Salmon River Watershed Natural Resources Assessment

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ACKNOWLEDGMENTS

This Salmon River Watershed Natural Resource Assessment represents the collective work of numerous individuals, agencies and organizations. Several local citizens, private and government resource managers, elected officials, and scientists attended three one-day-long workshops to identify conservation targets, assess potential factors that threaten those targets, and develop workable strategies for ensuring the long-term protection of the watershed's uncommon wealth of high quality natural resources. Participants of these three workshops are provided in Appendices 1, 2 and 3, and their contributions to this process are acknowledged here. In addition, several individuals provided further guidance and feedback during the preparation of this report through their participation in expert working groups (Appendix 4) that focused on matters related to the aquatic, wetland and forest resources of the watershed. 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 or recommendations 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 public participation process and development of this report:

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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. Several offices of New York State's Department of Environmental Conservation provided raw data or summaries that were used to describe the current condition of various resources in the watershed. These contributions are cited within the text of the viability analysis.

Tracey Tomajer, Michelle Peach, John Bartow, Linda Gibbs, Doug Carlson, Charles Parker, Mary Penney, Neil Cheney and Peter Rosenbaum provided review and thoughtful criticism of earlier drafts.

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EXECUTIVE SUMMARY

The Salmon River Watershed drains approximately 280 square miles of forested, agricultural and rural residential lands on the western slopes of the Tug Hill Plateau, in Oswego, Lewis, Jefferson (and a small area of Oneida) Counties, New York, and discharges into eastern Lake Ontario. The watershed is extensively forested and supports world-class salmon and trout fisheries. The purpose of this Salmon River Watershed Natural Resources Assessment is to compile available data to describe the current condition of natural resources within the watershed, identify goals, objectives and tools for sustainably managing these resources, and determine necessary actions required for attaining those resource management goals. This assessment will guide priorities for the New York State Department of Environmental Conservation's Unit Management Planning process, and will provide valuable information to private landowners, non-governmental organizations and municipalities who are involved in resource management.

Several local, county and state agencies (NYS Dept. Environmental Conservation, NYS Tug Hill Commission, NY Natural Heritage Program, Oswego County Environmental Management Council); non-profit organizations (The Nature Conservancy, Tug Hill Tomorrow Land Trust); and universities (NY Sea Grant, SUNY-Oswego, SUNY-ESF) participated in guiding this project through an open, transparent and public process. Three separate full-day public workshops were held to 1) identify conservation targets, 2) assess threats to those conservation targets, and 3) develop strategies for implementing conservation actions. Additional expert working groups were convened to inform the development and compilation of a natural resource viability analysis that detailed the current condition of the watershed's natural resources. An analysis using geographic information systems was conducted to assess the current known occurrences of rare species and unique natural communities, and to develop a computer-based model to predict additional occurrences of natural heritage elements within the watershed.

Seven conservation targets were identified that then served as subjects of the viability analysis, threats identification and strategies development.

- 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)
- Salmon River Gorge and Other Steep Slope Communities.

The viability analysis identified numerous indicators of the ecological condition of the each of the seven targets. These indicators were used to quantify the current condition of the targets and to provide baseline information with which to monitor future change.

This viability analysis indicated that many of the watershed's natural resources are currently in good condition and worthy protection or restoration.

Priority issues in the watershed include the continued protection and sustainable management of its excellent fisheries and extensive forests; ongoing commitment to a viable tourism and recreation industry; management and protection of the substantial wetland systems in the watershed, some of which support rare species; protection of the abundant, clean freshwater resources; maintenance of the rural character and open spaces in the watershed; and maintaing the ability of the watershed's resources to adapt and recover in the face of large-scale threats such as global climate change, invasive species, and atmospheric deposition of acid, nitrogen and mercury.

Seven critical threats were identified that <u>have the potential</u> to profoundly affect the condition of the conservation targets.

- *<u>invasive species</u>*, including several aquatic and terrestrial plants and some fish (gobies, carp, lamprey);
- *<u>regional and global issues</u>*, namely atmospheric deposition of acid, nitrogen and mercury, mercury and PCB contamination of migratory lake fish, global climate change, and water level regulation of Lake Ontario;
- *<u>altered hydrology</u>* that would reduce base flow in headwaters and higher order streams of the watershed, reduce variability in surface water discharge, increase surface water temperatures, and reduce wetland area and saturation levels;
- *<u>land cover/land use changes</u>*, including sprawling development, roads and utility rights-of-way, dams, and stream crossings by roads that lead to loss or fragmentation of stream networks, wetlands and forests;
- *<u>physical habitat disturbances</u>*, which occur when soil or vegetation is disturbed or basic habitat structure altered, and that include streamside soil disturbance by ATVs, livestock, and over-use by anglers, flooding by beaver, clearing for development or streamside access and views, and unmitigated forest management practices;
- *<u>pollution and sedimentation</u>* includes all point and non-point sources of nutrients, toxins, and other forms of pollution, as well as erosion, run-off and other types of sedimentation, including poorly functioning septic systems, urban runoff, industrial point sources, and agricultural and forestry practices that do not meet recognized best management practices for water quality;
- *<u>pests, pathogens and diseases</u>* that threaten the health and productivity of fish, wildlife and forest species, and including viral hemorragic septacemia (VHS), type E botulism, viburnum leaf beetle, beech bark disease complex, sirex woodwasp, eastern and forest tent caterpillars, emerald ash borer, Asian long horned beetle, and hemlock wooly adelgid.

Numerous strategies were articulated to address and curtail these critical threats.

I. INTRODUCTION AND BACKGROUND

A. Purpose and Benefits

The purpose of this Salmon River Watershed Natural Resource Assessment is to:

- compile data developed from other venues and during this process to describe the current condition of several conservation targets within the watershed;
- identify planning tools that can be utilized by private and public entities to sustainably manage the watershed's resources;
- establish measurable goals and objectives with specific outcomes aimed at maintaining and improving environmental quality within the watershed; and
- identify on-the-ground actions needed to attain those goals and objectives.

The intent of this watershed assessment is not to replace ongoing initiatives (such as the Lakewide Management Plan (LaMP) for Lake Ontario; Great Lakes Strategy 2002; New York Comprehensive Wildlife Conservation Strategy; and several projects of the NY Natural Heritage Program, NYS Department of Environmental Conservation, The Nature Conservancy, Tug Hill Commission, Tug Hill Tomorrow Land Trust, etc.), but rather to build on work done to date, coordinate interests and efforts, and focus conservation programs where they can be most effective in attaining watershed-based goals for natural resource conservation.

The assessment will provide the blueprint for implementing specific conservation projects on the ground, which will occur subsequently with other funding sources or other grant proposals. The plan will also indicate priorities and provide a framework for the Unit Management Planning process on New York State lands. The conclusions of this project will also provide valuable information to private landowners, non-governmental organizations, municipalities, and state land managers whose management decisions can affect extensive portions of the watershed.

This project was initiated through funding from the US Fish and Wildlife Service and made available through the Wildlife Conservation and Restoration Program (WCRP) to the New York State Department of Environmental Conservation (NYSDEC) - Division of Fish, Wildlife and Marine Resources. The NYSDEC became the eligible recipient of WCRP and subsequent State Wildlife Grants funds for New York after completing a statewide Comprehensive Wildlife Conservation Strategy in 2005. 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.

Conservation opportunities within the Salmon River Watershed are great:

- The Salmon River Watershed is in excellent condition, presenting a great opportunity to protect the area's significant natural resources before they are lost or degraded.
- The watershed has a variety of large landowners whose decisions could affect extensive portions of the system. Opportunities exist to work with these large landowners and to help them think about their property management decisions in the context of the full watershed and the decisions of other large landowners.
- A variety of partners are in place to develop and implement the watershed conservation plan's strategies. Potential partners include The Nature Conservancy, Tug Hill Commission, Tug Hill Tomorrow Land Trust, Ducks Unlimited, NYSDEC Regions 6 & 7 (particularly fishery, wildlife, and forestry staff), Oswego County, NYSDEC Great Lakes Program, U.S. Environmental Protection Agency, and NY Natural Heritage Program, NY Sea Grant, USGS Tunison Laboratory, and several regional research universities (e.g., SUNY-Oswego, SUNY-ESF, Clarkson University, Syracuse University, Cornell University).
- The project area is in a region where implementation funds can be procured. Potential funding sources include various USEPA, New York State Great Lakes, USDA Farm Bill Conservation Programs, and USFWS State Wildlife Grant Programs.

There is strong local support for maintaining the character and environmental quality of the Salmon River basin. In a 1995 survey (Salmon River Greenway Committee 1996) of landowners within the Salmon River corridor, the majority of respondents stated that the area's rural atmosphere, open spaces and parks, and natural resources (forests, streams, wildlife) were "very important" or "important" reasons for choosing to live or own property in their communities. Majorities considered productive farmland, clean streams and groundwater, wildlife habitat, open space, large blocks of forest land and wetlands as "very important" or "important." Furthermore, majorities of respondents endorsed the use of various regulatory and ownership (conservation easements, public purchase of environmentally sensitive areas) techniques to manage development within their communities in order to maintain their current character.

B. Partners and Process

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:

- New York State Department of Environmental Conservation (NYSDEC)
- The Nature Conservancy (TNC)
- New York Natural Heritage Program (NYNHP)
- New York Sea Grant (NYSG)
- Tug Hill Tomorrow Land Trust (THTLT)
- Oswego County Environmental Management Council (EMC)
- S.U.N.Y. Oswego
- S.U.N.Y. College of Environmental Science and Forestry (ESF)
- New York State Tug Hill Commission (THC, Commission)

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 was 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 representing the range of biodiversity within the watershed that would become the subjects of further natural resource planning. Thirty-eight people participated in the day-long Natural Resource Target Selection forum, held on September 25, 2006, in Pulaski (Forester 2007a; full text provided in Appendix 1). The following seven conservation targets were selected at this forum and further refined through consultation with regional experts and through focus group meetings.

- 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)
- Salmon River Gorge and Other Steep Slope Communities

Step 2: Target Viability Analysis

Determination of the current state of natural resources within the watershed occurred over two years through two separate analyses.

a. Salmon River Watershed Inventory and Land Analysis (Howard 2006)

The purpose of this analysis was to apply Geographic Information System (GIS) techniques to identify and rank the highest quality sub-watersheds within the entire basin. There were three components to the analysis:

- Using known locations for rare species statewide, NYNHP built GIS computer models for rare species and natural communities that are likely to occur within the watershed.
- NYNHP conducted field inventories for rare species and significant natural communities based on the predictions of the models and other factors.
- NYNHP conducted an assessment of the sub-watersheds within the entire basin using its computer models, field inventory data, and other available GIS data.

The THTLT and NYNHP sent letters to 84 private landowners, and to an additional 51 landowners of large parcels, requesting permission to conduct inventories based on predictions for suitable rare species habitat or of unique natural communities. Of the 84 private parcels having predictions for rare species or natural communities, 63 of these were targeted toward rare plants, 9 were targeted for rare animals (least bittern and a dragonfly, *Ophiogomphus anomalus*), and 15 were targeted for natural community inventory (with some parcels being targeted for more than one group).

Sixteen private landowners gave permission for NYNHP to conduct inventories on their property. As NYNHP was also visiting public lands, they had to prioritize final visits into the field. NYNHP made it to many of the private landholdings, but not all. During the winter of 2006, NYNHP provided information to those landowners who requested follow-up information on the surveys. NYNHP provided information on what was found to THTLT, who, in turn, sent follow-up letters to each of these landowners.

b. Salmon River Watershed Natural Resource Viability Analysis (McGee 2008)
This second analysis was initiated in November 2006. Working group meetings (Appendix 2) were held for several aquatic targets (November 2006), the matrix forest communities (January 2007) and wetlands (March 2007) to gather professional opinions and to guide data acquisition and literature reviews in order to assemble information on the current condition of the seven conservation targets.

The viability analyses for each of the natural resource targets consisted of a three-step procedure.

1. 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.
- **-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.
- **-Landscape Context** considers the processes and conditions that surround a particular target and which may influence the condition of the target. Context integrates pattern, connectivity, fragmentation, and patchiness of a target.

2. Establish Quantifiable Indicators of the respective attributes, and benchmarks suggestive of the viability of the attributes. Indicators are measurable/quantifiable variables used to assess the status and trend of a key ecological attribute.

3. 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 Excellent, 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 even 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 (Forester 2007b; full text provided in Appendix 3).

Step 4: Strategies

A third and final public workshop was held on June 21, 2007 to develop plans for moving forward on implementing conservation actions. Strategies were proposed to abate the threats identified in the previous workshop and maintain or enhance the current condition of the natural resource targets (Forester 2007c; full text provided in Appendix 4). Project partners further refined and clarified the numerous strategies that were articulated at the public workshop.

C. Anticipated Timeline

This document is meant to initiate a long-term process of adaptive management through which there will be periodic review of the state of the watershed and of the success of various strategies intended to improve various aspects of the watershed's ecological condition. Through an ongoing, public process (e.g., a "Salmon River Watershed Coalition"), stakeholders in the basin such as resource managers, community leaders, landowners and business people can review, modify and update this plan in order to meet changing conditions on a 5- to 10-year cycle.

D. Geographic Scope

The Salmon River Watershed is situated in northern New York midway between the cities of Watertown and Syracuse (Figure 1). It is the largest of New York's coldwater tributaries to Lake Ontario, and drains ~280 square miles (~181,000 acres) of forested headwaters, agricultural lands and rural residential areas in Oswego, Lewis, and Jefferson Counties (in addition to a very small area of Oneida County). Administration of environmental regulations and management within the watershed fall to NYSDEC Regions 6 and 7. The US Geological Survey Hydrologic Unit Code (HUC) system places the watershed within the Southeast Lake Ontario Subregion (Subregion 0415, Figure 2) of the Great Lakes Hydrologic Region (Region 04).

The Salmon River system is one of several that form the radial stream drainages of the Tug Hill Plateau, a landform that slopes gently upward and eastward from the Ontario Lake Plain to an elevation of 2100 ft in the east-central portion of the region. The Tug Hill Plateau terminates abruptly at an escarpment on its eastern edge at the Black River Valley. Elevations of the Salmon River watershed range from 1,900 feet at the upper headwaters to 250 feet at the Salmon River mouth on eastern Lake Ontario.

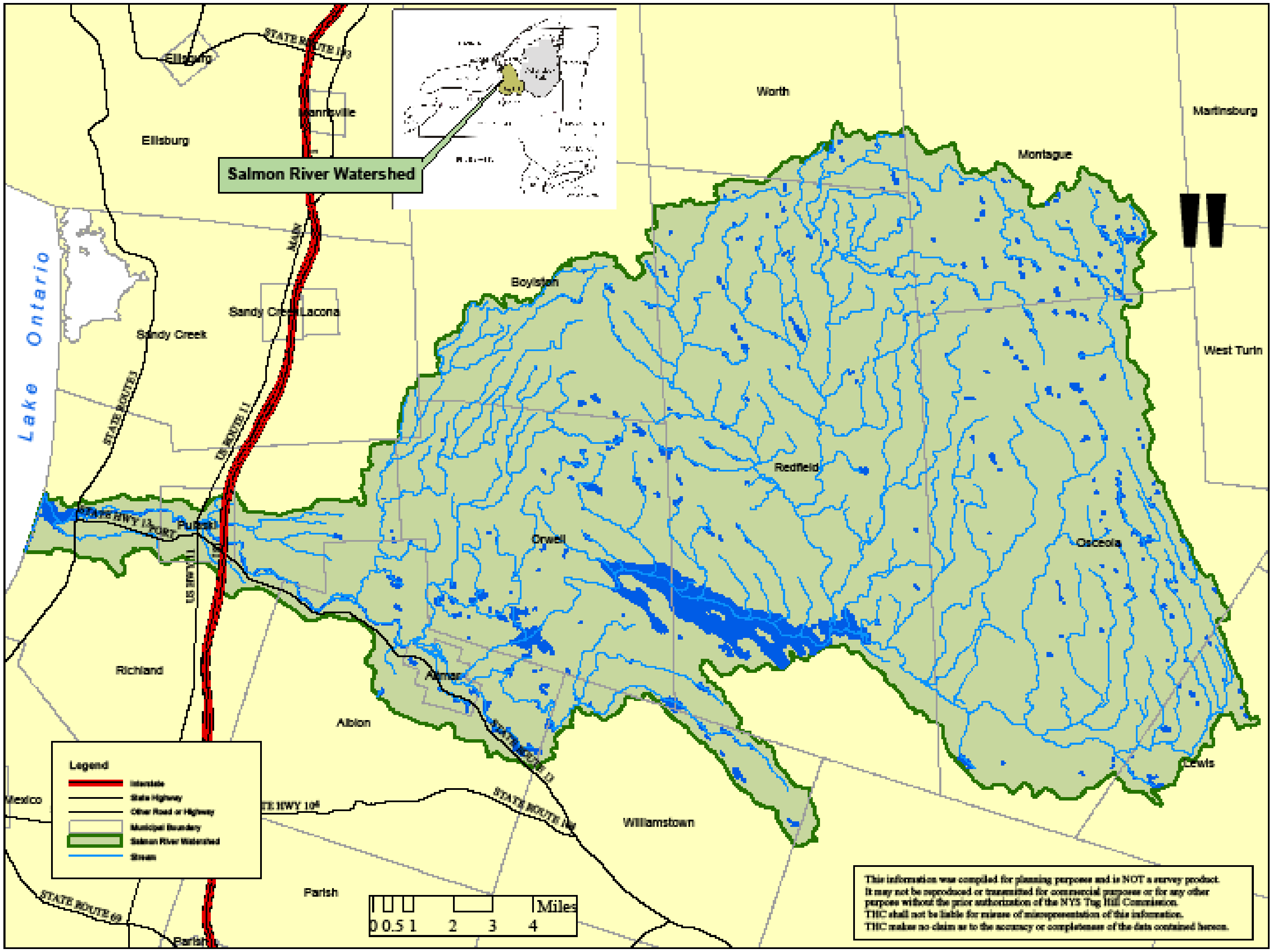

Figure 1. Salmon River Watershed Study Area.

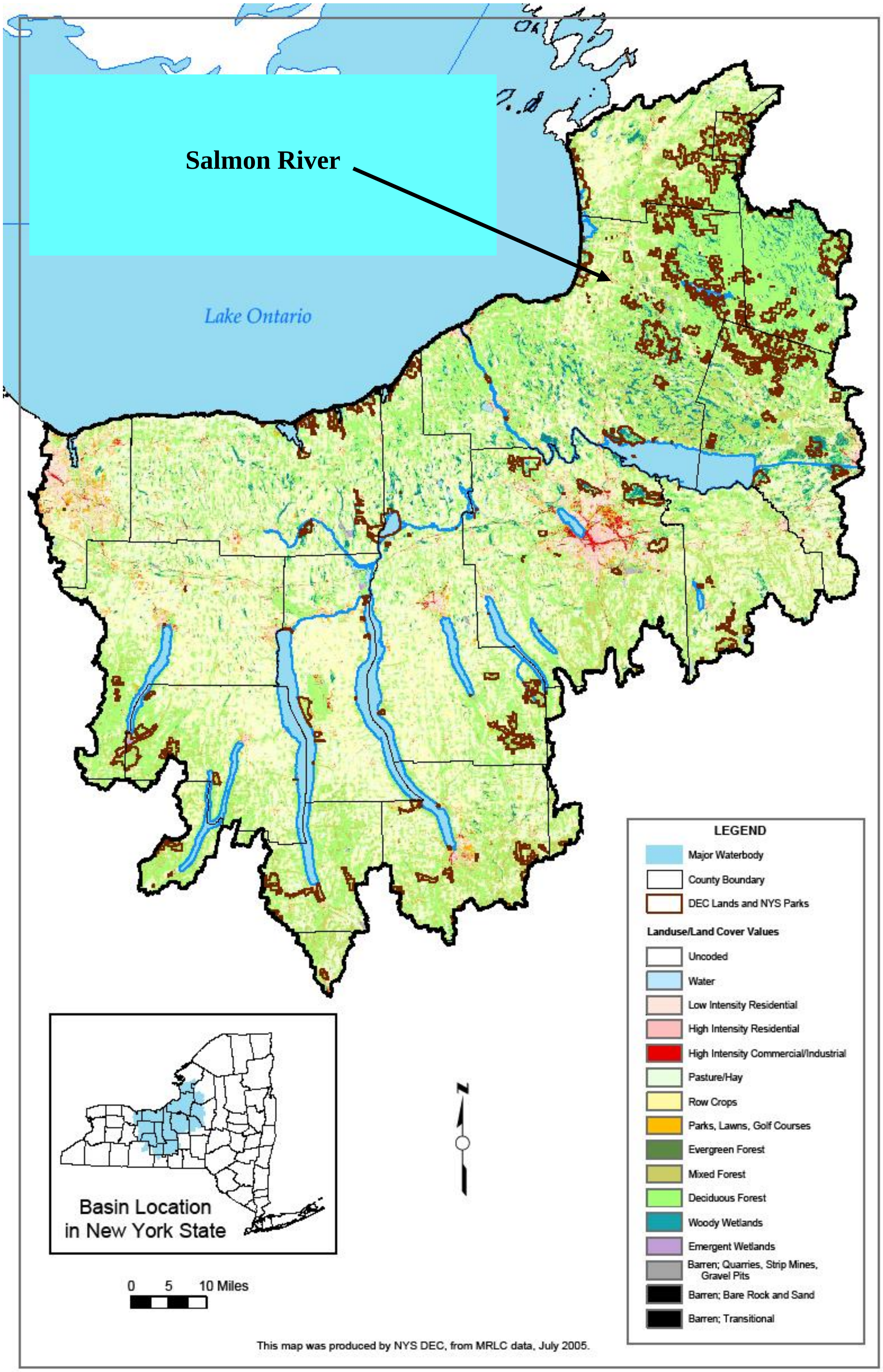

Figure 2. Southeast Lake Ontario Basin (Source: NYSDEC 2006)

To facilitate more focused consideration on aspects of the Salmon River watershed, Howard (2006) further subdivided the watershed into fifteen sub-watersheds (Figure 3, Table 1). The Salmon River Falls represents a natural migration barrier within this drainage system. Currently the hydroelectric dam at the Lighthouse 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 Lighthouse 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 forests exist east and above the escarpment. Since there are natural differences in the biotic communities, and in the 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 to facilitate discussion of condition, stresses and strategies in these different locations (Table 1).

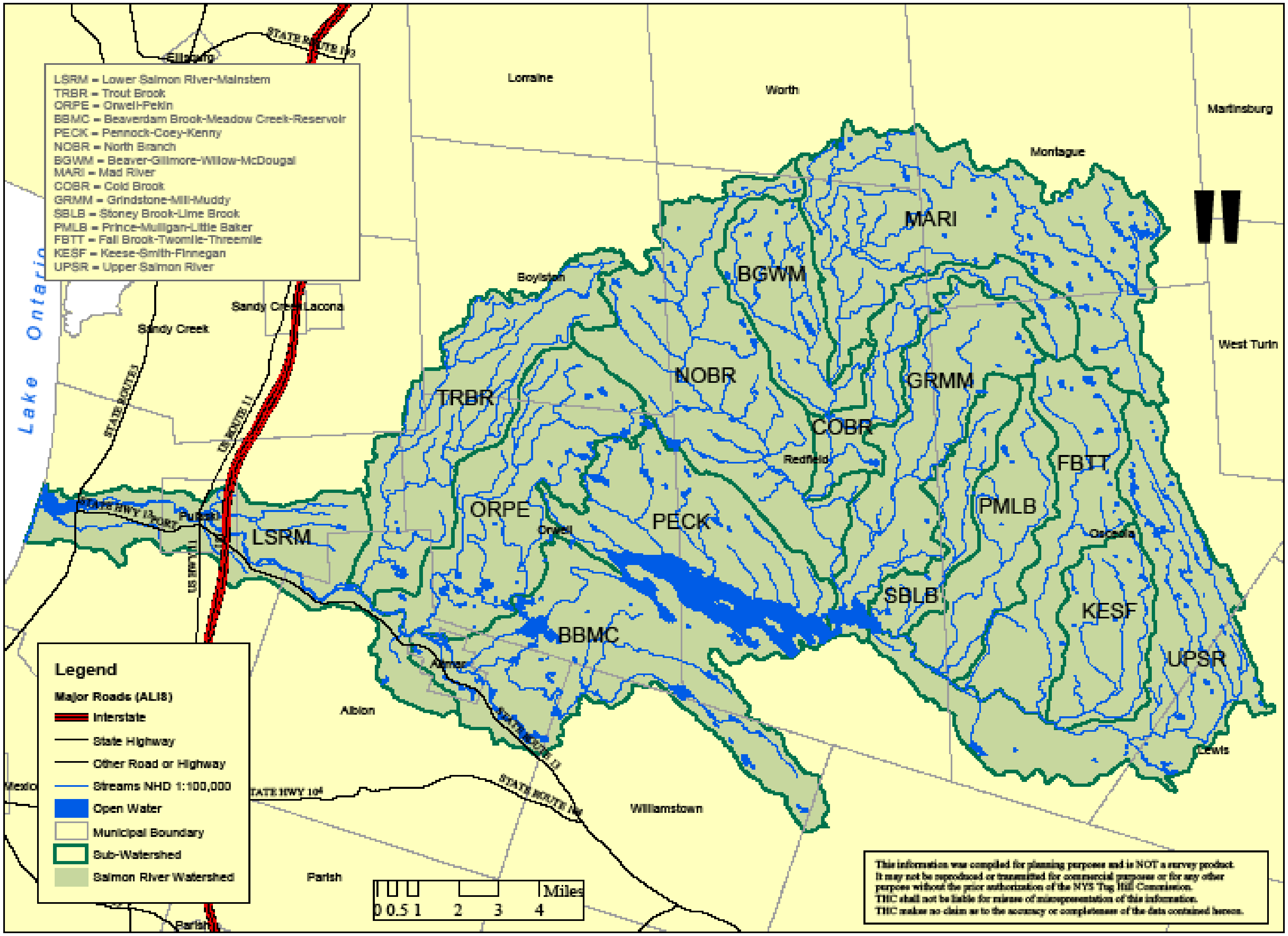

Figure 3. Location of fifteen sub-watersheds within the Salmon River watershed (from Howard 2006).

Table 1. Summary of sub-watersheds within the Salmon River Watershed (from Howard 2006). The "upper" and "lower" categories refer to the location of respective drainage basin mouths above ("upper") or below ("lower") the Lighthouse Hill Reservoir.

Code	Name	Area (acres)	Sub-watershed towns
Upper sub-watersheds			
BGWM	Beaver-Gillmore-Willow-McDougal	6,963	Worth, Redfield
COBR	Cold Brook	6,558	Worth, Redfield, Montague
FBTT	Fall Brook-Twomile-Threemile	9,862	Osceola
GRMM	Grindstone-Mill-Muddy	11,183	Redfield, Osceola, Montague
KESF	Keese-Smith-Finnegan	6,419	Osceola
MARI	Mad River	21,013	Worth, Redfield, Montague, Osceola
NOBR	North Branch	17,993	Boylston, Worth, Redfield
PECK	Pennock-Coey-Kenny	10,880	Orwell, Redfield
PMLB	Prince-Mulligan-Little Baker	7,245	Redfield, Osceola
SBLB	Stony Brook-Lime Brook	4,623	Redfield, Osceola
UPSR	Upper Salmon River	16,365	Osceola, Lewis
Lower sub-watersheds			
BBMC	Beaverdam Brook-Meadow Creek-Reservoir	19,721	Albion, Williamstown, Florence, Redfield, Orwell
LSRM	Lower Salmon River-Main Stem	11,544	Richland, Albion
ORPE	Orwell-Pekin	12,992	Albion, Orwell, Boylston
TRBR	Trout Brook	12,938	Richland, Orwell, Boylston

II State of the Basin

A. Overview of Resources

Water Resources

The greater Tug Hill, in which the Salmon River watershed is embedded, is a region where exceptionally good water quality is predicted due to an overall lack of impervious surface and to high levels of forest cover (Figure 4). A recent analysis conducted by The Nature Conservancy (TNC) that used six indicators of watershed condition (population density, road density, protected lands, dam density, natural land cover, and interior forest cover) determined that the Tug Hill area represents one of the most intact landscapes in New York (NYSDEC 2006a, Figure 5). The region contains over 4,000 miles of rivers and streams, 117,000 acres of wetlands, and one of the largest (121,000 acres) intact forest blocks in the state.

The abundance of water resources within the Tug Hill region is attributed, in part, to the 42-50 inches of precipitation that fall annually across the region (Eschner et al. 1974). Precipitation patterns are influenced by the position of the Tug Hill on the eastern shore of Lake Ontario in conjunction with dominant westerly air masses that deliver lake effect snow and rain to the region. Lake effect precipitation delivers more than half of the annual precipitation to the region and results in high seasonal variation of stream flow. Annual water surplus (a measure of excess precipitation: surplus = precipitation minus losses by evaporation and plant transpiration) ranges from 40” of surplus water at the highest elevations to approximately 16” near Lake Ontario (Eschner et al. 1974). Consequently an abundance of water is available during most of the year to sustain the extensive wetland systems, high velocity streams and eroded gulfs of the region. The wetland systems also serve to retain seasonal runoff and discharge it over longer periods of time, thereby helping to maintain stream flow throughout much of the year.

The Salmon River stream system is a network of headwater stream communities (marsh headwater streams, rocky headwater streams), mid-reach stream communities, and a freshwater estuary at the river’s mouth on the eastern shore of Lake Ontario. Its headwaters are generally intact, with high-quality cold water streams. The river system contains several dams, including the hydroelectric facilities at the Lighthouse Hill and Redfield Reservoirs.

The exceptional water quality of the Salmon River supports a world-class fishery. The Salmon 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). The river is stocked with more than 412,000 fish, including brown and brook trout, steelhead rainbow trout, and Chinook and coho salmon. The fishery represents a significant local economic resource. Prindle et al. (2005) reported the results of an angler survey for 28 Lake Ontario tributaries in New York. They found that the Salmon River accounted for 30% of the total angler trips and 60% of the total angler effort (angler hours) in 2005 for all of the New York tributaries to Lake Ontario.

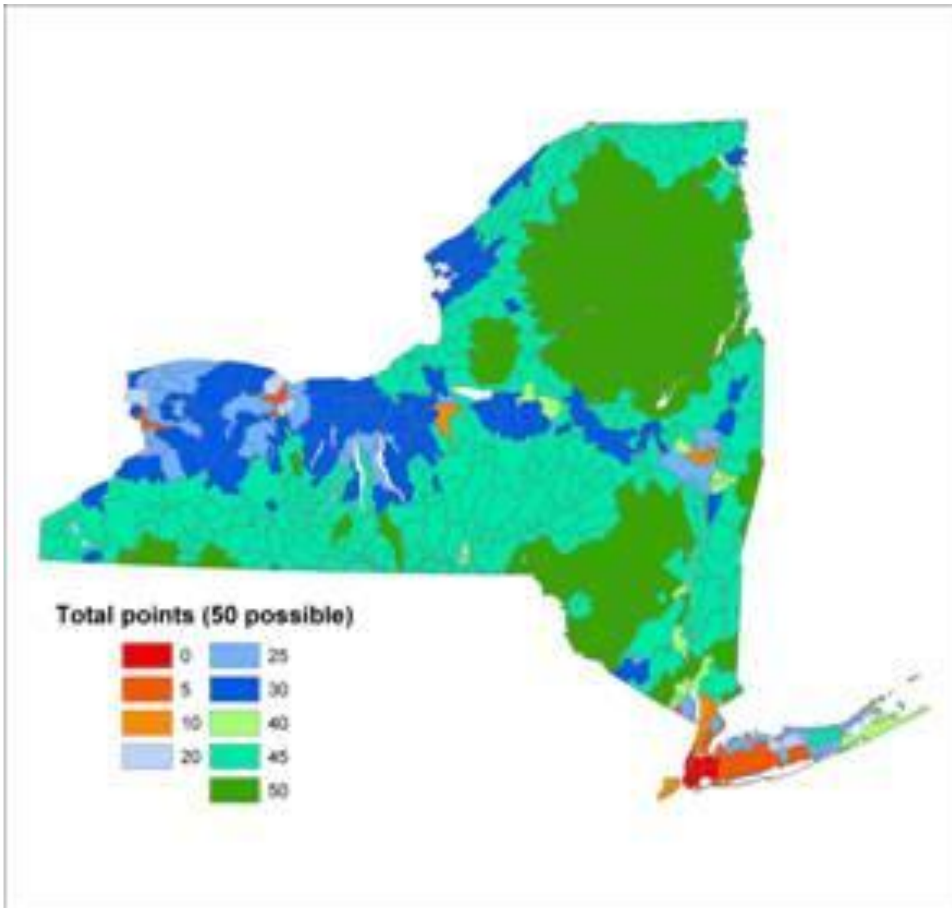

Figure 4. Statewide ranking of predicted surface water resources based upon analysis of impervious surfaces and forest cover (T. Howard, NY Natural Heritage Program, unpublished data). Key: red shades indicate impaired watersheds, greens indicate high quality watersheds.

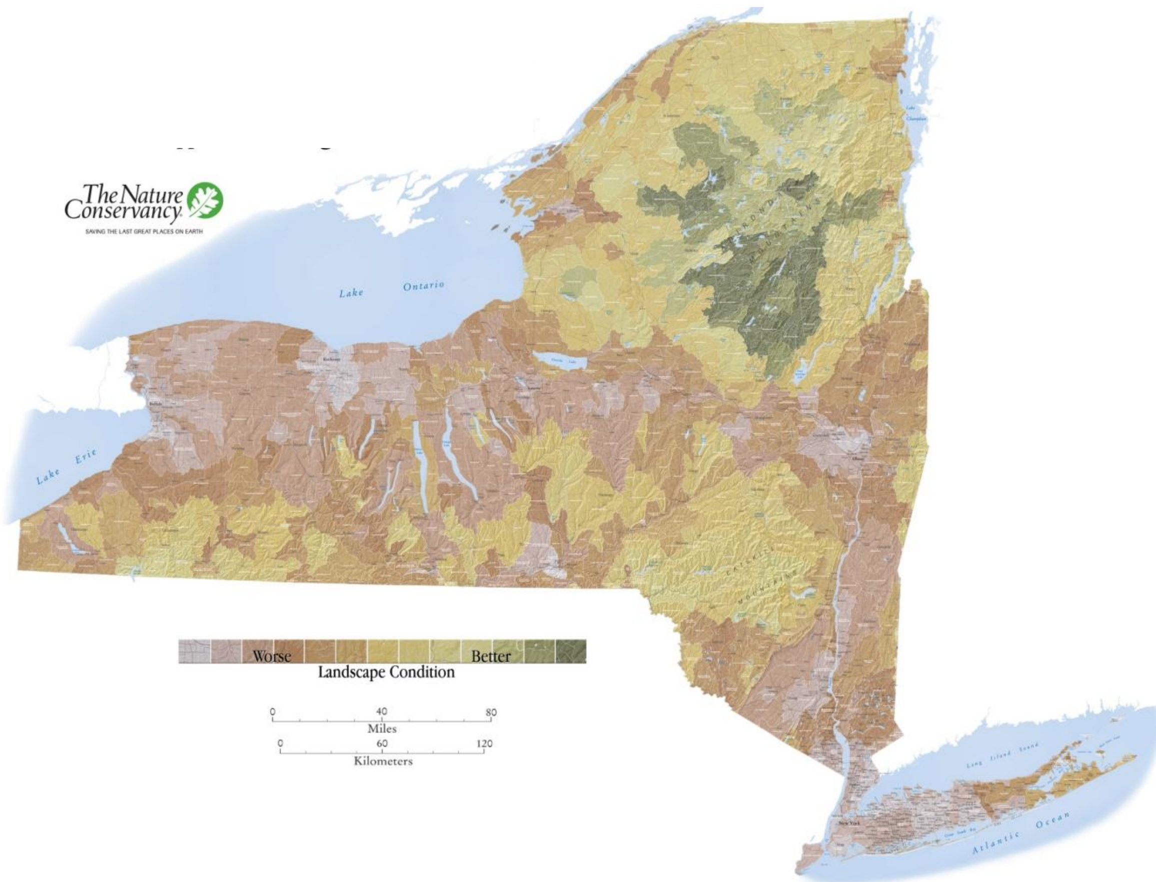

Figure 5. Summary of regional landscape conditions in New York (Source: Nature Conservancy).

The Salmon River was first among New York tributaries to Lake Ontario in the 2005 catch of Chinook (56% of total catch), coho salmon (96% of catch), and steelhead (28% of catch). For brown trout, the Salmon River was second (13% of catch) to Eighteenmile Creek, which accounted for 52% of the total number of brown trout caught. The 2004 creel survey for the Salmon River (Bishop and Penney-Sabia 2004) estimated angler effort for the period September – November 2004 at 90,825 angler-days. New York residents accounted for 35% of those surveyed, while residents from New Jersey and Pennsylvania accounted for 37% and those from New England states accounted for 18%. Anglers from outside the northeastern US, including Holland, Ireland and the Czech Republic accounted for 10% of the effort.

A previous survey (Connelly et al. 1990) reported angler participation in 1989 to be 180,000 angler-days, up from 5,700 in 1973. Total local expenditures on fishing activities were estimated at $62,000 in 1973 and $10,024,000 in 1989. Approximately 66% of the anglers using the river in 1989 were out-of-state residents.

Geology and Soils

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 (Cressey 1966; Miller et al. 1989). 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 6). 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). Soils in the lower watershed support a productive dairy industry, which is one of the primary economic factors in the region (New York State Tug Hill Commission 2002).

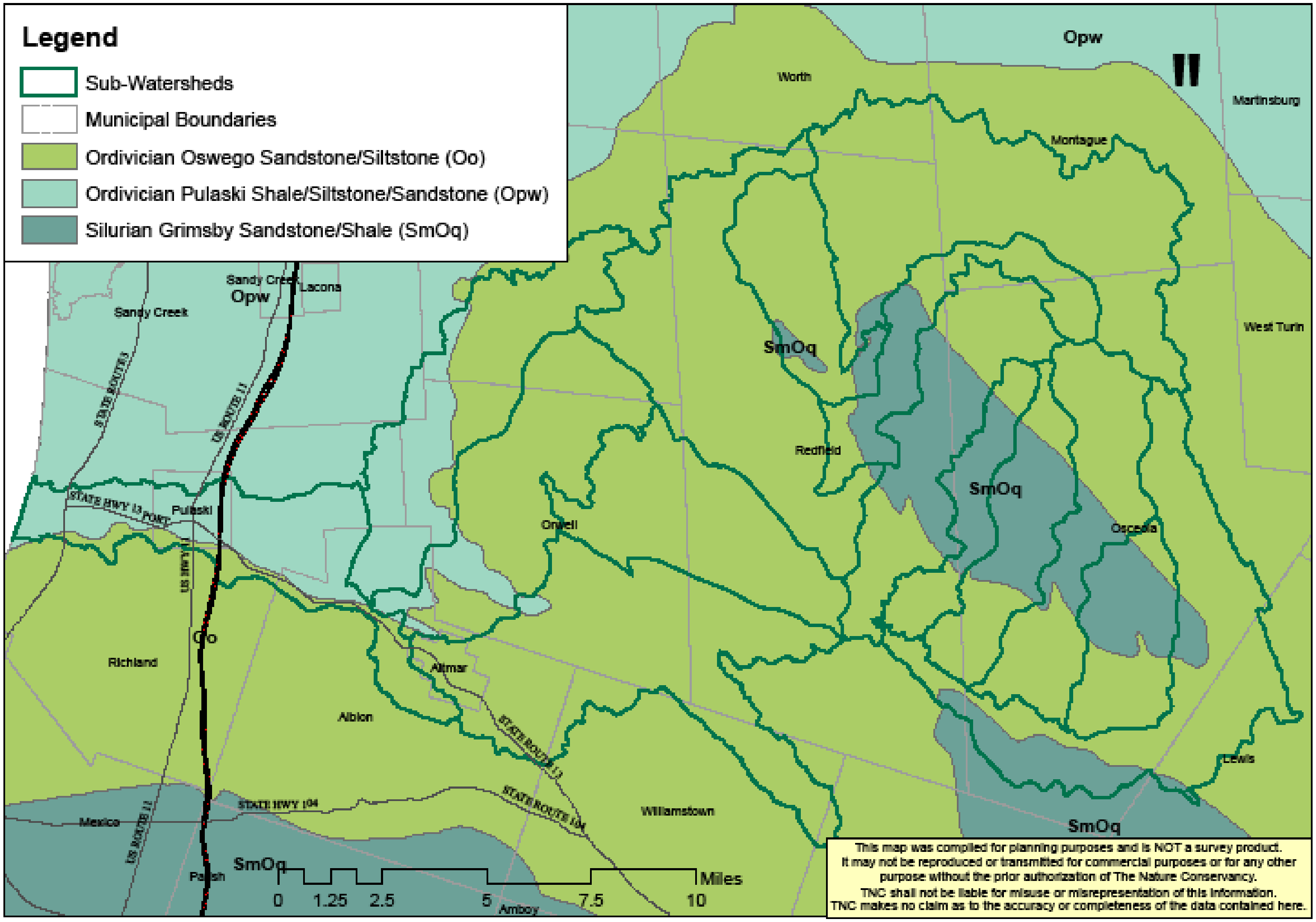

Figure 6. Bedrock geology of the Salmon River Watershed.

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 7). Private, municipal and industrial wells served ~14,500 people and pumped 6.12 Mgal/day from the aquifer in 1986 (Miller et al. 1989). The Tug Hill Aquifer is a potentially important factor regulating summertime baseflow and temperatures in all four of the lower sub-watersheds (Trout Brook, Orwell-Pekin, Beaverdam Brook-Meadow Creek-Reservoir, and Lower Salmon – Main Stem). There it recharges cool, mineral-enriched water to spring-fed headwaters and stream channels, especially during baseflow periods in late summer (Miller et al. 1989). The aquifer's regulation of baseflow and temperature may be particularly critical in the Trout Brook, Orwell Creek and Beaverdam Brook since these tributaries are not regulated in any way by discharge from the Lighthouse Hill reservoir.

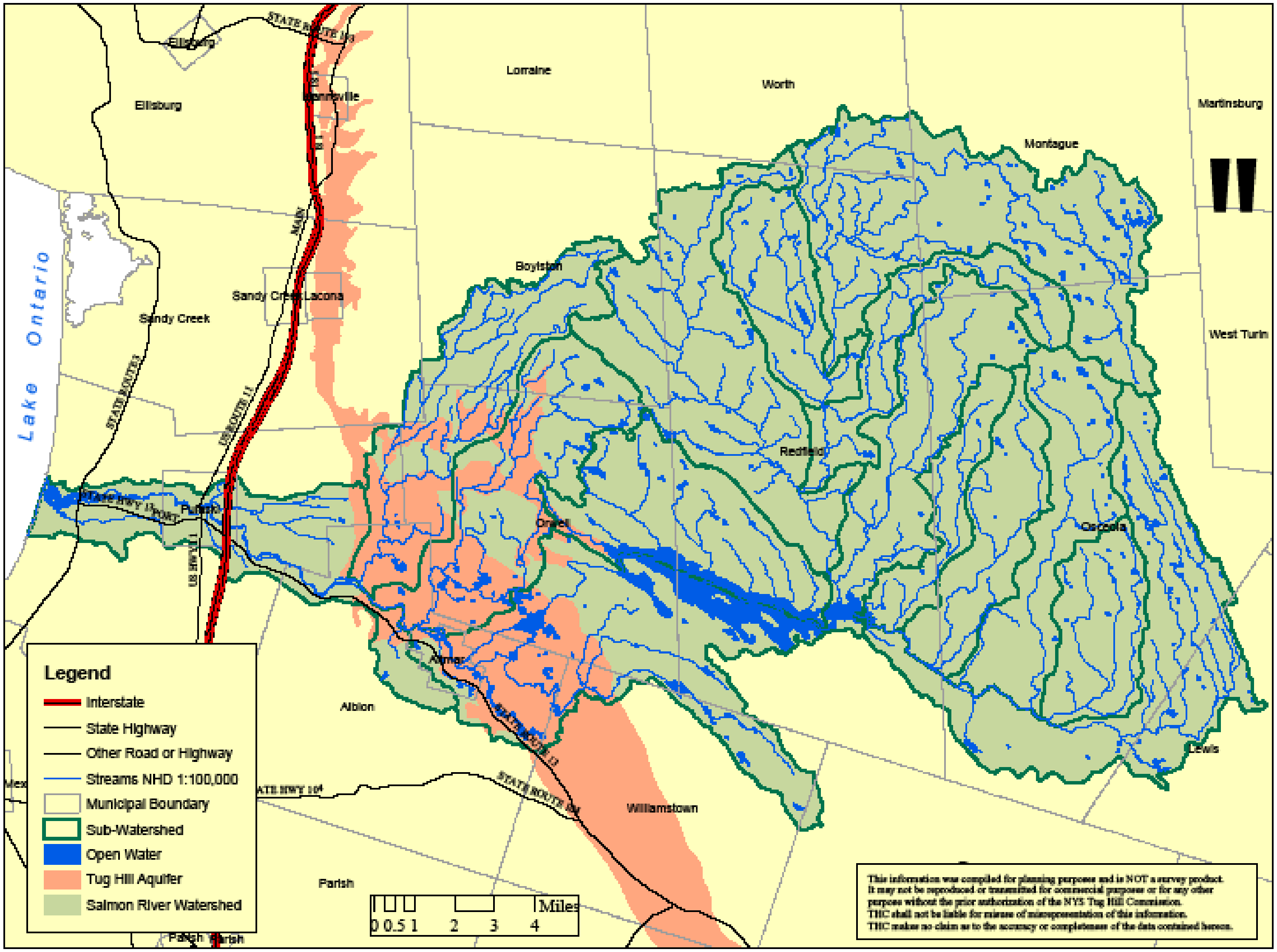

Figure 7. Location of the Tug Hill Aquifer.

