description
Description: Wastewater treatment facilities (also called "point sources") are issued State Pollutant Discharge Elimination System (SPDES) permits regulating their discharge. "Point sources" means discrete conveyances such as pipes or man made ditches. These facilities are municipal, industrial or larger private, commercial, institutional (ie. shopping malls, restaurants, hospitals, correctional facilities, trailer parks, etc) waste water treatment plants.
Use in this report: Appears on Figure 23, which shows the locations of facilities within the Salmon River watershed with National Pollution Discharge Elimination System (NPDES) or USEPA Toxic Release Inventory (TRI) discharge permits

Layer: Roads (ALIS), (Appear in Legends as Interstate, State Highway, State or County Road, and Other Road or Highway)
Data Type: line
Source: NYS DEC, Department of Motor Vehicles (DMV), and Department of Transportation (DOT) http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=932
Description: The Accident Location Information System (ALIS) project is a multi-agency project that the NYS Office of Cyber Security & Critical Infrastructure Coordination (CSCIC) is jointly developing with the NYS DMV and the NYS DOT. A major component of the ALIS Project is the creation of an up-to-date statewide GIS street map file containing all public roads, along with their street names, alternate/alias street names, route numbers, and address ranges on each street segment.
Use in this report: This dataset was used primarily for visual reference in many of the maps and also as described in the "Stream Crossing" Layer below. It was also used to show segments of road within 540 ft, of a NYS regulated wetland (See "NYS Regulatory Wetland" Layer below).

Layer: Streams NHD 1:100,000 (Appear in legends as Main Branch or Major Tributary, Headwater Stream, etc.)
Data Type: line
Source: USGS Great Lakes Science Center, Tunison Laboratory of Aquatic Sciences, USGS Gap Analysis Program
Description: The National Hydrography Dataset (NHD) is a vector data layer of *The National Map* representing the surface waters of the United States. The NHD includes a set of surface water reaches delineated on the vector data. Each reach consists of a significant segment of surface water having similar hydrologic characteristics, such as a stretch of river between two confluences, a lake, or a pond (USGS, 2000).
Use in this report: Appears on many figures as background information. In addition this dataset was used to derive stream targets: Main Branch and Major Tributaries (greater than second order streams) and Headwaters (first and second order streams). This dataset, processed along with a specific buffer size and the NLCD 2001 data, was also used to derive and display each reach in relation to the amount of area (0%-10%, 11%-25% or greater than 25%) of non-natural cover through which it travels. An example: this reach, as a whole, runs through an area of land that is classified as being greater than 25% non-natural cover. Derivative data appear in figures: 11, 13, 25, 26, 27 and 30.

Layer: Bedrock Geology
Data Type: polygon
Source: Distributed by USGS and compiled by NYS Museum/NYS Geological Survey
Description: The scale of the data is 1:250,000. It shows broadly defined bedrock geology materials.
Use in this report: Used in Figure 3 to show the bedrock geology of the Salmon River Watershed.

Layer: NYS Regulatory Wetland layer
Data Type: polygon
Source: NYS DEC (Distributed by Cornell University Geospatial Information Repository (CUGIR), http://cugir.mannlib.cornell.edu)
Description: Based on official New York State Freshwater Wetlands Maps as described in Article 24-0301 of the Environmental Conservation Law. Data are not, however, a legal substitute for the official maps. The purpose of these data are to provide a faithful representation of official New York State regulatory freshwater wetlands maps for GIS resource analysis at scales equal to the 1 to 24,000 scale of original mapping or smaller scales (e.g., 1 to 100,000 scale).
Use in this report: Used to map the extent of the Non-Estuarine Wetland Target and to assess the potential of wetland wildlife coming into hazardous contact with motorized vehicles. Appears in Figures 34 and 36.

Layer: National Wetlands Inventory
Data Type: polygon
Source: U.S. Fish and Wildlife Service (USFWS) - Division of Habitat and Resource Conservation
Description: This data set represents the extent, approximate location and type of wetlands and deepwater habitats in the conterminous United States. The NWI wetland maps were produced as topical overlays using USGS topographic maps as the base. The hard copy product is a composite map showing topographic and planimetric features from the USGS map base and wetlands and deepwater habitats from the Service's topical overlay. Thus, the data are intended for use in publications, at a scale of 1:24,000 or smaller. Due to the scale, the primary intended use is for regional and watershed data display and analysis, rather than specific project data analysis. The map products were neither designed nor intended to represent legal or regulatory products.
Use in this report: Used to help delineate the Non-Estuarine Wetland Target and analyze wetland community types (Figure 34) as well as evaluate the extent of beaver impacts on Open Waters (Figure 32). NWI data was also used to delineate the extent of wetlands within the Freshwater Estuary Target (Figures 7 and 10)