Land Use

Historic and current land-use patterns have been influenced by broad geologic and hydrologic features of the region. Agriculture and accompanying settlements have persisted at lower, western elevations on more fertile and better drained soils (Figure 8, Table 2). Developed land accounts for an estimated 1.5% of the total watershed land base (2001 National Land Cover Data). The lower sub-watersheds contain 90% of the developed land present in the watershed, with the Lower-Salmon River sub-watershed accounting for 60% of the total. Overall, agriculture accounts for approximately 4% (7,400 acres) of the total land base in the watershed, but accounts for 5-21% of the land cover in the lower, western sub-watersheds (Beaverdam Brook-Meadow Creek-Reservoir, Orwell-Pekin, Trout Brook and Lower Salmon River).

At upper elevations agriculture was attempted and abandoned during the late 19th and early 20th centuries. Many of the abandoned lands in the upper elevations were incorporated into the New York State Forest system in the 1940s and 1950s. Compared to other regions of New York, the greater Tug Hill region, including the upper, eastern portion of the Salmon River watershed represents a landscape in relatively good condition based upon the abundance and unfragmented condition of natural community types (Figure5).

Compared to other regions of New York, the greater Tug Hill region, including the upper, eastern portion of the Salmon River watershed, represents a landscape in relatively good condition based upon the abundance and unfragmented condition of natural community types.

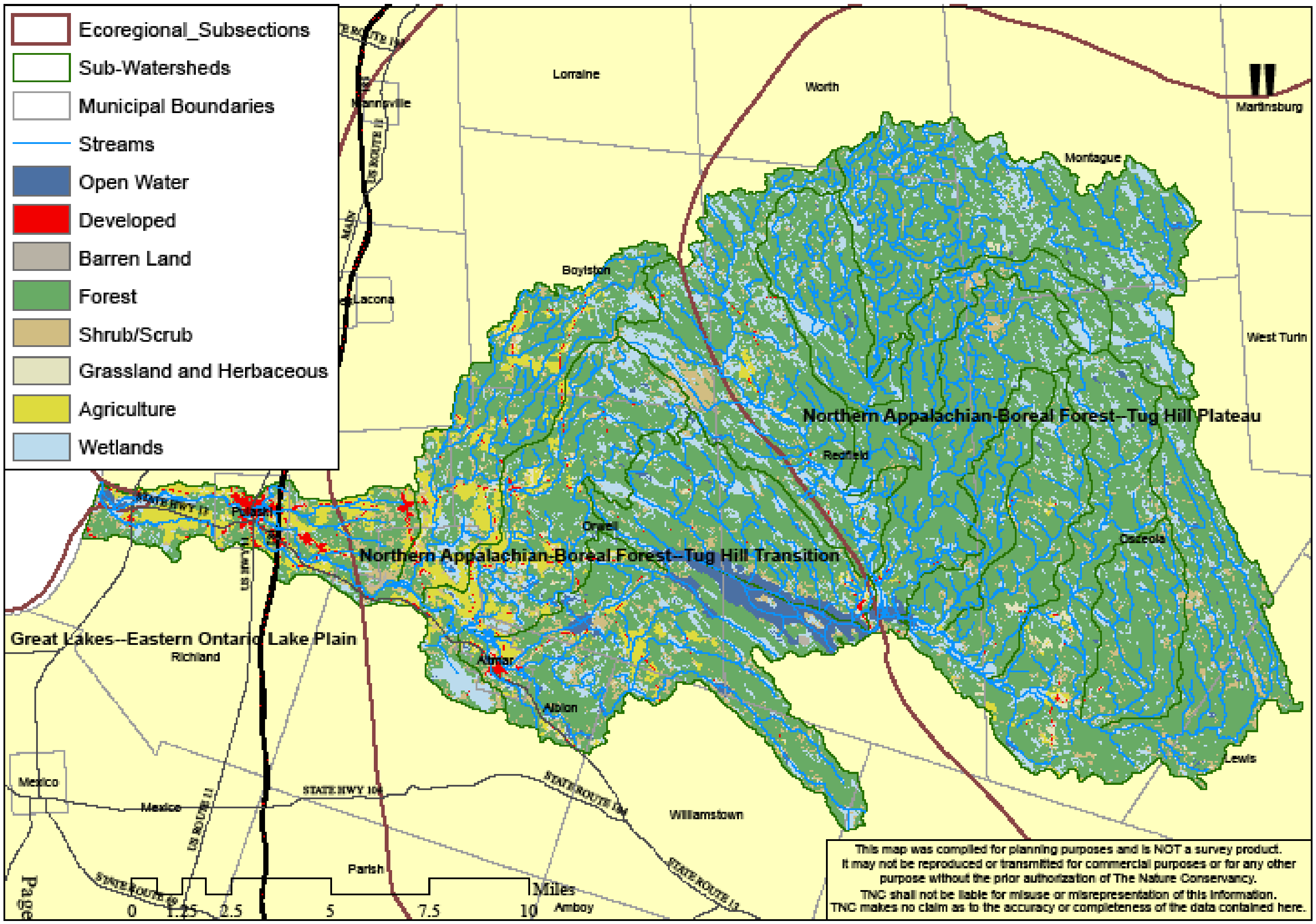

Figure 8. Land cover-types of the Salmon River Watershed.

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
Upper sub-watersheds											
BGWM	0	0	2	1,292	79	1	100	5,243	148	27	6,891
COBR	0	4	0	997	36	1	194	5,178	47	51	6,512
FBTT	22	0	79	1,506	61	159	374	7,268	234	76	9,780
GRMM	12	0	29	1,316	31	9	346	8,945	95	113	10,897
KESF	1	0	1	586	10	12	279	5,182	194	106	6,372
MARI	0	2	11	4,233	268	63	232	15,551	77	258	20,696
NOBR	50	0	181	4,300	82	62	951	10,903	766	562	17,856
PECK	57	0	78	1,614	53	80	565	5,971	9,870	539	18,827
PMLB	14	0	28	959	12	74	284	5,560	204	91	7,226
SBLB	0	0	10	491	9	1	135	3,844	54	28	4,572
UPSR	15	4	128	1,771	72	96	974	11,762	869	403	16,098
Lower sub-watersheds											
BBMC	222	41	921	2,482	212	173	1,642	9,624	1,375	552	17,285
LSRM	1,025	38	2,362	1,482	126	142	1,411	2,990	1,130	453	11,197
ORPE	127	0	1,466	2,244	95	291	902	6,287	965	416	12,793
TRBR	149	0	2,104	1,400	71	281	1,002	6,783	567	510	12,866
Watershed Totals	1,694	90	7,400	26,673	1,216	1,444	9,390	111,092	16,595	4,184	179,868

Forests

Due to the range in elevation and location, the Salmon River watershed spans two ecoregional subsections. Ecoregions represent geographic areas possessing similar types, quality and quantity of ecological resources, and serve as a spatial framework for research, management and monitoring of ecosystems (USDA Forest Service 2004, 2005). The US Forest Service ecoregion framework is a hierarchical system that places progressively finer units of "sections" and "subsections" within each of the ecoregions.

- The Eastern Lake Ontario Lake Plain Subsection is a component of the Great Lakes Ecoregion, and occurs at the lowest elevations of the watershed. This ecoregional unit is characterized by relatively flat topographic relief and shallow drainages associated with rolling glacial till-plains and glacial lake deposits. Sedimentary rocks underlie the glacial deposits. Potential natural vegetation types include beech-maple mesic forests with a mixture of oaks and hickories, and aspen. Climate-induced disturbances include winter ice storms and frontal and cyclonic wind events.

- The Tug Hill Plateau Subsection represents the extreme western limit of the Northern Appalachian – Boreal Forest Ecoregion. This ecoregional unit occurs at the upper elevations of the interior Tug Hill Plateau. Forests are dominated by boreal red spruce-balsam fir types at high elevations and in areas of poor soil drainage. Sites with better soil drainage are dominated by sugar maple, yellow birch and American beech, with a mixture of eastern hemlock and red spruce. Natural disturbances include severe wind events (frontal and cyclonic), winter ice storms, and several insect pests and diseases.

Elements of the watershed's terrestrial flora and fauna reflect the characteristics of these broad ecoregions, and much of the watershed shows transitional elements between the two ecoregions (Figure 8). The Salmon River watershed comprises 45% of the total area of the Tug Hill Plateau ecoregional subsection and 14% of the Tug Hill Transition ecoregional subsection (NYSDEC 2006a).

Other, early sources (Hotchkiss 1932; Stout 1958) report that Tug Hill 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. However, by the mid-1950s successional northern hardwood types (dominated by red maple, white ash, black cherry) characterized the region due to regrowth on abandoned farmlands and decades of selective harvesting (Stout 1958) to support a regional $80 million wood products and paper manufacturing industry (New York State Tug Hill Commission 2002). Late-successional forests are uncommon in the watershed. Known occurrences are limited to three small, isolated, "satellite" state forest preserves in the towns of Lewis and Osceola.

The Tug Hill has been identified as an area where great potential exists for participation in the Forest Stewardship program by private non-industrial woodland owners (Figure 9). The purpose of this program, which is administered by the USDA Forest Service, is to encourage long-term stewardship of non-industrial private forest lands by assisting landowners in efforts to keep forests productive and healthy through planning and technical assistance (USDA Forest Service 2005). Each state, through its state Forest Stewardship Plan (e.g., NYSDEC 2003) is required to identify forest resource areas where program outreach and activity will be emphasized. Ranking of forest resource areas is based on resource threat factors (development risk and forest health) and resource potential factors (amount of private land; forest patch size; riparian corridors; public water supplies, priority watersheds, threatened and endangered species; wetlands, proximity to publicly-owned lands; conservation easements; slope).

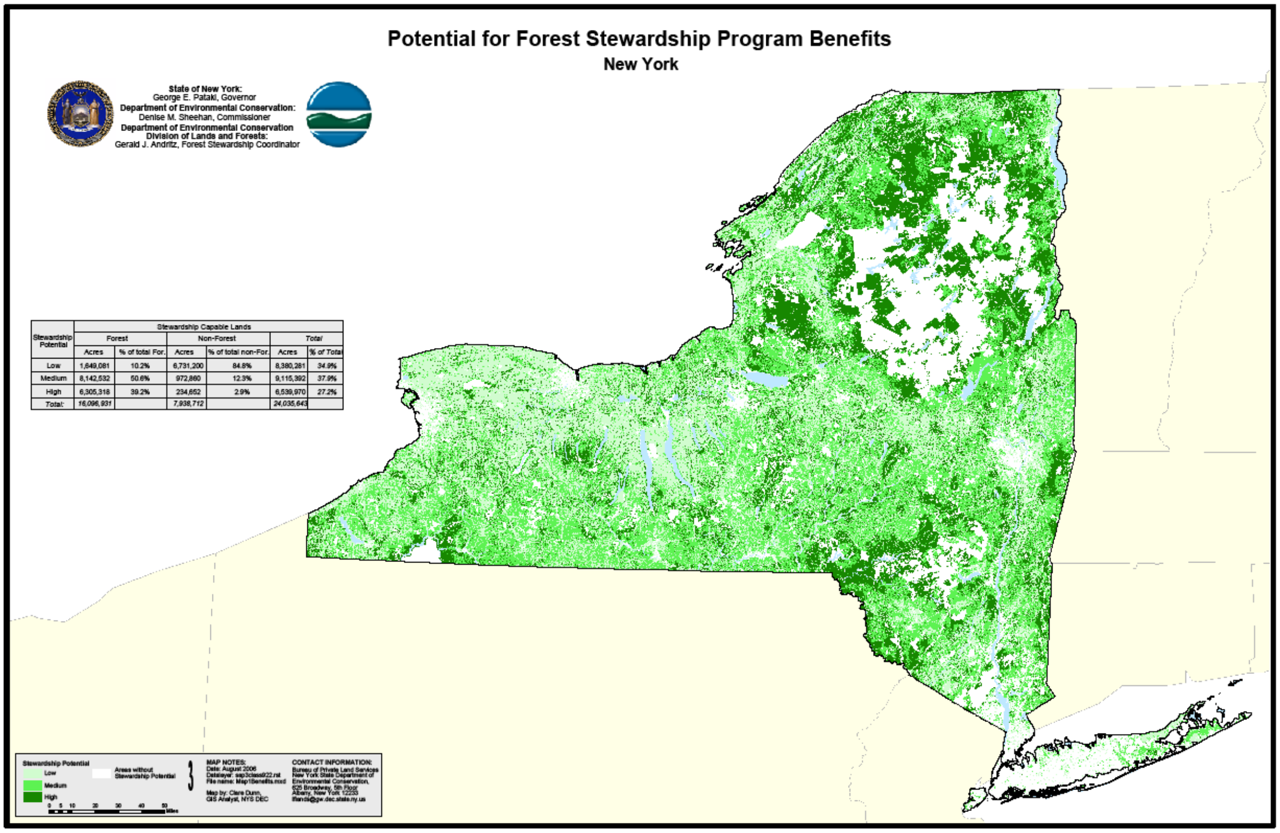

Figure 9. Potential for Forest Stewardship Program benefits in New York (Source: NYSDEC).

Rare and Endangered Species

The Salmon River watershed has a number of known and suspected occurrences of rare, threatened and endangered species within its boundaries.

- The state endangered bog buckmoth (*Hemileuca* sp.) is present here, and three different species of state-listed dragonflies (*Williamsonia fletcheri, Somatochlora forcipata*, and *Somatochlora incurvata*) are expected in the watershed as well.

- The New York Natural Heritage Program suspects that two state special concern amphibians, the Jefferson's salamander (*Ambystoma jeffersonianum*) and the blue-spotted salamander (*Ambystoma laterale*), will occur in the watershed. The federally-listed bog turtle (*Glyptemys muhlenbergii*) is known to occur in the wetlands just outside the extreme western end of the watershed. Three other species of special concern, the spotted turtle (*Clemmys guttata*), the wood turtle (*Glyptemys inscupta*), and the lake sturgeon (*Acipenser fulvescens*), and a threatened species, the Blanding's turtle (*Emydoidea blandingii*) are known to occur in the region. Additional survey efforts are needed to determine the presence of these species in the watershed.

- One endangered (black tern, *Chidonias niger*) and four threatened bird species (northern harrier, *Circus cyaneus*; least bittern, *Ixobrychus exilis;* pied-billed grebe, *Podilymbus podiceps*; and sedge wren, *Cistothorus platensis*) are known to occur within the watershed.

- State rare, threatened, or endangered plants currently known to occur in the watershed include eastern Jacob's ladder (*Polemonium vanbruntiae*), yellow mountain-saxifrage (*Saxifraga aizoides*), bird's-eye primrose (*Primula mistassinica*), slender bulrush (*Schoenoplectus heterochaetus*), sand dune willow (*Salix cordata*), and low sand-cherry (*Prunus pumila var. pumila*).

- Natural communities of statewide significance already known to occur in this watershed include sedge meadow, shrub swamp, spruce-fir swamp, hemlock-hardwood swamp, red maple-hardwood swamp, black spruce-tamarack bog, dwarf shrub bog, deep emergent marsh, shallow emergent marsh, marsh headwater stream, rocky headwater stream, and beech maple mesic forest.

Additional inventories will undoubtedly add to these lists of significant natural communities and rare species.

B. Conservation Targets

1. Salmon River Freshwater Estuary and Dune System

The ~270-acre Salmon River Freshwater Estuary is a system of open waters and marshes located at the mouth of the Salmon River at Port Ontario. The system is bounded by barrier dunes at Lake Ontario to the west, and by the last river riffle in the Salmon River, located approximately 1200 feet east of County Rt. 3 (Figure 10). 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.

The freshwater estuary is a shallow (3-7 ft), open bay along with a dynamic system of braided river channels and sandbars. Several wetland habitat types occur here that correspond primarily with water depth (Harman et al. 2000).

- <u>Riverine wetlands</u> (~130 acres) are 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 beds of emergent and submergent aquatic plants within the freshwater estuary provide some of the most productive warm water fish habitat around Lake Ontario. Further, it is an important staging area for annual migrations of spawning salmonines on the Salmon River.

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. The dunes and associated ponds, marshes and fens, represent the most extensive freshwater sand dune formation in New York. Freshwater dune systems are of global ecological significance. This system offers habitat for a number of rare and endangered plant and animal species, and has been recognized as a Bird Conservation Area (BCA) due to the significant breeding and over-wintering habitat that it provides, as well as serving as a critical corridor for migratory birds.

Since the 1970’s substantial areas adjacent to the freshwater estuary have been developed for residences, camps, marinas, and motorboat access facilities resulting in considerable habitat disturbance. The short segment of the Lake Ontario dune system within the Salmon River watershed is nearly completely developed.

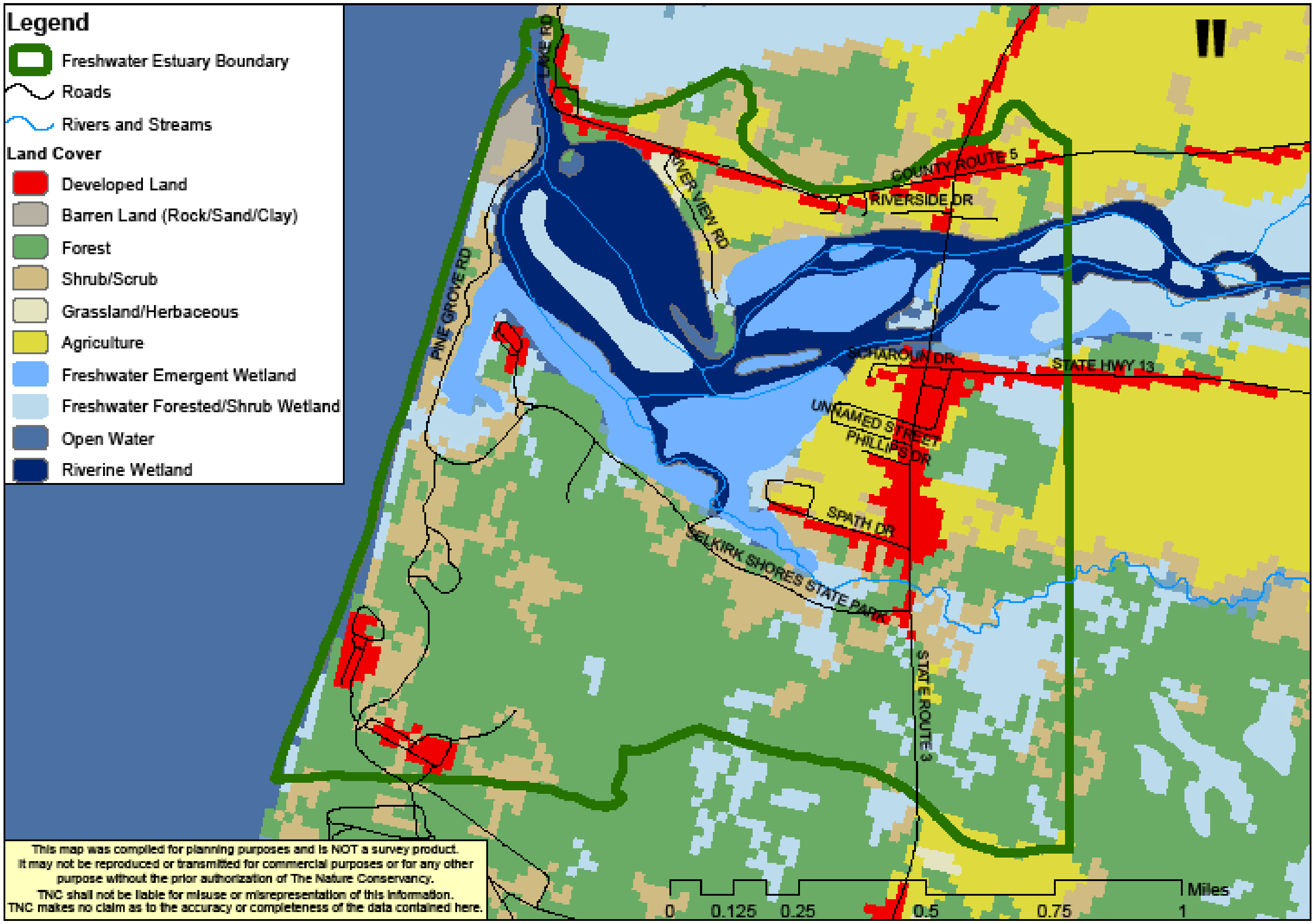

Figure 10. The Salmon River freshwater estuary and local sub-watershed.

2. Main Branch Salmon River and its Major Tributaries

The main branch/major tributaries target reflects the midreach streams of the watershed (Figure 11). For the purposes of this report, this target is defined as 3rd-order and higher stream reaches. Such waters represent fast flowing sections of relatively large streams having moderate to gentle gradients. They possess well-defined segments of riffles, pools and runs that occur within confined valleys. Stream velocity is great enough to cause lateral erosion that creates braids, bars and channel islands; and to create coarse-rocky, gravelly and sandy stream-beds. These stream segments have high water clarity and are well oxygenated.

The Salmon River Falls represents a natural migration barrier within this drainage system. Currently the hydroelectric dam at the Lighthouse 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 Lighthouse Hill Reservoir/Salmon River Falls reach. Critical habitat for migratory salmonines occurs within the sixteen mile reach between the river mouth and the Lighthouse Hill Reservoir. Additional critical habitat is provided below the reservoir by the Beaverdam Brook (mapped 2nd-order headwater), Orwell Creek and Trout Brook. Major tributaries in the upper watershed include the Mad River, Fall Brook, and segments of the North Branch Salmon River and Mill Stream.

3. Headwaters

This conservation target represents intermittent, and 1st- and 2nd-order perennial, or constantly-flowing streams described by Edinger et al. (2002). Intermittent streams represent the small upper-most reaches of stream systems where surface water flows only during the spring or following heavy rains. Substantial variation in headwater streams exists throughout the state with regard to water chemistry and temperature, gradient, underlying bedrock and soil types, surrounding forest types and the characteristic communities of aquatic organisms that subsequently inhabit these streams. The perennial headwater streams (Figure 12) include both “rocky” and “marsh” headwaters, which share the characteristics of being small- to moderate-sized, 1st- to 2nd-order streams.

- Rocky headwaters are typically shallow and narrow, and posses moderate to steep gradients, with cold, oxygenated water flowing over bedrock, boulders and cobbles. High gradients lead to downward erosion with minimal deposition of sediments. They are typically surrounded by upland forest and are situated in confined valleys.

- 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 interspersed with gravel- or sand-bottomed pools. However, silt, muck or peat frequently occurs on the bottoms of pools. These streams may have high turbidity and varying color and sometimes be somewhat poorly oxygenated.

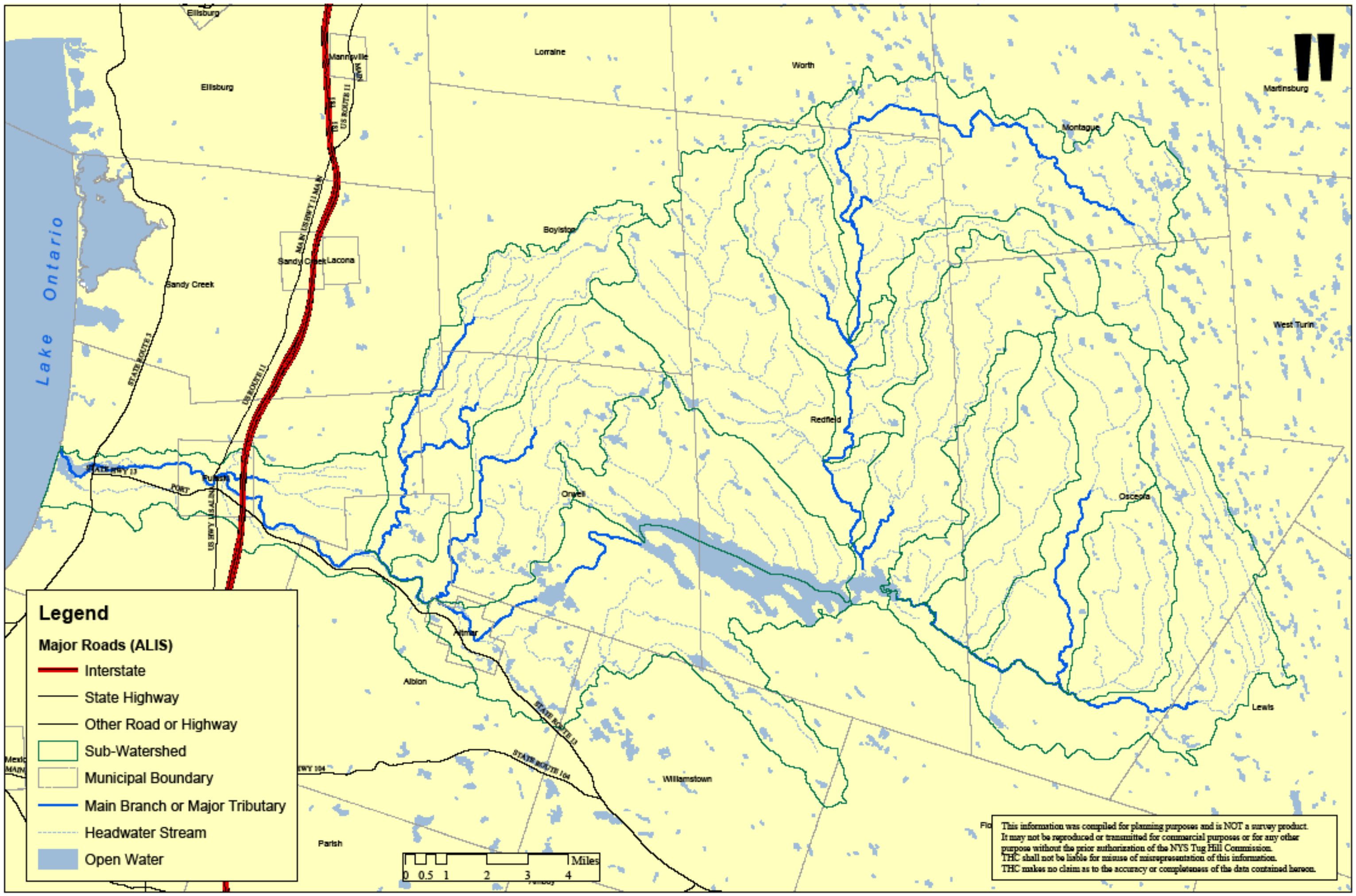

Figure 11. Main Branch and major tributaries of the Salmon River.

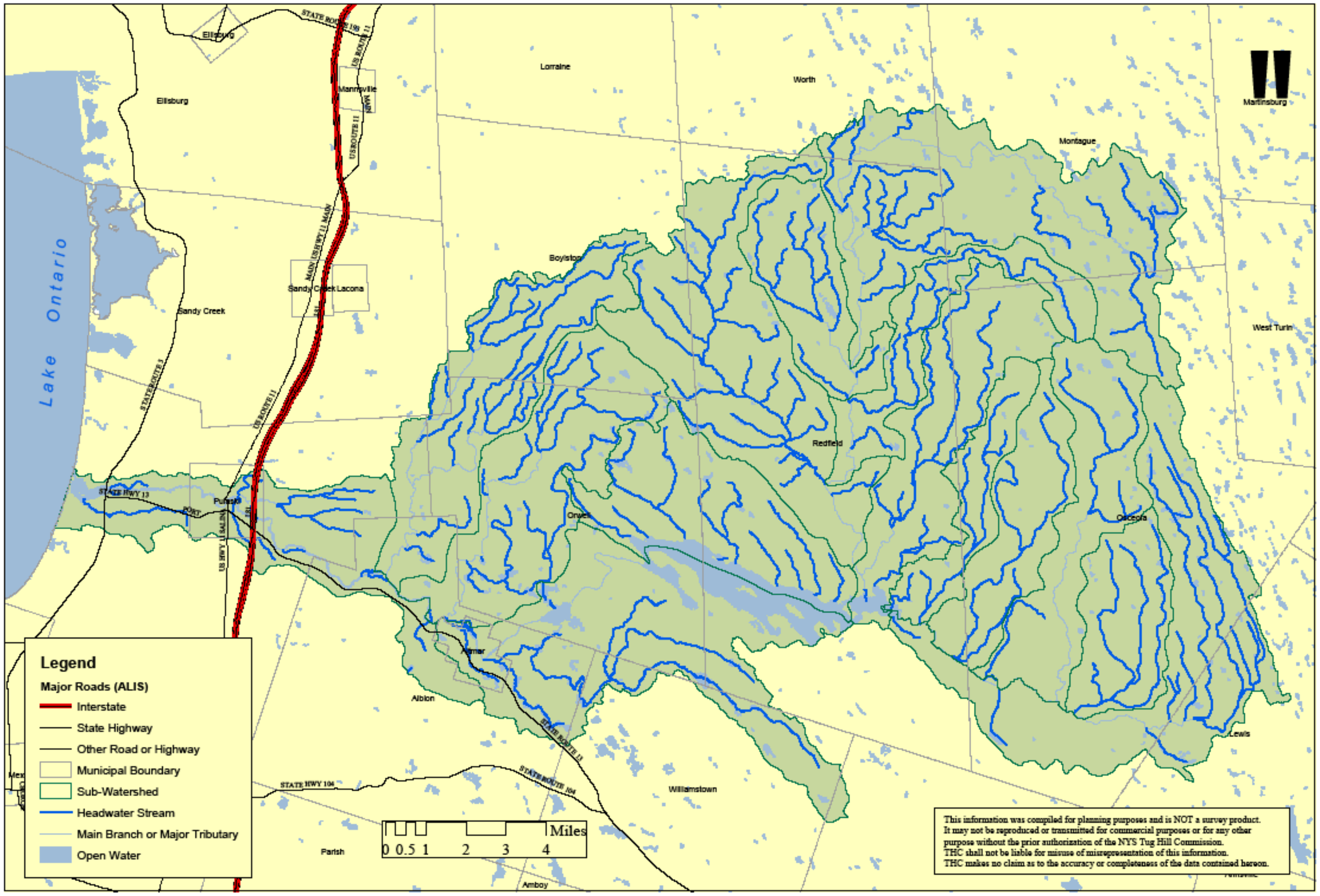

Figure 12. Perennial headwater (1st- and 2nd-order) streams of the Salmon River Watershed.

4. Open Waters

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 to numerous farm ponds, two notable impoundments exist in the watershed; the Lighthouse Hill and Redfield Reservoirs (Figure 13).

5. Non-Estuarine Wetlands

This target is intended to reflect the palustrine (wetlands containing emergent vegetation, i.e., not open water) systems that exist throughout the watershed outside of the Salmon River freshwater estuary system. 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 14). The abundance of wetlands within the region is due to the abundance of precipitation and the 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.

A number of wetland community types are known to occur within the Salmon River watershed. These wetland communities, along with their NY Heritage Rankings 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)

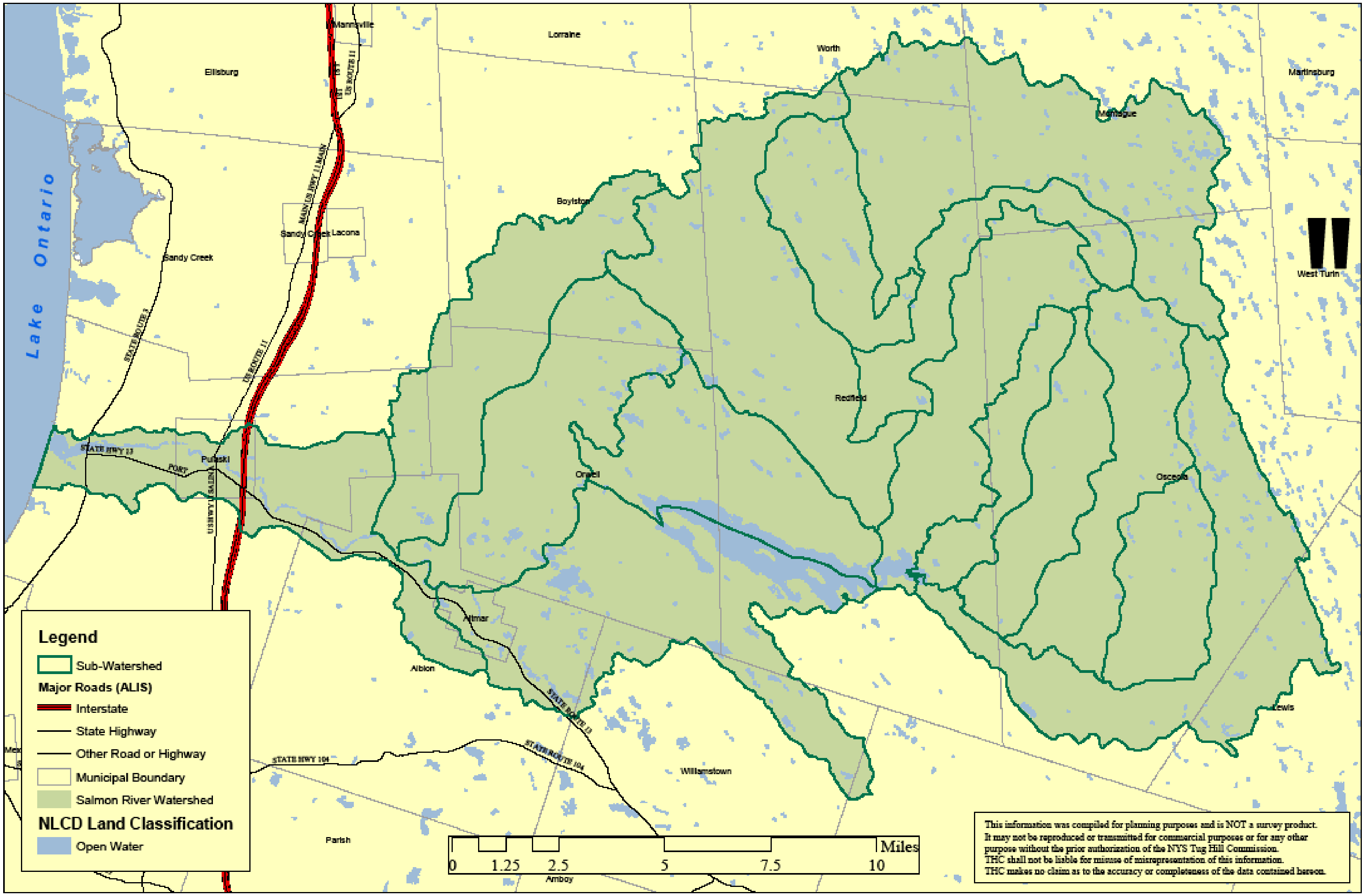

Figure 13. Open Waters of the Salmon River Watershed.

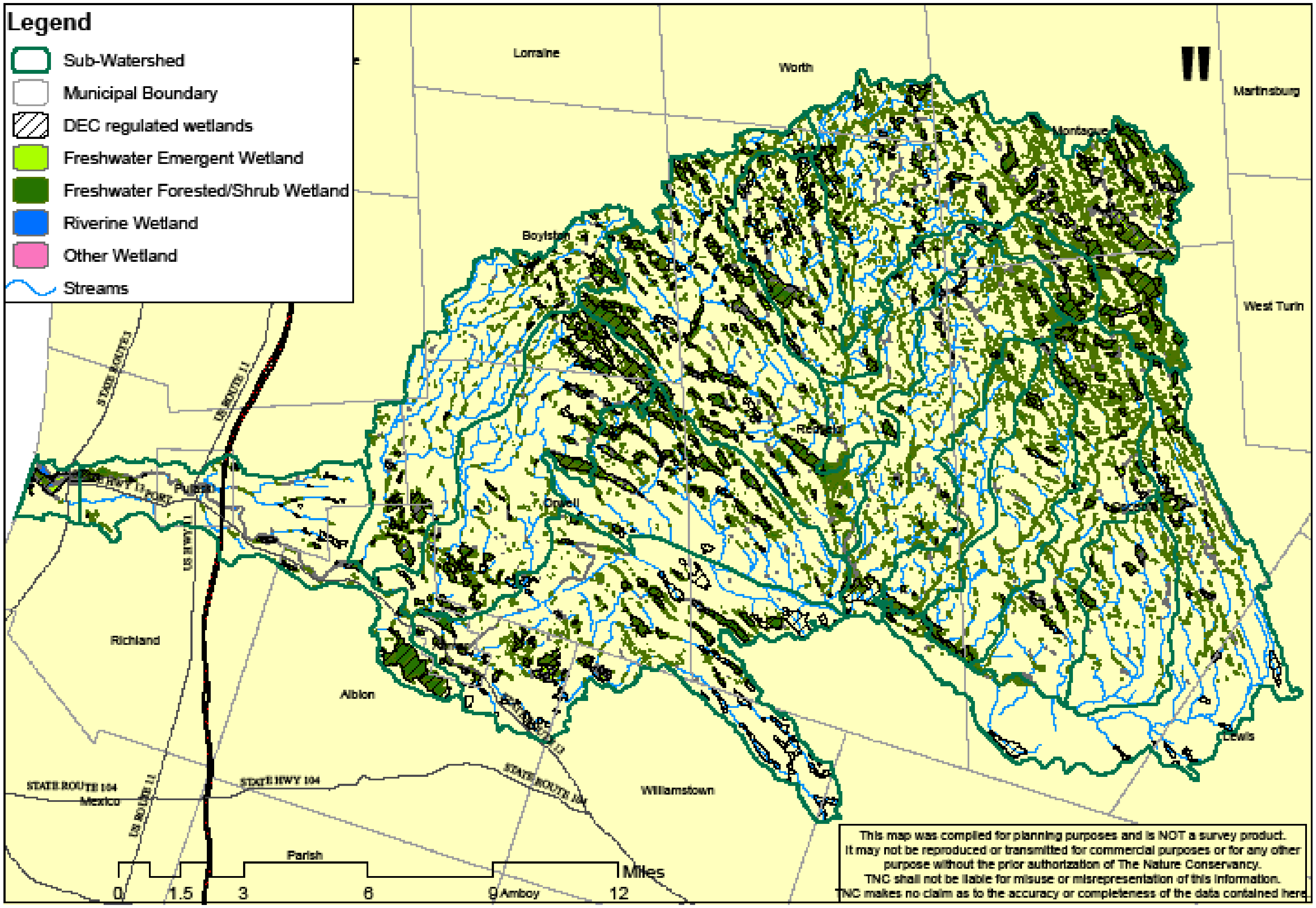

Figure 14. Palustrine and riverine wetlands in the Salmon River Watershed. Data are from the National Wetlands Inventory and the New York State Department of Environmental Conservation.

6. Matrix Forest

The matrix forest includes the majority of land cover in the watershed and represents the mix of upland forests of varying composition and successional stages, including early successional shrub and herbaceous vegetation types. Although wetland forest types are embedded within this matrix, they are considered within the non-estuarine wetland target.

The forests of the Salmon River Watershed span two broad ecoregional subsections (Figure 15). The Eastern Lake Ontario Lake Plain Subsection of the Great Lakes Ecoregion occurs at the lowest elevations of the watershed. These forests intergrade with those 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).

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 can perpetuate the occurrence of many species that are currently declining in the Northeast. However some areas of New York are neither important nor appropriate for focusing efforts on conservation of grassland species. The US Department of Agriculture Farm Bill programs, DEC's Landowner Incentive Program, and the Audubon Society New York Important Bird Areas program have designated certain "focus areas" to which priority will be placed for conservation efforts aimed at grassland bird species (e.g., Finger Lakes region, Montezuma Wildlife Refuge, St. Lawrence Valley). No focus areas have been designated for the Salmon River Watershed (Figure 16). Therefore, although grasslands provide habitat for certain wildlife species, these systems were not identified as a conservation target for the Salmon River watershed. Rather, they were considered as a component of the Matrix Forest target.

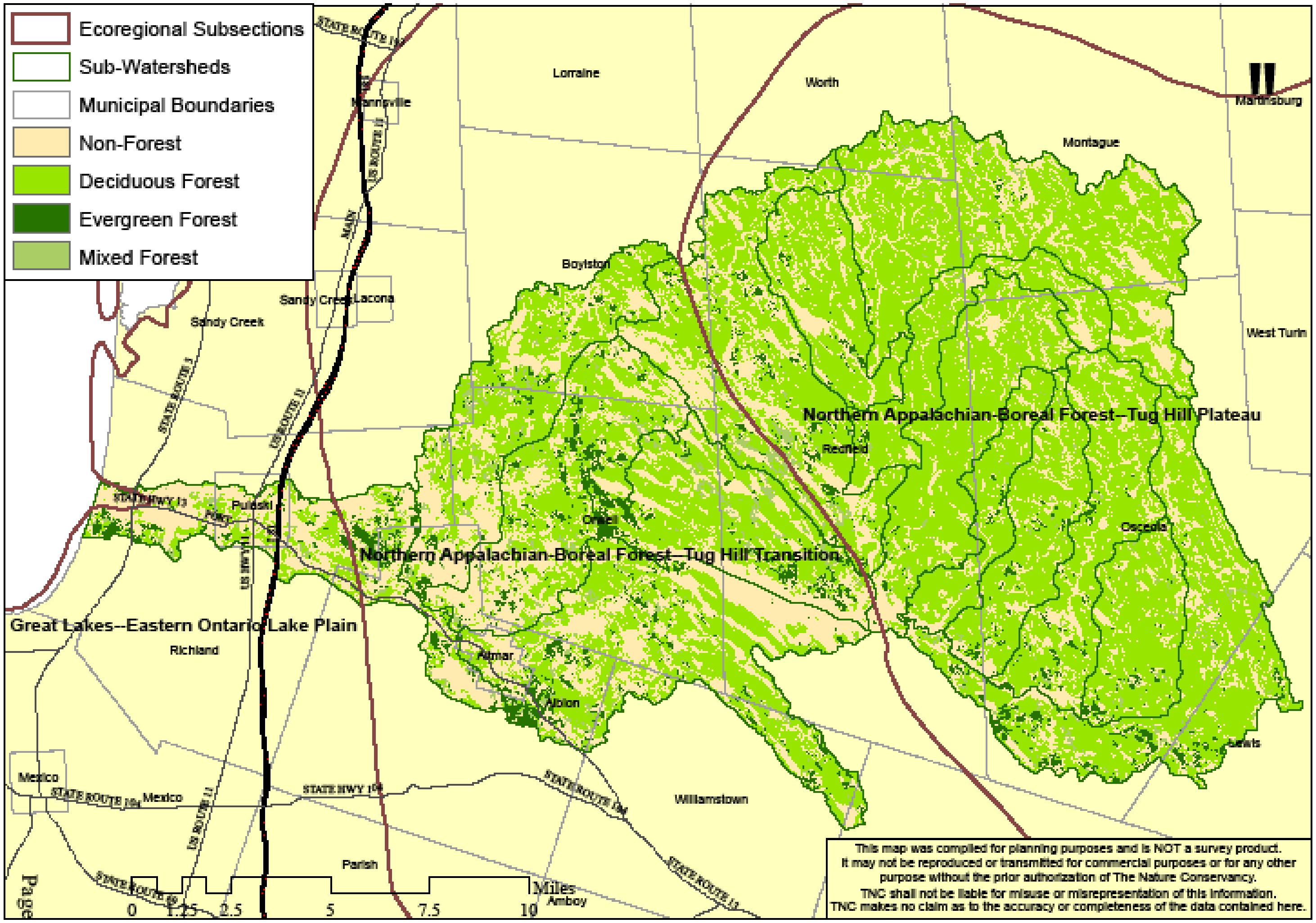

Figure 15. Matrix forests and ecoregional subsections of the Salmon River Watershed.

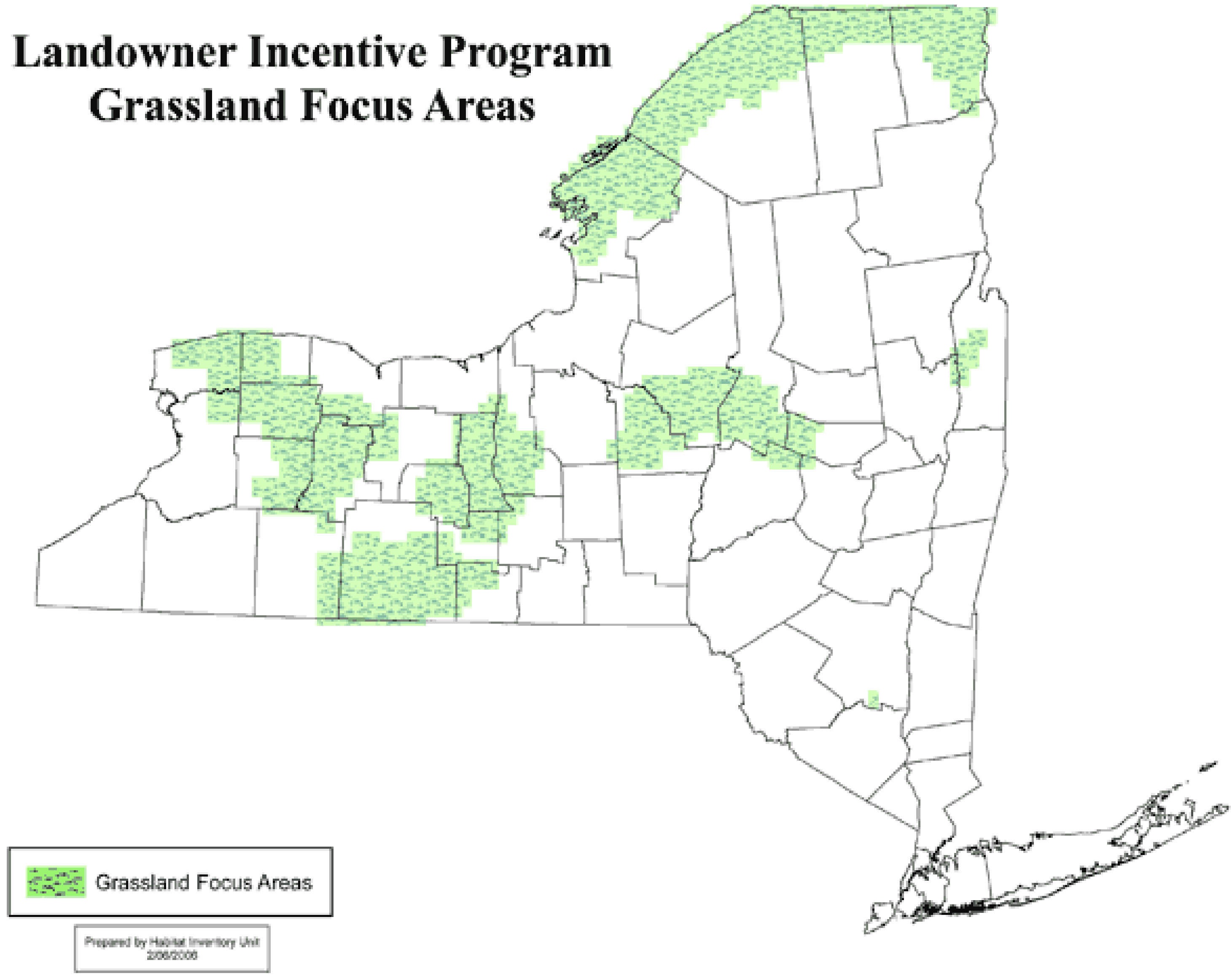

Figure 16. Locations of Grassland Bird Focus Areas in New York. These areas have been defined by the National Audubon Society as having the greatest likelihood of supporting grassland bird species. (Source: Audubon, New York).

7. Salmon River Gorge and Steep Slope Communities

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 110-ft high falls and continues downstream for approximately 3000 ft (Figure 17). The Gorge includes 120-ft 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 Salmon River Main Stem and Matrix Forest targets. The 112-acre area immediately surrounding the falls and gorge was purchased by the State of New York in 1993 (Figure 17) and is currently managed as a NYSDEC Unique Area (Sawchuck 2006).

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 18). 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.

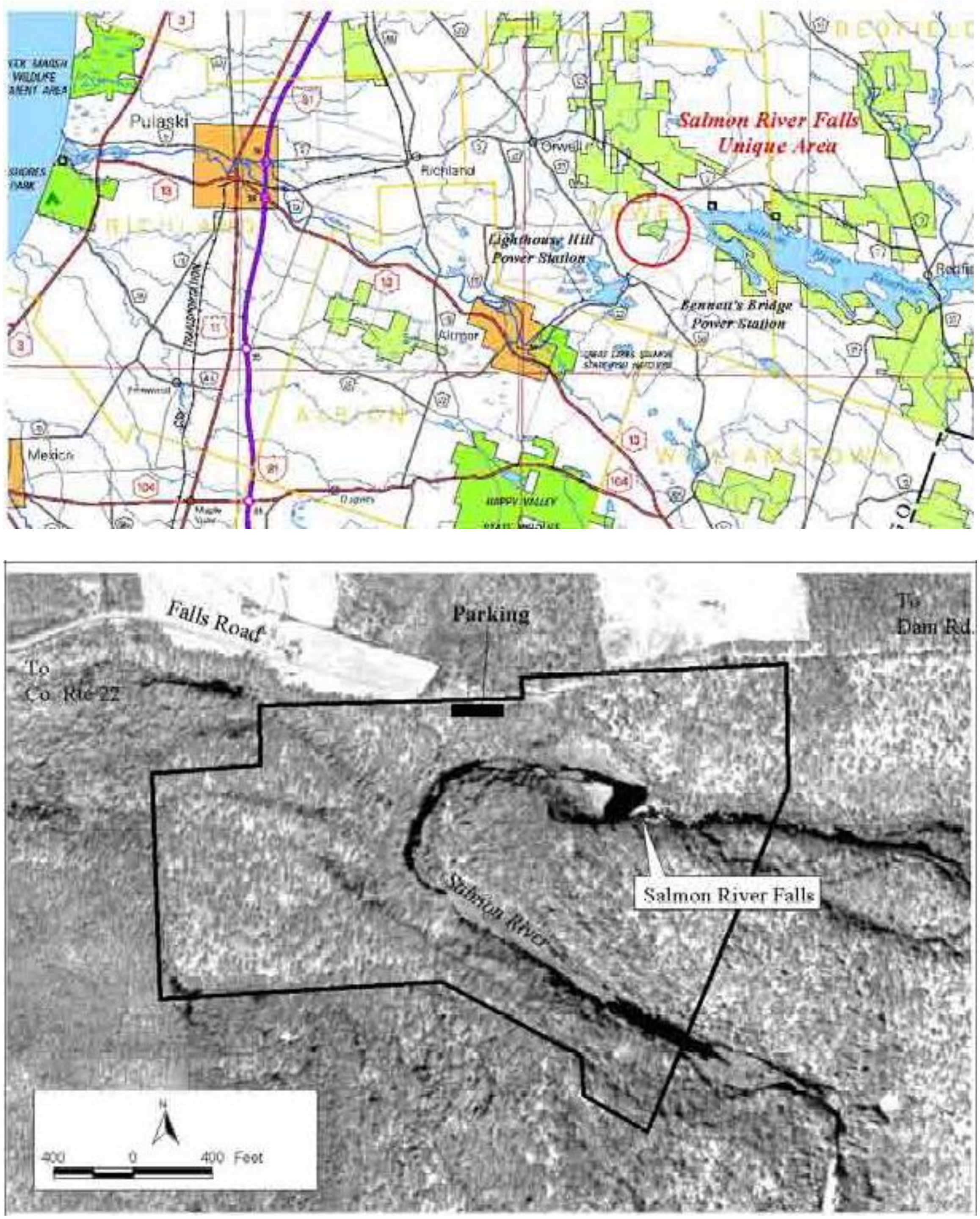

Figure 17. Site location map and aerial view of the Salmon River Gorge (From Sawchuck, 2006).

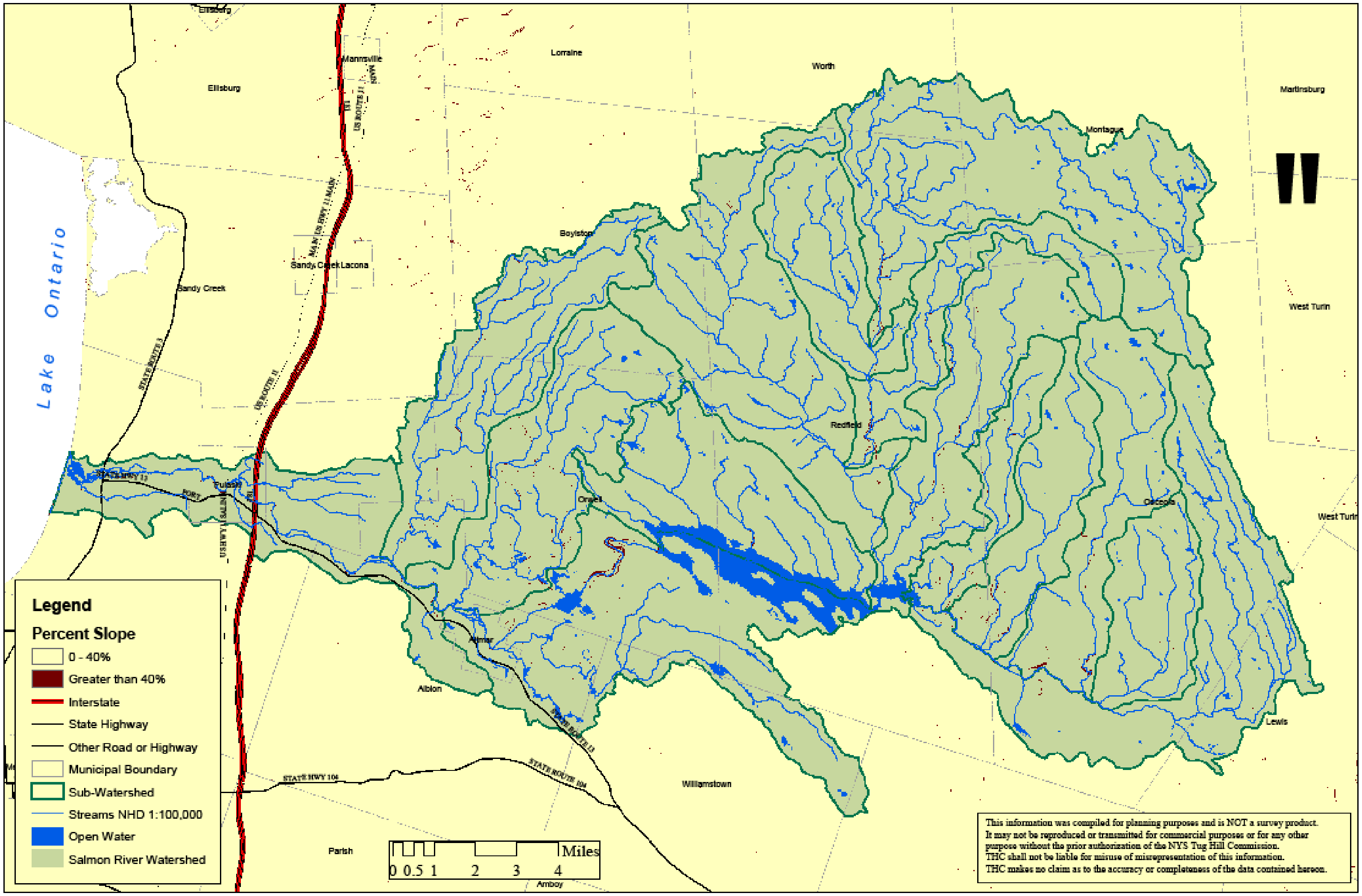

Figure 18. Distribution of landforms in the Salmon River Watershed having greater than 40% slopes.

C. Summary of Salmon River Watershed Inventory and Land Analysis

In 2006 the New York Natural Heritage Program (NYNHP) completed the Salmon River Watershed Inventory and Land Analysis (Howard 2006). The objective of that analysis was to evaluate the natural integrity and comparative quality of sub-watersheds within the 176,000-acre Salmon River watershed using GIS-based predictions of rare species and natural communities in the respective sub-watersheds and subsequent ground-truthing of model predictions (where land owners granted permission to search for element occurrences); and GIS-based assessments of levels of fragmentation of aquatic and terrestrial habitats within the watershed.

That analysis revealed that the Salmon River Watershed encompasses different ecosystems between its western extent at Lake Ontario shoreline to the upper elevations on the Tug Hill Plateau. Many rare species occur or are predicted to occur at the lower reaches and mouth of the Salmon River (Figure 19), but the more contiguous and less altered natural communities occur in the eastern watershed at upper elevations (Figure 20). Known rare species occurrences are summarized in Table 3.

The rare species and natural community inventories turned up new locations for rare animals, rare plants, and significant natural communities. NYNHP does not feel that all element occurrence locations are known for the entire Salmon River Watershed, and that there is excellent potential for other rare species sites in the basin with additional survey effort. In all, 61 different occurrences of rare species and significant natural communities are known within the entire basin. Eleven of these are locations for rare animals, twelve for rare plants, and 39 for significant natural communities. Clusters of rare species and significant natural communities occur near the mouth of the Salmon River, in a few of the larger peat lands in the basin, such as Sloperville Fen, and within the Salmon River Gorge. More locations are believed to exist on private lands and in other locations that NYNHP just did not have time or opportunity to visit. However, the known locations of rare species and significant natural communities provide an excellent picture of both the general and specific patterns of biodiversity throughout the basin. The information and tools presented in this report can help guide a multi-tiered conservation planning effort that focuses at the smaller scales of species, the small to large scales of natural communities, and the large scale of sub-watersheds.

Table 3. Summary of rare and endangered species occurrences within the Salmon River Watershed (Source: Howard 2006).

	Lower Sub-watersheds				---------Upper Sub-watersheds----------										
Species	BBMC	LSRM	ORPE	TRBR	BGWM	COBR	FBTT	GRMM	KESF	MARI	NOBR	PECK	PMLB	SBLB	UPSR
Plants															
Jacob’s ladder										♦					
wild Sweet-William										♦					
broad-lipped twayblade							♦								
lesser bladderwort	♦														
bird's-eye primrose	♦														
yellow mountain-saxifrage	♦														
pod grass			♦												
sand dune willow		♦													
low sand-cherry		♦													
ram’s-head lady slipper		♦													
slender bulrush		♦													
giant pine-drips		♦													
Animals															
three-toad woodpecker										♦					
bald eagle	♦		♦												
pied-billed grebe		♦	♦												
northern harrier		♦													
least bitern		♦													
black tern		♦													
pitcher plant borer moth	♦														

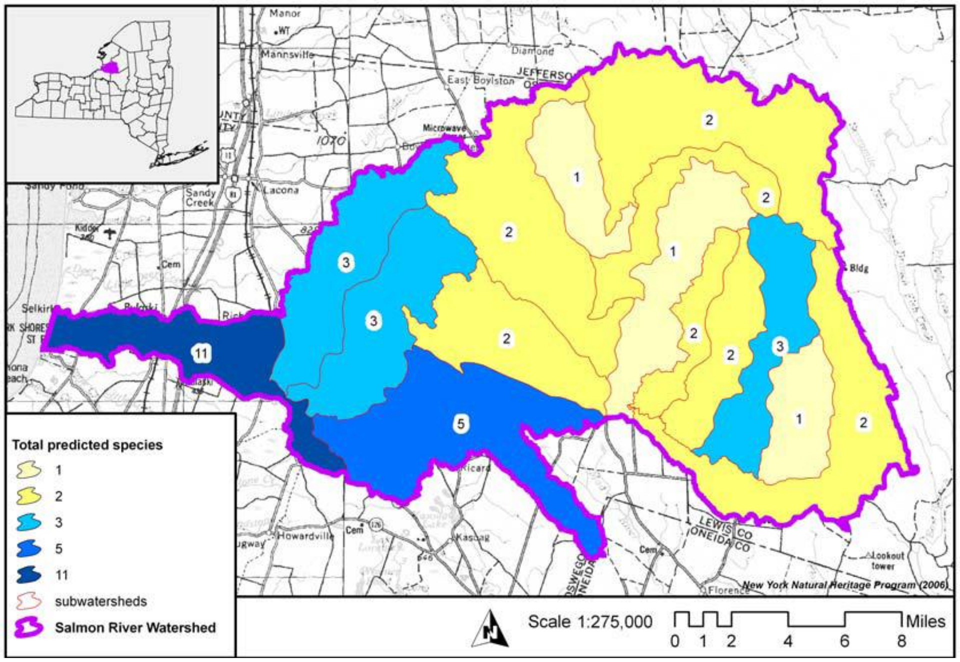

Figure 19. Element distribution model (EDM) of biodiversity ‘hotspots’ by sub-watershed, showing the number of predicted rare and endangered plant and animal species for respective sub-watersheds (Source: Howard 2006).

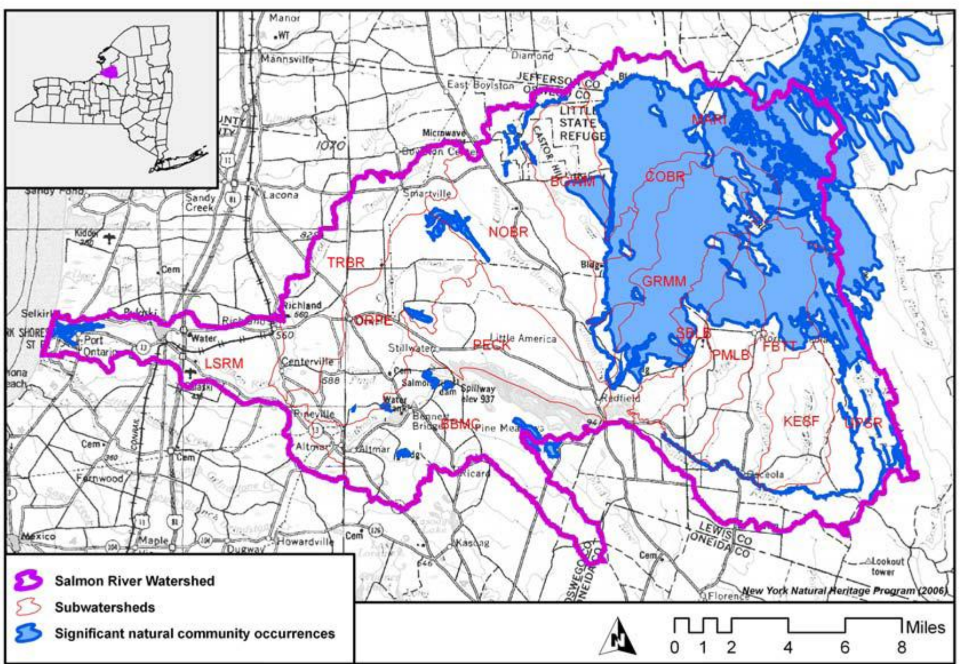

Figure 20. Significant community occurrences in the Salmon River Watershed (Source: Howard 2006).

Mad River (MARI)

The Mad River sub-watershed is the largest sub-watershed, at 21,000 acres, and is located in the northern portions of the basin. A large portion of the upper reaches of this sub-watershed is owned by TNC, and protected by a conservation easement held by the NYSDEC.

Holding 98% natural lands places it seventh based on this category. It has, however, a very high road-less block score, meaning that it intersects and/or contains the largest road-less blocks in the basin. No dams were found within this sub-watershed and there are only a few roads (20 miles). One rare plant (Jacob's ladder, *Polemonium vanbruntiae*) occurs within this sub-watershed, and another (wild Sweet-William, *Phlox maculata* ssp. *maculata*) is known just beyond the sub-watershed boundaries. One rare bird (three-toed woodpecker, *Picoides dorsalis*) has been observed in the sub-watershed. In addition there exists a large area of palustrine (wetland) natural communities (shrub swamp, sedge meadow, spruce-fir swamp, and black spruce-tamarack bog). In all, the Mad River rises to the top as the sub-watershed with the highest landscape integrity.

Cold Brook (COBR)

Cold Brook is a narrow sub-watershed, with a width less than a mile wide in most places. At 6,600 acres, Cold Brook is the third smallest sub-watershed and, as with all the sub-watersheds in the Tug Hill core, has a high percentage of natural land (4th highest: 98.6%). Cold Brook has the highest road-less block score. As with the Mad River, this sub-watershed ranked slightly lower for the amount of natural land adjacent to streams. This pattern may be due to misclassification within the land use/land cover layer of the large sedge meadows and other beaver meadows in these sub-watersheds or our lack of inclusion of the emergent wetland types into the "natural lands" group. Even still, these apparent inconsistencies do not play a large role in the overall assessment of these sub-watersheds. No occurrences of rare plant or animal species are known for this sub-watershed.

Beaver-Gillmore-Willow-McDougal (BGWM)

This sub-watershed consists of a merger of the lowest portion (about 2.5 miles) of the North Branch of the Mad River with the Cold Brook sub-watershed flowing from the east and the next portion (about 1 mile) with the series of tributaries flowing from the west, adjacent Cottrell Creek. These tributaries include Beaver Creek, Gillmore (Gillman) Creek, Willow Creek, and McDougal Creek. The Beaver-Gillmore-Willow-McDougal sub-watershed is the fourth smallest in the basin at 6,960 acres. It has the highest proportion of natural land (99.5%), the third from highest road-less block score, and the highest proportion of natural land near its streams (99.3%). No dams are known in this sub-watershed and only 2.5 miles of roads with eight road/stream crossings exit here. There was only one, unspecified, rare species predicted to have appropriate habitat within this sub-watershed, and there are no known occurrences of rare species within the sub-watershed. The final assessment score for this sub-watershed ranked it third overall.

Upper Salmon River (UPSR)

The Upper Salmon River sub-watershed is sickle-shaped, beginning at the upper end of the upper reservoir and extending in a curve about 17 miles to the headwaters of the Mad River. Pickens Brook, West Fork Salmon River and East Fork Salmon River make up the major tributaries in this sub-watershed. Significant natural communities within or crossing into this sub-watershed include confined river, marsh and rocky headwater streams, black spruce-tamarack bog, dwarf shrub bog, beech-maple mesic forest, and floodplain forest. A dwarf shrub / black spruce-tamarack bog exists at the northwestern headwaters of this sub-watershed. This peatland is re-vegetating from beaver flooding, and it is believed that periodic flooding by beaver may be the dynamic that keeps this and other peatlands in the region open and relatively free of trees. No rare species have been recorded in this sub-watershed. The Upper Salmon River sub-watershed is fourth largest, at 16,400 acres. It has a relatively moderate amount of natural land, both overall (97%) and within the 100m stream buffer (97%). This sub-watershed is 5th in its road-less block score, and has the lowest proportion of road crossings per stream mile. These factors help bring the relative overall ranking for this sub-watershed to fourth.

Grindstone-Mill-Muddy (GRMM)

The major feature of this basin is the documentation of the high quality rocky headwater stream, encompassing most of Mill Creek and its tributaries. At 11,000 acres, Grindstone-Mill-Muddy falls in the middle of the pack for size. The metric for proportion natural lands places it fifth (98.4%) and for proportion of streams in natural land places it fourth (98.6%). There are no dams in this sub-watershed and about 12 miles of roads. With 57 miles of stream and 14 stream/road crossings, there are 0.25 road crossings per stream mile. No rare species have been recorded in this sub-watershed, but element distribution models predicted appropriate habitat for one rare animal species and two rare plant species that were not specified. Overall, this sub-watershed was ranked fifth.

Stony Brook-Lime Brook (SBLB)

Stony Brook flows from the north into the Salmon River just east of the upper reservoir. About 2.5 miles upstream, Line Brook diverges and both continue in parallel up towards the old logging camp called New Campbellwood Wye. Stony Brook-Lime Brook is the smallest sub-watershed, at about 4,600 acres and averaging about 0.7 mile wide and about 7 miles long. Only the extensive beech-maple-mesic forest matrix-forming significant natural community occurs in this sub-watershed. No rare species have been documented within this sub-watershed, although element distribution models predicted appropriate habitat for one rare animal species and two rare plant species that were not specified. A very high proportion of this watershed is natural (98.6%) and a very high proportion of natural land occurs within the stream buffers (98.3%), and received a moderate road-less block score. Overall, this sub-watershed was ranked sixth.

North Branch (NOBR)

At 17,400 acres, North Branch is the third largest sub-watershed in the basin. This sub-watershed falls along the cusp between the Tug Hill Transition and Tug Hill Core zones, with a larger proportion of agricultural lands than those solely in the Tug Hill Core. This sub-watershed has many streams (69 miles), moderate road mileage (30 miles), and a moderate number of stream/road crossings (33). The very bottom of the North Branch, at the confluence with the Mad River, is classified as a confined river and recognized as one of these stream courses of statewide significance. This natural community occurrence continues up the Mad River. Cottrell Creek supports a mosaic of beaver – altered wetlands and high quality floodplain forest that was mapped as a significant natural community. The North Branch was ranked seventh. No rare species have been recorded or predicted for this sub-watershed.

Fall Brook-Twomile-Threemile (FBTT)

Fall Brook merges with the Salmon River at Osceola. Crooked Brook, Onemile Creek, Twomile Creek, and Threemile Creek are all small tributaries to Fall Brook and included in this sub-watershed, which encompasses 9,800 acres. The extensive beech-maple mesic forest matrix-forming significant natural community occurs in this sub-watershed. The confined river significant natural community of the East Branch also passes along (and makes up) the southern boundary of this sub-watershed. The only record for a rare species in the sub-watershed is a 1927 New York State Museum herbarium specimen of the orchid *Listera convallarioides* (broad-lipped twayblade). NYNHP searched for this plant in 2005 but did not find it. No other rare species were predicted in this sub-watershed. Overall, this sub-watershed ranks eighth in the evaluation.

Keese-Smith-Finnegan (KESF)

The Keese-Smith-Finnegan sub-watershed is the second smallest sub-watershed at 6,400 acres. It has a high proportion of natural land (98.8%, second highest) and natural land within the 100m stream buffer (98.7%, second highest). These tributaries to the Salmon River represent extensions of the confined river significant natural community mapped for this river. New significant natural communities were mapped within this sub-watershed, including a dwarf shrub bog and a tamarack bog now revegetating from flooding. Periodic beaver flooding may be the dynamic that keeps this peatland and others in the region open and mostly free of trees. No rare species have been recorded or predicted for this sub-watershed. However, two dams were located in this sub-watershed, and it had a relatively poor road-less block score (ranked tenth). The final score for his sub-watershed was ninth.

Prince-Mulligan-Little Baker (PMLB)

At 7,200 acres, the Prince-Mulligan-Little Baker sub-watershed is fifth smallest. It has lower proportions of natural land (97%) and natural land within stream buffers (97%), primarily because of North Osceola and environs. There are no known dams, fourteen miles of road, and 13 road-stream crossings with a resulting 0.46 road crossings per stream mile. No rare species have been reported in this sub-watershed. One unspecified rare animal and two rare plant species were predicted for this sub-watershed. Overall, this sub-watershed was ranked tenth.

Beaverdam Brook-Meadow Creek-Reservoir (BBMC)

At 19,700 acres, the Beaverdam Brook-Meadow Creek-Reservoir sub-watershed is the second largest in the basin. It has a relatively low amount of natural land cover (82%), and a relatively low road-less block score. The largest number of known dams is in this sub-watershed (11), but these dams are spread throughout the second largest number of streams (70 miles). Combine this stream mileage with the second longest road mileage and the result is the largest number of road-stream crossings in the basin. Three rare plants (lesser bladderwort, *Utricularia minor*; bird's-eye primrose, *Primula mistassinica*; and yellow mountain-saxifrage, *Saxifraga aizoides*) and two rare animals (pitcher plant borer moth, *Papaipema appassionato*; and bald eagle, *Haliaetus leucocephalus*) have been recorded in this sub-watershed. Element distribution models predicted additional, unspecified rare plant and animal species for this sub-watershed. Strategies for conserving or otherwise protecting natural biodiversity within this watershed might be most appropriately targeted towards specific sites or species. The final overall rank for this sub-watershed is low (fifth from last).

Orwell-Pekin (ORPE)

The Orwell-Pekin sub-watershed, at nearly 13,000 acres, spans most of the Tug Hill Transition zone. In comparison with those further up on the Tug Hill, this sub-watershed has relatively low forested cover (82%), a low road-less block score, and a lower than most others (but still quite impressive) percentage of streams within natural lands (93%). A fairy large number of roads (30 miles) and road/stream crossings appear here. On the plus side, Orwell-Pekin has rare species present and predicted. A bald eagle has nested in the southern portion of this sub-watershed. A new pied-billed grebe (*Podilymbus podiceps*) nesting site was found as a result of surveys undertaken as a part of this project. A cluster of vernal pools, an inland poor fen, and a new site for pod grass (*Scheuchzeria palustris*) were newly documented in this sub-watershed during the Salmon River Greenway project. Two headwater areas contain significant natural communities. A spruce-fir swamp and shallow emergent marsh at Pennock Bog feed into Pekin Brook. A very large hemlock-hardwood swamp encompasses much of "Tamarack Swamp" to the north. The Orwell-Pekin sub-watershed ranks twelfth in the evaluation.

Pennock-Coey-Kenny (PECK)

At 11,000 acres, the Pennock-Coey-Kenny sub-watershed ranks ninth of the 15 sub-watersheds for size, twelfth in natural land cover (90%) and road-less block score, and second from last in the proportion of natural land nearby streams (79%). No significant natural communities or rare species have been recorded in this sub-watershed. This sub-watershed ranks twelfth in the final ranking.

Trout Brook (TRBR)

At the edge of the Lake Ontario plain in the transition zone to the Tug Hill, the Trout Brook 12,900 acre sub-watershed has a large agricultural base. Although relatively large in size, this sub-watershed has the second lowest coverage of natural land (76%). There are no known rare species or significant natural communities for this sub-watershed. However, the narrow ravines in and around Trout Brook Reforestation Area and the larger wetlands in the southern portion of the sub-watershed may support uncommon species or natural communities. Agricultural systems, however, play an important role in biodiversity conservation and maintenance. Many grassland birds, for example, depend on un-mowed fields for nesting. Also, the open space and relatively un-fragmented nature of agricultural systems is far more beneficial to wildlife than other commercial or residential developments. In the final ranking scheme, the Trout Brook sub-watershed comes out second to last behind the Lower Salmon River.

Lower Salmon River-Mainstem (LSRM)

At 7,000 acres, the Lower Salmon River sub-watershed is the sixth smallest of the fifteen. Being located on the Lake Ontario plains carries some integrity issues: this sub-watershed has by far the least natural land cover (64%), has the lowest road-less block score, the fewest acres in larger natural blocks, and the lowest percentage of streams running through natural land (79%). These development pressures also create more roads (60 miles of them), more stream/road crossings (39), more dams, and more documented point-sources of pollution. However, the Lake Ontario plain also brings unique geology, landforms, and habitats to this basin. The wetlands and natural areas in and around the mouth of the Salmon River are hot spots for biological diversity, rare species, and unique natural communities. There are five documented occurrences of rare plants (sand dune willow, *Salix cordata*; low sand-cherry, *Prunus pumila* var. *pumila*; ram's-head lady slipper, *Cypripedium arietinum*; slender bulrush, *Schoenoplectus heterochaetus*; and giant pine-drops, *Pterospora andromedea*) and four known occurrences of rare animals (northern harrier, *Circus cyaneus*; least bittern, *Ixobrychus exilis*; pied-bill grebe, *Podilymbus podiceps*; and black tern, *Chlidonias niger*) in the sub-watershed. Element distribution modeling predicted the highest number of rare species in this sub-watershed (22) as well as the highest number of species (11) predicted in any single location (i.e., "hot spot") in a sub-watershed. These factors make evaluation of this watershed important, perhaps less at the scale of the sub-watershed but more at the scale of specific targets and sites.

D. Summary of Salmon River Watershed Natural Resource Viability Analysis

This section summarizes the findings of Salmon River Watershed Viability Analysis (McGee 2008), which was conducted to assess the current condition of the seven natural resource targets in the watershed. The following text presents the Key Ecological Attributes (KEAs – those aspects of each target that, if missing or altered, would lead to loss of that target over time) that were identified for each conservation target; quantifiable indicators that can be used to rank the current condition of a KEA; and a qualitative ranking (Excellent, Good, Fair, and Poor) of each KEA's current condition, based upon a given indicator. 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 even when they could be quantified. See McGee (2008) for more detailed consideration of available data used to inform the rankings, and for rationale regarding the ranking criteria for each of the indicators. Tabular summaries of the KEA viability rankings follow the narratives for each of the conservation targets.

1. Freshwater Estuary and Dunes

Freshwater Estuary

KEA - Size
Indicator – Freshwater estuary area (acres)
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. Wetland community types vary based upon lake water levels, along with erosion and deposition of sand and gravel by the river. 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.

KEA - Plant Communities
Two different marsh communities occur in the freshwater estuary (Edinger et al. 2002, Howard 2006); shallow emergent marshes occur in areas where water depths range from 0.5 to 3 feet during flooding, but are typically exposed during dry periods in late summer; and deep emergent marshes where water depths fluctuate seasonally from ~0.5 to 6.5 feet, but where soils rarely dry out.

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. Many state-protected marsh birds breed, nest, hunt and forage in beds of aquatic plants that occur in these marshes.

Indicator – Total Cover Aquatic Vegetation
Current Condition - Good

Abundance of resident fish, invertebrates and breeding birds are directly related to habitat quality. No information is available on the natural range of variation in aquatic vegetation of the freshwater estuary. Harman et al. (2000) reported that aquatic plants occurred in a patchy distribution across the freshwater estuary and that, in their judgment, total coverage was good. 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%.

Indicator – Invasive Plant Species Frequency and Abundance
Current Condition – Good to Fair

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.

The exotic, invasive species purple loosestrife (*Lythrum salicaria*), Eurasian milfoil (*Myriophyllum spicatum*), curly pondweed (*Potomogeton crispus*) and European frog-bit (*Hydrocharis morsus-ranae*) occur within the freshwater estuary (Harman et al. 2000; Howard 2006). Given the boating activity within the freshwater estuary and level of establishment by invasive plants within the Great Lakes, potential exists for invasives to reduce diversity and ecosystem functions of the freshwater estuary. The total cover of purple loosestrife, Eurasian milfoil and curly pondweed was estimated at 1-6% by Harman et al. (2000) and Howard (2006). Eurasian milfoil occurred in 17% of random samples (McKenna, unpublished data).

KEA - 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 Species Richness
Current Condition - Good

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, however more recent surveys exist that can provide a baseline for future monitoring. Two recent, unpublished and ongoing surveys of the freshwater estuary fish communities (J.McKenna, unpublished, 1996-2003; NYSDEC Rare and Endangered species survey, 1997) together recorded 44 species between 1996 and 2003. 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). Regional fisheries managers believe the freshwater estuary possesses a good level of species richness.

Indicator – Index of Biotic Integrity
Current Condition – Good

Carlson et al. (2006) developed an index of biotic integrity (IBI) to describe the overall condition of fish community composition in 35 bays along the eastern and southern shores of Lake Ontario. The Salmon River Freshwater Estuary received the highest IBI score (41) of all 35 bays included in that study.

Indicator – Invasive Species Densities
Current Condition – Sea lamprey, Good

NYSDEC fisheries managers considered the sea lamprey (*Petromyzon marinus*) to be the most invasive fish 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. 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. 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)

Current Condition – Common Carp, Good

Common carp (*Cyprinus carpio*) is another potentially invasive fish species known to inhabit the freshwater estuary and other tributaries of Lake Ontario. Fisheries managers currently do not believe that this species poses a substantial threat to biodiversity in the freshwater estuary.

KEA - Rare and Endangered Species
Several wildlife species of concern are known to occur within the freshwater estuary.

Indicator – Numbers of black tern breed pairs
Current Condition – Fair
Black terns (*Chidonias niger*) are endangered insectivorous birds that nest within the freshwater estuary. They nest colonially, 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). The carrying capacity for nesting pairs of black terns is not known for the Salmon River freshwater estuary. The New York Natural Heritage program (Howard 2006) reported the number of nesting pairs (unspecified) has been lower than in recent years, but habitat availability is still excellent. Heavy development potential harassment by boaters may represent potential stresses for this species.

Indicator – Numbers of pied-billed grebe breeding pairs
Current Condition – Good to Fair
Pied-billed grebes (*Podilymbus podiceps*) are threatened in New York. 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). The carrying capacity for nesting pairs is not known for this location. 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
Current Condition – Good to Fair
Least bittern (*Ixobrychus exilis*) is a threatened species that 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 and constructs its nest on floating vegetation (Cornell Lab of Ornithology 2007). The carrying capacity for nesting pairs has been determined for least bitterns in this system. The NY Natural Heritage Program reported at least two pairs of least bitterns were present at the freshwater estuary in 2005 (Howard 2006). The area of suitable habitat (emergent marsh, with open channel and bay) is large.

Indicator – Number of sedge wren breeding pairs
Current Condition - Unranked
Sedge wrens (*Cistothorus platensis*) are threatened in New York. 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). The

species has been observed in the freshwater estuary. No quantitative information exists regarding its abundance in the system.

Indicator – Numbers of Lake Sturgeon
Current Condition – Poor

Lake sturgeon are threatened in all states where they occur due to over exploitation, and to loss or degradation of habitat and spawning beds due to dam construction, channelization and pollution. 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), but are thought to be extirpated from the Salmon River Freshwater Estuary. 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 is a potential site for reintroduction (D. Carlson, NYSDEC, personal communication).

KEA - Hydrology
Indicator – Surface Water Level Variation
Current Condition – Fair to Poor

Water levels within the freshwater estuary are influenced primarily by levels in Lake Ontario. Variability in water level probably served as an historic periodic disturbance that influenced plant community composition and local biodiversity. Water fluctuations would flood or dry out patches of emergent plants. 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.

Lake Ontario water levels were stabilized beginning in the late 1950s 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 and robust 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). 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.

Indicator – Salmon River Baseflow
Current Condition - Good

Although water levels within the freshwater estuary are influenced primarily by the levels of Lake Ontario, water chemistry and temperature is determined largely by surface water discharge by the Salmon River, local tributary streams (e.g., Mud Creek), and possibly groundwater discharge. The barrier dunes at the mouth of the Salmon River reduce circulation and mixing of water by wave action from 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, with some contribution by the major tributaries entering the river below the dam. The licensing agreement (NERC 1996) for the hydropower plants requires an artificially sustained minimum baseflow of 185 cubic feet per second during the critical dry summer months. This minimum baseflow is greater than historic flows that were not influenced by upstream dams.

Indicator – Groundwater Discharge
Current Condition - Unranked

Groundwater discharge into the freshwater estuary would influence freshwater estuary temperature and water quality and potentially help to maintain summer baseflow conditions. There is currently no information available regarding groundwater discharge into the freshwater estuary and its consequences for freshwater estuary viability.

KEA - Water Quality

Indicator – Percent natural vegetation in 100-ft shoreline buffer
Current Condition - Fair

Vegetated buffers along waterways are important for maintaining several aspects of water quality and habitat viability. Vegetation within 100-ft buffers is effective at sequestering nutrients, stabilizing soils, delivering organic material to be used as aquatic energy sources, and providing shade to moderate water temperatures (Klapproth and Johnson 2000, Baird and Wetmore 2006).

Developed, agricultural and barren land uses comprise 8%, 9% and 4%, respectively, of the freshwater estuary’s 100-ft buffer area (total 21%, Figure 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 dunes was mapped as scrub-shrub, but substantial development of seasonal homes exists there.

Indicator – Phosphorus (P) concentrations
Current Condition - Good

Phosphorus is a naturally occurring mineral nutrient that frequently limits 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.

US EPA guidelines suggest total phosphates in streams entering lakes or reservoirs should not exceed 0.05 mg/L (Mueller and Helsel 1996). No data are 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.

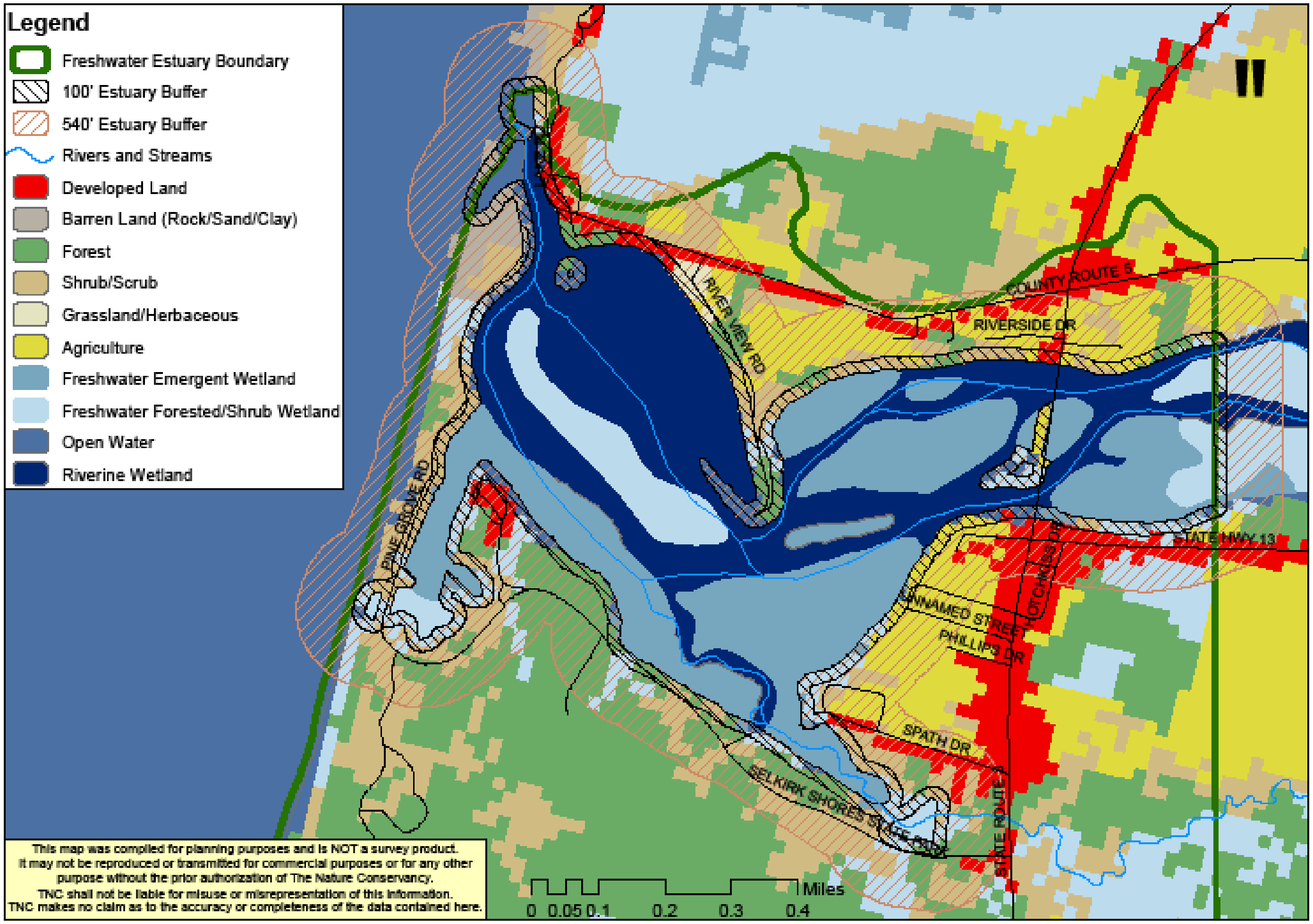

Figure 21. Analysis of land cover-types in 100- and 540-ft-wide buffers of the Salmon River freshwater estuary. Data are from the National Land Cover Database (2001).

Indicator – Summertime water temperature
Current Condition - Good

Temperature regulates the solubility of gases (particularly oxygen) in water – more oxygen can dissolve in cold water than in warm water. Also, biological processes such as bacterial decay of organic material are higher in warm water, thereby leading to more rapid oxygen depletion under warm conditions. The freshwater estuary naturally warms during the day and cools 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.   Available data suggest that summertime high water temperatures fall within the range of tolerance for common warm water fish species. No summer fish kills associated with lethal temperatures have been reported for the freshwater estuary.

KEA - Pathogens

Several pathogens of concern to wildlife, fisheries and human health occur in or near the watershed and are being monitored by NYSDEC (A. Noyes, NYSDEC Aquatic Pathologist, personal communication).

Indicator – Type E Botulism occurrence
Current Condition – Fair

Type E Botulism is a disease caused by a neurotoxin that is produced by a bacterium. The disease leads to paralysis and 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). 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.

Indicator – Bacterial Kidney Disease (BKD) occurrence
Current Condition - Fair

Bacterial Kidney Disease (BKD) is caused by a bacterium 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. The bacterium has occurred sporadically in the Salmon River fishery but has not been detected since 2003.

Indicator – Furnunculosis occurrence
Current Condition - Good

Furnunculosis is a bacterial disease that 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. The pathogen was recently detected in approximately 5-10% of fish in the Salmon River, but no disease symptoms have been observed.

Indicator – Infectious Pancreatic Necrosis (IPN) occurrence
Current Condition - Good

Infectious Pancreatic Necrosis 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. 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 – Enteric redmouth disease (ERM) occurrence
Current Condition - Fair

Enteric redmouth (ERM) is caused by a bacterium. Infected fish develop red mouths and are often found at the top of the water and isolated from other fish, and may stop eating. The bacterium is common in Appalachian and mid-Atlantic fisheries as well as in the western Great Lakes. ERM most often infects rainbow trout, but it also affects several other salmonines. The disease is present but not common in the Salmon River.

Viral Hemorrhagic Septicemia (VHS) occurrence
Current Condition - Good

Viral Hemorrhagic Septicemia (VHS, IV-B strain) 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 salmonines 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. The virus has not yet been detected in the Salmon River.

KEA - Toxins

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

Indicator – Mercury tissue concentration in game fish
Current Condition – Fair

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, mercury also enters the watershed through precipitation of rain, snow, dust and aerosols.

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 – PCB tissue concentration in game fish and snapping turtle eggs
PCBs (polychlorinated biphenyls) are a class of organic chemicals that are persistent and bioaccumulate in aquatic food chains. PCB's are known to cause cancer, reproductive and developmental disorders, and nerve damage in humans.

Current Condition – game fish tissue concentrations - Poor
There is currently an NYSDOH fish consumption advisory for PCBs in smallmouth bass taken from the Salmon River from the mouth to the Redfield Reservoir (NYSDOH 2006).

Current Condition – snapping turtle eggs - Fair
There are no data available for snapping turtle PCB concentrations in the watershed, but scientists have begun measuring PCB levels in snapping turtle eggs in order to monitor local contamination levels. 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. Since turtles are not migratory their contamination levels directly reflect those of their immediate environment.

Current Condition – mink jaw lesions – Poor: There are no data available on the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Haynes et al. (2007), mink feeding within the Lake Ontario system near Rochester appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue (40 ppb), and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario.

Indicator – Mirex concentration in game fish tissue and snapping turtle eggs
Mirex is an organochloride that was used as an insecticide and flame retardant before it was banned in the US in the 1970s. It is persistent and bioaccumulates in aquatic food webs. Mirex causes cancer, reproductive and developmental disorders, and nerve damage in humans (NYSDOH 2006, PAN Database 2007).

Current Condition – Game fish tissue concentrations – Poor
There is currently an NYSDOH fish consumption advisory for Mirex in smallmouth bass taken from the Salmon River from the mouth to the Redfield Reservoir (NYSDOH 2006).

Current Condition – Snapping turtle eggs - 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.

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 21). Natural vegetation surrounding the freshwater estuary provides habitat and migration corridors for wildlife species that utilize the freshwater estuary for certain aspects of their life histories, and provides certain ecosystem functions such as nutrient sequestration and sediment control.