Layer: Tug Hill Aquifer
Data Type: polygon
Source: NYS Tug Hill Commission (THC)
Description: Digitized by the NYS THC as part of the USGS Water Resources Investigation Report 88-4014 titled: Hydrogeology and water quality of the Tug Hill glacial aquifer in northern New York. http://pubs.er.usgs.gov/usgspubs/wri/wri884014
Use in this report: Appears on Figure 4, which shows the location of the Tug Hill Aquifer within the Salmon River Watershed.

Layer: 100 Ft. Buffer and 540 Ft. Buffer
Data Type: polygon
Source: Derived using ESRI's buffer analysis
Description: Derived using ESRI's buffer analysis on features from other data sources, such as wetlands and steams.
Use in this report: Buffers of the following targets: Non-Estuarine Wetlands, Open Waters, Main Branch and Major Tributaries, Freshwater Esturay, and Headwater Streams. Appears on Figures 10 and 33. Although not shown on Figures 13, 25, 27 or 30, these buffers were used in the analyses of these figures as described in "Streams NHD 1:100,000" above.

Layer: Percent Slope (0-40%, Greater than 40%)
Data Type: image
Source: New York State Digital Elevation Models (DEM)
USGS (distributed through CUGIR at http://cugir.mannlib.cornell.edu)
Description: The 7.5-minute DEM (10- by 10-m data spacing, elevations in decimeters) is cast on the Universal Transverse Mercator (UTM) projection (the quads UTM zone can be found in the header record (Record A)) in the North American Datum of 1927. Slopes derived using ESRI Spatial Analyst.
Use in this report: Appears on Figure 48, which maps the Gorge and Steep Slope Target (>40% slope) of the Salmon River watershed.

Layer: National Land Cover Database (NLCD) Land Classification (Appear in map legends in various ways)
Data Type: image, polygon
Source: **NLCD 2001** U.S. Geological Survey <http://www.mrlc.gov>
Description: The NLCD 2001 for mapping zone 64 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies (www.mrlc.gov), consisting of the USGS, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), the U.S. Forest Service (USFS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and the USDA NRCS. The MRLC data set consists of 30 by 30-meter cells that correspond to an area on the earth. <http://www.mrlc.gov/mrlc2k.asp>.
Use in this report: This dataset, or derivatives from it, appear on many figures as background information. When used as a background dataset to show landcover (e.g. Figures 5, 6, 7, and 10), NLCD 2001 Data was often reclassified as shown in the table below under "Reclassification 2." In several figures NLCD 2001 Data was reclassified into one of three categories shown in the table below under "Reclassification 1" to derive the Open Waters, Natural Vegetative Cover, and Non-natural Vegetative Cover classifications (e.g. Figures 13, 25, 27, 30, and 33). These maps were then used to derive Percent Non-Natural Vegetative Cover parameters, the results of which are described in the text. NLCD 2001 Data was also used to map the geographical extent and community types of the Matrix Forest Target in Figure 37.

Data Classification	**Reclassification 1**	**Reclassification 2**
Open Water	Open Water	Open Water
Developed, Open Space	Non-natural Vegetative Cover	Developed
Developed, Low Intensity	Non-natural Vegetative Cover	Developed
Developed, Medium Intensity	Non-natural Vegetative Cover	Developed
Developed, High Intensity	Non-natural Vegetative Cover	Developed
Barren Land (Rock/Sand/Clay)	Non-natural Vegetative Cover	Barren Land
Deciduous Forest	Natural Vegetative Cover	Forest
Evergreen Forest	Natural Vegetative Cover	Forest
Mixed Forest	Natural Vegetative Cover	Forest
Shrub/Scrub	Natural Vegetative Cover	Shrub/Scrub
Grassland/Herbaceous	Non-natural Vegetative Cover	Grassland/Herbaceous
Pasture/Hay	Non-natural Vegetative Cover	Agriculture
Cultivated Crops	Non-natural Vegetative Cover	Agriculture
Woody Wetlands	Natural Vegetative Cover	Freshwater Forested/Shrub Wetland
Emergent Herbaceous Wetland	Natural Vegetative Cover	Freshwater Emergent Wetland