Indicator – Percent of local sub-watershed land in natural vegetation
Current Condition – Poor to Fair

Seventy-five percent of the land cover in the local sub-watershed is "natural cover types" (i.e., wetland, forest, scrub/shrub, grassland, Figure 21). This overestimates natural land cover-types since available data classify the barrier dunes forming the western limit of the freshwater estuary as scrub/shrub. These dunes are wooded, but developed lots. The majority of natural cover within the freshwater estuary's sub-watershed is provided by Selkirk Shores State Park.

Indicator – Percent of 540-ft shoreline buffer in natural cover types
Current Condition - Poor

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. 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) suggested that a natural buffer of ~540 ft from wetlands would capture 95% of the local amphibian populations. Agriculture, development and barren lands comprise 33% of the 540-ft buffer surrounding the freshwater estuary (Figure 21). The balance (67%) is in some form of natural cover-type (forest, scrub/shrub, grassland, wetland).

Indicator – Percent of 540-ft shoreline buffer isolated by roads
Current Condition - Poor

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. The freshwater estuary is completely surrounded and isolated by paved roads (Figure 21). 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 tributary streams
Current Condition - Poor

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 feet can provide effective nutrient and sediment controls. The Mud Creek watershed has high agricultural use, and the buffer along the length of the creek contains less than 75% natural cover.

DUNE COMMUNITIES

KEA - Size

Indicator – Dune area (acres)
Current Condition - Good

Approximately 33 acres of barrier dunes are present at the mouth of the Salmon River. These dunes are contiguous with the larger dune system extending northward from the mouth of the Salmon River. The area of existing dunes at the Salmon River mouth does not appear to be reduced by interruptions of natural dune building processes. A recent study (Woodrow et al. 2002) determined that the Salmon River does not contribute sediments to the beach/dunes and that the jetty system at the river's mouth 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.

KEA - 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 rare communities occur in New York only along the eastern shore of Lake Ontario (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. With time and stability, shrub and vine communities establish. With further stabilization and time, open oak-maple forest communities establish (Bonanno 1992). The dunes within the Salmon River watershed are all on private lands that have been largely developed.

Indicator – Total vegetation cover
Current Condition - Unranked

No information exists on the plant communities of these privately-owned dunes.

Indicator – Rare species population densities/cover
Current Condition – Fair to Poor

Three rare plant species occur on the dunes at the Salmon River freshwater estuary: Champlain beachgrass (*Ammophila champlainensis*), low sand-cherry (*Prunus pumila var. pumila*) and sand dune willow (*Salix cordata*). The NY Natural Heritage Program

(Howard 2006) estimated the sand-cherry population 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. No information is available for Champlain beachgrass at this location.

Indicator – Invasive species occurrence/dominance
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.

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)					~270-Good	SG; ranking based on current area
KEA-Condition -Estuary Plant Community						
Ind. - Total cover aquatic vegetation					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)					40+ Good	SGR, local fisheries managers
Ind. – Index of Biotic Integrity		>38	33-38	<33	Good	Carlson et al. 2006
Ind.- Invasive fish species relative densities (sea lamprey)	0	<5	5-25	>25	0.1% Good	Drake et al. (2003)
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					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. - PCB-induced mink jaw lesions (ppb)		0	<40	>40	Poor	Haynes et al. (2007)
Ind.- game fish Mirex concentrations (ppm)					Poor	NY State Dept. Health (2006)
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. Main Branch Salmon River & Major Tributaries

KEA – Area

Indicator: Volume Flow (cubic feet per second – cfs)

Current Condition = Good

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.

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), which requires that continuous minimum baseflow of 185 cfs be maintained. The required baseflow 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. 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.

The Tug Hill Aquifer (Figure 7) is one of the largest and most productive groundwater reserves in New York and potentially very important for 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.

KEA – Water Quality

Indicator - Percent Natural Cover-Types in 100-ft Stream Buffers

Current Condition: Upper sub-watersheds, Good; Lower sub-watersheds, Fair

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).

The vast majority of stream reaches within the watershed are well-buffered by natural vegetation (i.e., forest, scrub/shrub, grassland, wetland; Figure 22). No stream reaches in the watershed were ranked as “poor” (<75% natural cover) 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).

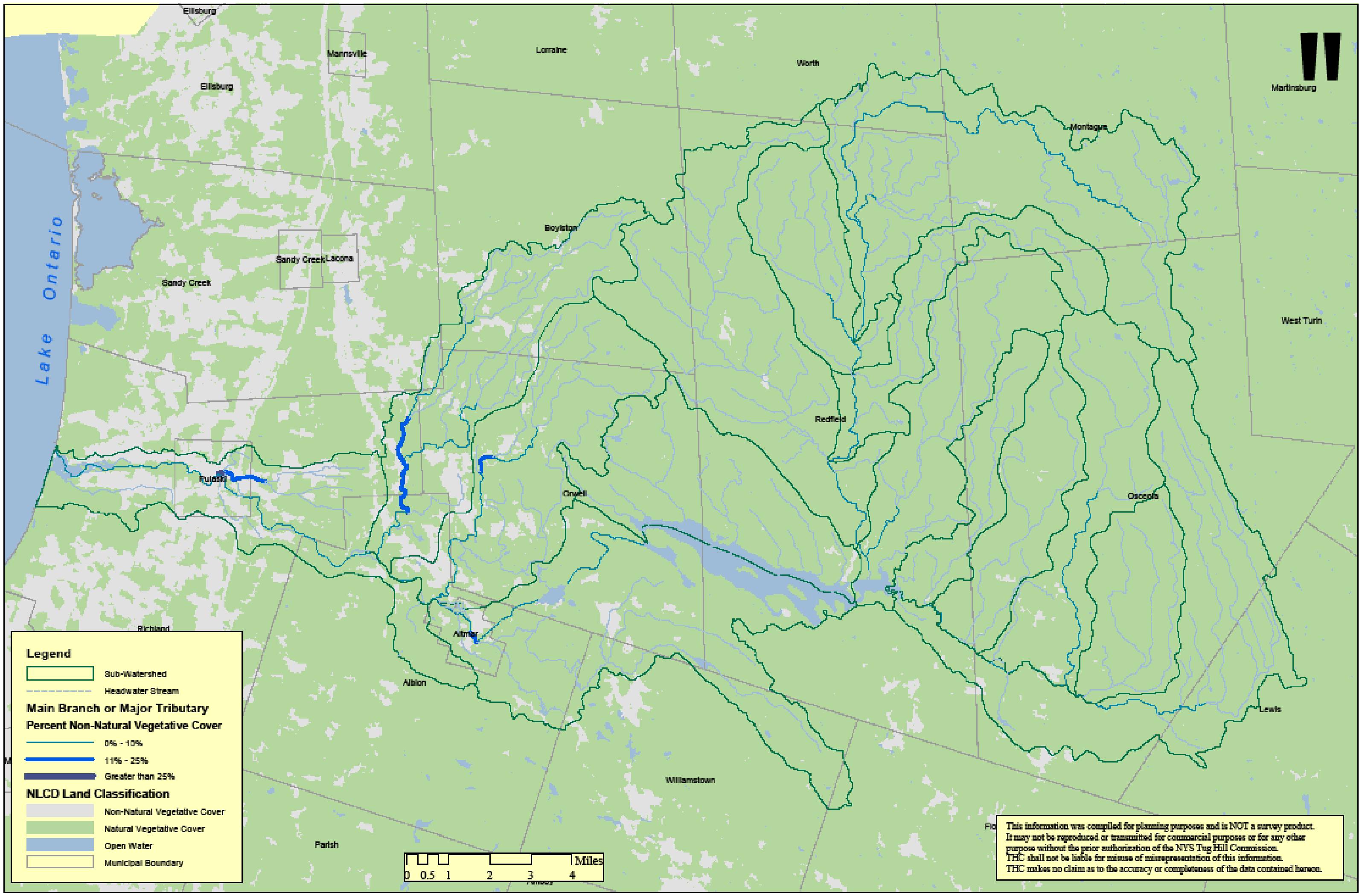

Figure 22. Analysis of land-cover types in 100-ft buffers of the Main Branch of Salmon River and its major tributaries. Data are from the National Land Cover Database (2001).

Indicator – embeddedness
Current Condition – Unranked

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.

Indicator - Summertime high temperature
Current Condition – Lower sub-watersheds, Good/Fair; Upper sub-watersheds, Good

Temperature is an important regulator of gas solubility (particularly oxygen) in water. Higher concentrations of water can dissolve in cold water than in warm water. Furthermore, all aquatic organisms possess maximum temperature thresholds at which they begin to experience adverse physiological effects, and at which they are more susceptible to 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.

Several studies (Bode et al. 1996, Hallock 2003, Everitt 2006) have reported that summertime 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 salmonines (70 °F) for at least one day. No information is available to describe the duration of time for which temperatures surpass tolerance thresholds.

GAP analysis (J. McKenna, unpublished data) reveals that most of the higher-order stream reaches in the watershed are predicted to reach 70-73 °F in mid-summer, 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).

Indicator: pH
Current Condition - Good

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). Acidified waters typically impact aquatic organisms by increasing the solubility of aluminum (Al^{n+}) to toxic levels. Surface waters with pH <6.0 place aquatic biota at risk (Driscoll et al. 2001).

Faigenbaum (1940) reported pH of the Salmon River at Pulaski in June 1939 was 8.6. Springtime pH values in high order streams ranged 6-7 in 2000, while under summer baseflow conditions, pH values ranged from 7-8 (Hallock 2003). NYSDEC Division of Water indicates no water bodies in the Salmon River drainage are impaired by acidification (NYSDEC Draft 2006 Section 303d list).

Indicator – total alkalinity
Current Condition - Good

Alkalinity refers to the ability of water to neutralize acids or resist changes in pH. Water with total alkalinity <2.5 mg/L $CaCO_3$ is considered sensitive to acidification, and water with total alkalinity >100 mg/L $CaCO_3$ is considered well-buffered (Driscoll et al. 2001).

In early March, 2000, alkalinity measures were <60 mg/L for all river segments sampled by Hallock (2003). Alkalinity increased during summer baseflow periods that year, with Orwell and Trout Brooks attaining alkalinity values >100 mg/L. Summertime alkalinity in the Mad River and N. Branch Salmon River were 67 and 61 mg/L (averaged over 1-3 years of sampling; source - R. Klindt, unpublished.

Indicator: dissolved oxygen (mg/L)
Current Condition – Good

Cold water fish such as trout and salmon generally require dissolved oxygen concentrations > 6 mg/L (Kozuchowski et al 1994). Hallock (2003) reported that dissolved oxygen (DO) concentrations in the Salmon River and its major tributaries never dropped below 8 mg/L during spring peak or summer baseflow periods in 2000. Bode et al. (1997) reported DO concentrations ranging from 7.7-9.2 mg/L in August 1996.

Indicator: phosphorus (P) concentration
Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair

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. 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).

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 (Hallock 2003).

Indicator – Nitrogen concentration
Current Condition – Fair

Nitrogen (N) is an 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. 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 (in the form of nitrate, NO_3^-) can have adverse human health effects (Driscoll et al. 2003).

In 2000 (Hallock 2003), stream water N concentrations in upper sub-watersheds and in the lower Main Branch of the Salmon River exhibited a seasonal effect for TDN (higher concentrations in spring, 0.6-0.7 mg/L versus summer, 0.3-0.5 mg/L) that probably reflects pollution inputs with the melting snowpack. Concentrations of TDN remained higher than the anticipated levels for unpolluted forest landscapes. The lower sub-watersheds (Beaverdam, Orwell-Pekin and Trout Brooks) exhibited higher TDN concentrations during summer baseflow (0.8-1.1 mg/L) than during spring snowmelt. Agricultural runoff may be the source of high summertime N in the lower sub-watersheds. Even still, N concentrations remain well below USEPA drinking water standards throughout the watershed.

KEA – Macroinvertebrate Communities

Macroinvertebrates are important components of stream ecosystems, and many 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.

Indicators – Indices of Biotic Integrity
Current Condition – Good

Bode et al. (1997) developed several indices of water quality in the Salmon River using information on the abundance of different macroinvertebrate species and their respective tolerances for degraded water quality. They 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. 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) suggested that the reservoir dams are inhibiting the movement of organic debris, and that high and sustained summer discharges may be removing some types of invertebrates from the substrate and flushing them through the system.

KEA - Fish Communities
Indicator – Species Richness
Current Condition – Unranked

Local fisheries managers believe that species richness within the watershed is very good. Forty-two species have been sampled from the lower reaches of the Salmon River (various NYSDEC surveys, J. McKenna unpublished data). 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 (McKenna, unpublished, Figure 23) predict the 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.

Indicator – Select Fish Species Distributions
Current Condition – common carp, exotic species - Unranked

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 a recent GAP analysis (McKenna, unpublished) 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.

Indicator – Select Fish Species Distributions
Current Condition – brown and brook trout, game species – Unranked

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 (McKenna, unpublished) indicates they are both common throughout the watershed, and that brown trout are generally predicted to occur in greater numbers.

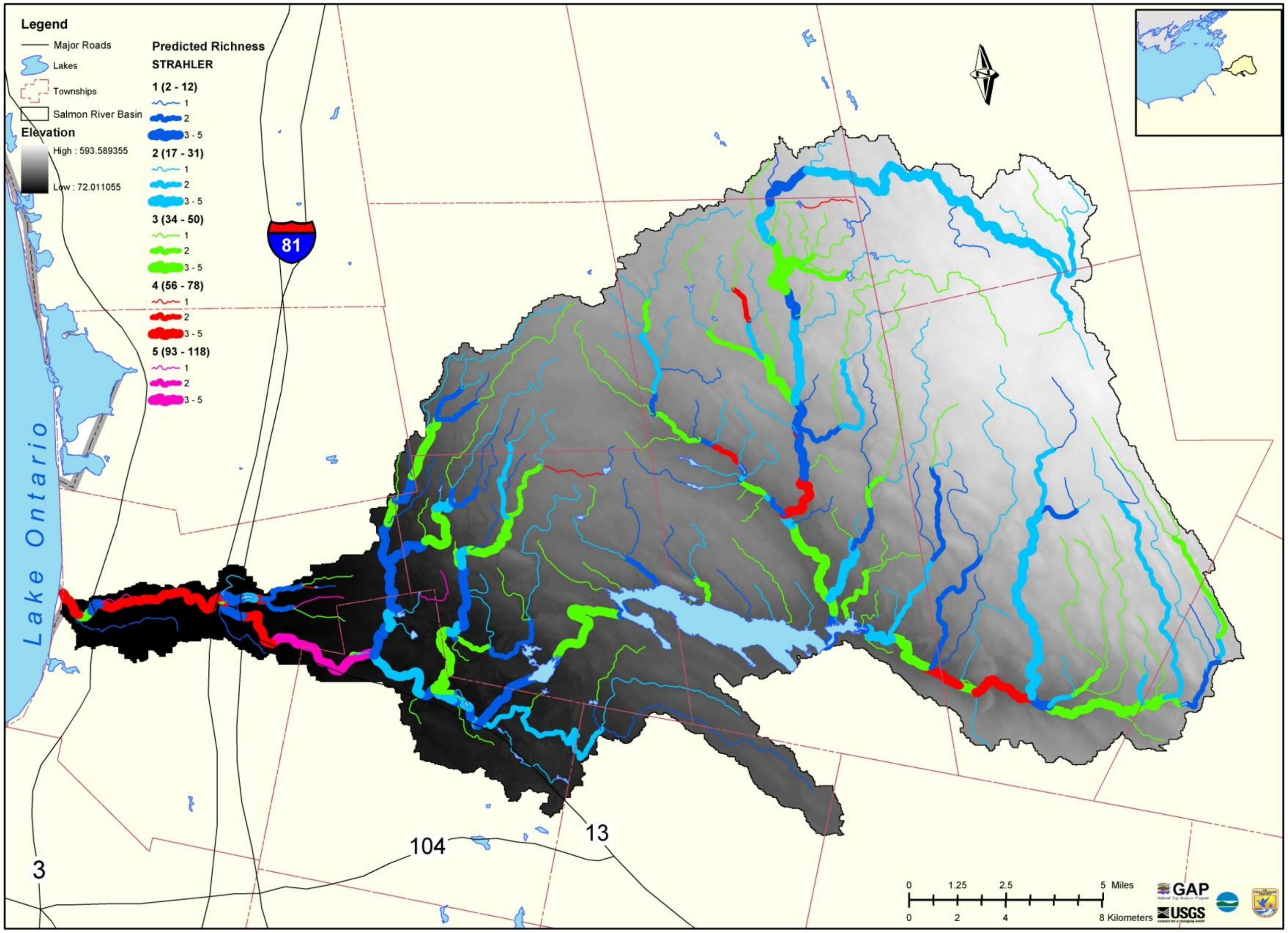

Figure 23. Predicted species richness in stream reaches of the Salmon River Watershed. Stream reaches are color coded to number of predicted species. Line thickness of each depicted stream reach reflects the respective Strahler stream order (from 1st- to 5th-order). (Source: McKenna, unpublished data.)

Indicators of natural salmonine reproduction

The level of natural salmonine production within the watershed (below the Lighthouse Hill Reservoir) integrates 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 stages of Chinook salmon and rainbow trout.

Indicator – Salmonine spawning habitat (proportion of available area)
Current Condition – Good

Chinook salmon have specific requirements for substrate size in which to create redds (nests), as well as for water depth and velocity during spawning. 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)
Current Condition – Good

The number of adults contributing to the naturally reproducing salmon population is that which is able to survive spawning runs, and escape anglers and hatchery harvest operations. Everitt (2006) estimated that ~6000-11,000 (12-18%) of returning adult salmon survived the spawning runs, anglers and hatchery harvest in 2004 and 2005 to produce 14.6 – 41.4 million eggs in those years; and concluded that with expected levels of mortality, the number of smolt that return to the lake from natural reproduction (146,000 – 414,000) is comparable to that produced by the hatchery (300,000).

Indicator – Salmonine juvenile recruitment
Current Condition – Good

Estimations of juvenile recruitment have been made only for rainbow trout that 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 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).

KEA - 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 – Mercury tissue concentration in game fish

Current Condition – Lower sub-watersheds, Fair; Upper sub-watersheds, Unranked

See page 56 for background on mercury contamination. 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). 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 on mercury contamination in fish for the upper sub-watersheds.

Indicator – PCB tissue concentration in game fish

Current Condition – Lower sub-watersheds Poor; Upper sub-watersheds, Unranked

See page 57 for background on PCB contamination. 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). There are currently no fish consumption advisories for sport fish above the Redfield Reservoir or for any of the upper sub-watersheds.

Indicator – PCB-induced mink jaw lesions

Current Condition – Lower sub-watersheds, Poor; Upper sub-watersheds, Unranked:

There are no data available on the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Beckett and Haynes (2007) mink feeding within the Lake Ontario system near Rochester appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue (40 ppb), and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario. 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 – Mirex tissue concentration in game fish

Current Condition – Lower sub-watersheds, Poor; Upper sub-watersheds, Good

See page 57 for background on Mirex contamination. There is currently an NYSDOH fish consumption advisory for Mirex in smallmouth bass taken from the Salmon River from the mouth to the Reservoir (NYSDOH 2006). 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 24).

Current Condition – Felix Schoeller Technical Papers, Pulaksi – Good

The facility has not been out of compliance with discharge schedules since 1991.

Current Condition – Pulaski Sewage Treatment Plant, Pulaski – Fair

The last violation of NPDES permit requirements for this facility was December 2002.

Current Condition - Pulaski Ford and Mercury, Pulaski – Unranked

No permit documents were found through the USEPA web database for this facility.

Current Condition - New York State Fish Hatchery, Altmar – Fair

The last violation of NPDES permit requirements for this facility was May 2004.

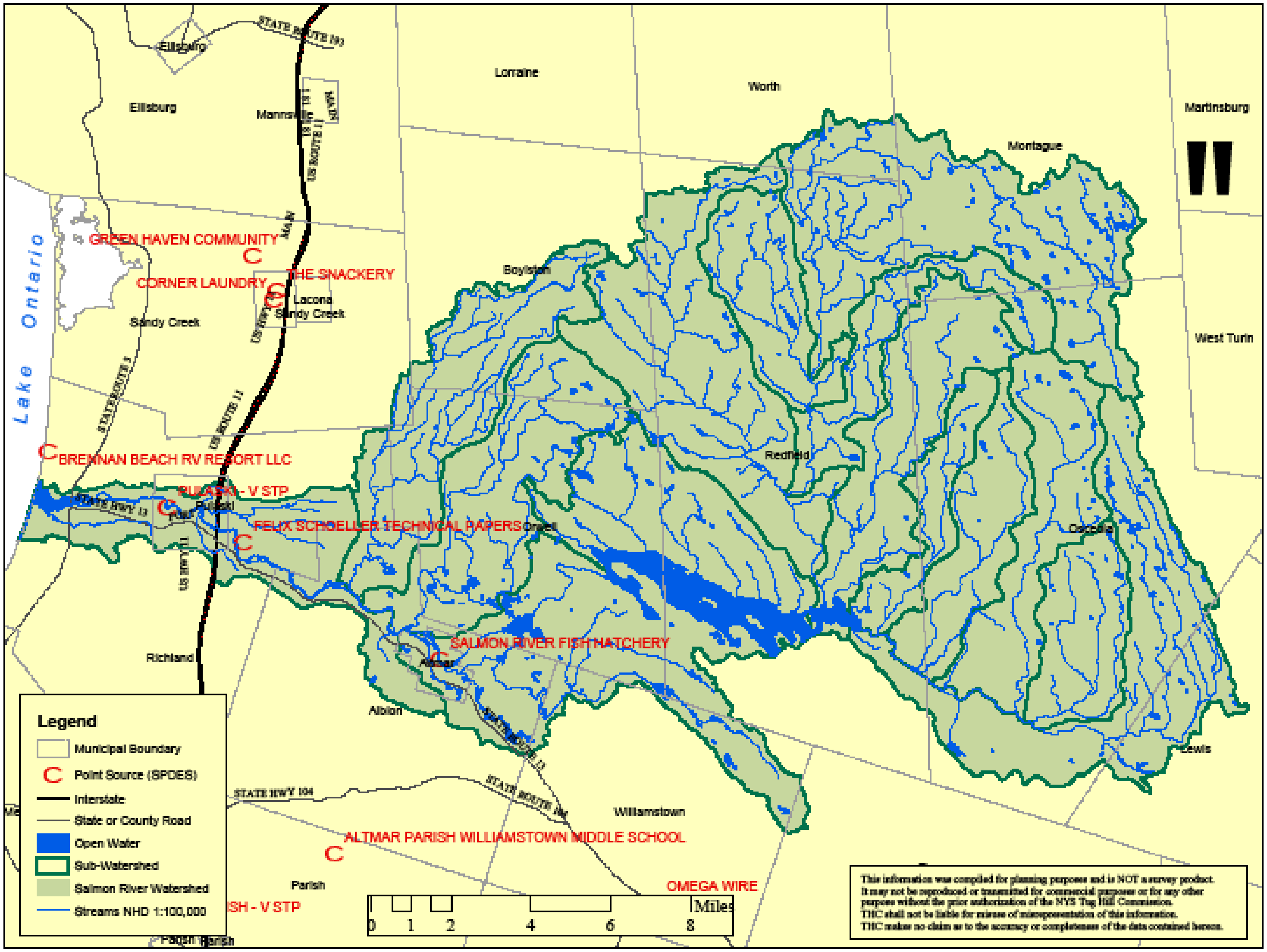

Figure 24. Location of facilities with National Pollution Discharge Elimination System (NPDES) or USEPA Toxic Release Inventory (TRI) discharge permits in the Salmon River Watershed.

KEA - 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). See section on Salmon River Freshwater Estuary for background on these pathogens.

Indicator – Bacterial Kidney Disease occurrence
Current Condition – Fair

The bacterium that is the agent for this disease has occurred sporadically in the Salmon River fishery but has not been detected since 2003.

Indicator – Furnunculosis occurrence
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
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 *(enteric redmouth disease) occurrence*
Current Condition – Fair

The disease is present but not common in the Salmon River.

Indicator – Viral Hemorrhagic Septicemia (VHS)
Current Condition – Fair

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

KEA –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 – greater impairment in lower sub-watersheds

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 (Figure 25). Migration capacities of aquatic organisms are more impaired by dams at the lower sub-watersheds (average 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 – greater impairment in lower sub-watersheds

There are 314 road-stream crossings within the entire watershed (Figure 25). 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). 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/mile).

Indicator – Proportion of 540-ft buffer in natural cover
Current Condition: Upper sub-watersheds, Good; Lower sub-watersheds, Fair-Poor

Naturally-vegetated (i.e., by forest, scrub/shrub, grassland, wetland) 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. A buffer analysis (Figure 26) 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.

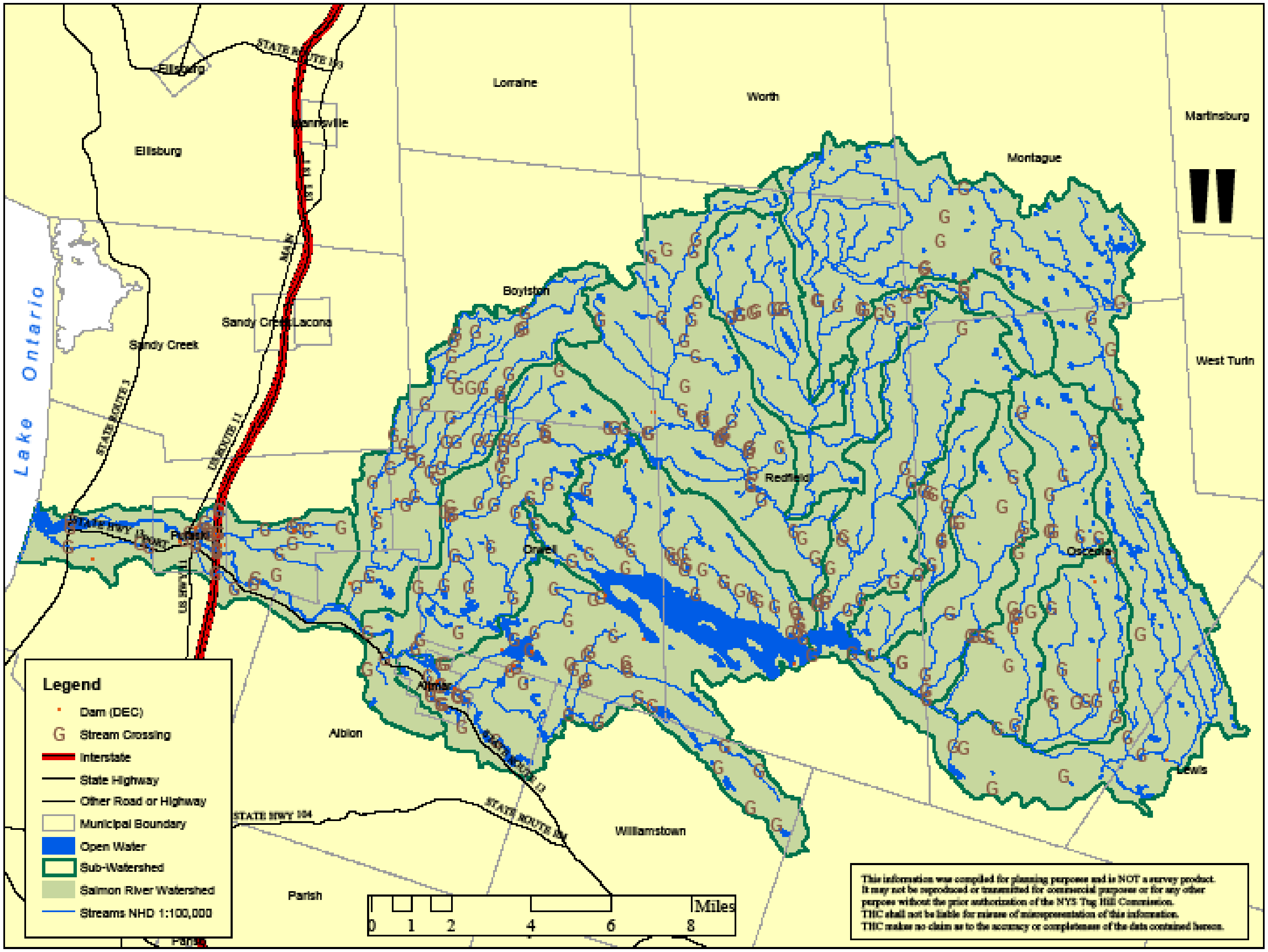

Figure 25. Locations of dams and stream crossings within the Salmon River Watershed.

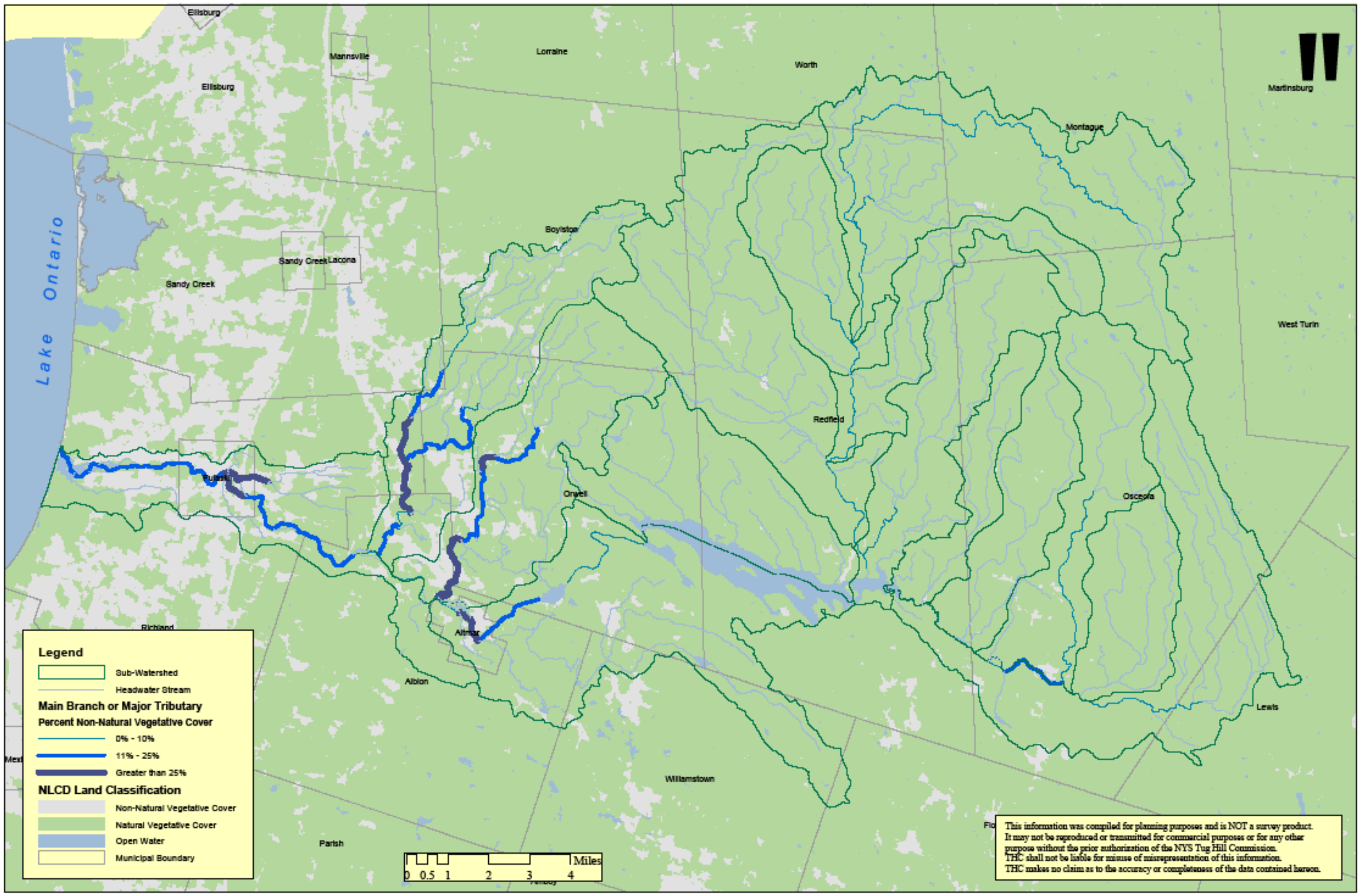

Figure 26. Analysis of land-cover types in 540-ft buffers of the Main Branch of Salmon River and its major tributaries.

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 Current	Driscoll et al. (2003)

	Exellent	Good	Fair	Poor	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						
no. Chinook redds		1900-2900			Good	SGR-Everett (2006)
% substrate acceptable for Chinook redds		15%			Good	SGR-Everett (2006)
Ind. -natural Chinook egg production		$15\text{-}41 \times 10^{6}$			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. - % natural cover in 540-ft buffer		>90	75-90	<75		SGR, Semlitsch (1998)
upper sub-watershed					Good	
lower sub-watershed					Faur-Poor	

3. HEADWATERS

KEA - Area

Indicator – Total stream length (mi) and stream density (mi. stream/mi.^{2} area)

Current Condition – Unranked

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. Stream densities in the sub-watersheds average 2.1-3.2 mi/mi^2.

KEA - Water Quality

Indicator - Percent Natural Cover in 100-ft Buffer

Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair-Poor

Only two headwater stream reaches in the upper sub-watersheds exhibited 75-90% vegetative cover (i.e., forest, scrub/shrub, grassland, wetland), while all others contained >90% cover of natural vegetation (Figure 27). However in the lower sub-watersheds numerous headwater streams had poor (<75% natural cover) to fair (75-90%) levels of natural cover in the 100-ft buffers.

Indicator – Summer time high temperatures

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. Summertime temperatures are predicted (J. McKenna, unpublished data) to 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.

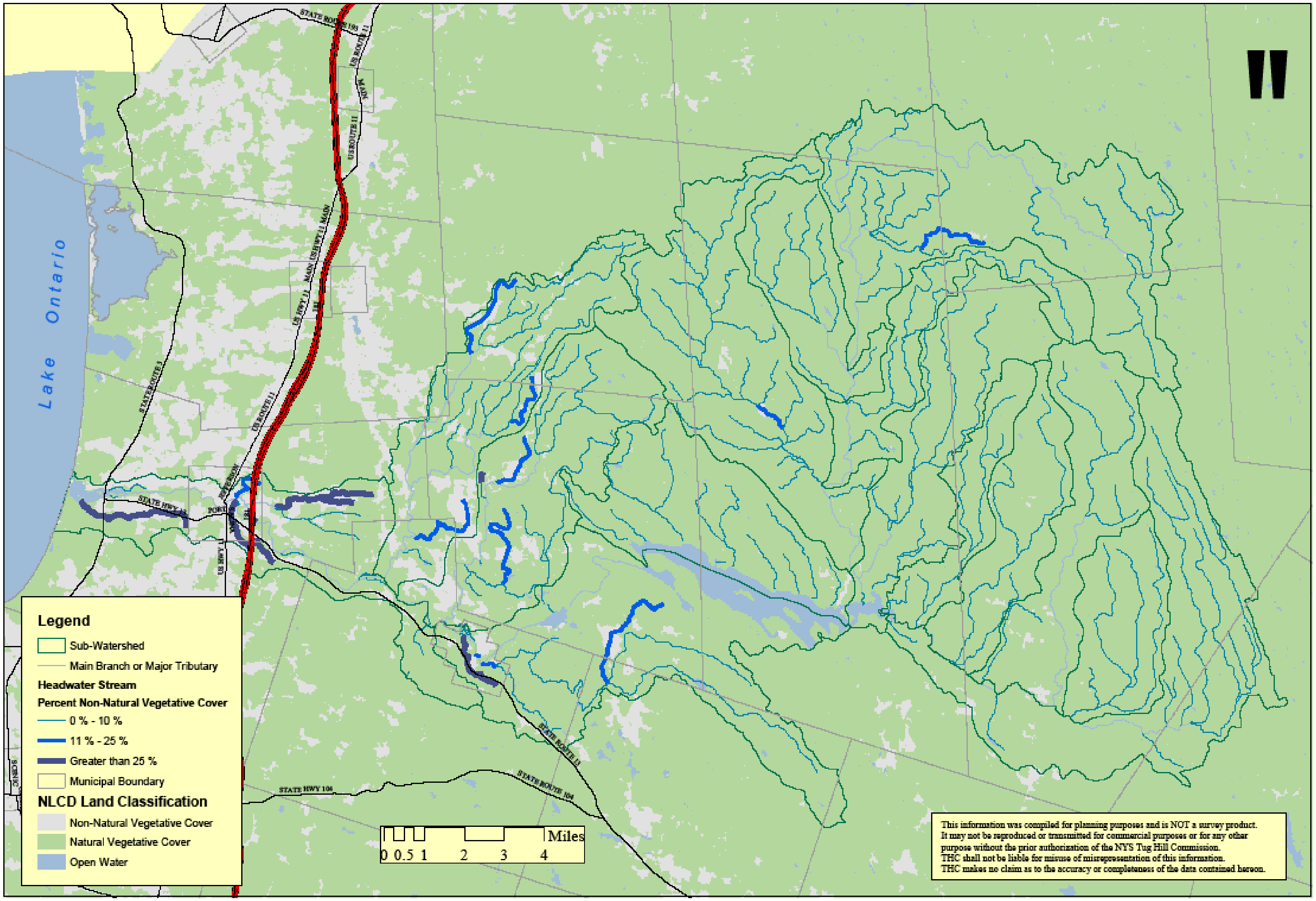

Figure 27. Analysis of land-cover types in 100-ft-wide buffers along headwaters of the Salmon River Watershed.

Indicator – pH
Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Unranked
No water quality data are available for headwater reaches in the lower sub-watersheds, but based upon the rankings for the main branch target, pH values are probably good for the lower sub-watersheds.

Indicator – total alkalinity
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, alkalinity values are probably good for the lower sub-watersheds. The headwater streams of the upper sub-watersheds are not currently sensitive to acidification.

Indicator: dissolved oxygen (mg/L)
Current Condition – Unranked
No data are available on headwater stream oxygen concentrations within the watershed. Based upon the rankings of the main stem target, 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
Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair
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 sub-watersheds are good, while those of the lower sub-watersheds are fair.

Indicator – Nitrogen (N) concentrations
Current Condition – Fair
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. Nitrogen concentrations remain well below USEPA drinking water standards.

KEA – Trout Habitat
Indicator – trout habitat
Current Condition – Unranked
Native trout populations are good indicators of stream quality. Apart from requiring cold to cool water temperatures and high dissolved oxygen concentrations, good trout habitats have (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. 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, and in approximately 5-10% of the reaches in exemplary marsh headwater streams. No information is available on the range of habitat conditions within the watershed or greater Tug Hill region.

Indicator – trout densities
Current Condition – Unranked

No data were obtained that describe observed densities of brook (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) in the headwaters of the watershed. A GAP analysis (J. McKenna, unpublished) predicts 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.

KEA – Macroinvertebrate Communities
Indicator – Indices of Biotic Integrity
Current Condition – Unranked

The indices of biotic integrity described in the Main Branch section may be applied to rocky headwater streams only with extreme 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.

Indicator – Macroinvertebrate abundance (#/m^2)
Current Condition – Unranked

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. 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
Current Condition – Unranked

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. No similar data were obtained for streams in the lower sub-watersheds, or for streams representing the range of conditions within the watershed.

KEA – Fur-Bearing Animals
Indicator – beaver and otter population densities
Current Condition - Unranked

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. The only data available for these species are NYSDEC fur-bearer trapping records, which are assembled on a town-by-town basis. These data cannot be used to estimate populations, and therefore are of limited value for ranking this indicator. These data indicate increasing levels of trapped beaver between 1960 and the mid-1980s. A 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.

KEA – 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 – greater impairment in lower sub-watersheds

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 (Figure 25). Migration capacities of aquatic organisms are more impaired by dams at the lower sub-watersheds (average 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 – greater impairment in lower sub-watersheds

There are 314 road-stream crossings within the entire watershed (Figure 25). 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). 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/mile).

Indicator – Proportion of 540-ft buffer in natural cover
Current Condition – Upper sub-watersheds, Good; Lower sub-watersheds, Fair-Poor

The vast majority of headwater stream reaches within the upper sub-watersheds are well-buffered by natural vegetation (>90% cover of forest, scrub/shrub, grassland, wetland). 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 28).

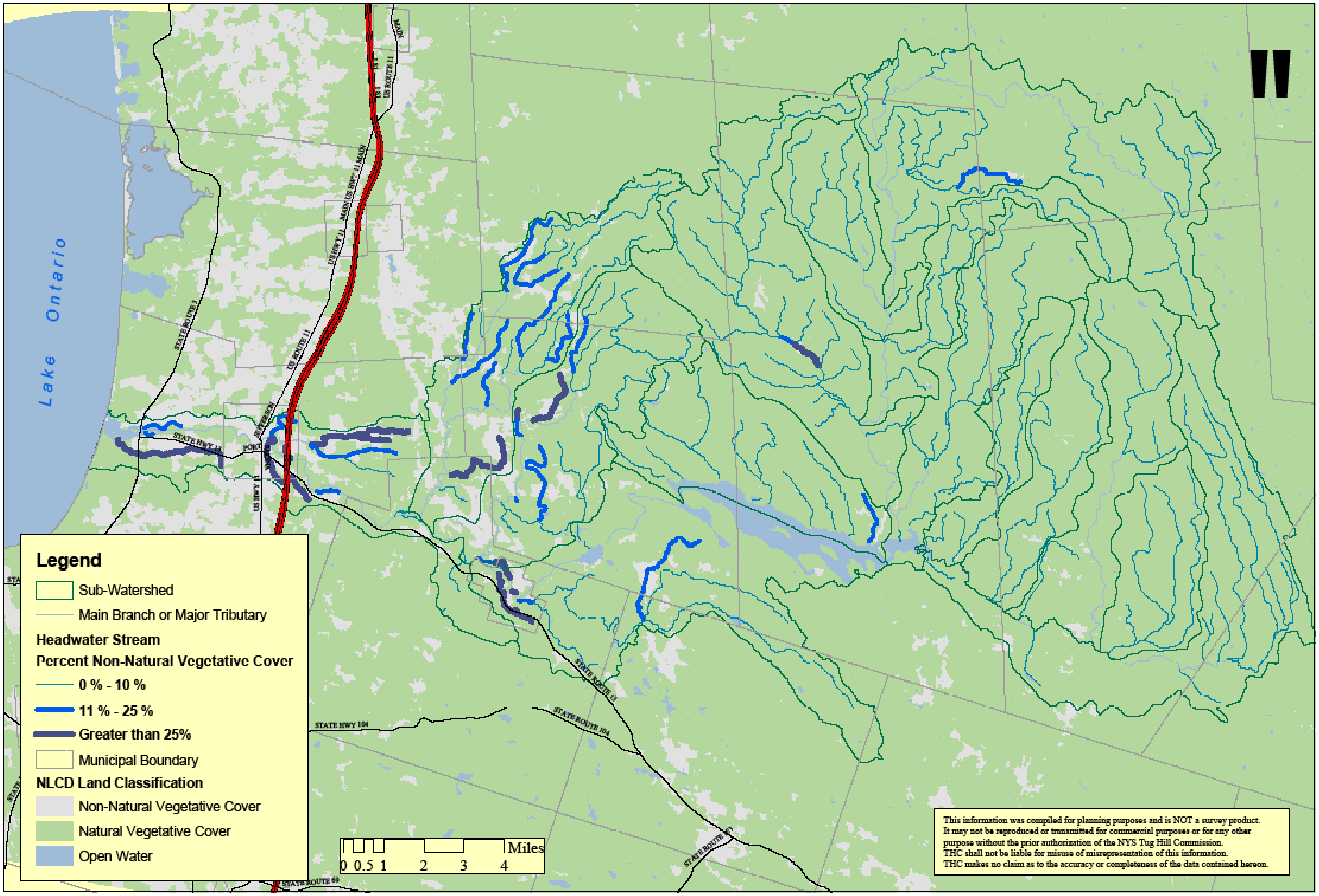

Figure 28. Analysis of land-cover types in 540-ft-wide buffers of headwater streams (1st- and 2nd-order) of the Salmon River Watershed.

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 su-bwatersheds					Good	
lower sub-watersheds					Fair-Poor	
Indi. - 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

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
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. - macroinvertebrate 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	

	Exellent	Good	Fair	Poor	Current Condition	Notes on Guidance for Current Condition
KEA-Landscape Context						
Ind. - no. dams/stream mile					Unranked	NG
Ind. - no. 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	

4. OPEN WATERS

KEA-Area
Indicator – Open Water Area (acres)
Current Condition – Good

The components of total open water area in the watershed that are most subject to change are the numerous, small beaver dams that exist there. Surface areas of the larger open waters, the Lighthouse Hill and Redfield Reservoirs, will remain constant due to regulation of these reservoirs. 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. Beaver have recovered across northern New York from historic lows in the 19th century (Brocke and Zarnetske 1974). Therefore, open water area is now probably near expected natural levels, at least in some sub-watersheds.

There are currently ~450 open water bodies in the watershed that occupy ~4,300 acres. Note that open water areas are underestimated for the Beaverdam Brook-Meadow Creek, Keese-Smith-Finnegan, Fall Brook-Twomile-Threemile and Upper Salmon River sub-watersheds due to incomplete NWI data. Sixty-five percent of the total open waters in the watershed are accounted for by the 2,660-acre Redfield Reservoir and 150-acre Lighthouse Hill Reservoir. 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.

KEA – Beaver Dams
Indicator – Proportion of total open waters as beaver-influenced:
Current Condition - Unranked

Beaver (*Castor canadensis*) are recognized as important ecosystem "engineers" whose presence and activities contribute to maintaining diverse and variable natural communities. Figure 29 illustrates the beaver-influenced open waters of the watershed. 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. 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).

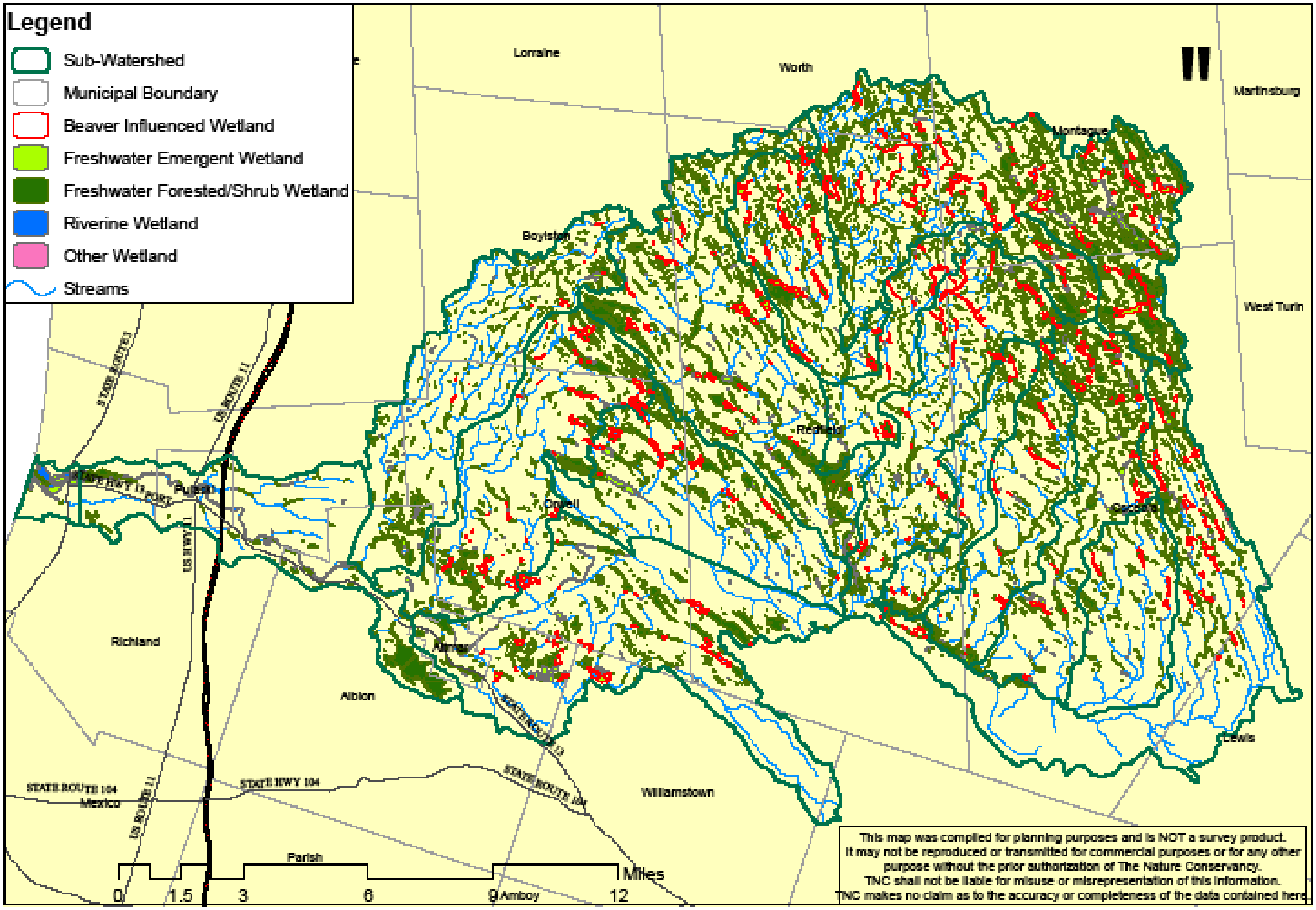

Figure 29. Beaver-influenced wetlands of the Salmon River Watershed.

KEA – Water Quality

Indicator - Percent Natural Vegetation in 100-ft-wide Buffer

Current Condition – Lighthouse Hill Reservoir, Good; Redfield Reservoir, Good

This indicator is ranked here only for the two reservoirs. Buffer analysis for the other open waters is incorporated in the non-estuarine wetland section. Natural vegetation (i.e., forest, scrub/shrub, grassland, wetland) represents 91% and 98% of the land-cover types within the 100-ft buffers of the Lighthouse Hill and Redfield reservoirs, respectively (Figure 30).

Indicator – pH

Current Condition – Good

The NYSDEC (Bureau of Fisheries, unpublished data) reports 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 their pH probably does not vary greatly from the other surface waters in the watershed.

Indicator – total alkalinity

Current Condition – Good

The NYSDEC (Bureau of Fisheries, unpublished data) reports 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 their alkalinities probably do not vary greatly from the other surface waters in the watershed.

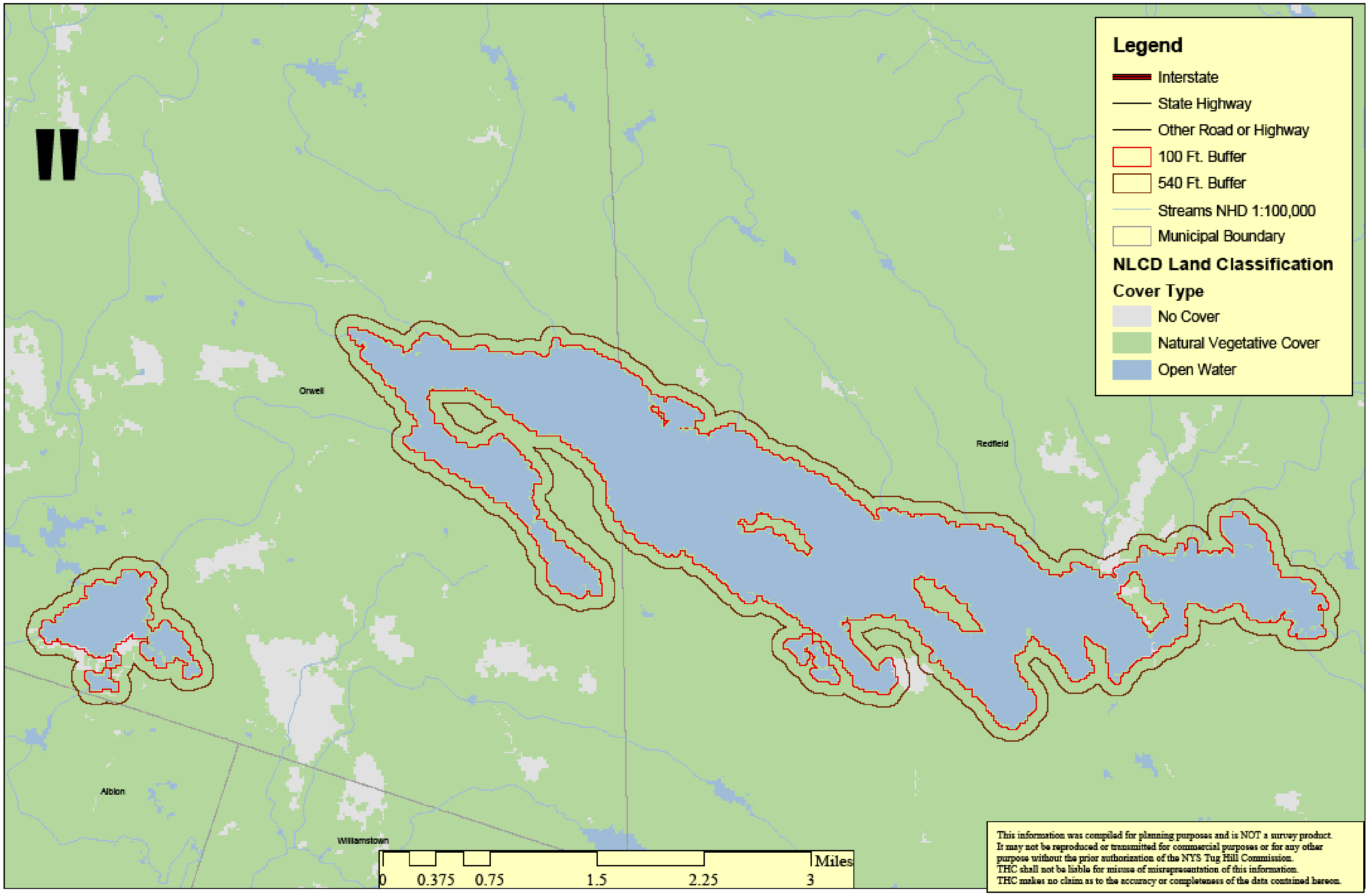

Figure 30. Analysis of land cover-types in 100- and 540-ft-wide buffers of the Lighthouse Hill and Redfield Reservoirs.

KEA – Toxins

Indicator – Game Fish Tissue Mercury Concentration

Current Condition – Redfield Reservoir, Poor

See page 56 for background on mercury. 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

The mercury in the Reservoir is not expected to affect other water bodies upstream. However, it is 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

See page 57 for background on PCB. No information is 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.

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. Snapping turtle egg criteria, (Pagano et al. (1999) indicate 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

See pag 57 for background on Myrex. 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.

KEA – 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
Current Condition – Good

No information on the anticipated natural range of variation in aquatic vegetation of the Redfield Reservoir could be located to serve as a quantitative baseline for estimating viability. Harman et al. (2000) reported that most of the shoreline is emergent or shrub wetland, and that the lake supports little true aquatic vegetation. The submerged plants are diverse, but are few within the reservoir. An earlier survey by (Petreszyn 1990) indicated the presence of no aquatic plants in the reservoir in 1990.

Indicator – Invasive Species Cover
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), in low relative abundance. Milfoil was not thought to be a threat since it tends to occur in disturbed, eutrophic environments.

KEA – Fish Communities

Indicator – Fish Species Richness and Community Composition
Current Condition - Good

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. The Redfield Reservoir is a warm/cool water fishery that is managed by NYSDEC for game fish species. The reservoir currently contains at least 16 species, including six game fish species. Stocking for walleye began in the reservoir in 2005. 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, 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 personal communication).

KEA – Barriers to Migration

Indicator – Proportion of Natural Vegetation Cover in 540-ft Buffer

Current Condition – Lighthouse Hill Reservoir, Fair; Redfield Reservoir, Good

Figure 30 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.

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. – 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
upperr 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

5. Non-Estuarine Wetlands

KEA - Wetland Area
Indicator – Total Wetland Surface Area (ac)
Current Condition – Unranked

The ability of wetland systems to provide ecosystem services is related to both area of wetlands (i.e. habitat) and the proportion of land area occupied by wetlands (i.e. nutrient retention and water regulation). Total palustrine (excluding lakes and ponds) wetland area within the watershed is approximately 29,000 acres (Table 2). Note that this estimate includes only NYSDEC Regulated Wetlands, which are ≥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 wetlands are not included or detected. It should also be noted that no digital NWI data were available for portions of the Beaverdam Brook-Meadow Creek-Reservoir, Fall Brook-Twomile-Threemile, Keese-Smith-Finnegan, and Upper Salmon River sub-watersheds. Therefore, reported areas are underestimated for these sub-watersheds.

The total 29,000 acres of wetland within the watershed represents approximately 16% 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). 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 8). 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.

KEA –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 some wetlands of the Salmon River Corridor (A. Nelson, in Dru Associates 2001).

Recognized wetland community types within the watershed, along with their NY Heritage rankings 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 Type
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.

KEA – Invasive Species

Indicator – Frequency of Invasive Plant Occurrence in Wetlands
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 agree 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.

KEA – Rare Species Populations

Several species of concern are known to inhabit wetland communities within the watershed. Species reported by Howard (2006) along with their NY Natural Heritage rankings are:

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 (unknown)

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).

KEA – Pests and Pathogens

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

Indicator – Viburnum Leaf Beetle Occurrence
Current Condition – Poor

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. No quantitative data exist for viburnum beetle infestations in the watershed, however local botanists have reported recent widespread defoliation and mortality of arrow-wood (a host species) throughout the Tug Hill region.

KEA- Sentinel Groups (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
Current Condition – Good

There are no sources of data specific to the watershed indicating expected abundance of amphibians and reptiles in different wetland types The New York Amphibian and Reptile Atlas database (NYSDEC 2007a) lists presence/absence of species throughout the state, and can coarsely infer frequency of species occurrence. 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. Of these, 24 species (92%) occur with equal or greater frequency in the watershed than the whole of New York.

Indicator – Numbers of Breeding or Migratory Waterfowl
Current Condition – Unranked

No quantitative data exist for migratory waterfowl use of wetlands within the watershed or in the NYSDEC wildlife management units of the greater Tug Hill region.

KEA – Hydrology

Different wetland types develop through variations in quantity and quality of surface and groundwater flow. 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)
Current Condition – Good

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. Deviations in annual water surplus from natural levels of variation would indicate potential for region-wide disruptions of wetland hydrology.

Current average water surplus values sustain widespread and diverse wetlands within the watershed. No data were obtained with which to analyze the historic range of variation in these levels for the region.

Indicator – Source Alteration (% from Groundwater and Surface Water)
Current Condition – Unranked

The source and quality of water supply to individual wetland systems dictates wetland community type and condition. 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.

KEA – Toxins

Indicator – Game Fish Tissue Mercury Concentrations
Current Condition – Upper Sub-watersheds, Unranked; Lower Sub-watersheds, Fair

See page 56 for background on mercury contamination. 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. 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.

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.

Indicator - PCB tissue concentration in snapping turtle eggs
Current Condition – Upper Sub-watersheds, Unranked; Lower Sub-watersheds, Fair
See page 57 for background on PCBs. There are no data available for snapping turtle PCB concentrations in the watershed. The regional source for PCB contamination of turtle eggs 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. 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 – PCB-induced mink jaw lesions
Current Condition – Lower sub-watersheds, Poor; Upper sub-watersheds, Unranked:
There are no data available on the occurrence of cancerous lesions in mink for the Salmon River watershed. However, based upon the work of Beckett and Haynes (2007) mink feeding within the Lake Ontario system near Rochester appear to be exposed to sufficiently high PCB concentrations to induce growth of lesions in jaw tissue (40 ppb), and this exposure is apparently from food sources exposed to contaminated water in Lake Ontario. 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 – Mirex tissue concentration in snapping turtle eggs
Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Fair
See page 57 for background on Mirex. There are no data available for snapping turtle Mirex concentrations in the watershed. As with PCBs, the regional source for Mirex contamination of turtle eggs 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. Therefore, it is probable that Mirex contamination of wetland fauna will be lower in the upper sub-watersheds than in the lower sub-watersheds.

KEA – Eutrophying Nutrients (Nitrogen and Phosphorus)
Wetlands play key roles in cycling of nitrogen (N) and phosphorus (P). In general, wetlands tend to remove these nutrients from ground and surface waters.
Although wetlands are capable of long-term capture and removal of N and P, high inputs of these nutrients are known to reduce wetland biodiversity. Inputs traced to elevated N deposition include linkages to N-saturated upland forests, 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 31).

Plant species able 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).

Indicator – Soil Nutrient Concentrations and Plant Richness
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 a scale broad enough to apply ranking criteria.

Indicator – Percent Natural Land Cover-types in 100-ft wetland buffers
Current Condition – Good

Natural vegetation cover-types (i.e., forest, scrub/shrub, grassland) occupied greater than 90% of the 100-ft wetland buffers in all sub-watersheds. In general, the lower sub-watersheds had greater levels of non-natural cover-types (i.e., developed, agriculture, barren) in the buffers. The Lower Salmon River-Main Stem, Trout Brook and Orwell-Pekin sub-watersheds contained 7%, 7% and 3% non-natural cover, respectively. Note the analysis was conducted only on NYSDEC-regulated wetlands (>12.94 acres).

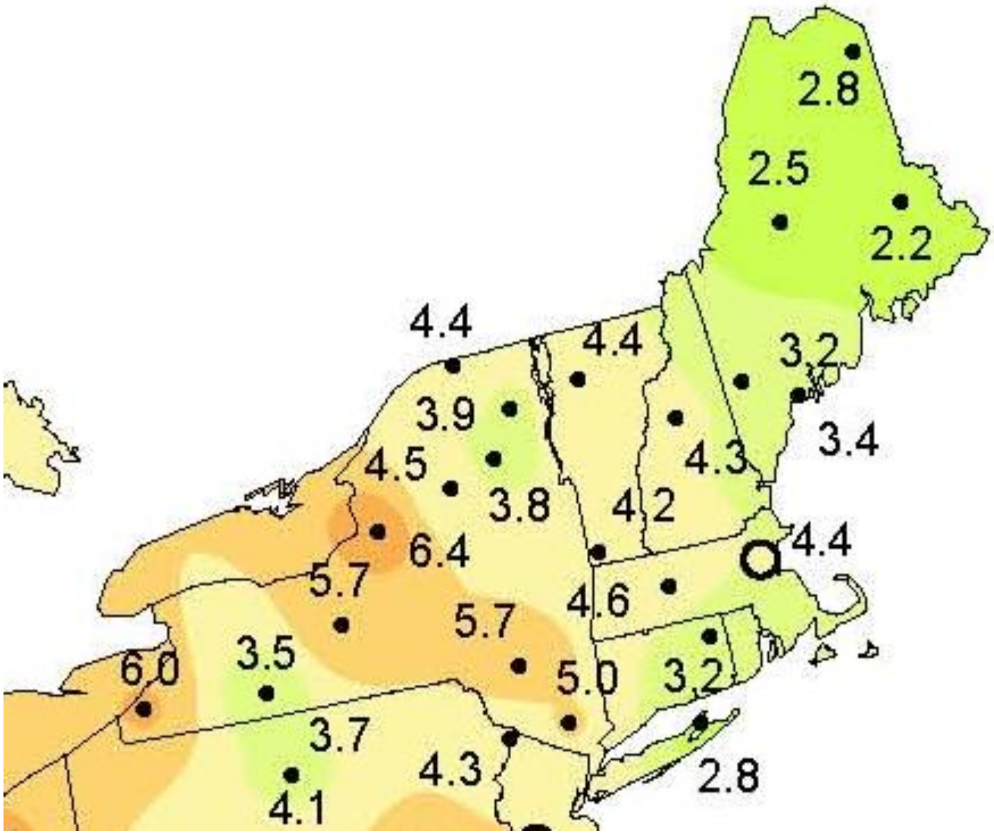

Figure 31. Annual (2005) total wet nitrogen (kg/ha as NO_3^- and NH_4^+) deposition in the northeastern US. (Source: National Atmospheric Deposition Program. http://nadp.sws.uiuc.edu/).

KEA – Barriers to Migration

Indicator – Proportion of Natural Land Cover-types in 540-ft Wetland Buffers

Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Fair

All of the upper sub-watersheds contain > 95% natural cover-types (i.e., forest, scrub/shrub, grassland) in 540-ft wetland buffers. The lower sub-watersheds generally contained more non-natural cover-types in the buffers. The Lower Salmon River-Main Stem, Trout Brook and Orwell-Pekin sub-watersheds contained 14%, 13% and 9% non-natural cover, respectively. Note that this analysis was conducted only on NYSDEC-regulated wetlands (> 9.4 acres).

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

Current Condition – Unranked

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. Semlitsch (1998) estimated 95% of salamander populations occur within 540 ft of wetlands.

An estimated total of ~107 miles of road segments (~33%) occur in the watershed within 540 ft of NYSDEC-regulated wetlands (Figure 32). 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%).

Note that this analysis was conducted using only the mapped NYSDEC wetlands (>12.94 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.

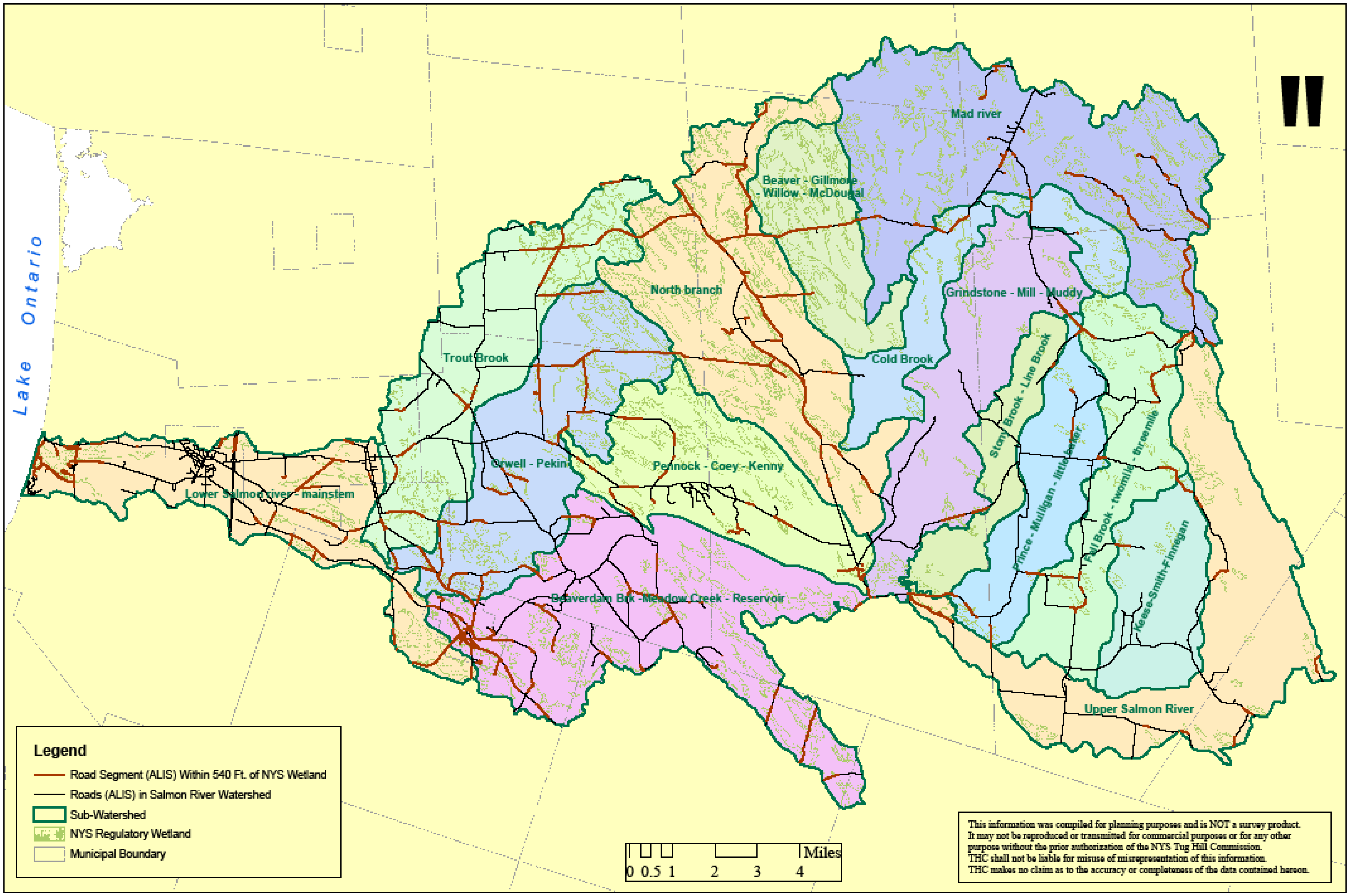

Figure 32. Road segments occurring within 540 ft of NYSDEC-regulated wetlands in the Salmon River Watershed.

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)						
Upper 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 (ppm)		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 – Migration Barriers						
Ind. - % of 540-ft buffer in natural land cover-types		>90	75-90	<75	Good	SGR
Ind. – Road length (mi.) bisecting 540-ft' wetland buffers					Unranked	NG

6. Matrix Forests

KEA – Forest Area and Cover

Indicator – Total Contiguous Forest Cover (ac)

Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Fair

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), some of which 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).

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" (Figure 33). The Core Forest is a large area (~120,000 acres) of intact forest and wetlands, and is the third largest area of forested landscape in New York (after the Adirondacks and Catskills). 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

Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Poor

Percent of a landscape in forest cover reflects the 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. 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. Matrix forest cover in the lower, western sub-watersheds averaged 69% of upland cover-types and ranged from from 48% (Lower Salmon River-Main Stem) to 79% (Beaver Brook-Meadow Creek-Reservoir).

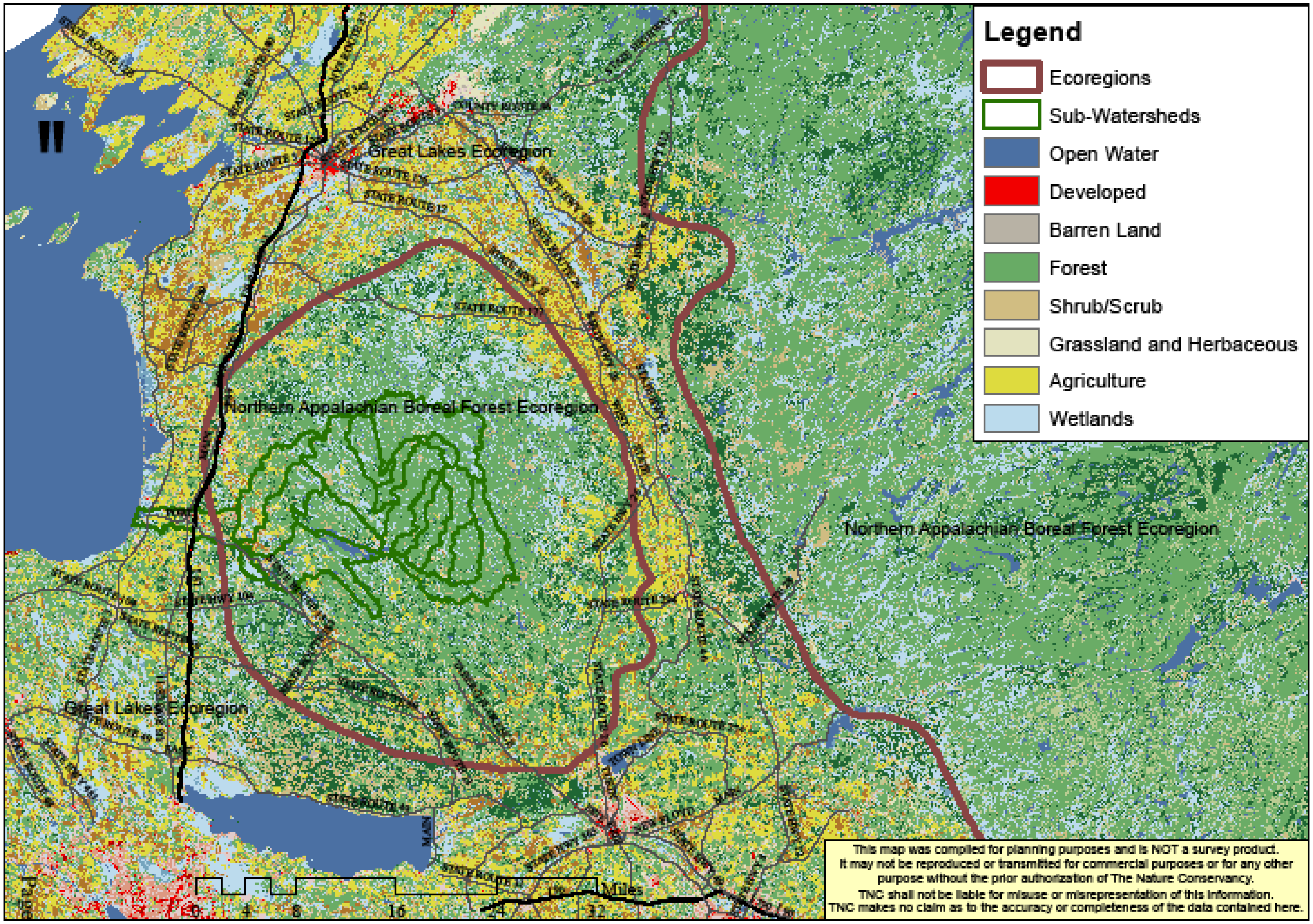

Figure 33. Regional land-cover types surrounding the Tug Hill Plateau.

Indicator – Area by Forest Cover-Type
Current Condition – Unranked

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).

The matrix forests of the watershed are dominated by deciduous types (81% of lower sub-watersheds; 85% of upper sub-watersheds). The Pennock-Coey-Kenny sub-watershed contains 60% conifer forest type, reflecting the several NY State reforestation areas that occur 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, red spruce regeneration was encountered on 41% of sampled hardwood dominated forests across the Tug Hill, including sites within the Salmon River watershed (see regeneration indicator). Therefore potential exists for re-establishing widespread mixed conifer-hardwood stands in the upper sub-watersheds.

KEA - 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. Reduced reproductive success of many nesting bird species (Rosenberg et al. 1999) can occur in forest edges. Road corridors and utility rights-of-way also provide avenues for dispersal of invasive plants.

Indicator – Edge:Area Ratio
Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Fair

The degree of forest fragmentation is described as the ratio of forest perimeter to area. The forests of the upper sub-watersheds are largely contiguous and unfragmented by non-natural vegetation types. A major fragmenting feature in the upper sub-watersheds are roads and trails. The fragmentation 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. The Lower Salmon River-Main Stem sub-watershed has the highest ratio (2.6).

Indicator – Frequencies of Forest Interior Birds
Current Condition – Unranked

Different bird species are influenced, negatively or positively, by forest fragmentation and availability of edge. Several "forest interior" bird species will breed only in large tracts of forests that are far from an edge. Other species thrive in woodlands that are interspersed with open habitats.

New York State Breeding Bird Atlas data (2000-2005) indicate less frequent distributions of forest interior species in the western, more fragmented section of the watershed. However, when substantial (>10%) difference in bird frequencies 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.

Indicator – Presence of Wide-ranging Forest Mammals
Current Condition – Unranked

Several wildlife species that are native to the Tug Hill region (black bear, bobcat, fisher, possibly moose) require large home ranges of unfragmented forest (Saunders 1988, Fox 1990, Serfass and Mitcheltree 2004). 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. Fox (1990) identified the western Adirondacks and eastern Tug Hill Plateau as one of three core population centers for bobcats in New York (the other two being in the Catskills and Taconics). 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. It is not known whether the recent lack of river otter sightings represents a meaningful trend.

Indicator – Connectivity to Regional Forest Types
Current Condition – Upper Sub-watersheds, Good-Fair; Lower Sub-watersheds, Poor

Fragmentation influences forest community health at both small and large (ecoregional) scales. Many wide-ranging animals require large blocks of unbroken habitat to meet all their needs and to sustain regional movement. 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 western-most limits of the Northern Appalachian-Boreal Forest Ecoregion. Biodiversity of these forests will be sustained, in part, through continued connectivity to the forest of the greater Tug Hill region and the

Adirondack and northern Appalachian forests. Forests of the lower, western portion of the watershed represent the eastern extreme of the Great Lakes Ecoregion (Figure 33), and require connectivity to other communities within that ecoregion.

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 33). 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.

KEA- Distribution of Forest Successional Stages

It is likely that the current landscape of the Tug Hill and Salmon River watershed has a greater diversity 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 (e.g., Chambers 1983, Keller et al 2003, PADCNR 2007). 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 Distribution
Current Condition –Unranked

Forest stands are traditionally categorized into stand-size classes that can be used to provide limited guidance on developmental stage of the stand (Alerich and Drake 1995). From smallest to largest, these stand-size classes are: Sapling, Poletimber, Sawtimber.

Forests of the Tug Hill region have exhibited a shift in estimated stand-size class distributions between 1968 and 2004. Although the overall amount of commercial forest land did not change appreciably during this time, there is regional trend toward 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.

Indicator – Early Successional Community Cover (ac) and Percent Cover
Current Condition – Good

Shrub lands and inactive grasslands occupy approximately 11% (~5800 ac) and 4% (~5000) of the lower and upper sub-watersheds, respectively. 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 NYSDEC, in conjunction with the USDA Grassland Reserve program, has not identified the Salmon river watershed as a Grassland Reserve Zones (Figure 16), indicating that the watershed has low potential for management of natural grassland habitat.

Indicator – Grassland Bird Species Occurrence
Current Condition – Unranked

The New York State Landowner Incentive Grassland Protection Program (NYSDEC 2007b) 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. 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.

KEA – Forest Structural Diversity

Terrestrial and aquatic ecologists have long recognized that multiple habitats are important for maintaining biodiversity. A variety of forest successional stages (e.g., grasslands; shrub lands; and sapling, pole, and sawtimber forest size classes) provide different habitats that support greater diversity of plants and animals than an equal area of a single type (Chambers 1983, Keller et al 2003). Similarly, within a forest stand structural habitat features such as large-diameter trees, decaying logs of different species and decay stages, and standing dead trees provide unique habitat for numerous forest-dwelling organisms (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
Current Condition – Fair

Large, old trees, whether they occur in natural or managed forests, provide unique and necessary habitat for a number of organisms 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). Northern hardwood stands across the Tug Hill region, including sites in some upper sub-watersheds, contain an average ~3 trees/acre greater than 20" diameter. No data were located that describe canopy structure in the Lake Plain forests in the lower sub-watersheds.

Indicator – Decaying Log Volume
Current Condition – Fair

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). 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 (McGee et al. 1999), it is expected that forests of the Salmon River watershed would contain approximately 60 m^3/hectare of decaying logs.

KEA – 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) from primarily human activities 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 31). When nitrogen accumulates in forests to the point where it exceeds the forests biological demand, that forest is said to be "nitrogen saturated." Nitrogen saturation 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, nitrogen saturation leads to depletion of other soil nutrients, altered nutrients in plant tissues, and the release of aluminum in potentially toxic levels.

Indicator-Foliar N Concentration
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 in experiments in ME and MA, which receive far less N deposition than the Tug Hill region (Magill et al. 1997). These high foliar N concentrations suggest potential onset of nitrogen-saturated conditions in regional forests.

Indicator-Forest Floor C:N ratio
Current Condition – Poor

As nitrogen accumulates in soils relative to carbon, C:N ratios decline. Available data indicate that Tug Hill forest soils may have accumulated N to levels that indicate the onset of N-saturated conditions.

Indicator-Seasonal Surface Water NO_3^- Concentrations
Current Condition – Good to Fair

Surface water nitrate (NO_3^-) concentrations are one of the most sensitive indicators of the effects of atmospheric N deposition to forest ecosystems (Aber et al. 2003). Observed NO_3^- concentrations in Tug Hill headwater streams indicate the region may be entering early stages of N-saturation.

KEA – Nutrient Cycling Processes: Acidification

Acidic deposition leads to the leaching of several base nutrients from soils: calcium, magnesium, and potassium. Soil nutrient depletion, in turn, leads to foliar deficiencies and increased dysfunction to plant root systems. These conditions predispose forests to decline from multiple stresses including drought, insect defoliation and freezing damage (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
Current Condition – Upper Sub-watersheds, Fair; Lower Sub-watersheds, Good

Soil pH can be used to suggest the resilience of soils to acidifying processes. Upland forest and agricultural soils in the higher, eastern sub-watersheds are generally strongly to extremely acid, 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. Therefore the soils of the lower sub-watersheds generally have better buffering capacity against detrimental impacts of acidic deposition.

Indicator-Foliar Ca:Al ratio
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 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 undergoing acidification.

KEA – 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 carnivores. 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
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).

KEA – 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
Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Unranked

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. 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. No invasive plant species were tallied on sample plots during the 2001 Salmon River Greenway Corridoor survey (Dru Assoc., 2001), but some were included in the flora checklist for the corridor's study area. 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). These surveys suggest that, although terrestrial invasive plant species are present within the watershed, they are not dominant components of the forest flora. Information regarding invasive plant occurrences in forests of the lower sub-watersheds is especially lacking.

Indicator – Native Forest Herb Densities/Frequencies
Current Condition – Upper Sub-watersheds, Good; Lower Sub-watersheds, Unranked

No quantitative information exists that provides baseline conditions for native 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. McGee (unpublished data, 2005) found that the most frequently encountered species in 49 northern hardwood study sites across the Tug Hill, including sites in the watershed westward to approximately Redfield, were among the common species listed by Hotchkiss. However, McGee also found that a number of competitive and weedy species (briars, hay-scented fern and New York fern) are currently more frequent than is suggested by Hotchkiss data. No information is available on herb communities in forests of the lower watershed.

KEA – 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 that are best suited for a given site and management objective (Nyland 1996).

Indicator – Regeneration Frequency
Current Condition – Good

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. Two recent studies recorded seedling/sapling frequencies on sites along the Salmon River Corridor (Dru Associates 2001) and on Tug Hill northern hardwood sites, including some in the eastern portion of the Salmon River watershed (McGee unpublished data, 2005). 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
Current Condition – Unranked

Seedling and sapling densities, by height class, of component forest tree species provide the best indication of potential regeneration success. No data were obtained reporting seedling/sapling densities in the forests of the watershed.

KEA – 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, changes in the extent and intensity of natural or human disturbances, or deliberate management decisions to favor certain species.

Indicator – Invasive Species Frequencies/Dominance
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 (Wink, 2002; McGee unpublished, 2005; NYSDEC 480A forest management plans). No quantifications of forest canopy composition are known for the Ontario Lake Plain forests.

*Indicator – Rank Abundance of Native Component Specie*s
Current Condition – Upper Sub-watersheds, Fair; Lower Sub-watersheds, Unranked
In the absence of wide-scale human disturbances, a forest landscape will be dominated by species that are most adapted to prevailing site conditions and historic disturbance regimes. Historic considerations of the natural vegetation of the Tug Hill region indicate that regional forests were dominated by various combinations of American beech, yellow birch and sugar maple with an abundant mixture of conifers. 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 large change in the dominance distribution of forest overstory trees on a landscape scale indicates the occurrence of some historic shift in regeneration processes.

Available data, primarily from sites in the the upper elevations and transitional sections of the watershed (Wink, 2002; McGee unpublished, 2005; NYSDEC 480A forest management plans) indicate that red maple and black cherry, which are early- to mid-successional species, together account for 40% of the relative basal area of the region. Their dominance in regional forests may reflect their widespread establishment on abandoned post-agricultural lands throughout portions of the watershed, and/or management decisions that favor the regeneration and growth of these species. Red spruce accounts for only 1% of the regional forest canopy tree basal area, although it occurs on 31% of sampled sites. Its relatively high frequency but low basal area reflects its selective removal in the 19th century, and its potential for becoming a dominant forest canopy component in the future. American beech occurs frequently, but comprises only 7% of the average basal area, reflecting widespread effects of beech bark disease on regional forest structure.

No information is available on forest canopy composition of the Ontario Lake Plain forests.

KEA – 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
Current Condition – Fair

Sirex woodwasp (*Sirex noctilio*) is a wood-boring pest of conifers, primarily 2 & 3-needled pines. It is a recently introduced invasive species that was first discovered in New York near the town of Fulton in 2004. Since then the presence of 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 within the watershed. The cumulative result of woodwasp impacts is death of the tree within 2-3 years.

A few specimens of *Sirex* have been trapped in Oswego County; its presence poses a serious threat to the regional forests. 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.

Indicator – Forest tent caterpillar distributions
Current Condition – Fair

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. 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, these species are known to cause periodic, extensive defoliation. 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). NYSDEC aerial survey data (Figures 34) 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. Depending on the intensity and extent of defoliation, forest trees may experience diminished productivity, direct mortality, or may be predisposed to forest decline through other contributing agents such as past disturbance or drought. When extensive defoliation occurs, 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.

Forest management influences the ability of woodlands to recover from defoliation. A recent study found that Tug Hill forests subjected to selective removal 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).

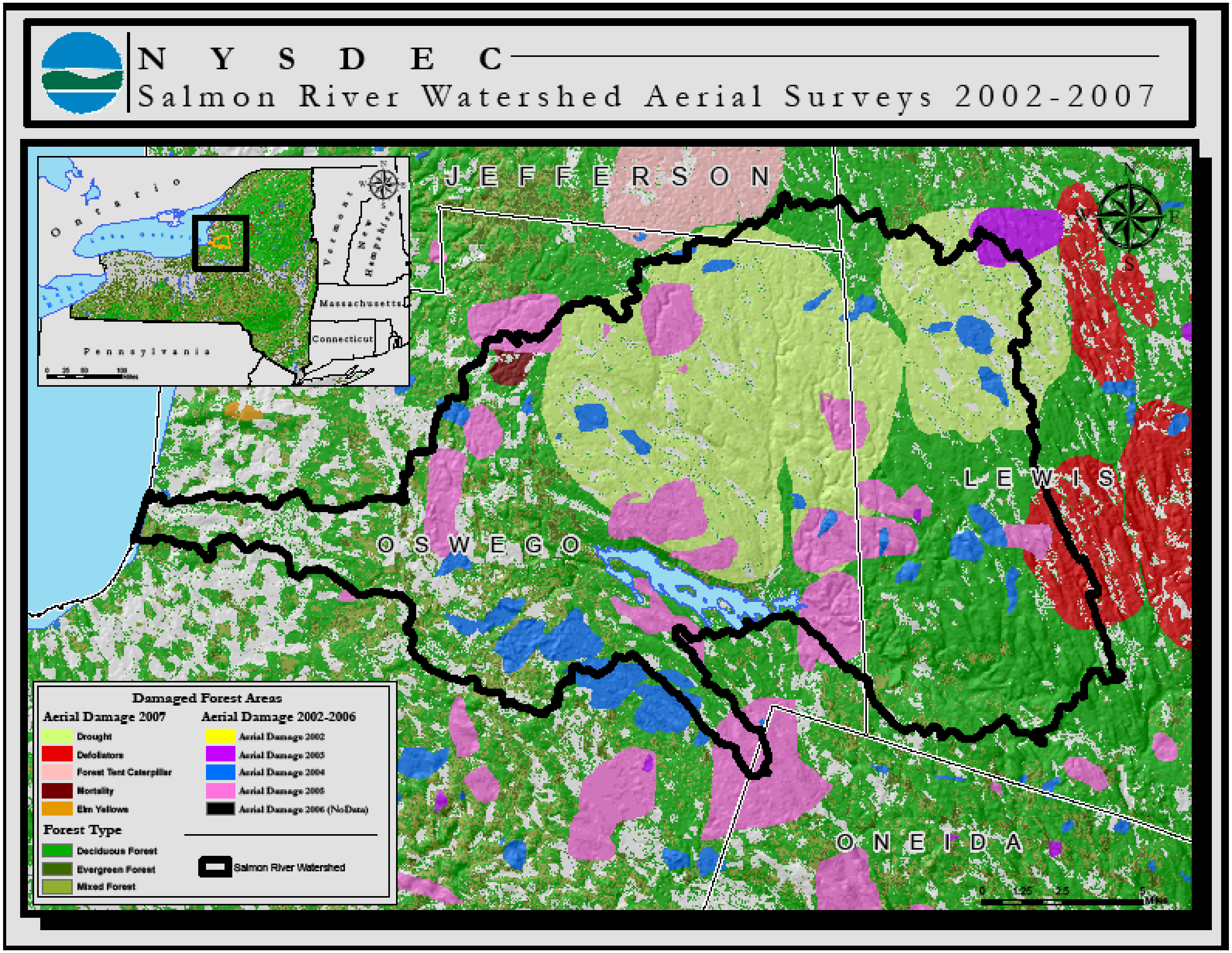

Figure 34. NYSDEC aerial survey data of forest damage in the Salmon River Watershed during the period 2002-2007.

Indicator – Beech bark disease distribution
Current condition – Poor

Beech bark disease is caused by fungi, preceded by beech scale 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, which leads to establishment of extensive root-sprout thickets (Shigo 1972) that may impose heavy competition on other understory woody and herbaceous species.

Beech bark disease has spread throughout the Tug Hill and affects stand structure and composition there. In a survey of four unmanaged New York State Forest Preserve stands within the Tug Hill region, data from McGee (unpublished) indicate 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.

There are several other 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 wood-boring beetle that attacks all species and varieties of ash. 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.

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. The maple-dominated forests of northern New York, including the Salmon River watershed are highly susceptible to infestation by the beetle (TNC 2007b).

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, but could potentially cause extensive ecological damage to New York’s forests.

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	

	Exellent	Good	Fair	Poor	Current 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

7. SALMON RIVER GORGE AND STEEP SLOPE COMMUNITIES

SALMON RIVER GORGE

One of the pronounced geologic features of the Tug Hill region is the numerous, steep, and often deep gorges. The only such feature in the watershed is the Salmon River Gorge, which begins at 110-ft high falls and continues downstream for approximately 3000 ft.. The Gorge includes high sheer cliffs and talus slopes that support unique plant assemblages and several rare plant species.

KEA – Hydrology
Indicator – Frequency of Low Flow Volume (cfs)
Current Condition – Unranked

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, but current low flows are due primarily to diversions for hydropower production. Minimum flow rate over the falls are 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 cliff- or pool-dwelling organisms. Furthermore, it is not known whether the historic, regulated minimum flows have caused contraction or extirpation of such organisms.

KEA – Fish Communities
Indicator – Fish Species Richness
Current Condition - Good

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 Lighthouse Hill Reservoir and its tributaries. No stocking occurs within this section of river and it is not managed as a fishery.

KEA – Plant Communities
Sawchuck (2006) described four, and Howard (2006) an additional two plant community types within the Salmon River Gorge (Figure 35):

- northern hardwood forest
- hemlock forest
- shale talus slope woodlands (S3)
- shale cliff and talus community (S3)
- calcareous cliff community (S3S4)
- calcareous shoreline outcrop (S2)

Of these community types, the talus slope and the shale cliff/tallus communities have been classified as unique communities by the New York Natural Heritage Program (Edinger et al. 2002) with a state ranking of S3 (typically 21-100 occurrences of limited acreage). The calcareous shoreline outcrop is ranked S2 (< 20 occurrences or demonstrably vulnerable).

Indicator – Unique 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).
Current Condition – 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).
Current Condition – Shale Cliff and Talus Communities, Good
The community has high species richness, is in a protected landscape and is inaccessible (Howard 2006).
Current Condition – Shale Talus Slope Woodland, Good
Howard (2006) rated the occurrence of this community type at this location.

Indicator – Threatened Species Population Densities
Current Condition - Good
Two state-protected plant species occur within the shale cliff and talus communities of the Salmon River gorge: yellow mountain saxifrage (*Saxifraga aizoides*) and birds-eye primrose (*Primula mistassinica*). 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.

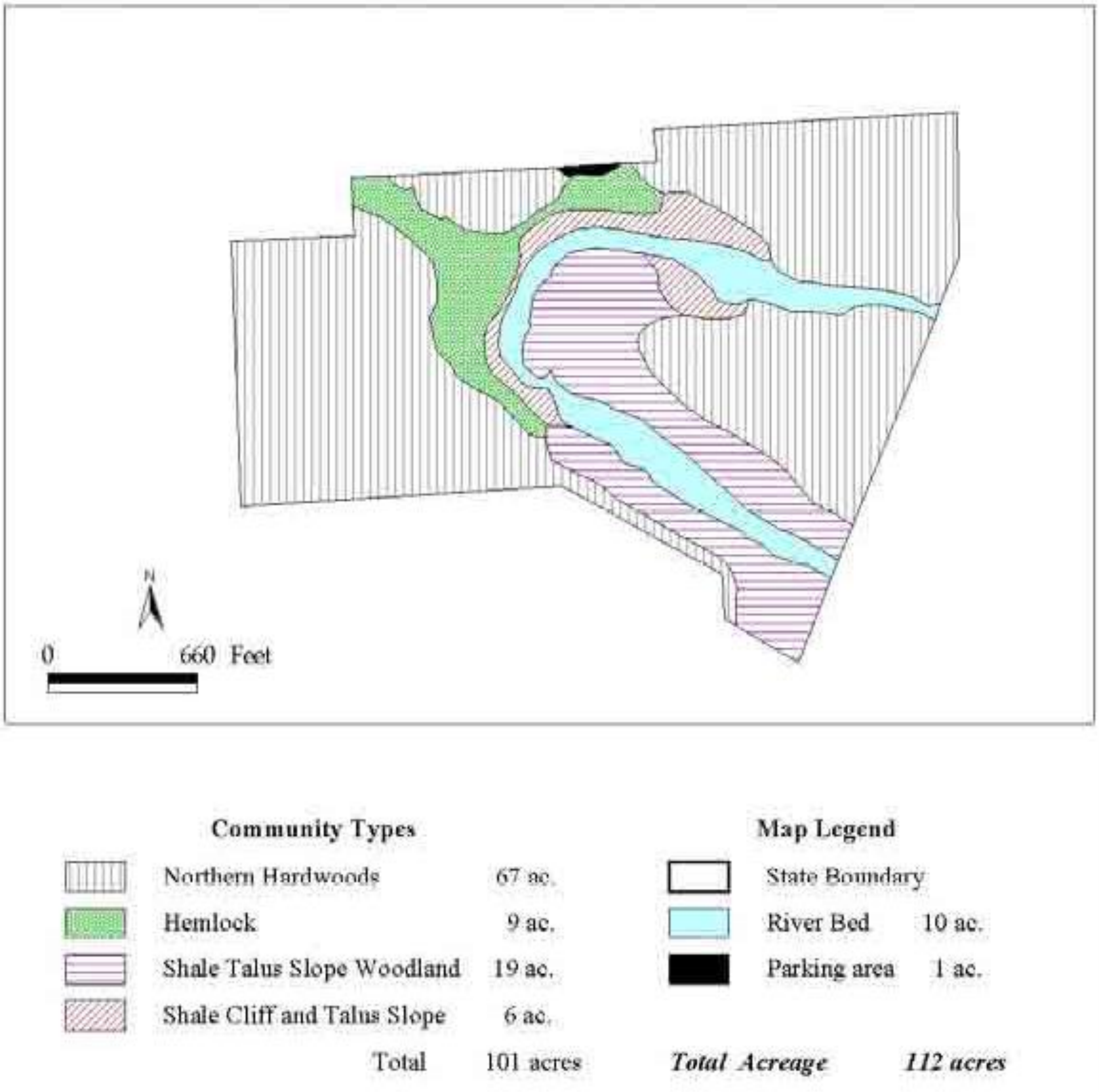

Figure 35. Salmon River Gorge plant communities (from Sawchuck 2006).

Indicator – Invasive Species Cover or Frequencies
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.

OTHER STEEP SLOPE COMMUNITIES

KEAs and Indicators of Steep Slope Communities and Species

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 (Howard 2006). At this time, limited data are available with which to build these element distribution models, 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 locations of rare outcrop and steep slope communities, and rare species such as yellow mountain-saxifrage, birds-eye primrose, smooth cliff brake, alpine cliff fern. 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.

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

E. Trends and Projected Cumulative Impacts

Population Growth and Land Use

The Salmon River watershed is located within the 4.3 million-acre Southeast Lake Ontario Basin, which spans the area from Stony Creek, southward and westward to Rochester and includes the Great Lakes Plain, the Finger Lakes, the Tug Hill, and the Syracuse metropolitan area. There are about 1.3 million people living in the basin, about 45% of which live in and around Syracuse. The region's population growth rate has been near zero over the past 40 years and has been negative over the past decade. Population decline is expected to continue into the near future (NYSDEC 2006a). Similarly, the population growth of the Northeastern Lake Ontario & St. Lawrence watershed, which begins just north of the study area and possesses a rural character much like the Salmon River watershed has been very low for more than a century (Figure 36).

For the four counties in which the Salmon River watershed is located, Lewis and Oneida have experienced recent population declines of 1% and 0.6% between 2000 and 2006, while populations have grown 2.3% and 0.6% in Jefferson and Oswego Counties (Table 4). The Jefferson County growth rate is greater than the overall growth rate for New York (1.7%). Population densities of the four counties range from 21/sq. mile (Lewis) to 194/sq. mile (Oneida). Population density for the whole of New York is 402/sq. mile. The median household incomes in each of the four counties is below the state-wide median income, but poverty levels for these counties are also below the state-wide level (US Census Bureau, 2007a).

The total percentage of developed land in the Southeast Lake Ontario Basin other than agriculture is 5% (NYSDEC 2006a). In comparison, developed lands comprise approximately 1.5% of the Salmon River watershed area. In the lower, western sub-watersheds, 2.8% of the land base is developed. The watershed maintains among the most rural conditions of the southeast Lake Ontario region.

However, it is not expected that population declines will lead to slowing of habitat loss by human development. For example, even though there was a loss of 6,500 residents in central New York between 1982 and 1997, 100,000 acres became urbanized in the region during that same timeframe (Pendall 2003). Rural development and land conversion closely track subdivision (greater numbers of smaller properties brought about by subdivision) trends. In the Salmon River Watershed, subdivision pressures are greatest within the western sub-watersheds (Figure 37). Recent interest in large-scale development plans for retail, tourism and research in the northern Syracuse metropolitan area may lead to increased housing and development pressures northward along the Interstate 81 corridor toward Pulaski.

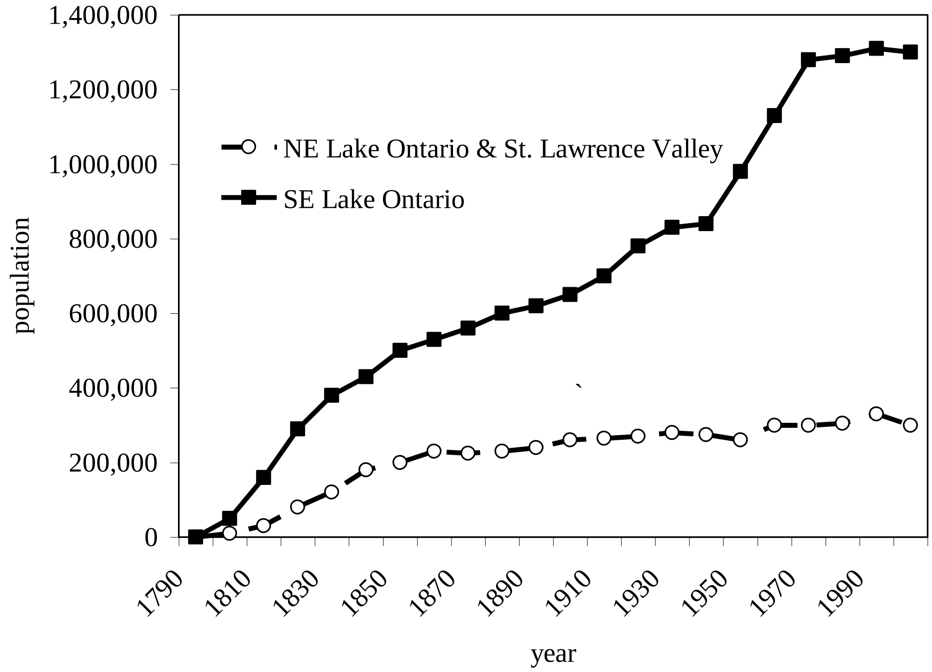

Figure 36. Long-term population trends in northwestern New York (Source: US Census Bureau

Table 4. Population statistics for counties of the Salmon River Watershed (US Census Bureau 2007a).

	population 2006	population change (%) 2000-2006	population density (#/sq mi) 2000	median household income 2004	population (%) below poverty level 2004
New York State	19,306,200	1.7	402	$45,300	14.5
County					
Jefferson	114,300	2.3	88	$35,500	13.9
Lewis	26,700	-1.0	21	$36,000	12.8
Oneida	234,000	-0.6	194	$37,300	13.6
Oswego	123,100	0.6	128	$39,200	13.6

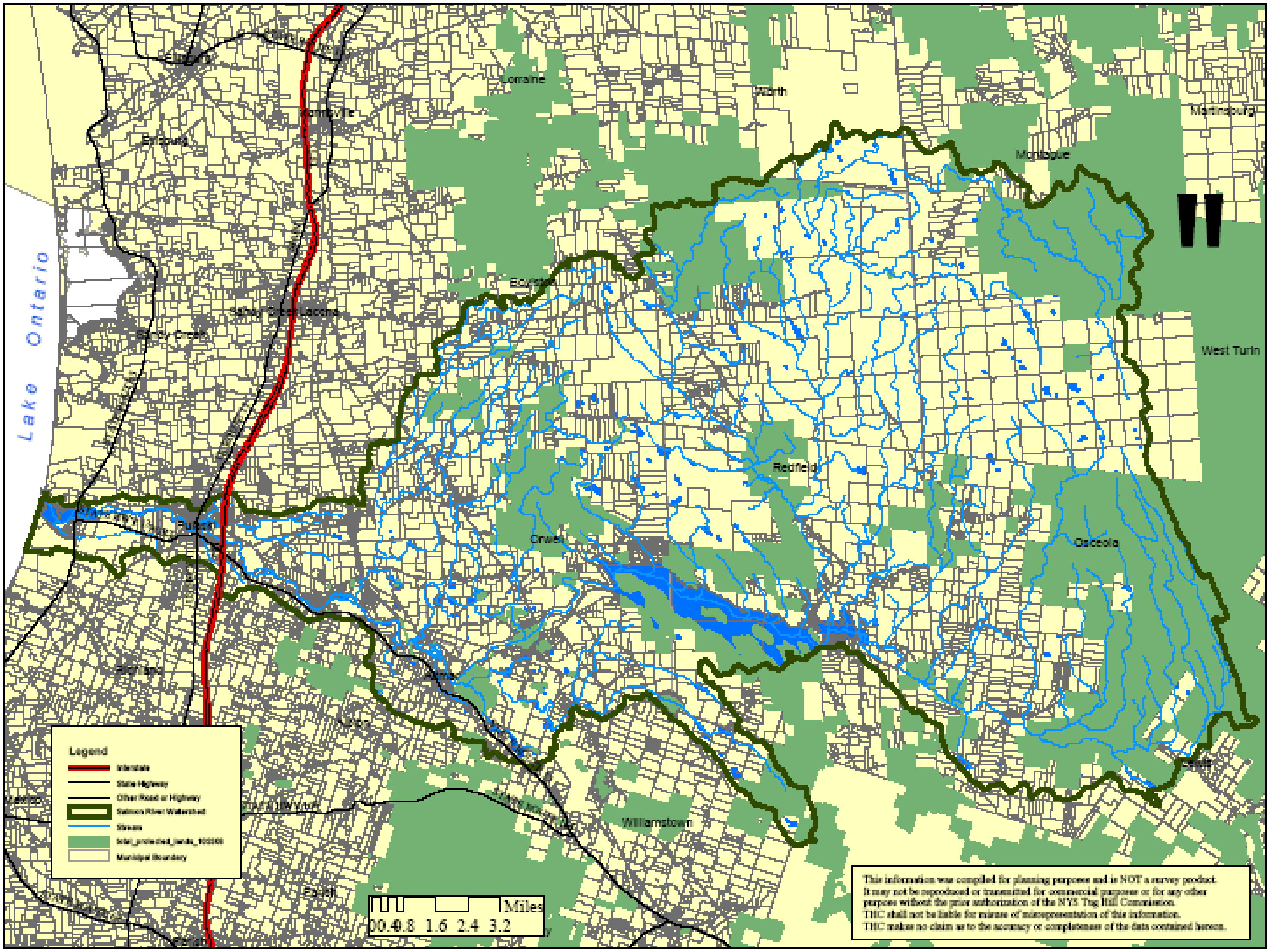

Figure 37. Property parcel map of the Salmon River Watershed (2001).

National trends in the decline of the family farm and agricultural land use are partially reflected in the four counties of the Salmon River watershed (Table 5). The number of farms in the four counties declined between 1997 and 2002, while the average size of farms and total agricultural production increased during this time period. Total farmland area declined in Oswego and Oneida Counties, but increased in Jefferson and Lewis (US Census Bureau 2007b).

Table 5. Agriculture statistics for counties of the Salmon River Watershed (US Census Bureau 2007b).

	number of farms		farmland area (ac)		average farm size (ac)		total value of farm products ($)	
	1997	2002	1997	2002	1997	2002	1997	2002
Jefferson	1,042	1,028	298,322	330,561	286	322	76,343,000	99,952,000
Lewis	731	721	194,860	196,774	267	273	62,357,000	72,178,000
Oneida	1,113	1,087	229,888	220,486	207	203	75,263,000	78,370,000
Oswego	737	682	109,232	103,156	148	151	34,013,000	31,526,000
TOTAL	3,623	3,518	832,302	850,977	227	237	247,976,000	282,026,000

Fisheries

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 salmon, *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. Fisheries management within the watershed continues to focus on maintenance of Pacific salmonines and other game fish in the lower sub-wateshed; cold-water trout (brook and brown) in upper sub-watersheds; and warm-water fisheries in the freshwater estuary and reservoirs.

Recreation

Outdoor recreation is a vital component of the economy in the watershed, as well as the greater Tug Hill region. Recreational opportunities include hunting, trapping, fishing, hiking, camping and nature study. Many individuals canoe on the region's small open waters and calm streams, boat from Port Ontario, and rafting on the Salmon River when recreational releases of water from the reservoirs permit. The region's lake-effect snows are enjoyed by many who snowmobile, snowshoe and cross-country ski. Off road use of all-terrain-vehicles and mountain bikes is promoted by many towns and businesses in the area, and visitation of riders has steadily increased over the past decade.

Wetlands

The finest resolution regarding trends in wetland area in New York is provided at the broad, eco-regional scale (Huffman and Associates, 2000). The Salmon River watershed spans two of these eco-regions, the Lake Plain and Appalachian Highlands. Total wetland area has remained relatively stable in these two eco-regions between the mid-1980s and mid-1990s. However, emergent and shrub-dominated wetland area has declined, while forested wetlands and open waters have increased in area (Table 6).

Table 6. Change in wetland area in Lake Plain and Appalachian Highland ecoregions of New York (Huffman and Associates, 2000).

		Lake Plain		Appalachian Highlands	
Wetland type	time period	area (ac)	% change	area (ac)	% change
forested	1980s	592,000	7	244,000	7
	1990s	631,000		261,000	
shrub	1980s	219,000	-8	103,000	-5
	1990s	201,000		98,000	
emergent	1980s	93,000	-16	67,000	-24
	1990s	78,000		51,000	
open water	1980s	21,000	52	29,000	24
	1990s	32,000		36,000	
Total	1980s	925,000	2	443,000	1
	1990s	942,000		446,000	

Forest Resources

The forest resources of the greater Tug Hill region are vital to the economic viability and cultural heritage of the region. They contribute more than $200 million and 7,000 jobs to the region through timber harvesting, wood and paper products manufacturing, recreation (hunting, snowmobiling) and sugar maple production (New York State Tug Hill Commission 2002).

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. Widespread selective cutting resulted in increased dominance of red maple on many sites by the mid-1950s (Stout 1958). As is the case in all forest types in the Northeast, continued selective cutting on some forestlands in the region has reduced the abundance of large-diameter trees below those levels expected under natural conditions and under prescription for sustainable production of large sawtimber (McGee unpublished data, Arbogast 1957, Bohn and Nyland 2006).

By the late 19th forest clearing to support subsistence agriculture peaked in central and northern New York. In the Southeast Lake Ontario basin, 90% of the land was in agricultural use (NYSDEC 2006a). Agricultural history in the lower, more fertile western portion of the Salmon River watershed likely reflects that of the broader region. However, agriculture was never attempted in much of the higher elevations in the eastern watershed. 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), and the planting of numerous conifer plantations on NY State Reforestation Areas (Stout 1958).

F. Threats

THREAT IDENTIFICATION

On May 4, 2007, a day-long public workshop was held in Pulaski to develop an understanding of the existing and potential factors that may negatively impact the quality of the natural resources in the Salmon River Watershed (Forester 2007b; Appendix 2). The participants of this workshop were charged with the following tasks:

- identify activities and conditions that negatively affect the long- and short-term viability of each of the conservation targets in the watershed;
- develop an understanding of the causal factors influencing the level of each threat; and
- rank the significance of each threat with respect to each target based upon its
  - scope (how widespread the threat currently is or is likely to be in 10 years);
  - intensity (the magnitude of the impact where the threat is present); and
  - irreversibility (the difficulty in abating the threat and restoring the natural resource).

The results of these ranking process were combined to give each threat a single, qualitative rank, “very high,” “high,” “medium” or “low,” for its impact on a specific natural resource target. Rankings were then combined across all targets to identify the most critical threats to the natural resources of the Salmon River watershed.

Through this process, the following seven general threat categories (listed in order of their significance), having negative impacts on multiple targets and/or having substantial impacts on the targets they do affect, were identified. These general threats each had several more specific threats included within them (see Table 7).

- Invasive Species
- Regional/Global Issues
- Altered Hydrology
- Land Cover/Land Use Change
- Physical Habitat Disturbance
- Pollution and Sedimentation
- Pests/Pathogens/Diseases

Table 7. Summary of threat rankings for the Salmon River Watershed. Specific threats identified by workshop participants for each of the seven watershed conservation targets are listed under seven general threat categories. Qualitative threat rankings (**V**ery **H**igh, **H**igh, **M**edium, **L**ow, or if blank, no perceived threat) were determined by workshop participants for each of the specific threats under each target. The Summed Rank is a unit-less value that sums the overall perception of all workshop groups of importance of each general threat category – the value should be used only for general comparison purposes.

General Threat Category	Specific Threats	Summed Rank	Main Stem & Major Tributaries	Head-waters	Steep Slopes & Gorge	Open Waters	Non-estuarine Wetlands	Fresh-water Estuary	Matrix Forest
Invasive Species		63	VH	M	H	H	H	VH	M
	Invasive Species			M		H	H	VH	M
	Terrestrial Invasive Species		VH		H				
	Aquatic Invasive Species		M		M				
Regional / Global Issues		53	H	VH		VH	VH	H	H
	Atmospheric Deposition		H			VH	VH		
	Temperature Change		H	VH		M	L		
	Climate Change							H	H
Altered Hydrology		48	H	VH	H	M	H	H	
	River Flow Alteration							M	
	Change in Base Flow		M						
	Bypass Baseflow				M				
	Lack of Groundwater Discharge			M					
	Temperature Change		H	VH		M	L		
	Altered Hydrology		H	L	H	M	H	H	

Table 7, continued. Summary of threat rankings for the Salmon River Watershed.

General Category	Specific Threats	Summed Rank	Main Stem & Major Tributaries	Head-waters	Steep Slopes & Gorge	Open Waters	Non-Estuarine Wetlands	Fresh-water Estuary	Matrix Forests
Land Cover / Land Use Change		43	H	VH	M		H	VH	H
	Land Use Change								H
	Land Cover Change		H						
	Vegetation Cover				M				
	Physical Habitat Disturbance						H		
	Habitat Fragmentation							VH	M
	Temperature Change		H	VH		M	L		
	Removal of Riparian Vegetation		H						
Physical Habitat Disturbance		42	H	VH	H	M	M		
	Loss of Soil/Habitat				H				
	Beavers		H			M	M		
	Habitat Changes			H					
	Temperature Change		H	VH		M	L		
	Physical Stream Impacts			M					
Pollution and Sedimentation		39	H	M		H	H	M	
	Non-Point Source Pollution					H	H		
	Pollution							M	
	Increased Nutrient Loading		M						
	Sedimentation		H	M					
	Towns		H					M	
Pests / Pathogens / Diseases		28	H					VH	M
	Pests / Pathogens / Diseases							VH	M
	Fish Disease		H						

SUMMARY OF GENERAL THREAT CATEGORIES

The following text describes the current understanding of how the seven critical threats are known or suspected of impacting the respective conservation targets of the Salmon River watershed.

Invasive Species

Invasive species are those non-native, terrestrial or aquatic, plant or animal species that, after establishing within a natural community, becomes so dominant that it reduces the diversity of native species. Terrestrial and aquatic invasive species were recognized as threats to all seven natural resource targets in the watershed. Invasive species were considered a very high threat to the main stem of the Salmon River, and the freshwater estuary.

Potentially invasive plant species that are currently present in the freshwater estuary and along the main branch and major tributaries include purple loosestrife (*Lythrum salicaria*), Eurasian milfoil (*Myriophyllum spicatum*), curly pondweed (*Potamogeton crispus*), European frog-bit (*Hydrocharis morsus-ranae*) and knotweed (*Polygonum cuspidatum*). Potentially invasive fish species in the watershed include sea lamprey (*Petromyzon marinus*) and common carp (*Cyprinus carpio*).

Invasive species were perceived as high threats to steep slopes, open waters and wetlands. The plant species listed above for the Main Stem and freshwater estuary may pose threats to all wetland systems, headwaters and open waters. Eurasian milfoil and purple loosestrife are known to occur in the Redfield Reservoir. Sea lamprey and carp are currently known to occur only in the lower sub-watersheds, and their migration to upper sub-watersheds is inhibited by the dam at Lighthouse Hill Reservoir and the Salmon River Falls.

Participants recognized invasive species as a medium threat to headwater streams and matrix forest. Brown-headed cowbirds (*Molothrus ater*) are known to occur in the majority of survey blocks in both the upper and lower sub-watersheds, but occur more frequently in the lower, western sub-watersheds. A number of terrestrial invasive vascular plant species are known to occur in the watershed, but none have been dominant components of any reported floristic surveys in the watershed – these species include: garlic mustard (*Alliaria petiolata*), purple loosestrife (*Lythrum salicaria*), common reed grass (*Phragmites australis*), Japanese knotweed, common and smooth buckthorn (*Rhamnus cathartica, R. frangula*), black locust (*Robinia pseudoacacia*) and black swallowwort (*Vincetoxicum nigrum*). Other terrestrial invasive plants that likely occur in the watershed that have not been reported include Russian and autumn olive (*Elaeagnus angustifolia, E. umbellata*), fly and Tatarian honeysuckle (*Lonicera morrowii, L. tatarica*), and white sweet-clover (*Melilotus alba*). Other native species for which concern has been expressed due to their competitiveness and increasing abundance include hay-scented fern (*Dennstaedtia punctilobula*), New York fern (*Thelypteris noveboracensis*) and red maple (*Acer rubrum*).

Regional/Global Issues

The regional global/issues represent threats that originate outside of the Salmon River watershed, but that impact the natural resources of the watershed. Regional/global issues were not identified as threats to the steep slopes conservation targets, but were rated very high threats to headwater streams, open water and wetlands, and as high threats to the main stem, freshwater estuary, and matrix forests.

These threats include the following.

- Atmospheric deposition of acid, nitrogen and mercury: The Tug Hill region receives some of the highest rates of nitrogen and acid deposition in North America (Figure 31). Natural buffering capacity of the region's soils appears to provide a degree of resilience to the detrimental effects of acidic deposition on the watershed's aquatic communities. The region's headwater streams, and forest soils and vegetation are showing signs of excessive nitrogen deposition and accumulation, indicating the potential for future declines in forest health and productivity. Given the high rate of acid and nitrogen deposition to the region, mercury deposition is also speculated to be high here. Furthermore, since mercury becomes biologically available and toxic under conditions common to wetlands (saturated, low oxygen, high organics), and given the abundance of wetlands in the watershed, mercury may pose a substantial, but yet unknown, threat to the watershed's biota.

- Mercury and PCB contamination of migratory fish in Lake Ontario: Contamination of the watershed's fish and other aquatic and semi-aquatic wildlife by mercury and PCBs may also be due to sources in and around Lake Ontario. This contamination can enter the watershed by migratory fish returning to the watershed from Lake Ontario. Fish consumption advisories for PCBs continue to be issued by the State of New York for some game fish in the lower Salmon River, including the freshwater estuary.

- Global climate change: Global climate change will have unknown consequences for the terrestrial and aquatic communities of the watershed. Possible effects include altered regional precipitation patterns that will, in turn, influence the hydrologic regime of the streams, wetlands and open waters of the watershed; and overall warming of surface water and soil that may cause large-scale changes in plant, animal and microbial communities. The capacity of the watershed's terrestrial and aquatic communities to respond to global change may be hindered by features that isolate the watershed's resources from other relatively intact regional communities. The matrix forest of the upper sub-watersheds is contiguous with the greater Tug Hill forest, but this is largely isolated from other regional forests by agricultural lands in the Black River Valley and by agriculture and urbanization in the Mohawk Valley. Matrix forest of the lower sub-watershed is embedded within the highly fragmented agricultural landscape of the Ontario Lake Plain. Functional wildlife migration corridors (i.e., 300-ft-wide) along naturally vegetated riparian zones are disrupted in several locations in the lower sub-watersheds. While the aquatic communities of the lower sub-watersheds have connections with the Great Lakes systems, the upper sub-watersheds are isolated by the Lighthouse Hill Reservoir Dam and by the Salmon River Falls.

- Water level regulation of Lake Ontario (for the freshwater estuary): The stabilization of Lake Ontario water levels in the 1950s to facilitate shipping traffic through the St. Lawrence River has reduced variation in plant community types in coastal marsh communities along the lake including the Salmon River freshwater estuary. This has caused a 50% reduction in meadow marsh and emergent-floating vegetation within the Lake Ontario wetland systems, as well as a reduction in the variety of marsh communities. These changes, in turn, reduce the habitat availability for marsh-dwelling birds, reptiles and amphibians, and fish.

Altered Hydrology

Altered hydrology is a broad threat related to changes in the volume, variability and seasonality of surface water flow and groundwater that influence the availability and quality (substrate type, water temperature) of in-stream habitat. Altered hydrology was not considered a threat to the matrix forest, but was ranked a very high threat to headwater streams; a high threat to the main stem of the Salmon River, steep slopes (especially for the Salmon River Gorge), wetlands and the freshwater estuary; and a medium threat to open waters.

Specific threats associated with altered hydrology include the following.

- Reduced baseflow in headwaters and high order streams: Baseflow represents water present in stream channels that is provided by groundwater (especially during low-flow periods); is impounded and slowly released on a more or less continuous basis from wetland systems; or is the regulated discharge released from the reservoirs under the FERC license agreement (this influences only the Bypass Reach and lower reaches of the Salmon River). Baseflow in the lower reaches of the Salmon River is well regulated by discharge from the reservoirs, but the other major tributaries to the Salmon River are subject to baseflow fluctuations caused by natural variation groundwater recharge (which may be subject to future change by global climate change) as well as by municipal and industrial water withdrawls. The high quality fisheries and aquatic communities of most major tributaries and headwaters require adequate baseflow to maintain water coverage across their channels for habitat, especially during dry summer months. Native and stocked trout species require cold groundwater recharge into streams for successful spawning beds. Cold groundwater discharge into streambeds helps to maintain adequate temperatures for sustaining cold water fish and associated invertebrates through summer months. This cold water remains important as it discharges into the freshwater estuary and regulates water temperature there. These important stream habitat qualities are sensitive to degradation if future industrial, municipal and residential groundwater withdrawl becomes excessive. The abundant wetlands within the watershed (many of which are created and maintained by beaver activity) serve to maintain baseflow discharges in the headwaters during dry summer months. However, tree mortality caused by flooding of riparian forest vegetation by beavers reduces streamside shading, thereby causing localized increases in water temperature that may be detrimental to cold water fish species.

- Variability in surface water discharge: Variability in surface water discharge produces variation in substrate conditions (e.g., amount of gravel and boulders on stream beds) and maintains natural stream meanders while not causing excessive stream bank erosion.

- Increase in surface water temperatures brought about by lack of riparian buffers: Stream water temperature is also greatly influenced by the amount of shade provided by overhanging riparian vegetation. The lack of riparian vegetation along some high-order stream reaches in the agricultural and urbanized western sub-watersheds can cause stream bed substrate will heat up on sunny summer days, sometimes to levels that threaten many aquatic organisms. Removal of riparian cover by logging remains a constant but uncommon threat to aquatic communities in the watershed. It is especially important during low baseflow periods to maintain shaded conditions above pools that provide refuge for aquatic organisms. Excessive beaver activity may also lead to an imbalance in the availability of cold, fast-flowing headwater streams.

- Maintenance of wetland area and saturation levels: Loss of wetland area due to drainage and filling threatens the hydrologic functions and biodiversity provided by these systems. The greatest development and agricultural pressures on wetland habitat are in the western, lower sub-watersheds, while wetland area has likely increased in recent decades following agricultural abandonment in the more forested upper sub-watersheds.

Land Cover/Land Use Changes

Land cover/land use change is a broad threat category that includes loss of habitat and fragmentation of remaining habitat through removal of natural vegetation. This was ranked as a very high threat to headwater streams and the freshwater estuary; a high threat to the main stem of the Salmon River, wetlands and the matrix forest; and a medium threat to steep slopes. It was not identified as a threat to open waters.

The most important cause of habitat loss is sprawling patterns of land conversion to residential and commercial uses. Even though the overall population of the Southeast Lake Ontario Basin has not increased over the last 50 years, and current estimations are for a continuation of that trend, sprawling development continues to cause irreversible conversion of the land base, increases in impervious cover (which in turn increases runoff and non-point source pollution) and fragmentation by roads and utility rights-of-way. Areas for which greatest concern has been expressed over uncontrolled future development include Pulaski, Orwell, the Salmon River Corridor from Redfield to Port Ontario, and shorelines of the Redfield and Lighthouse Hill Reservoirs.

Habitat fragmentation poses a significant threat to terrestrial and aquatic communities by providing corridors for dispersal and establishment of invasive species, and by hindering the movement of dispersal-limited plants and wildlife among suitable habitat patches. Many birds, mammals and amphibians utilize natural vegetation within riparian corridors (up to 540 ft wide) movement and migration. Past agricultural and residential land conversion, especially in the western sub-watersheds, has eliminated functional riparian corridors along many reaches of headwater (Figure 28) and high-order streams (Figure 26). Furthermore, roads that traverse riparian buffers (Figure 32) are known to cause substantial mortality to migrating amphibians and reptiles, and isolate breeding populations of these animals. The north and east shores of the freshwater estuary are nearly completely isolated by residential development, agriculture and roads (Figure 21). At a broader, regional scale, the whole of the Tug Hill is completely isolated from other large habitat blocks by agricultural land use and urbanization (Figure 33).

Dams and culverts and road crossings serve as fragmenting features for many aquatic and semi-aquatic organisms in the watershed. Stream crossings average 0.72 per stream mile in lower sub-watersheds and 0.35 per stream mile in upper sub-watersheds (Figure 25). Migration capacities of aquatic organisms are potentially more impaired by dams (Figure 25) at the lower sub-watersheds (average dam density = 0.07/mile) than at the upper sub-watersheds (average = 0.03/mile).

Physical habitat disturbance

Physical habitat disturbance occurs when the soil or vegetation is disturbed or the basic structure of the habitat is altered (but not lost) due to human or natural disturbances. Physical habitat disturbances were ranked as very high threats to headwater streams, high threats to the main stem Salmon River and steep slope communities, and medium threats to open waters and wetlands.

Disruption of riparian vegetation and soils along headwater and higher-order streams leads to increased water temperature and degradation of aquatic habitat due to erosion and sedimentation. Sources of streamside soil disturbance include ATVs, livestock, over-use by anglers. Flooding from beaver activities also disturbs natural vegetation.

Pollution and sedimentation

Pollution and sedimentation includes all point and non-point sources of nutrients, toxins, and other forms of pollutions as well as erosion, run-off and other types of sedimentation. Pollution and sedimentation was identified as a high threat to the main stem of the

Salmon River, open waters, and wetlands, and a medium threat to the freshwater estuary and headwater streams.

Four facilities within the Salmon River watershed are permitted point sources of pollutant discharges through the National Pollution Discharge Elimination System (NPDES) water discharge or USEPA Toxic Release Inventory (TRI) programs. All facilities discharge into the lower Salmon River (Figure 24).

- Felix Schoeller Technical Papers: permitted for temperature, turbidity, biological oxygen demand (BOD), pH, total suspended and settleable solids, phosphorus, and aluminum. Toxic releases from this facility have declined from 976,580 lb in 1987 to 380 lb in 2005. The facility has not been out of compliance with discharge schedules since 1991.

- Pulaski Sewage Treatment Plant: permitted for 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.

- New York State Fish Hatchery: permitted for 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.

- Pulaski Ford and Mercury: NPDES permit is on record, but no other permit documents were found for this facility.

Agriculture, especially in the lower, western sub-watersheds, represents one important non-point source of nutrients such as phosphorus and nitrogen. The lack of adequate (100-ft-wide) vegetated buffers along headwater (Figure 27) and higher-order streams (Figure 22) in some locations of the western sub-watersheds contributes to runoff, sedimentation and nutrient loading of streams there. Other important non-point sources of pollution and sedimentation include poorly functioning septic systems, runoff from urbanized areas, and forestry operations that do not meet recognized best management practices for maintaining water quality.

Pests, Pathogens and Diseases

There may be some overlap between pest/pathogens/diseases (PPDs) and invasive species, but typically invasive species efforts have not focused extensively on PPDs. In addition, PPDs can include native as well as exotic species. Threats posed by PPDs were ranked very high in the freshwater estuary, high for the main stem of the Salmon River and medium for the matrix forest target.

The following pests, pathogens and diseases currently pose important threats to fisheries of the freshwater estuary and high-order streams of the western sub-watersheds, and to regional wetlands.

- Perhaps the most serious pathogen currently threatening the watershed's fisheries is viral hemorragic septacemia (VHS). This disease, which has spread into the Great Lakes, but is not yet known to occur in the Salmon River, targets fish such as walleye, perch, minnows and gobes.

- Type E Botulism has affected affect fish-eating shore birds in the Great Lakes since 1999 (NYSDEC 2006), and an outbreak recently affected gulls, grebes and loons along the southern and eastern shores of Lake Ontario. No birds within the Salmon River's freshwater estuary have yet been observed with the disease.

- Other diseases being monitored by regional fisheries managers include Bacterial Kidney Disease (BKD), Furnunculosis, Infectious Pancreatic Necrosis (IPN), and Enteric Redmouth Disease (ERM).

- The viburnum leaf beetle (*Pyrrhalta viburni*) is a non-native insect defoliator that stands to devastate arrow-wood, which is a dominant shrub in regional wetlands.

The following pests, pathogens and diseases currently pose important threats to the region's forests.

- The beech bark disease complex has substantially altered regional forest structure and composition. Beech bark disease is caused by the fungi *Nectria* spp., preceded by the beech scale *Cryptococcus fagisuga* on American beech. The complex causes above-ground mortality to pole and sawtimber size beech trees, and promotes root sprouting from the surviving root systems. Understory dominance by beech saplings is exacerbated by past and ongoing selective harvests that increase beech dominance in impacted stands. The disease seriously complicates management options for sustaining yields of high quality wood products and for retaining wildlife value in affected forests.

- The sirex woodwasp (*Sirex noctilio*) has been confirmed in Oswego County and poses a serious threat to regional forests, especially state reforestation areas that contain white, red and Scots pine.

- The eastern (*Malacosoma americanum*) and forest (*Malacosoma disstria*) tent caterpillars are two important tree defoliators deciduous hardwood stands in New York. Hardwood stands in this part of New York normally experience some "background" level of defoliation every year, and native tree species are well adapted to it. However, severe outbreaks can cause periodic, extensive defoliation that can cause direct mortality to affected trees or predispose those trees to mortality by other agents such as drought. Poor forest management practices that leave the smallest and weakest trees in a stand can predispose the forest to increased mortality from subsequent defoliation.

- Other exotic forest pests that occur within the northeast that pose substantial threats to the watershed's forests include the emerald ash borer (*Agrilus planipennis*), Asian long horned beetle (*Anoplophora glabripennis*), and hemlock wooly adelgid (*Adelges tsugae*).

G. Priority Issues

Fishing Industry

The Salmon River watershed supports a world-class fishery for salmon, trout, warm water fish, and lake fish. Significant economic activity results from anglers visiting the watershed from outside the region, the state and the US. The regional fishing industry includes guide services, river and lake charters, fish cleaning, bait shops, restaurants and hotels. The fishing industry is active year-round to cater to salmon fishing in the lower reaches of the Main Stem and the major tributaries, trout fishing in the cold headwaters of the upper watershed, warm water bass fishing as well as ice fishing on the freshwater estuary and the reservoirs, and lake fishing from Port Ontario. Anglers are known to have different recreational fishing interests, with many visiting the watershed only to fish for salmon, or to fly-fish for trout, or to access Lake Ontario, etc. Many anglers seek the experience of fishing for native brook trout, and therefore interest exists in sustaining populations of naturally-reproducing, native trout. Much interest also exists to restore native Atlantic salmon populations to this and nearby watersheds. Substantial risks to the fishing industry are posed by fish pathogens, invasive fish (such as carp, gobes, lamprey). Other concerns that challenge long-term management of this productive and diverse fishery include potential over-fishing, stream bank destabilization and erosion due to excessive use, loss of public access on private lands, pollution and contamination by toxins, and surface water and groundwater withdrawals.

Forests and Forestry

The watershed possesses a working forest landscape that is vital to the local forest products industry. Forest lands include a mix of private (industrial; small, non-industrial; and NGO) and public (NY State forests, wildlife management units, and a few small satellite forest preserves) holdings. The extensive forest cover throughout the watershed is fundamental to sustaining the water quality and habitat that is necessary to maintain the region's fisheries and it contributes to the large, un-fragmented core forest landscape of the Tug Hill. Substantial concern has been expressed about the capacity for private woodland owners to continue holding forest lands in the face of rising property taxes, property tax policy that keeps landowners from managing forest land sustainably, and increasing land values brought about by subdivision, sprawling development and seasonal, second home development. Other concerns have been expressed for the long-term impacts of past, and to some extent ongoing, exploitive cutting on forest health and productivity, and on the ability of the region's woodlands to continue producing high quality and diverse wood products. Several forest pests and pathogens, and atmospheric deposition of nitrogen and acid represent potential stresses to the watershed's forests.

Tourism

Tourism is another important economic driver in the Salmon River Watershed. Apart from the fishing industry, which draws approximately 1/3 of all anglers from out-of-state, there are other important "traditional" recreational uses of the region's resources including hunting and trapping. Many hunting clubs include members who travel to the region from elsewhere. Other low-impact recreational uses of the watershed's resources include bird watching, hiking, cross-country skiing and snowshoeing. Periodic recreational releases of water from the Lighthouse Hill Reservoir provide opportunities for whitewater rafting on the Salmon River. Travel and tourism jobs numbered over 5,900 in 2000, with 95% of those jobs being year-round, despite 63% of businesses being seasonal. According to the results of a feasibility study in the summer of 1999, snowmobile activity generated $20 million of direct and indirect economic benefits to Oswego County each year. Emerging dynamics in the use of ATVs are creating new management challenges for water quality, wildlife and invasive species on private and state lands.

Wetlands
The substantial wetland areas in the Salmon River watershed provide important ecosystem and hydrogeological functions/benefits. They maintain rich biological diversity and provide habitat for many of the watershed's rare plant and animal species. They retain and slowly discharge surface and ground water into streams to maintain baseflow in the watershed stream network during dry summer months, and serve to filter surface waters to maintain high water quality. Their protection is critical in order to maintain the high quality fisheries and wildlife habitat of the region. However, wetlands also offer challenges to landowners who may be limited in the use of their properties that contain wetlands. Fragmentation of wetland systems and wetland buffers by roads and development offers further challenges to wildlife management. Recent increases in beaver populations following state-wide extirpation in the 19th century are causing changes in wetland community types and offer challenges to landowners and resource managers. Several invasive species also pose impending threats to the composition and diversity of many wetland systems, especially in areas of the watershed where dispersal vectors such as roads, ATVs, and boats, increase the rate of invasive species dispersal into wetlands.

Water Quality/Quantity
The Salmon River watershed possesses an abundant, but finite supply of freshwater due to high levels of lake effect precipitation, in combination with gentle topography that supports development of extensive wetland systems. This water recharges the Tug Hill Aquifer, which is a substantial groundwater source that, in turn, maintains baseflow in many headwater streams of the lower sub-watersheds; discharges cold spring water into streams, which is necessary for salmon and trout spawning; and serves as a residential, municipal, and industrial water source. Protection of the quantity and quality of the surface and groundwater resources in the watershed is paramount for ensuring long-term viability of the region's fisheries, communities and industry. Potential factors that would degrade the quality or reduce the quantity of water include unplanned and excessive consumption and diversions for residential, agricultural, commercial and industrial uses; degradation by pollution and sedimentation; and atmospheric deposition of acid, mercury and PCBs.

Open Space/Development/Rural Character
The Salmon River Watershed maintains a rural character with its handful of villages and hamlets set within agricultural and forested landscapes. Residents of the watershed share a desire to maintain the rural character of the region and the traditional uses of its natural

resources. This they desire while allowing for wise, directed economic growth because they realize that sustainable economic growth will depend on maintaining the character of region and the quality of the natural resources. Concern has been expressed regarding potential long-term impacts of recent subdivision trends and sprawling development in some communities in the watershed. Such changes pose threats to the character of the region through outright loss of open space, increased amounts of non-point source pollution, and increasing tax burdens associated with maintenance of new, widely scattered services. These increasing tax burdens, in turn, lead to management and ownership decisions by private and industrial land owners that diminish the capacity for long-term sustainability.

Regional Issues
A number of regional issues, for which residents of the watershed have no control, also pose existing or potential future threats to the quality and sustainability of the watersheds natural resources. The issues include global economy and trade, which exacerbates the dispersal of invasive species; global climate change, which is expected to alter the terrestrial and aquatic environments in unpredictable ways; and regional air pollution patterns that deposit acid, nitrogen and mercury, which may soon cause declines in forest productivity and wildlife populations.

Payment of Local Property Taxes on State-Owned Lands and Conservation Easement Properties

As this report was being finalized for printing, a new issue emerged via the court system. A challenge to the State's method of paying taxes to localities for state-owned lands and conservation easement holdings was upheld in western New York. A decision was issued in November 2007 from the State Supreme Court in Chautauqua County in a case of the State vs. Dillenburg that said that the State's method of paying taxes to localities for its properties is indeed haphazard, and ordered that all payments to localities by the State (including the Adirondacks) be halted and a comprehensive policy be developed. The decision was immediately stayed and appealed by the State. To date, no decision has emerged from the appeal.

Currently, only a legislative method is possible, where localities must work with their State legislative representatives to have their locality included in legislation allowing payments, such as in the State's Property Tax Law. This is how certain Tug Hill municipalities have attained tax revenue from the State for lands owned within their boundaries, owing to significant public land acreage. Should the State be ordered to stop all payments to municipalities currently receiving tax revenues on state-owned lands and conservation easement properties, several Tug Hill towns would be severely affected. For example, the public land in the Town of Montague, located in the northeast portion of the Salmon River watershed, comprises over 54% of the town's land area. Greater than 40% of the tax revenue received by the Town of Montague is received from the State of New York.

III. Strategies for Basin-Wide Implementation

On June 21, 2007, the third and final workshop in the Salmon River Watershed Restoration and Protection Strategy project was held in Altmar to develop plans for implementing conservation actions within the watershed (Forester 2007c; Appendix 3). Participants used data gathered in past workshops, including the situation diagrams developed in Workshop 2 (Forester 2007b; Appendix 2) illustrating the paths by which the various threats act on the targets, and their own expert knowledge for this work. Strategies were proposed to abate the seven critical threats identified in Workshop 2, and to maintain or enhance the current condition of the natural resource targets. The proposed strategies were further refined, clarified and synthesized by the project partners in several follow-up meetings.

The objectives and strategic actions to address the seven, respective critical threat are outlined below.

THREAT: ALTERED HYDROLOGY

Goal: Maintain local hydrology by sustaining long-term forest cover throughout the watershed at or above current levels.

Objective: Minimize subdivision (to no more than 10% of 2008 level) and encourage long-term land ownership over next five years in priority areas (e.g. Orwell; 1-mile-wide corridor along Salmon River from Redfield to Lake Ontario; reservoir shorelines; and the lower sub-watersheds (Orwell Brook, Beaverdam Brook-Meadow Creek, Trout Brook, Lower Salmon River)); and focus development and subdivision in villages and hamlets where infrastructure is present (Villages of Pulaski and Altmar, Hamlets of Orwell and Redfield).

Actions:

- Promote landowner use of existing conservation programs (e.g., Forest Land Enhancement Program, Conservation Reserve Program, Wetland Reserve Program, Forest Legacy, NY State Conservation Landowner Incentive Program, Conservation Easements, Conservation Reserve Enhancement Program, Purchase of Development Rights, Transfer of Development Rights, Inheritance Planning) to provide landowners with financial incentives to limit development and land conversion.
- Permanently codify state reimbursement to towns experiencing greater than a 1% shift in tax revenues due to 480A enrollment.
- Increase capacity of local conservation organizations (e.g., Tug Hill Tomorrow Land Trust) to protect open space.
- Investigate creation of forest/conservation tax districts to alleviate property tax burdens and curtail land conversion.

- Express to the NY state legislature a need for a change in the tax code so that property tax values are based on current use rather than potential use.
- Express to the NY state legislature a need for a change in the tax code so that timber is no longer assessed as “real property” (Empire State Forest Products Association, NY Forest Owners Association, Nature Conservancy, Tug Hill Commission).
- Express to NY state legislature the need to codify low-volume roads classification by towns.

Objective: Double compliance with New York Forestry Best Management Practices Field Guide by 2018.

Actions:

- Determine existing compliance levels.
- Require training/certification of loggers to cut wood off of public land.
- Provide local or state tax relief incentives to forest property owners who demonstrate continued utilization of loggers who are certified through FSC or NYS Logger Association.
- Encourage local mills to purchase wood only from certified/trained loggers.
- Ensure that BMP workshops are offered annually as part of the New York Trained Logger Certification Program (ESFPA)

Objective: Increase by 10% private landowner participation by 2015 in established sustainable forest management programs (e.g., Forest Stewardship Council, Sustainable Forestry Initiative, Tree Farm), particularly where DEC has identified the highest potential for Forest Stewardship Program benefits (Figure 9).

Actions:

- Determine existing participation in established forest management/certification programs.
- Codify state reimbursement to towns experiencing greater than a 1% shift in tax revenues due to 480A enrollment.
- Provide resources to increase DEC staff time devoted to landowner interaction, and to develop outreach materials and programs.
- Provide landowner incentives to participate in established forest certification programs.
- Enable FSC training for local consulting foresters to become FSC-certified in order to enroll forest owners.
- Within five years, develop funded program with partners (e.g., SUNY-ESF, Cornell Extension) to conduct outreach using existing materials to landowners of more than 50 acres to educate them about forestry management, invasive species, rare/endangered species and wetlands protection.

Objective: Maintain state-wide Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) certification (achieved in 2008) on NYSDEC forest lands.

Actions:

- NYSDEC Bureau of Lands and Forests to correct all minor nonconformities spelled out in SFI (Ferrucci 2007) and FSC (Griffin 2007) certification audit reports.
- Express the need to state legislature to allow NYSDEC to use timber revenue to hire sufficient staff to maintain certification standards.

Objective: By 2018 establish and retain >90% vegetative cover in 100-ft stream buffers, where possible, throughout the watershed. Target efforts along reaches of Beaver Dam Brook, Trout Brook, Orwell Brook and the Lower Salmon River Main Branch that currently have <90% natural vegetation in buffer zones (Figure 22) , and several headwaters in the four lower sub-watersheds with buffers having <90% natural vegetation cover (Figure 27).

Actions:

- Utilize existing State and land trust programs for establishing voluntary conservation easements on private lands to maintain buffers in the above reaches as well as in other sub-watersheds with high development pressure (e.g., E. Branch Salmon River).
- Utilize existing agriculture programs such as Conservation Reserve Program.
- By 2010 convene discussion forums (e.g., Tug Hill Land Trust and Tug Hill Commission) with landowners to develop incentive ideas.
- Support the Salmon River Greenway Trail Project and its efforts to enhance stream bank vegetation restoration.

Goal: Maintain current hydrologic conditions (seasonal variation in flow, temperature, etc.), that are regulated through the FERC license, and which are adequate to maintain salmonine populations (steelhead and Chinook) in the <u>Main Stem Salmon River</u> (see also tributaries, below).

Objective: Maintain FERC (Federal Energy Regulatory Commission) licensing agreement, which mandates minimum seasonal baseflow requirements, through the length of the agreement (February 1, 2036).

- 285 cfs January-April
- 185 cfs May-August
- 335 cfs September-December

Actions:

- Continue annual meeting of FERC Flow Management Team to discuss state-of-knowledge on the adequacy of Main Stem Salmon River flows and reservoir levels.
    - Dave Clark, Chief of Environmental Compliance, National Park Service
    - Bruce Carpenter, New York Rivers United
    - James W. Atkinson, Supervisor, Town of Richland

- Connie Rogers, Tug Hill Chapter Trout Unlimited
- Karen Noyes, Oswego Co Planning Department
- Current member, Oswego County Legislator 2nd District
- Roy Lamberton, Alternate, Trout Unlimited
- David Stilwell, US Fish & Wildlife Service
- Bob Reinhardt, NYS OPRHP
- Ernest Wheeler, Mayor, Village of Pulaski
- Bob Adamski, Pulaski/Eastern Shore Chamber of Commerce
- Steve Murphy, Brookfield Power
- Tom Burke, Oswego Co. River Guides
- Jerry Hargrave, American Whitewater
- Frank Adams, Town of Redfield
- Representative, NYS Conservation Council
- Vaughn Roy, Brookfield Power
- Gerald P. Rasmussen, Natural Resource Supervisor, NYS DEC
- John Feltman, Division of Environmental Permits, NYS DEC
- Jim Pasco, Oswego Co. Federation of Sportsmens Clubs
- Peter Skinner, American Whitewater Affiliation
- John Elmer, Brookfield Power
- Fran Verdoliva, NYS DEC
- Dan Bishop, NYS DEC
- Bill Kuipers, Alternate, Adirondack Mountain Club
- Mark Woythal, NYS DEC

Objective: Prevent major diversions and consumptive uses of surface and groundwaters in the Salmon River Watershed by 2010.

Actions:

- Encourage NY Governor to sign NY State Great Lakes Diversion and Consumptive Uses Act (SB 4324B).
- Support Great Lakes Compact approval by US Congress.

Objective: Maintain sufficient flow to sustain critical water temperature (current best understanding is 70-72 °F), velocity (40 cms for Chinook), and dissolved oxygen (> 5 ppm) within tolerable thresholds for Chinook and steelhead, and associated macro-invertebrates.

Actions:

- NYSDEC and/or regional fisheries research stations (SUNY-ESF, Cornell University, USGS Tunison Laboratory) to assess effects of current FERC flow agreement for natural reproduction of steelhead and Chinook during critical life history stages, e.g., autumn high flows (as they influence spawning habitat and reduce mortality by angling), winter-spring (egg incubation stage), spring (emergence) and summer baseflow (juvenile and summer-returning adult habitat).

- Reestablish and maintain year-round, long-term monitoring of water temperature, velocity, discharge, and dissolved oxygen in upper (at Lighthouse Hill Reservoir by Brookfield Power), middle (USGS at Pineville Station) and lower (a new monitoring site below village of Pulaski) reaches of Main Stem.

Objective: By 2018 implement stream bank stabilization measures in key areas along the major tributaries along reaches of the Main Stem Salmon River.

Actions:

- NYSDEC to identify key areas for stream bank stabilization along the Main Stem, between Altmar and Pineville, by 2012, and implement stabilization plan by 2016 using Occidental Chemical settlement funds.

Objective*:* Maintain vegetative buffer along Salmon River Main Stem to within 10% per mile of existing cover by 2016.

Actions:

- NYSDEC, USFWS, USGS and/or regional research institutions to identify by 2013 areas that are critical for maintaining natural buffers.
- Restore streamside buffers in reaches having <90% cover by 2028 (Figure 22)
- In addition to the recent Niagara-Mohawk land acquisition, encourage DEC to acquire stream-side conservation easements on a voluntary basis, particularly on sites where a vegetated buffer would enhance stream quality. Priority segments include:
    - downstream of Sportsman Pool to County Rt. 2A;
    - downstream of County Rt. 2A through Village of Pulaski;
    - between Pulaski and the Salmon River Freshwater Estuary
- Where applicable, increase the width of vegetated buffer on newly acquired Niagara-Mohawk/National Grid properties beyond the existing vegetated stream banks.
- Utilize existing programs for establishing conservation easements on private lands.
- Utilize existing agricultural programs, such as the Conservation Reserve Program, where appropriate.
- Identify conifer-dominated stands that moderate early spring stream flow and work with private and public landowners to establish and maintain conifer components in those stands.

Goal: Maintain the hydrologic conditions (volume and seasonal variation in flow, temperature, cover) within tolerable thresholds of salmonine populations (steelhead, brook trout and Chinook salmon) in the <u>major tributaries</u> of the Salmon River.

Objective: Maintain sufficient flow to sustain critical water temperature (current best understanding is 70-72 °F), velocity (40 cms for Chinook), and dissolved oxygen (> 5 ppm) within tolerable thresholds for Chinook and steelhead, and associated macro-invertebrates.

Actions:
- NYSDEC and/or regional fisheries research stations (SUNY-ESF, Cornell University, USGS Tunison Laboratory) to assess current range of flow in major tributaries for ability to sustain natural reproduction of steelhead, brook trout and Chinook during critical life history stages, e.g., autumn flows (as they influence spawning habitat and egg deposition), winter-spring (egg incubation stage), spring (emergence) and summer baseflow (juvenile habitat).

Objective: Establish a monitoring system by 2012 to determine baseline data for ecological health (flow, temperature, water clarity, salinity) in Trout, Orwell, Beaver Dam, and Lindsay Brooks; East and North Branches of the Salmon River; and the Mad River.

Actions:
- In 2007-08, NYSDEC and regional fisheries research stations to determine most cost effective method for citing and operating gauges to adequately capture variation in hydrologic conditions in the tributaries; or to establish predictive models that link gauges to more specific locations.
- Work with private and public landowners to place gauges on major tributaries to monitor flow.
- Acquire funding for maintaining new gauges.
- Identify an objective institution to administer gauges.

Objective: By 2018 implement stream bank stabilization measures in key areas along the major tributaries.

Actions:
- NYSDEC to identify key areas for stream bank stabilization in major tributaries (Orwell-Pekin Brook, Trout Brook, Beaverdam Brook, Spring Brook) by 2016.
- NYSDEC to acquire funding and implement stabilization plans by 2018.

Objective: Maintain vegetative buffer along major tributaries at or above existing levels.

Actions:
- NYSDEC, USFWS, USGS and/or regional research institutions to identify by 2013 areas that are critical for maintaining natural buffers.
- Restore streamside buffers in reaches having <90% cover by 2028 (Figure 22)
- In addition to the ongoing Niagara-Mohawk/National Grid land acquisition (including land on the north shore of the Redfield Reservoir), encourage DEC to

acquire stream-side conservation easements particularly on sites where a vegetated buffer would enhance stream quality. Priority segments include:
  - Trout, Orwell, Beaver Dam, and Lindsay Brooks; East and North Branches of the Salmon River; Mad River; and tributaries to these streams.
- Utilize existing programs for establishing conservation easements on private lands.
- Utilize existing agricultural programs, such as the Conservation Reserve Program, where appropriate.
- Identify conifer-dominated stands that moderate early spring stream flow and encourage private and public landowners to establish and maintain conifer components in those stands.
- Encourage landowners to establish natural conifer components in other hardwood-dominated forests along riparian zones.

Objective: Assess impacts of current and projected future groundwater withdrawl from Tug Hill aquifer on the tributaries (Spring Brook, Orwell Brook-Pekin Brook, Trout Brook, Beaverdam Brook) and Main Stem of the Salmon River system by 2015.

Actions:
- Conduct USGS study to determine effects of current and projected water usage on surface water conditions.
- Identify institutional, governmental and academic partners to seek funding or appropriations for study.

THREAT: INVASIVE SPECIES

Goal: Prevent the introduction of new invasive species and the spread of existing populations within the watershed.

Objective: By 2010 institutionalize St. Lawrence-Eastern Lake Ontario (SLELO) Partnership for Regional Invasive Species Management (PRISM).

Actions*:*
- Obtain program funding from NYS and grants.
- Hire coordinator, support and seasonal staff.
- Identify office location for SLELO coordinator.
- Ensure that all future invasive species activities, including plant, animals, and diseases, in the watershed are coordinated through or with SLELO.

Objective: By 2018, double general public awareness about invasive species in the Salmon River Watershed.

Actions*:*
- By 2010, SLELO-PRISM coordinator to conduct survey that quantifies current level of awareness regarding invasive among general public.

- In 2013 and 2018, conduct repeat surveys to assess increases in public awareness.
- By 2010, SLELO-PRISM coordinator to establish network of local research scientists, resource managers and community leaders to facilitate communication among interested parties regarding status and control of invasive species.
- SLELO-PRISM coordinator to develop educational programs for schools in cooperation with agencies such as US Forest Service, US Fish and Wildlife Service, National Wildlife Federation, Cooperative Extension Youth Programs, SUNY-ESF "ESF in the Classroom" program, SUNY-Oswego Rice Creek Field Station, Lewis & Oswego County Conservation Field Days.
- Spread general, on-going messages regarding invasive species through public service announcements, editorials, press releases, newsletters.

Objective: By 2018, double awareness about invasive species among target audiences (people who live and/or recreate in areas where invasive species are likely to occur and/or engage in activities that are known to spread invasive species) in the Salmon River Watershed. Target areas include the Salmon River freshwater estuary, Redfield and Lighthouse Hill reservoirs, heavily fished reaches and more developed areas of the lower sub-watersheds. Target user groups include forest land owners, boaters, anglers, ATV clubs.

Actions:

- Utilize existing or develop new signs/flyers on invasive species issues. Distribute/ display where they are likely to occur or people who go into those areas are likely to see them (e.g., boat landings, fishing access areas, Salmon River hatchery, sporting goods outlets, bait shops, campsites, chambers of commerce, home and garden stores, plant nurseries, landowner associations, community centers).
- Distribute information materials with sporting licenses, camping permits, boat and ATV registrations on what invasive species are and how they are spread by human activities.
- Conduct public workshops in locations where invasive species exist and are likely to spread.
- Develop training workshops on invasive species for foresters and loggers, and work with existing groups (e.g. Empire State Forest Products Association, Northeastern Loggers Association) to incorporate them into their certification programs.
- Develop targeted workshops for groups that engage in the transport and trade of live organisms (e.g. proprietors and customers of food and pet retail outlets, nurseries, wood products, shipping industry).
- Engage local, county and state Departments of Transportation in invasive species identification, monitoring, and management.

Objective: By 2015, identify and monitor susceptible areas throughout the watershed that are conducive to terrestrial or aquatic invasive species establishment.

Actions:

- Establish protocols for baseline assessment and long-term monitoring programs.
- Through a combination of remote sensing and on the ground surveys (with permission), map existing populations of invasive species, likely places for new invasions (such as along transportation and stream corridors, in the freshwater estuary, in the reservoir) and Invasive Species Prevention Zones.
- Identify and incorporate existing invasive species monitoring programs (e.g. hydroplants, Salmon River hatchery) to establish a baseline occurrence database that will be administered and maintained by SLELO.
- Based on current scientific knowledge and existing modeling tools, determine criteria for susceptibility to invasive species establishment throughout the watershed.
- Establish a monitoring network of professionals and volunteers who follow protocols based on scientific research and quality assurance-quality control.
- Acquire funding sufficient to establish a scientifically rigorous program.

Objective: By 2018 implement local, regional, national and international policy initiative to eliminate or minimize new invasive species introductions, and to contain the spread of established invasive species.

Actions:

- Express support to state and federal leadership for prohibiting ocean-going vessels (which comprise 8% of Great Lakes shipping but have contributed the majority of invasive species) from the Great Lakes.
- Support state regulatory/legislative restrictions on the sale of invasive species.
- Expand the Environmental Protection Fund to include funding for early detection/rapid response and species other than plants.
- Increase funding for both monitoring and eradication of invasive terrestrial and aquatic species.
- Establish boat cleaning facilities at public launches and require them at private marinas.
- Pass local ordinances requiring boat cleaning prior to launch within the watershed.

Objective: Improve ability to manage spread of invasive species by 2013.

Actions:

- Develop criteria to determine whether a strategy of eradication, containment or managed co-existence is the most appropriate course of action in each situation.
- Develop strategies to manage environments permanently altered by invasive species.
- Have a system of coordinated responses established to deal with future invasions.

- Facilitate cooperative response to invasive species spread.
- Develop management strategies in anticipation of new invasive species and probable ecosystem changes.

Objective: Improve resistance and resilience of natural communities to impacts of invasive species by 2013.

Actions:
- Selectively utilize and maintain barriers to prevent the spread of aquatic invasives.
- Encourage management practices that improve landscape resistance and resilience to invasive species (e.g., maintenance of biodiversity and genetic diversity).

THREAT: LAND USE/LAND COVER CHANGE

Goal: Maintain current land use/cover types that have a variety of naturally occurring conifer and hardwood forest types.

Objective: By 2013 increase information to all municipal officials within the watershed to encourage resource protection through local comprehensive planning, especially where development and/or subdivision pressures are greatest.

Actions:
- Tug Hill Commission to provide more extensive and more spatially specific natural resources information to help municipalities focus development in appropriate areas.
- Tug Hill Commission and partners to develop, publish and distribute a comprehensive guide on how to design site development to minimize impacts.

Objective: Minimize (cap increase to <10% of current level) subdivision and encourage long-term land ownership within the next five years. Prioritize Pulaski area, Orwell, the Salmon River corridor within 1 mile of river from Redfield to Lake Ontario, shorelines of Redfield and Lighthouse Hill Reservoirs, and within the western sub-watersheds where development pressures are highest.

Actions:
- Implement a monitoring program to track subdivision trends within entire watershed.
- Promote landowner use of existing conservation programs (e.g., Forest Land Enhancement Program, Conservation Reserve Program, Wetland Reserve Program, Wildlife Habitat Incentive Program, Forest Legacy, NY State Conservation Landowner Incentive Program, Conservation Easements, Conservation Reserve Enhancement Program, Purchase of Development Rights, Transfer of Development Rights, Inheritance Planning) to provide landowners with financial incentives, limit development and land conversion.

- Permanently codify state reimbursement to towns experiencing greater than a 1% shift in tax revenues due to 480A enrollment.
- Increase capacity of local conservation organizations (e.g., Tug Hill Tomorrow Land Trust) to protect open space.
- Investigate creation of forest/conservation tax districts to alleviate property tax burdens and curtail land conversion.
- Express to the NY state legislature a need for a change in the tax code so that property tax values are based on current use rather than potential use.
- Express to the NY state legislature a need for a change in the tax code so that timber is no longer assessed as "real property" (Empire State Forest Products Association, NY Forest Owners Association, Nature Conservancy, Tug Hill Commission).

Objective*:* Maintain vegetative buffer along Salmon River Main Stem to within 10% per mile of existing cover, taking into account the goal of no additional loss of cover in sub-watersheds having <83% natural cover (Lower Salmon River-Main Stem, Orwell-Pekin Brook, Trout Brook, Beaverdam Brook) by 2016.

Actions:

- NYSDEC, in conjunction with partners, to inventory and map riparian areas to prioritize restoration and protection.
- Encourage NYSDEC to acquire stream-side easements, particularly on sites with wooded cover.
- Encourage public and private land owners to establish vegetated buffers.
- Develop BMP (best management practices) guidelines for riparian areas.
- Stabilize stream banks and restore vegetation in key riparian buffer areas (namely from Altmar to Pineville).
- Utilize existing programs for establishing conservation easements on private lands
- Utilize existing agricultural programs, such as the Conservation Reserve Program and the Wildlife Habitat Incentive Program, where appropriate

Objective: Restore and retain >90% vegetative cover within 540-ft wildlife corridors along all segments of the Main Branch and major tributaries in the lower sub-watersheds (i.e. Lower Salmon River-Main Stem, Orwell-Pekin Brook, Trout Brook, Beaverdam Brook, and Pennock-Coey-Kenny; Figure 26) by 2028.

Actions:

- Conduct survey to field-verify and document location of stream reaches having >90% natural cover in 540-ft buffers.
- Utilize existing programs for establishing conservation easements on private lands to maintain buffers in the above reaches as well as other sub-watersheds with high development pressure (e.g., E. Branch Salmon River).
- Utilize existing agriculture programs such as Conservation Reserve Program and the Wildlife Habitat Incentive Program.

- By 2012 convene Tug Hill Commission discussion forums with landowners to develop incentive ideas.

Objective: No net decrease of 300-ft vegetative buffers along steep slopes and 540-ft wildlife buffers along wetlands and open waters in eastern sub-watersheds by 2013.

Actions:
- Conduct survey to field-verify and document location of stream reaches having >90% natural cover in 540-ft buffers, after obtaining land owner permission for access.
- Establish and maintain properly designed trail systems and fishing access points within the 22 mile-long NYSDEC acquisition from Niagara-Mohawk.

Objective: Maintain 2008 wetland area and function in lower sub-watersheds, especially in areas currently susceptible to highest development pressures, including Pulaski area, Orwell, the Salmon River corridor within 1 mile of river from Redfield to Lake Ontario, shorelines of Redfield and Lighthouse Hill Reservoirs. Monitor on 10-year cycles.

Actions:
- Establish baseline wetland area in watershed.
- Support DEC efforts to update the map of regulated wetlands.
- Increase DEC enforcement abilities for DEC-regulated wetlands.
- Educate general public about importance of wetlands for flood control, water quality and biodiversity.
- Create incentives for landowners to maintain/restore wetland habitat, and educate landowners about existing incentive programs (Wetlands Reserve Program, Conservation Reserve Program, Conservation Reserve Enhancement Program, Ducks Unlimited, wetland banks, non-profit land trust conservation programs).
- Support state protection for unregulated wetlands (those under 12.4 acres and/or not covered under the Clean Water Act).

THREAT: PESTS, PATHOGENS AND DISEASES

Goal: Conduct research, monitoring, and public education efforts to prevent or minimize the impact of Pests, Pathogens and Diseases (PPDs).

Objective: Improve the understanding of a PPD's life history and habitat requirements to support effective management before 5% of watershed is affected by it.

Actions:
- Develop a research strategy for emerging and established PPDs (e.g. life history, population dynamics, habitat requirements, expansion mechanisms, control methods).
- Create a system for effective information exchange with and feedback from the monitoring programs.
- Create appropriate channels for information and technology transfer from researchers to educators and managers.
- Establish funding sources to develop all of the above.

Objective: Increase general public awareness of PPDs for 80% of the population by 2026.

Actions:
- Develop cooperative educational programs for schools (e.g., with US Forest Service, US Fish and Wildlife Service, National Wildlife Federation, Cooperative Extension Youth Programs, SUNY-ESF "ESF in the Classroom" program, SUNY-Oswego Rice Creek Field Station, Lewis & Oswego County Conservation Field Days, SLELO).
- Spread general, on-going messages regarding PPDs through public service announcements, editorials, press releases, newsletters.

Objective: By 2026, double awareness about PPDs among target audiences (people who live and/or recreate in areas where PPDs are likely to occur and/or engage in activities that are know to spread PPDs) in the Salmon River Watershed.

Actions:
- Develop signs/flyers on PPD issues and distribute/display where they are likely to occur (e.g., boat landings, fishing access areas, Salmon River hatchery, sporting goods outlets, bait shops, campsites, chambers of commerce).
- Distribute information materials with sporting licenses, camping permits, boat and ATV registrations.
- Develop and conduct workshops on PPDs for bait dealers and farmers, game farmers, and private aquaculturists.

Objective: By 2015, establish monitoring/assessment process to improve detection precision of changes in existing PPD populations or those that pose imminent threats by 50%.

Actions:

- Identify and consolidate existing PPD monitoring programs (e.g., NYSDEC, USFS Forest Inventory & Analysis Plots) to establish a PPD baseline occurrence database.
- Based on current scientific knowledge and existing modeling tools, determine criteria for susceptibility to PPD establishment throughout the watershed, and identify areas where new introductions are likely.
- Develop a system for information exchange.
- Identify gaps in existing monitoring programs and develop a strategy to fill them.

Goal: Develop and implement plans for introduction prevention, eradication, containment or managed co-existence of PPD within the watershed.

Objective: Improve ability to manage outbreaks of PPDs by 2013.

Actions:

- Develop criteria to determine whether a strategy of eradication, containment or managed co-existence is the most appropriate course of action.
- Develop strategies to manage environments permanently altered by PPDs.
- Have a system of coordinated responses established to deal with future PPD outbreaks.
- Facilitate cooperative response to PPD outbreaks.
- Develop a checklist for evaluating management decisions based on PPDs (State Environmental Quality Review, internal agency policies and procedures).
- Develop management strategies in anticipation of impending PPD outbreaks and probable ecosystem changes.

Objective: Improve resistance and resilience of natural communities to impacts of PPDs by 2013.

Actions:

- Utilize and maintain barriers to prevent the spread of aquatic PPDs (one specific example is placing a new barrier on Pekin Brook to halt spread of lamprey and eliminate the need for lampricide).
- Encourage management practices that improve landscape's resistance and resilience to PPD outbreaks (e.g., maintenance of biodiversity and genetic diversity).

THREAT: PHYSICAL HABITAT DISTURBANCE

Goal: Prevent physical habitat disturbance (including human and natural) from degrading or eliminating natural communities.

Objective: Establish buffers by 2012 for Natural Heritage elements using important areas modeling developed by the NY Natural Heritage Program.

Action:

- Ground truth the presence of elements that were identified by element distribution models (Howard 2006) where land owners grant permission for access.
- Identify appropriate buffer distances for each element type.
- Conduct outreach and education on prioritized areas to all town and county planners by 2012
- Prioritize on the ground actions for conservation of buffered target areas and lands by 2018.

Objective: Maintain current 2008 wetland area and function in lower sub-watersheds, especially in areas currently susceptible to highest development pressures, including Pulaski area, Orwell proper, the Salmon River corridor within 1 mile of river from Redfield to Lake Ontario, shorelines of Redfield and Lighthouse Hill Reservoirs

Actions:

- Support DEC efforts to update the map of regulated wetlands.
- Increase DEC enforcement abilities for DEC-regulated wetlands.
- Educate general public about importance of wetlands for flood control, water quality and biodiversity.
- Create incentives for landowners to maintain/restore wetland habitat, and educate landowners about existing incentive programs (Wetlands Reserve Program, Conservation Reserve Program, Conservation Reserve Enhancement Program, Ducks Unlimited, wetland banks, non-profit land trust conservation programs).
- Support state protection for unregulated wetlands (those under 12.4 acres and/or not covered under the Clean Water Act).

Objective: Ensure that the net impact of beaver activity across the watershed does not reduce viability of headwater stream and wetland communities below a “good” condition (as defined in the viability analysis) over the next 10 years.

Actions:

- Identify streams (e.g., Trout Brook and Orwell-Pekin Brooks) where beaver activity may need to be limited in order to meet other management objectives, such as sea lamprey control, natural reproduction of salmonines and other cold water fish.

- Make it possible to obtain a permit (via the "other" category) for beaver removal based on ecological management considerations (such as those described above), in addition to current nuisance permit program.
- Work with DEC wildlife staff to determine beaver population goals sufficient to maintain the natural process of wetland creation and conversion to ensure a diversity of wetland communities are present within the watershed.
- Work with DEC wildlife staff to remove beaver during an established trapping season. Nuisance permits can be used for those locations where other management techniques are ineffective.

Goal: Improve and maintain the quality and diversity and function of terrestrial and aquatic systems

Objective: Develop and implement BMPs for rare/endangered species and communities that are particularly vulnerable to physical habitat disturbance by 2012.

Actions:
- Develop a list of priorities for species and communities using vulnerability guides developed by NY Natural Heritage (www.guides.nynhp.org).
- Update NY Heritage data and guides for 50% of priority species and communities by 2018,
- Educate/advise landowners on those management practices for rare/endangered species.
- Send landowner packets over the next 5 years to landowners of more than 50 acres in the watershed to educate them about forestry management, invasive species, rare/endangered species, wetlands, etc. Identify grant to cover costs (similar to dune packets done by Sea Grant with a grant).

Objective: Minimize subdivision (to an additional 10% of 2008 level) and encourage long-term land ownership over next 5 years in priority areas (e.g. Orwell; 1-mile-wide corridor along Salmon River from Redfield to Lake Ontario; reservoir shorelines; and the lower sub-watersheds (Orwell Brook, Beaverdam Brook-Meadow Creek, Trout Brook, Lower Salmon River)); and focus development and subdivision in villages and hamlets where infrastructure is present (Villages of Pulaski and Altmar, Hamlets of Orwell and Redfield).

Actions:
- Promote landowner use of existing conservation programs (e.g., Forest Land Enhancement Program, Conservation Reserve Program, Wetland Reserve Program, Forest Legacy, NY State Conservation Landowner Incentive Program, Conservation Easements, Conservation Reserve Enhancement Program, Purchase of Development Rights, Transfer of Development Rights, Inheritance Planning) to provide landowners with financial incentives, limit development and land conversion.

- Permanently codify state reimbursement to towns experiencing greater than a 1% shift in tax revenues due to 480A enrollment.
- Increase capacity of local conservation organizations (e.g., Tug Hill Tomorrow Land Trust) to protect open space.
- Investigate creation of forest/conservation tax districts to alleviate property tax burdens and curtail land conversion.
- Express to the NY state legislature a need for a change in the tax code so that property tax values are based on current use rather than potential use
- Express to the NY state legislature a need for a change in the tax code so that timber is no longer assessed as "real property" (Empire State Forest Products Association, NY Forest Owners Association, Nature Conservancy, Tug Hill Commission).

Objective: Increase by 10% the acreage of private forest land enrolled in sustainable forest management programs (e.g., Forest Stewardship Council, Sustainable Forestry Initiative, Tree Farm) by 2018, particularly where DEC has identified the highest potential for Forest Stewardship Program benefits (Figure 9).

Actions:

- Determine current amount of forest land enrolled in sustainable management programs.
- Permanently codify state reimbursement to towns experiencing greater than a 1% shift in tax revenues due to 480A enrollment.
- Develop outreach materials and programs, perhaps including DEC staff time devoted to landowner interaction.
- Enable FSC training for local consulting foresters to become FSC-certified in order to enroll forest owners.
- Send landowner packets over the next 5 years to landowners of more than 50 acres in the watershed to educate them about forestry management, invasive species, rare/endangered species, wetlands, etc. Identify grant to cover costs (similar to dune packets done by Sea Grant with a grant).

Objective: Maintain state-wide Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) certification (achieved in 2008) on NYSDEC forest lands.

Actions:

- NYSDEC Bureau of Lands and Forests to correct all minor nonconformities spelled out in SFI (Ferrucci 2007) and FSC (Griffin 2007) certification audit reports.
- Express the need to state legislature to allow NYSDEC to use timber revenue to hire sufficient staff to maintain certification standards.

Goal: Reduce current and minimize future adverse effects of non-motorized recreational disturbances to all targets within the watershed while maintaining appropriate recreational access opportunities.

Objective: Develop a formalized trail system associated with the state easements along Salmon River from Redfield to Pulaski (~22 miles), where feasible. Complete entire trail system by 2026, and 5 miles of trail by 2017.

Actions:
- Provide adequate funds (at least $100,000/mile)
- Develop and construct 5 educational kiosks along Salmon River trail system and/or at key access points by 2017.

Objective: Educate 100% of landowners owning property restricted by conservation easements about permissible activities and the need to abide by restrictions, and inform adjacent landowners about permissible activities on neighboring lands and benefits of voluntary private land protection, by 2013.

Actions:
- Develop an ongoing strategy to work with landowners
- Identify priority conservation easement areas for outreach and education.

Objective: Work with all guides association and other legally registered guides (licensed by DEC) by 2010 to decrease by 50% habitat alteration along the river and educate about the importance of habitat.

Action:
- Hold educational meetings.
- Send technical habitat information.
- Identify priority sites to prevent habitat alterations.

Goal: Reduce current and minimize future adverse effects of motorized recreational disturbances to all targets within the watershed while maintaining appropriate recreational access opportunities.

Objective: Eliminate illegal use of ATVs on non-designated trails such as snowmobile and cross-country ski trails by 2018.

Actions:
- NYSDEC, in conjunction with local research partners and local ATV clubs (e.g., Oswego County ATV Club), to survey the extent and intensity of ATV use within watershed, by 2013.

- NYSDEC, in conjunction with local research partners and local ATV clubs (e.g., Oswego County ATV Club), to survey locations where ATV trails intersect sensitive ecological areas by 2013.
- Apply collected ATV registration fees to enforce ATV laws by hiring two DEC law enforcement officers by 2013.
- Establish and maintain an ATV trail system designed to avoid sensitive ecological areas and that follows best management practices for trail construction.
- Enact legislation to allow stiffer penalties for illegal operation of motorized recreational vehicles (ATVs, snowmobiles, dirt bikes), such as seizure of equipment, and enable admission of alternative evidence for conviction, such as photographs.

THREAT: SEDIMENTATION AND POLLUTION

Goal: Maintain or improve current state classification of Salmon River (Currently class C(t), which means designation for fishing, recreation and fish propagation).

Objective: Increase awareness of the causes and consequences of sedimentation and pollution (both point and non-point) to Salmon River and its tributaries for 75% of the individuals in target audiences (see table below) by 2015.

Actions:

- By 2008, inventory existing educational materials and programs and compare them with the table of identified needs (below).
- Update existing program information and tailor the programs for all audiences by mid 2009.
- Deliver relevant educational programs.

ABOUT	TO/WHERE (Audience)
Septic system operation and maintenance	Homeowners, realtors, home associations, town officials, enforcement officers, kids/schools
Recreational impacts	ATV safety trainers, sportsman groups, trail head kiosks, web sites, enforcement officers, stewards, sporting goods stores, local businesses, bait shops
Recycling and waste disposal	Schools/kids, stores, landfills/trash collectors
BMP requirements, methods, benefits, uses, info sources	Landowners, town officials, farmers, foresters, loggers, contractors that use heavy equipment, schools/kids
Permits	Same as above for BMPs
Water quality	Schools/kids, watershed groups, and all of the above audiences and groups

Objective: Achieve and maintain 100% compliance with point source permitting (NYSDEC Non-Point Source Discharge Elimination System) by 2009. The following facilities currently maintain NPDES permits: Felix Schoeller Technical Papers; Pulaski Sewage Treatment Plant, Pulaski; Pulaski Ford and Mercury, Pulaski; New York State Fish Hatchery, Altmar.

Actions:

- Re-evaluate/update NY State stream quality ratings for the main branch and major tributaries.
- Increase regulatory staffing at DEC.
- Achieve 100% enforcement and stiffen penalties for non-compliance.

Objective: Reduce levels of municipal stormwater discharge by 50% by 2028.

Actions:

- Commission targeted, synoptic survey of surface water quality to identify locations of potential pollution loading from municipal non-point sources by 2012.
- Encourage the NY State Building Code Council to review code for stormwater BMPs to focus on impacts of water discharges relative to sedimentation and pollution.
- Expand MS4 Performance Measures on a statewide basis.
- Inform local and state leaders of the benefits of the low volume road designation.
- Provide incentives to reduce usage and properly store road sand and salt, particularly along critical waterways.
- Provide incentives to towns to follow stormwater BMPs and establish stormwater collection systems where appropriate.

Objective: Increase proper disposal of municipal solid and hazardous waste by 50% by 2013.

Actions:

- Provide annual local funding and opportunities for collection and disposal of municipal household hazardous waste (e.g., County Household Hazardous Waste Days), used motor oil and tires.
- Enable/support free and accessible recycling and waste disposal facilities.
- Create fish waste collection and beneficial reuse program.

Objective: Reduce pollution from septic system operations in sensitive areas by 50% by 2018.

Actions:

- Assess adequacy of state and county resources for administration and enforcement of septic system regulations.
- Determine areas sensitive to pollution from septic systems.

- Commission a targeted survey of sensitive areas of septic systems near susceptible surface waters (e.g., freshwater estuary).
- Provide homeowner incentives (e.g., grant programs, free voluntary inspections, low-interest loans) for proper maintenance and improvement of existing septic systems.

Objective: Reduce pollution and sedimentation from new development by 50% through low-impact development and smart planning by 2018.

Actions:

- By 2014, change tax codes to reduce conversion of agricultural and forest lands for development (i.e., assess based on current land use; eliminate valuation of standing timber as real property).
- Provide technical assistance and incentives for communities to develop comprehensive plans that incorporate smart growth principles.
- Provide more extensive and spatially specific natural resources information to help municipalities focus development in appropriate areas.
- Develop, publish and distribute a comprehensive guide on how to site/manage development to minimize impacts.

Objective: Reduce sedimentation and pollution from non-point sources, such as logging, construction, agricultural activities and road maintenance by 25% by 2013.

Actions:

- Commission study to determine current level of and most important contributors to bank destabilization and sedimentation in the watershed.
- Prioritize locations for bank stabilization activities.
- Expand the use of timber harvesting best management practices by educating foresters, loggers, and forest landowners about the New York Forestry Best Management Practices Field Guide.
- Ensure that BMP workshops are offered annually as part of the New York Trained Logger Certification Program (ESFPA)
- Promote 3 forest BMP workshops in the next 3 years among landowners.
- Create incentives for loggers to gain FSC or New York Trained Logger certification, and for marketing certified forest products.
- Work with highway departments to implement best maintenance practices (e.g., Adirondack Highway Department Green Book) to reduce road salt and sand application and run-off.
- Include chloride monitoring in watershed water quality monitoring program.

THREAT: REGIONAL/GLOBAL ISSUES

Goal: Facilitate local action within the watershed to contribute to international initiatives aimed at abating global climate change.

Objective: Encourage immediate local energy conservation initiatives in homes, businesses and public facilities and adoption of renewable energy technology to reduce local carbon emissions by 2018.

Actions:

- Implement region-wide, residential and commercial energy conservation initiatives through partnerships with New York Energy Smart and the Syracuse Center of Excellence in Environmental and Energy Systems (Syracuse CoE).
- Within constraints of ecologically sustainable supplies (i.e., as determined through FSC certification) develop regional low grade forest product markets (biomass-to-energy, wood heating, ethanol).
- Develop incentives for co-generation of electricity.
- Encourage development and use of local biodiesel fuels.
- Create and support incentives that encourage forest landowners to keep intact forest lands.

Objective: Increase participation by individuals and businesses in energy conservation initiatives and renewable energy technology by 2013.

Actions:

- Support and participate in research that further elucidates net negative and positive impacts of wind energy developments on wildlife.
- Commission research to estimate and project region-wide sustainable yield of wood products from agricultural and woodland sources that could supply regional wood heat, biomass-to-energy, and cellulosic ethanol production without diminishing forest ecosystems or quality of water and soil resources.
- Encourage participation of local farmers and business leaders in Syracuse CoE/SUNY-ESF willow biomass project to evaluate its commercial viability, ecological impacts, and capacity to reduce net regional carbon emissions.
- Encourage participation of local farmers and business leaders in dairy waste-to-energy, manure and food waste co-digestion research into methane reduction, conducted through Syracuse CoE, Clarkson University and Cornell University.
- Encourage local farmers and business leaders to participate in Northeast Region Sun Grant Initiative (Cornell University) to develop diverse agricultural practices to support emerging biobased industries.

Objective: Support adoption of the Regional Greenhouse Gas Initiative (REGGI) by 2010.

Actions:
- Express to NYS legislators the benefits of regional measures to reduce carbon emissions.
- Establish Regional Greenhouse Gas Initiative (REGGI) carbon trading system that leads to long-term sequestration of carbon through forest management and production of durable goods, based on the best available science.

Goal: Improve understanding of mercury, nitrogen and acid deposition impacts to regional aquatic and terrestrial ecosystems and communicate information to state and federal regulators and policy makers.

Objective: Begin investigation levels of mercury contamination in soils, sediments, flora and fauna of the watershed by 2010.

Actions:
- Utilize guidance from the NY State Wildlife Grant Program research project entitled "Biogeography of mercury contamination in New York – risk to species of greatest conservation need" to establish continued research programs on private and state land in the watershed with local research laboratories (e.g., Syracuse University, Clarkson University) that:
  - assesses current levels of mercury contamination in soils, sediments, invertebrates, insectivorous song birds and bats, turtles, amphibians and predatory fish and mammals;
  - determines the sources and fate of mercury in the respective upper and lower sub-watersheds and the Redfield and Lighthouse Hill reservoirs.

Objective: Monitor effects of nitrogen and acid deposition on terrestrial and aquatic communities of the watershed.

Actions:
- Encourage local research laboratories (e.g., Syracuse University, Clarkson University, SUNY-ESF, SUNY-Oswego) to establish long-term monitoring stations for forest and headwater streams in the upper and lower sub-watersheds to monitor trends in :
  - in stream water N, acid and alkalinity;
  - soil and vegetation nitrogen accumulation and acidification.

Goal: Create, maintain, and manage terrestrial and aquatic ecological communities in the watershed that can adapt to and recover from the effects of global change.

Objective: Improve adaptability and recovery ability of Salmon River watershed forest and stream habitats by establishing and protecting connective corridors with adjacent largely undeveloped areas, such as the Adirondacks, and by decreasing isolation of woodlands in the Lake Plain forests by 2028.

Actions:

- The Nature Conservancy to complete connectivity modeling for wide ranging mammal species between the Tug Hill and Adirondacks by 2013.
- Work with private and public cooperators to improve natural habitat corridor through area including Webster Hill, Jackson Hill, Buck Hill, Clark Hill, Benn Hill State Forest, and across the Black River Valley to provide migration routes for wide ranging mammal species between the Adirondacks and Tug Hill.
- Establish integrated, private and/or public woodland preserve system in lower sub-watersheds that creates large, connected forest parcels that typify the lower elevation Lake Plain forest type by 2028.
- Identify appropriate areas to eliminate effects of man-made barriers (culverts, bridge abutments, dams) on the habitat and movement of aquatic organisms and amphibians by 2013.
- Implement findings or apply locally the methodology of NY State Wildlife Grant Program research on "Incorporating aquatic SGCN requirements and conservation objectives into state transportation planning" that will:
    - prioritize streams across New York using models for SGCN and their habitats as criteria;
    - identify the most important culverts, dams, and bridges for improving and restoring SGCN habitat and ecosystem functions;
    - prioritize the previous results based on the existing DOT five-year transportation plan and maintenance program.

Objective: Maintain or increase the current (2008) diversity of community types and occurrences of rare species within terrestrial and aquatic habitats.

Actions:

- Increase resources available to NY Natural Heritage Program to monitor occurrences of aquatic species and community types, and to maintain up-to-date records of occurrences for the following heritage elements that occur within the watershed:

<u>plants</u>

Jacob's ladder, *Polemonium vanbruntiae*
wild Sweet-William, *Phlox maculata* ssp. *maculata*
broad-lipped twayblade, *Listera convallarioides*
lesser bladderwort, *Utricularia minor*
bird's-eye primrose, *Primula mistassinica*
yellow mountain-saxifrage, *Saxifraga aizoides*
sand dune willow, *Salix cordata*
low sand-cherry, *Prunus pumila* var. *pumila*
ram's-head lady slipper, *Cypripedium arietinum*
slender bulrush, *Schoenoplectus heterochaetus*
giant pine-drops, *Pterospora andromedea*)
pod grass (*Scheuchzeria palustris*)

<u>animals</u>

northern harrier, *Circus cyaneus*
bald eagle, *Haliaetus leucocephalus*
least bittern, *Ixobrychus exilis*
pied-bill grebe, *Podilymbus podiceps*
black tern, *Chlidonias niger*
three-toed woodpecker, *Picoides dorsalis*
pitcher plant borer moth, *Papaipema appassionato*
lake sturgeon, *Acipenser fulvescens*

- Promote a focus on regenerating diverse forest tree species.
- Educate landowners about the economic and ecological benefits of selection system and timber stand improvement cuts, as well as the responsible application of even-age stand management.
- Promote establishment of diversity of forest habitat structures (coarse woody debris, trees representing natural range of diameter classes, a mix of hardwood and conifer components) to sustain a broad diversity of forest-dwelling organisms.
- Increase private and state landowner participation in FSC certification programs.
- In anticipation of future climate change, establish long-term monitoring program to establish current baseline physical, chemical and flow conditions in river reaches throughout the watershed and detect future changes.
- In anticipation of future climate change, maintain minimum baseflows in river reaches throughout the watershed that are sufficient to keep physical and chemical parameters within natural range of variation.

IV Feedback on Implementation of Proposed Strategies

Follow-up groups consisting of regional resource managers, scientists, government officials, citizens, business representatives will be established to facilitate periodic (10-yr cycle) review of assessment and progress in implementation of strategies. Baseline information from the Viability Analysis will be used to inform future assessments of resource condition, and to adapt future strategies for sound resource management.

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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
SUNY Oswego
New York Sea Grant
NYS Tug Hill Commission

Prepared by:
Deborah Forester
Engaging People

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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
Tug Hill Tomorrow Land Trust

Linda Gibbs
NYS Tug Hill Commission

Christine Gray
Oswego County Dept. of Planning and Tourism

Charlie Hall
SUNY ESF

Tim Howard
NYNHP

Jim Johnson
Tunison Laboratory of Aquatic Science

Marie Kautz
NYS DEC

Dave MacNeil
NY Sea Grant

Amy Mahar
NYS DEC Region 8

Katie Malinowski
NYS Tug Hill Commission

Dick McDonald
NYS DEC

Greg McGee
SUNY ESF

Jim McKenna
Tunison Laboratory of Aquatic Science

Bob McNamara
Self-employed

John Muller
Gutchess Lumber

Fred Munk
NYS DEC Region 6

Richard Pancoe
NYS DEC

Michelle Peach
The Nature Conservancy

Mary Penney
NY Sea Grant

Jerry Rasmussen
NYS DEC

Peter Rosenbaum
SUNY Oswego, Dept. of Biological Sciences

Dan Sawchuck
NYS DEC

Rich Smardon
SUNY ESF

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

<u>Key ecological attribute – Nutrient load</u>
<u>Indicators</u>
- Nitrogen – trates – trites
- Phosphorus
- pH
- dissolved oxygen (water or soil characteristics
- conductivity

** range of variability will depend on specific wetland type

<u>Key ecological attribute – Buffer/Wetland edge</u>
<u>Indicators</u>
- 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

<u>Range of variability – Wetland buffer Indicators</u>

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

<u>Key ecological attribute – Intact hydrology</u>
<u>Indicators</u>
- 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

<u>Target: Forest</u>

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	
Advance Materials						**Comments**
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

SALMON RIVER WATERSHED
NATURAL RESOURCE ASSESSMENT

PROCEEDINGS OF WORKSHOP TWO: THREAT IDENTIFICATION AND SITUATION ANALYSIS

Salmon River Watershed
Natural Resources Assessment

Workshop Two: Threat Identification and Situation Analysis

A Report of Workshop Process and Products

May 4, 2007

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
SUNY Oswego
New York Sea Grant
NYS Tug Hill Commission

Prepared by:
Deborah Forester
Engaging People

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Appendices

Introduction

On May 4, 2007, a workshop was held in the Snow Building in Pulaski, NY to further the conservation planning process for the Salmon River Watershed as part of the Salmon River Watershed Natural Resource Assessment Project. The overall project objectives are to develop a hands-on land use planning tool for the Salmon River watershed that highlights the significant natural resource assets in the area, and can be used to guide local planning efforts, Department of Environmental Conservation management, and individual land use decisions.

This evaluative 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 primary 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 potential threats to the conservation targets (identified in an earlier workshop), and
2. Complete situation analyses to identify indirect threats and causal pathways.

Participants

Forty-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.

Threats Identification

The first step in the planning process was to identify conservation targets. In a workshop held September 25, 2006, 38 participants identified seven important conservation targets within the watershed. Those targets were:

- Freshwater Estuary
- Gorge/Falls/Cliffs
- Headwater Streams
- Main Stem Salmon River and its Tributaries
- Matrix Forest
- Non-Estuarine Wetlands
- Open Waters

During this second workshop, working in small groups, participants began by identifying direct threats to each conservation target. A direct threat is an agent or factor that directly degrades a target. Considering a ten-year time period, participants then ranked each direct threat on a scale of 1 (low) to 4 (high) for each of three characteristics: scope, severity, and irreversibility.

Scope was defined spatially as the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation). Severity was defined as the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances. Irreversibility was defined as the degree to which the effects of a direct threat can be restored. Irreversibility refers to the "effects of the direct threat on the target" not the direct threat itself; it is the "recoverability" of the target from the effects of the threat.

The scores for each characteristic were then added to provide a simple index ranking the seriousness of each threat. The index is a relative ranking of each threat in this watershed, for this target. The index number has no significant relevance outside of this exercise. Those threats with the highest rankings were deemed "critical" for the identified target.

For each of the conservation targets the following critical threats were identified (for a list of all direct threats associated with each target, and their scores and index number, please see Appendix Two).

- Freshwater Estuary
    - Invasive species
    - Pests/Disease/Pathogens
    - Altered hydrology
    - Climate change

- Gorge/Falls/Cliffs
    - Terrestrial invasives
    - Loss of soil/habitat
    - Atered Hydrology
    - Humidity

- Headwater Streams
    - Temperature stress
    - Habitat changes
    - Water Chemistry changes

- Main Stem Salmon River and its Tributaries
  - Invasive Species
  - Removal of riparian vegetation
  - Atered Hydrology
  - Sedimentation
  - Increased water temperature
  - Fish disease
  - Acid rain

- Matrix Forest
  - Land-use change
  - Climate change
  - Failure to regenerate
  - Severe climate
  - Loss of microhabitats

- Non-Estuarine Wetlands
  - Atmospheric Deposition
  - Invasive Species
  - Nonpoint Source Pollution
  - Altered Hydrology
  - Physical disturbance

- Open Waters
  - Atmospheric Deposition
  - Invasive Species
  - Nonpoint Source Pollution

Situation Analyses

The next step in the planning process was to develop situation analyses for each target. To achieve conservation critical threats must be abated and degraded targets restored. To do this effectively, requires an understanding of the system or situation that drives these problems and identifying promising conditions that may lead to solutions. This means understanding the biological, political, economic, and socio-cultural context within which targets exist – in particular, the indirect threats and opportunities behind each critical threat.

The purpose of this exercise was to start building a conceptual model for each target. A conceptual model is a diagram of a set of relationships between certain factors that are believed to impact targets. In other words, it illustrates the things ("factors") that have an impact on the targets. The goal was to identify the indirect threats that affect or cause the direct threats. The situations analysis for each target is meant to present a picture of the situation at the site, illustrate the critical threats and indirect threats, and show the assumed relationships between factors affecting the target. Situation analyses for each target 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-one 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.

Seventy-two percent of participants generally or strongly agreed that they understood the purpose of the Salmon River Watershed Natural Resources Assessment, and 85% felt that their time at the workshop was well spent. Over 80% of participants generally or strongly felt that the process of selecting and ranking the threats was productive; and 86% of respondents felt similarly about the process for completing the situation analysis. 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 “very good” or better by most participants. Participants rated workshop logistics higher than they had for the first workshop.

Next Steps

The Nature Conservancy will collate the threats information and situation analyses for each target. Using the data collected, the most critical threats for the entire watershed will be determined. The data and diagrams will be put into a form useful for sharing with workshop participants and other interested stakeholders.

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 third workshop to identify strategies to abate the critical threats is planned for June 21, 2007. It is anticipated that many of the participants of this workshop will attend. They will be joined by additional people with knowledge of the Salmon River Watershed and its resources. Feedback from workshop participants and other stakeholders will help to inform the development of appropriate conservation strategies.

Appendix One – Workshop Participants

Frances Adams
Town of Redfield

Paul Baxter
Salmon Rivers Council of Governments

Tom Bell
NYSDEC, Region 7

Bruce Brach
Harden Furniture, Inc.

Russ Briggs
SUNY ESF

Janet Clerkin
Oswego County Dept. of Tourism & Promotion

Patrick Crast
Harden Furniture, Inc.

Debbie Forester
Workshop Facilitator

Kristin France
The Nature Conservancy

Linda Garrett
Tug Hill Tomorrow Land Trust

Linda Gibbs
NYS Tug Hill Commission

Jennifer Harvill
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Tunison Laboratory of Aquatic Science

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Kwasniewski Club

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Ernie Wheeler
Village of Pulaski

Dave Zembiec
NYS Tug Hill Commission

Appendix Two – Direct Threats

Groups identified direct threats to each target, and then rated those threats on the criteria of scope, severity, and irreversibility. An additive process gives a simple index that ranks the seriousness of each threat. The importance is the relative ranking of each threat, not the index number per se.

Freshwater Estuary

Direct Threat	Scope	Severity	Irreversibility	Index
Invasive Species	4	4	3	11
Pests/Disease/Pathogens	3	4	4	11
Altered Hydrology	4	3	3	10
Climate Change	4	3	3	10
River Flow Alteration	4	2	1	7
Habitat Alteration	2	2	3	7
Pollution	2	2	2	6
Toxins	2	2	2	6

Gorge/Falls/Cliffs

Direct Threat	Scope	Severity	Irreversibility	Index
Terrestrial Invasives	3	4	3	10
Loss of soil/habitat	3	3	4	10
Altered Hydrology	2	4	3	9
Humidity	2	4	3	9
Light conditions	1	2	3	6
Aquatic invasives	1	2	3	6
Direct taking	1	3	2	6
Recreation	2	2	2	6
Vegetation cover	1	2	3	6
Bypass baseflow	1	3	1	5

Headwater Streams

Direct Threat	Scope	Severity	Irreversibility	Index
Temperature stress	4	3	4	11
Habitat changes	4	3	2	9
Water Chemistry changes	4	2	3	9
Non-native species (upper)	1	2	3	6
Invasive species	1	2	3	6
Lack of GW discharge	1	1	3	5
Physical stream impacts	2	2	1	5
Siltation/erosion (acceleration of)	2	1.5	1	4.5
Alterations to stream Structure/geomorphology	1	1	2	4

Headwater Streams

Direct Threat	Scope	Severity	Irreversibility	Index
Invasive species	4	3	4	11
Removal of riparian vegetation	3	3	4	10
Altered Hydrology	4	3	3	10
Sedimentation	3	4	3	10
Increased water temperature	3	3	4	10
Fish disease	3	3	4	10
Acid rain	3	3	4	10
Land cover change	2	3	4	9
Beaver	2	3	3	8
Increased evaporation	3	1	4	8
Toxins	3	2	3	8
Channelization	2	3	2	7
Change in base flow	2	3	2	7
Diversion of water	3	2	2	7
Increased nutrient loading	1	2	3	6
Aquatic invasives	2	2	2	6
Overfishing	1	1	2	4
Stocking	1	1	1	3
New barriers	1	1	1	3

Matrix Forest

Direct Threat	Scope	Severity	Irreversibility	Index
Climate change	4	1	4	9
Land Use Change	2	3	4	9
Severe Weather	1.5	3	4	8.5
Failure to regenerate	3.5	3	2	8.5
Loss of microhabitats	3	3	2	8
Fragmentation	2.5	1	3	6.5
Pests/Disease/Pathogens	3.5	3	2.5	6.5
Change in species diversity	1	2.5	3	6.5
Invasive Species	1	1	3	5

Non-Estuarine Wetlands

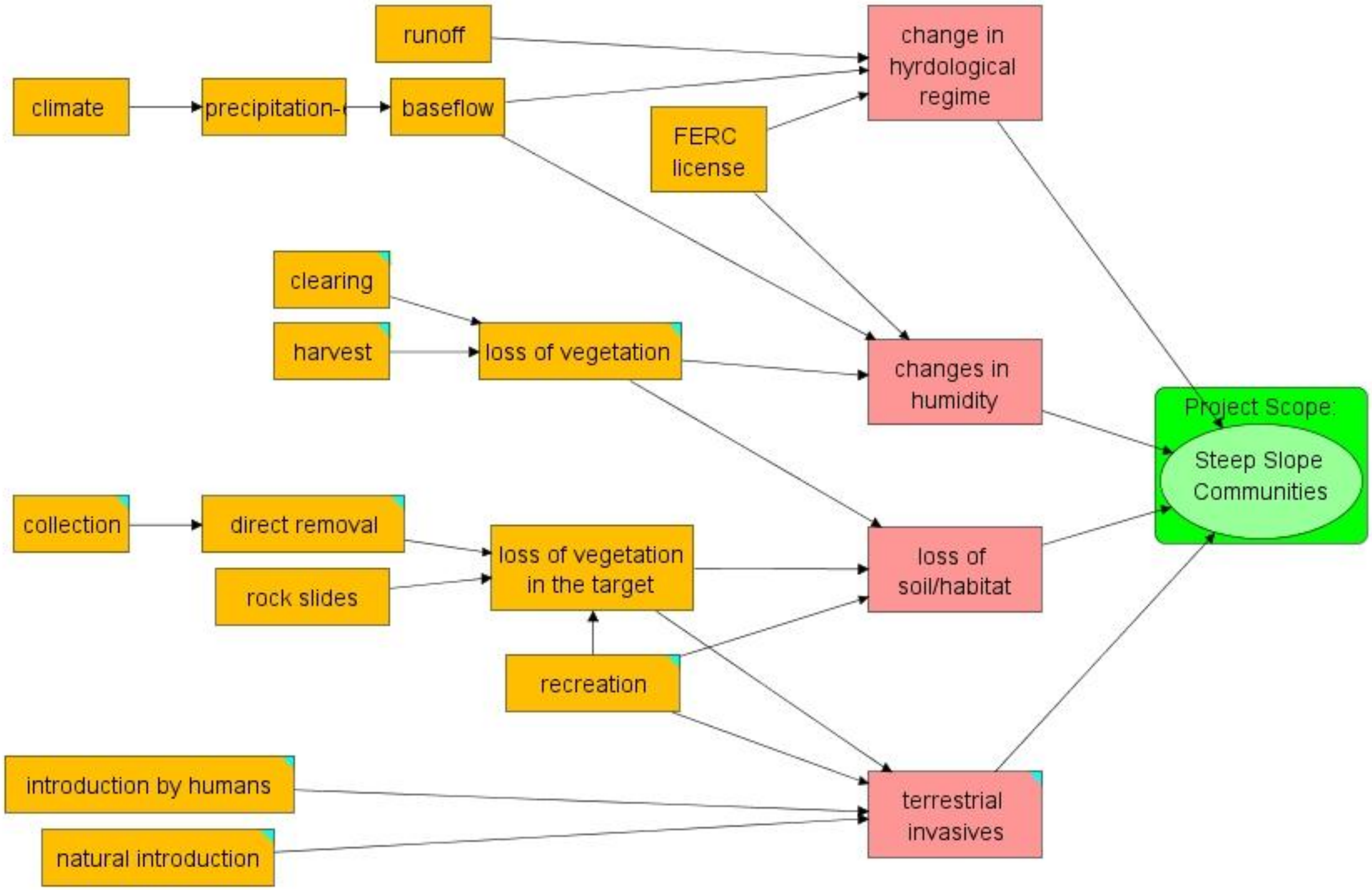
Direct Threat	Scope	Severity	Irreversibility	Index
Atmospheric Deposition	4	4	4	12
Invasive Species	4	3	3	10
Nonpoint Source Pollution	2	3	4	9
Altered Hydrology	3	3	2	8
Physical Disturbance	4	2	2	8
Beavers	3	3	1	7
Removal of Cover	3	1	1	5
Temperature Change	1	1	1	3

Open Waters

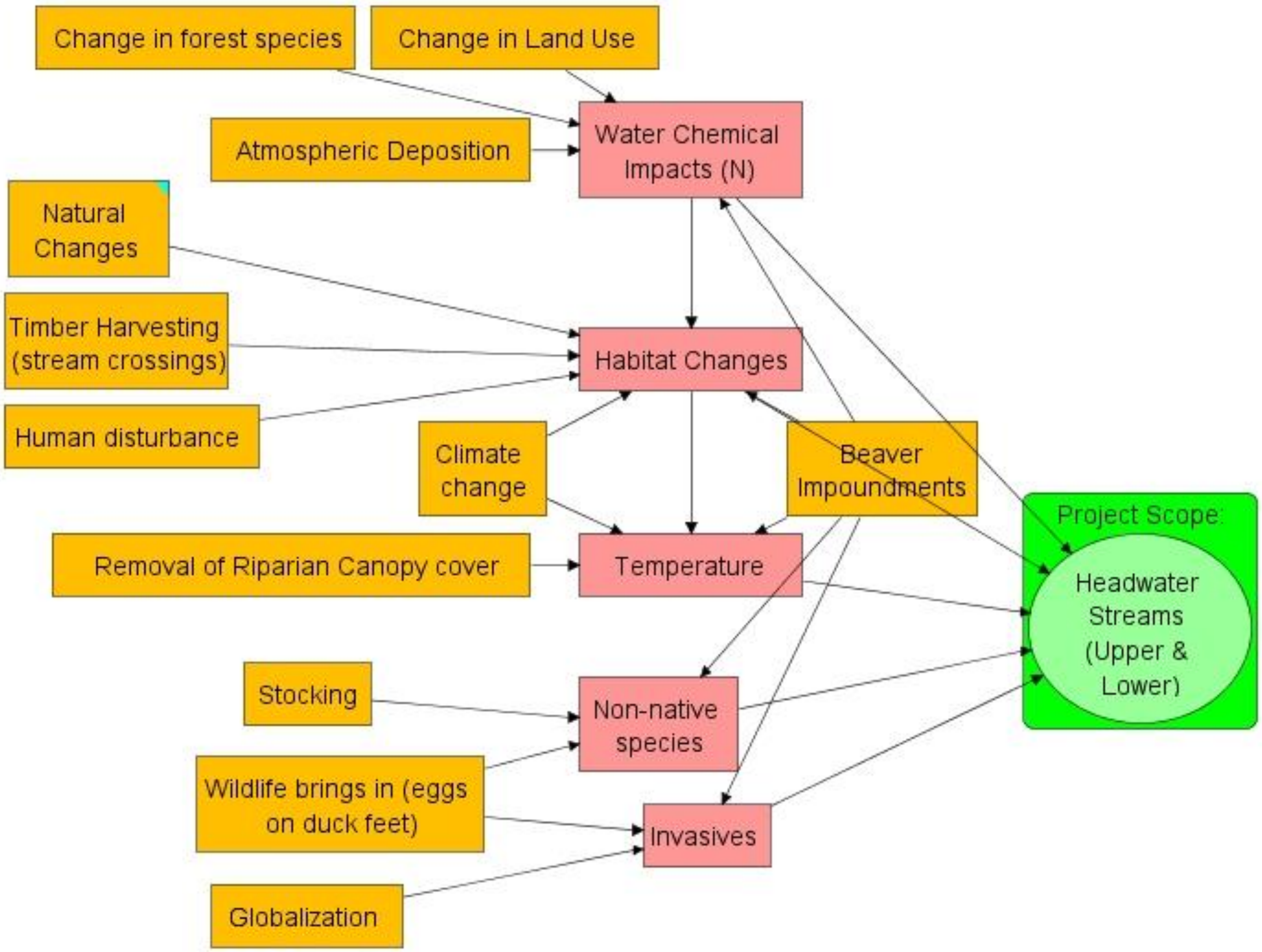
Direct Threat	Scope	Severity	Irreversibility	Index
Atmospheric Deposition	4	4	4	12
Invasive Species	4	3	3	10
Nonpoint Source Pollution	2	3	4	9
Beavers	3	3	1	7
Temperature Change	1	2	3	6
Altered Hydrology	1	3	2	6

Appendix Three – Situation Analyses
Freshwater Estuary

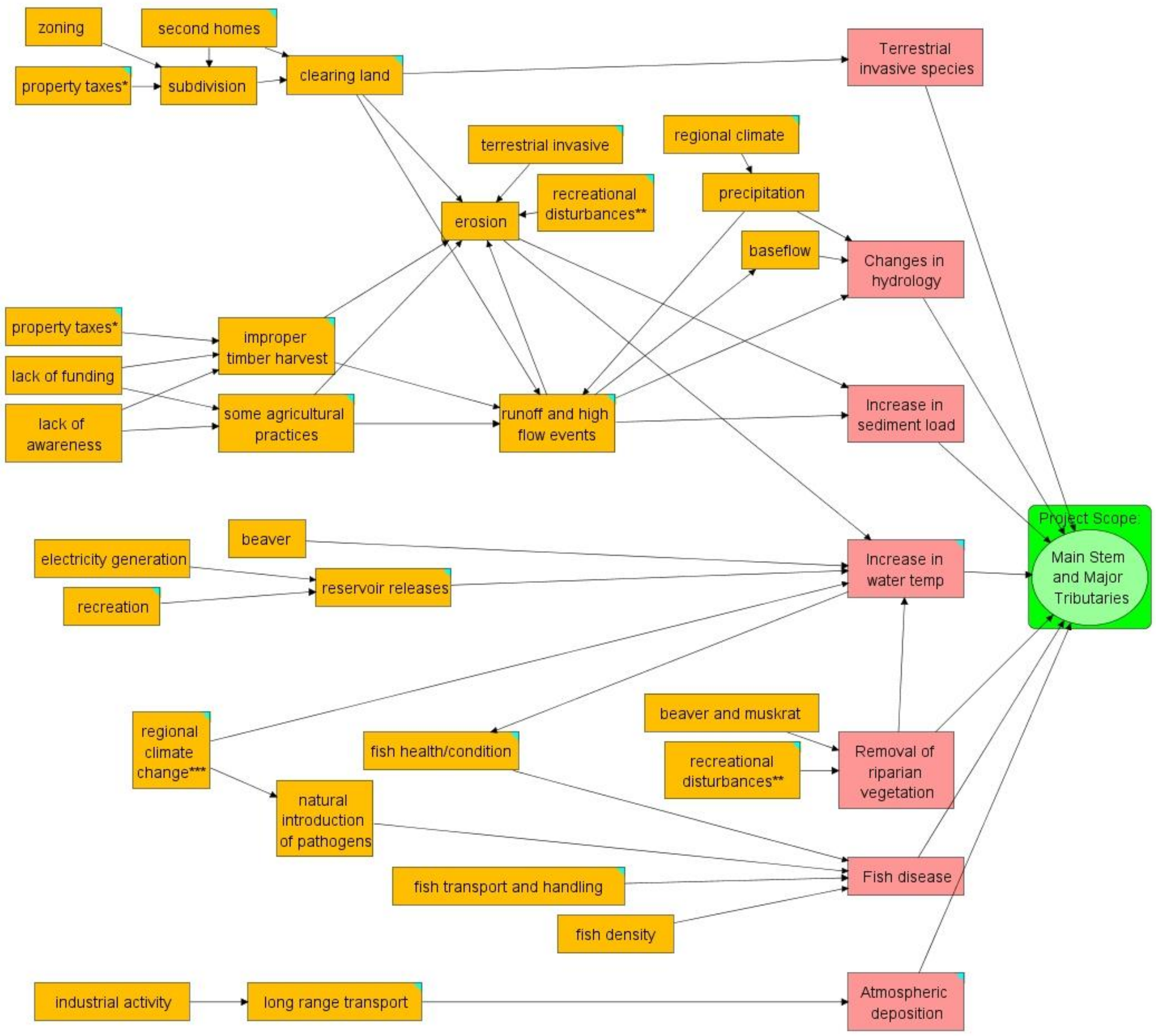
Gorge/Falls/Cliffs



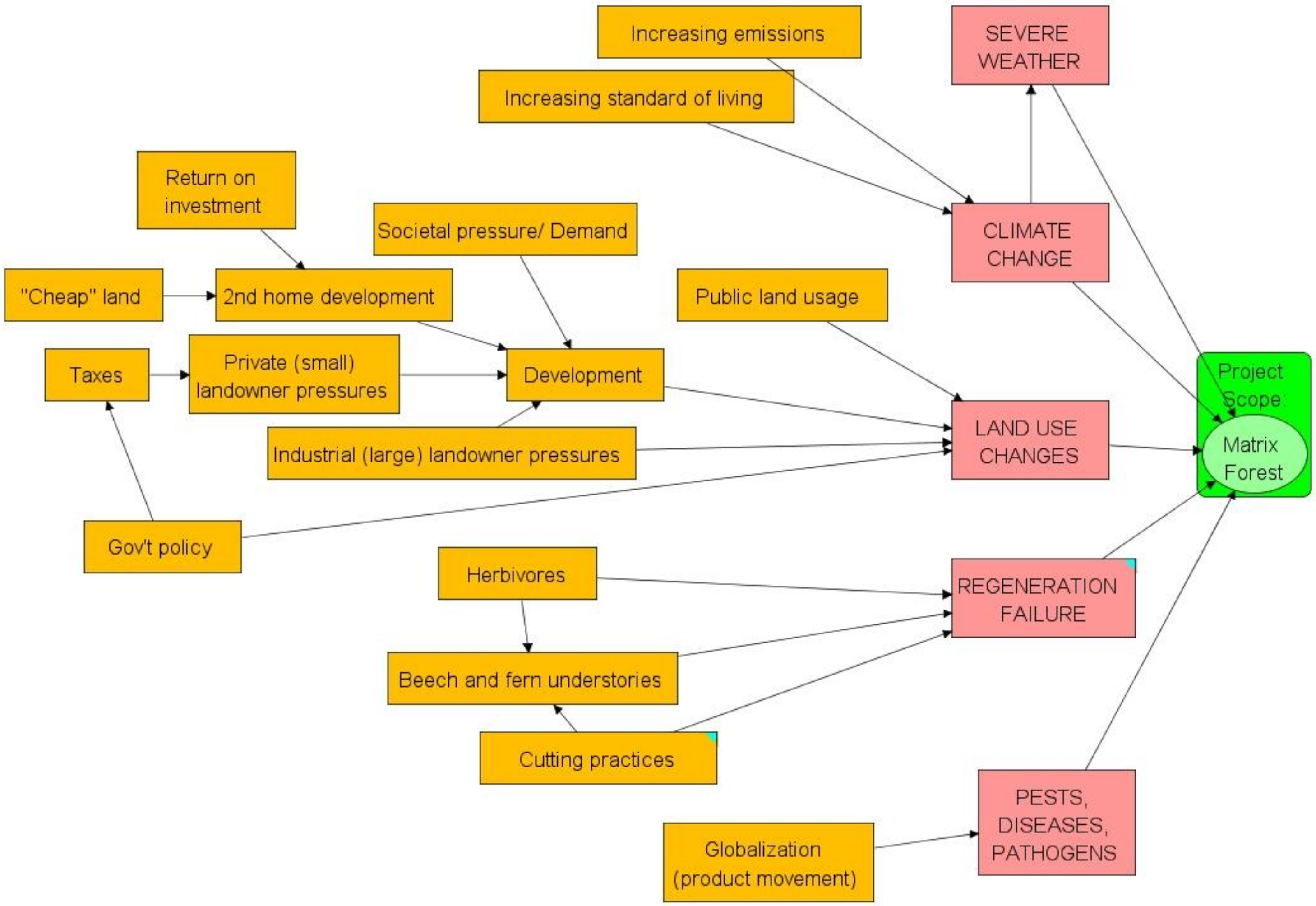
Headwater Streams



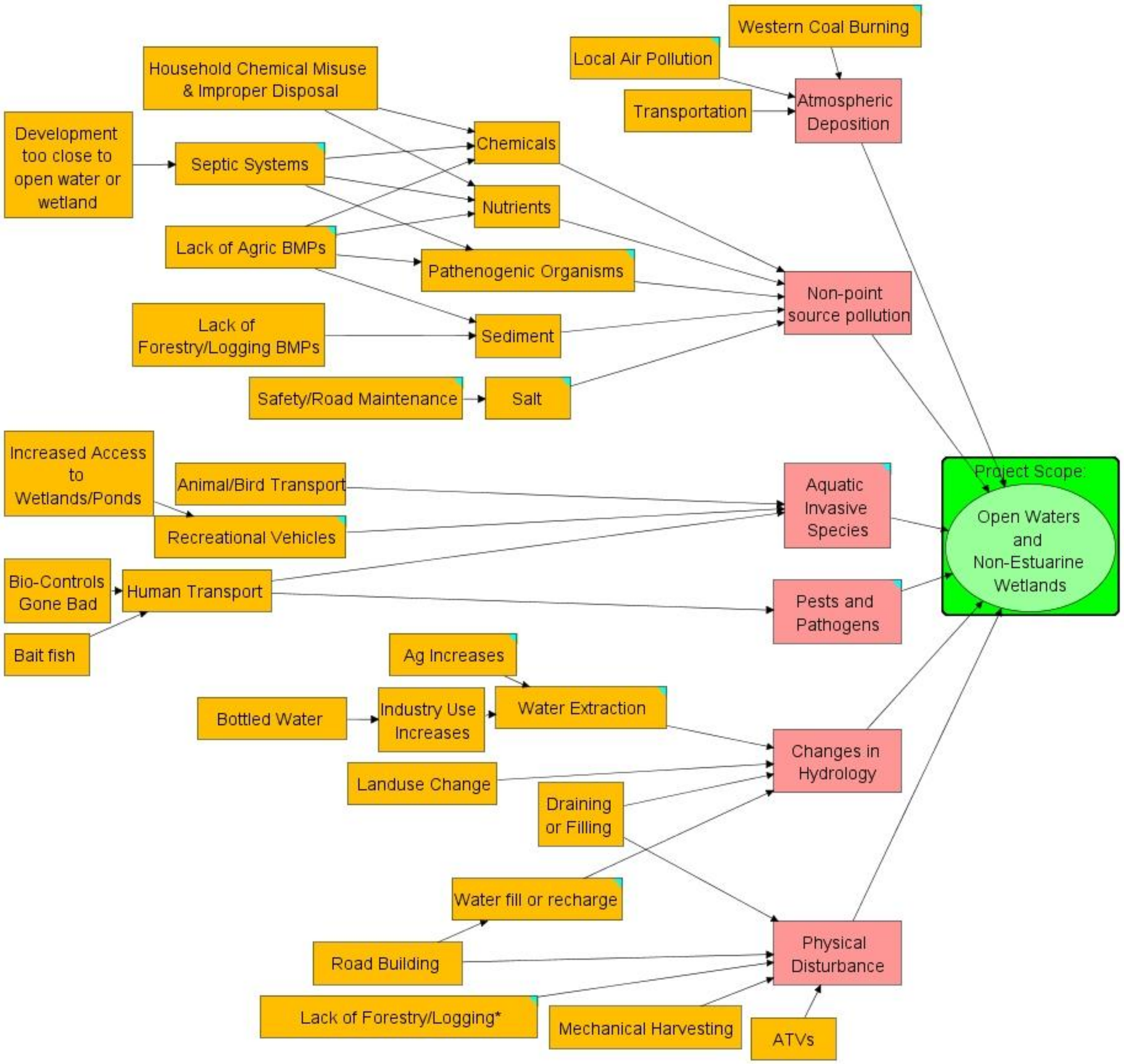
Main Stem Salmon River and its Tributaries



Matrix Forest



Non-Estuarine Wetlands and Open Waters



Appendix Four – Workshop Evaluation Results

Salmon River Watershed Natural Resources Assessment
Workshop 2—Threats
May 4, 2007

Evaluation of Workshop Content

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	14%	76%	10%	0	0
I understand what the purpose of the SRWNRA* is	29%	43%	29%	0	0
I understand the SRWNRA* process	40%	45%	15%	0	0
I understand what a threat is	45%	40%	15%	0	0
The process of selecting and ranking the threats was productive	33%	48%	19%	0	0
The process for competing the situation analysis was useful	29%	57%	15%	0	0
I understand how the products of the workshop will be used	29%	29%	33%	10	0
Participating in this workshop increased my knowledge of conservation in the Salmon River Watershed	33%	38%	19%	5	5
My participation in this workshop was valuable to the process	15%	65%	20%	0	0
My time today was well spent	25%	60%	15%	0	0

*Salmon River Watershed Natural Resources Assessment

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

- to understand others concerns
- increased our understanding of diversity of resources and issues affecting them --especially recreational use
- my organization is more interested in the outcome
- help develop voluntary guidelines
- it will be a good tool for use in our work
- to share with non-participants for their reactions --starting point for discussions
- ultimately the information can be used to do a better job with management
- we might be able to incorporate some of this information into management objectives
- the knowledge of knowing what other organizations would like to do with the natural resources we share
- Tug Hill management for invasive species
- we manage 10K acres in the watershed

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

- taxes --land use from tax burden
- local government and local citizen recognition of need for appropriate education and action
- local participation and acceptance
- property taxes
- population --2nd home development
- cooperation
- getting the public involved
- trying to balance diverse components, prioritize, and gather more complete information on current status are all challenges
- getting the general public involved
- development
- education
- consensus on necessary actions
- communicating the complexity of contributing factors in a simple, understandable way to local officials and the general public
- the variability across the watershed and the number of different landowners and other entities that influence how any recommendations might be implemented.
- globalization of the mass movements of goods and services bringing invasives and changing ideas of land management; increase population and development.

- knowing what to leave alone and what to change
- buy in from private landowners

Evaluation of Workshop Logistics

Please fill in the blank in each sentence by checking the appropriate box.

	Excellent	Very Good	Good	Fair	Poor	
Advanced Materials						**Comments**
In general, the materials sent prior to the workshop were ______.	20%	53%	13%	13%	0	
The advance materials gave me a(n) ________ understanding of the scope of the workshop, including the goals.	20%	47%	13%	20%	0	
The advance materials did a(n) ______ job of explaining new concepts.	13%	53%	20%	13%	0	
Workshop						
The facilitators did a(n) _____ job of keeping to the agenda.	29%	59%	6%	6%	0	
The workshop was ______ for achieving the objective of identifying conservation targets.	12%	53%	35%	0	0	
The workshop was ______ for becoming familiar with the process of viability assessments.	19%	44%	38%	0	0	
Logistics						
The meeting room was ______ for this workshop.	29%	35%	29%	6%	0	
The food and drink was _________.	53%	47%	0	0	0	

APPENDIX 3

SALMON RIVER WATERSHED
NATURAL RESOURCE ASSESSMENT

PROCEEDINGS OF WORKSHOP THREE: STRATEGIES

Salmon River Watershed
Natural Resources Assessment

Workshop Three: Strategies

A Report of Workshop Process and Products

June 21, 2007

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
SUNY Oswego
New York Sea Grant
NYS Tug Hill Commission

Prepared by:
Deborah Forester
Engaging People

Contents

Appendices

Introduction

On June 21, 2007, a workshop was held in the Snow Building in Pulaski, NY to further the conservation planning process for the Salmon River Watershed as part of the Salmon River Watershed Natural Resource Assessment Project. The overall project objectives are to develop a natural resources assessment of the Salmon River watershed that highlights the significant natural resource of the area, and can be used to guide local planning efforts, Department of Environmental Conservation management, and individual land use decisions.

This evaluative 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 primary 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:

3. Identify two to four objectives for each critical threat and/or the targets they affect, and
4. Identify up to 10 strategic actions that will advance each objective..

Participants

Fifty 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.

Workshops One and Two

The first step in the planning process was to identify conservation targets. In a workshop held September 25, 2006, 38 participants identified seven important conservation targets within the watershed. Those targets were:

- Freshwater Estuary
- Gorge/Falls/Cliffs
- Headwater Streams
- Main Stem Salmon River and its Tributaries
- Matrix Forest
- Non-Estuarine Wetlands
- Open Waters

During a second workshop, in May 2007, participants identified direct and indirect threats to each target. Using ranking criteria based on the scope, severity, and irreversibility of each threat, the most critical threats for each target were identified. The data on all of the threats were then combined to develop a "master list" of critical threats in the Salmon River Watershed. The seven threats identified are outlined below, along with the specific terms and threats used to describe them for individual targets.

Altered Hydrology

- Altered hydrology
- Bypass baseflow
- Change in base flow
- Lack of ground water discharge
- River flow alteration
- Temperature change

Invasive Species

- Aquatic invasive species
- Invasive species
- Terrestrial invasive species

Land Cover/Land Use Change

- Fragmentation
- Land cover change
- Land use change
- Removal of riparian vegetation
- Temperature change
- Vegetation cover

Pests/Pathogens/Diseases

- Fish disease
- Pests/Disease/Pathogens

Physical Habitat Disturbance

- Beavers
- Habitat changes
- Loss of soil/habitat
- Physical disturbance
- Physical stream impacts
- Temperature change

Pollution and Sedimentation

- Increased nutrient loading
- Nonpoint source pollution
- Pollution

- Sedimentation
- Toxins

Regional/Global Issues
- Atmospheric deposition
- Climate change
- Temperature change

Developing Objectives and Strategies

The seven critical threats in the Salmon River Watershed were the focus of this workshop. Participants used data gathered in past workshops, including the situation diagrams developed in Workshop 2 illustrating the paths by which the various threats act on the targets, and their own expert knowledge for this work. They brainstormed actions that could be taken to abate the critical threats, then grouped like actions and developed measurable objectives for abating the threat.

The objectives and strategic actions to address each critical threat are outlined below.

<u>Threat: Altered Hydrology</u>

Objective: No net loss of forest cover in watershed (presently 73%) with emphasis on sustainably managed forest – measured as biomass produced per acre per year

Strategic Actions: management of state forests and wildlife management units – state forests achieve FSC certification by 2015
- specific actions – develop unit management plans (UMPs) that incorporate
- UMPs include inter-division consultation
- UMPs based on thorough surveys of lands other than forestry – other threats could include ATVs, which also alter hydrology
- use timber revenue to hire the necessary staff so that FSC on 100% of state forests in watershed is achieved by 2012. Lobby state legislators to achieve this legislative change.
- promote maintaining current conifer stands on state lands to moderate early spring stream flow

Strategic Actions: management of commercial lands --
- Tug Hill Commission initiate dialogue to re-assess property tax values based on current use rather than potential use – timber should not be assessed as real property
- Will need special legislation from state to declassify timber as real property in Tug Hill – may add on to current Tug Hill legislation, by 2012
- encourage best management practices for silvicultural system

- enforce current DEC regulations – build up the staffing of DEC to add the necessary staff by 2012
- Tug Hill Commission work with towns to find incentives to encourage commercial timber to gain FSC-NYS Logger Association certification
- develop a method for educating and encouraging BMP use

Strategic Actions: Management of lands in individual private ownership

- identify critical areas for conservation measures
- incentives for private landowners to manage sustainably – 480A
- focus on buffers – find incentives to encourage buffers – CRP-like program
- watershed protection measures – CRP-like program for buffers; tax or assessment incentive for maintaining a buffer
- aim for 100ft buffer
- Tug Hill agency, with regulatory powers?
- landowners have to have ownership of the process, help design the incentives
- reimbursement for towns for 480A taxes by NYS as part of existing Tug Hill tax program. achieve 2012

Objective: Maintain the current hydrologic functions of the main-stem and tributaries – focal species are steelhead, brook trout and Chinook

Strategic Actions:

- establish gages Trout, Orwell, Beaver Dam Creeks and east branch of main stem (Mad River) and North Branch – find funding for more gages
- In 2007-08 establish committee to determine most cost effective method for operating gages
- Identify an objective institution to administer gages
- put gages in place by 2010
- need to reassess current use of TH aquifer, and establish an optimal maximum withdrawal – detailed survey to repeat USGS study from 20 years ago. Find a partner and funding, or seek Congressional appropriation

<u>Threat: Invasive Species</u>

Objective: By 2010 institutionalize St. Lawrence-Eastern Lake Ontario PRISM (partnership for regional invasive species management).

Strategic Actions

- Hire coordinator, support and seasonal staff
- Program funding from NYS and grants
- Obtain NGO status

- Decide where to house SLELO

Objective: By 2010 increase public awareness of invasive species in the Salmon River Watershed by implementing a Center for Community Studies (CCS) survey.

Strategic Actions:
- Workshops
- Printed materials
- Media outreach
- Public areas outreach
- Establish collaborative network of researchers and information
- Establish funding source
- Conduct survey

Objective: By 2015 asses ecological health of the watershed on public and private land (with permission) to identify susceptible areas that are conducive to invasive species establishment.

Strategic Actions:
- Conduct assessment of ecological health of key ecological attributes.
- Establish monitoring protocols to conduct assessment and monitoring programs.
- Establish a monitoring network of volunteers based on scientific research and quality assurance-quality control.
- Funding ($1 million over 5 years) for scientific rigor to establish program

Objective: By 2010 implement a public policy aimed at no new invasive species introductions and no net spread of invasive species.

Strategic Actions:
- Bi-national prohibition of ocean vessels on Great Lakes (only 8% of all ships on Great Lakes were on the ocean)
- State legislation on the sale/monitoring of invasive species
- Nuisance aquatic species (NAS) clean boater education and cleaning facilities at public sites.
- Expand the Environmental Protection Fund for early detection/rapid response and eradication of invasive terrestrial and aquatic plants.

Threat: Land Use/Land Cover Change

Objective: Over the next 20 years, maintain land use/cover to within 10% of current distribution

Strategic Actions:

- obtain better (more spatially specific? more extensive?) natural resources information to help municipalities focus development in appropriate areas
- develop, publish and distribute comprehensive guide to how to site/manage development to minimize impacts
- help residents stay here and not have to parcelize
    - fund Forest Land Enhancement Program (part of the Farm Bill)
    - get reimbursements from state to local governments for 480a taxes into a statute (currently has been done by decree from governor)
    - increase endowment/$ for Tug Hill Tomorrow
    - increase awareness of easements and their benefits to landowners
    - we need something broader than 480a…?

Objective: Maintain vegetative buffers along main stem, major tributaries, and steep slope communities to within 10% per mile of existing cover

Strategic Actions:
- determine what "vegetative buffers" are appropriate. Natural cover within 25 ft?
- develop BMP (best management practices) guidelines for steep slopes and riparian areas
- establish and maintain properly designed trail systems/fishing access points
- establish and maintain an ATV trail system AND **enforce use** with seizure of equipment
- institute targeted blanket beaver removal permit system throughout watershed
    - -"blanket" removal only applies to small spatial area specified in permit
    - -permit approved by biologist
    - -what conditions/nuisances do applicants need to demonstrate to get a permit?

Objective: Maintain current wetlands (no net loss) in viable condition (water quality, diversity (of both type of wetland and species?-KEAs all Good or Very Good?).

Strategic Actions:
- current wetlands-what size does this apply to?

<u>Threat: Pests, Pathogens and Disease</u>

Objective: Increase public awareness of PPDs for 80% of the population by 2026

Strategic Actions
- Develop educational programs for schools, such as invasives/PPD station at Conservation Field Days
- Develop signs/flyers on PPD issues where they are likely to occur, such as boat landings, with sporting licenses, campsites, etc.
- Use media outlets to spread the message

Objective: Establish monitoring and assessment process by 2015 to improve ability for detection of significant chances to PPDs by 50%

Strategic Actions:
- Establish PPD baseline occurrence database
- Identify areas where new introductions are likely
- Develop a system for information exchange
- Evaluate improvement to the current monitoring efforts

Objective: Improve ability manage outbreaks and prepare for future PPDs by x% by y year.

Strategic Actions:
- Develop strategies to management environments permanently altered by PPD
- Have a system of coordinated responses established to deal with future PPD outbreaks
- Utilize and maintain barriers to prevent the spread of aquatic PPDs
- Manage to maintain landscapes resistant and resilient to PPD outbreaks
- Develop management strategies in anticipation of future PPD obutreaks.
- Develop a checklist for evaluation management decisions based on PPDs
- Facilitate cooperative response to PPD outbreaks

Objective: Improve the understanding of PPD life history and habitat requirements to support effective management before 5% of watershed is affected.

Strategic Actions:
- Develop a research strategy for emerging and established PPDs
- Research strategy to prevent spread of PPD
- Provide information exchange and feedback with monitoring program
- Create appropriate channels for information and technology transfer (for education and management)
- Establish funding sources
- Develop criteria to determine whether a strategy of eradication, containment or managed co-existence is the most appropriate course of action

Threat: Physical Habitat Disturbance

Objective: Reduce or minimize adverse effects of recreational disturbances to flowing waters in the watershed by 50% by 20 years, while maintaining appropriate recreational access opportunities.

Strategic Actions:
- Provide adequate funds for development of formalized trail system along state easement along Salmon River where needed. Goal is to build 5 miles of trail by 2017 with a minimum of $500,000.
- Develop and implement 5 educational kiosks along trail system by 2017.
- Work with guides association and other legally registered guides (licensed by DEC) to control habitat alteration along the river and educate about the importance of habitat. Reach out to all guides by 2010.
- Work with all local ATV groups within the next two years (like Oswego County ATV Club) to minimize illegal use of snowmobile trails by ATVs.
- Add designated funding to enforce ATV laws and use funding to hire two DEC law enforcement officers by 2009.

Objective: Maintain or improve land management practices to improve water quality and maintain headwater systems through best management practices and education.

Strategic Actions:
- Follow timber harvesting best management practices and educate foresters, loggers, and forest landowners on those BMPs.
  - Offer 3 additional forest management workshops in the next 3 years targeted toward landowners.

- Identify specific key rare/endangered species sites that need their own management practices. Educate/advise landowners on those management practices when appropriate.
  - Send 100 landowner packets over the next 5 years to landowners of more than 50 acres in the watershed. Include information on forestry management, invasive species, rare/endangered species, wetlands, etc. Identify grant to cover costs (similar to dune packets done by Sea Grant with a grant).

  - Educate more about why it is important to have regulated wetlands; work with the smaller than 12.5 acre wetlands. Create incentives for landowners to maintain/restore wetland habitat, possible property tax reduction?

Threat: Pollution and Sedimentation

<u>Threat: Regional/Global Change Issues</u>

Objective – Community/Region lead effort to demonstrate renewables

Strategic Actions:
- Enhance/increase biomass energy
  - Community development
  - Climate changes
- Increase Low Grade Markets
  - Biomass
  - Wood – Ethanol (Catalyst Renewables)
  - Wood boilers for heat
- Promote energy renewable initiatives, schools in area that have biomass heating systems, introduce renewable energy into our region.
- Incentive to co-generate electricity.
- Regional Greenhouse Gas Initiative (REGI)
  - Carbon Exchange (used as an offset)
  - Changing REGI rules to recognize the role of forest management in decreasing carbon emissions
  - Opportunity of forest landowners to get an incentive for keeping their forest lands in tact
- Further consider benefits and impacts of wind energy

Objective - Forest able to respond

Objective – River System Able To Respond

Objective – Organism Migration

Workshop Evaluation Results

Twenty-four participants completed evaluation questionnaires at the end of the day. The complete results of this evaluation are included in Appendix Two.

More than three-quarters of participant generally or strongly agree that they understand the purpose and process of the Salmon River Watershed Natural Resources Assessment. Te vast majority of participants felt that their participation in the process was valuable and their time was well spent.

Individuals and organizations will use the results of this planning process in many different ways. Some of the potential uses of the materials and information noted included development of management plans, outreach and education, planning and prioritizing projects, and as a tool in support of program proposals.

Next Steps

A final report incorporating all of the data and results of this planning process will be prepared by the partners. It will be shared with workshop participants and other stakeholders in draft form, and then finalized before distribution to a wider audience. Interest was expressed in establishing a watershed-wide coordinating group that would meet at regular intervals to exchange information and establish opportunities to collaborate and coordinate activities.

Appendix One – Workshop Participants

Francis Adams
Town of Redfield

John Bartow
NYS Tug Hill Commission

Paul Baxter
Salmon Rivers Council of Governments

Tom Bell
NYSDEC

Dan Bishop
NYS DEC

Bruce Brach
Harden Furniture

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Linda Garrett
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Linda Gibbs
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Jennifer Harvill
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SRCG Executive Committee

Michelle Henry
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Ted Hoffman
Gutchess Lumber

David Hogestyn
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Tim Howard
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Jim Johnson
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Town of Orwell

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The Nature Conservancy

Laura Macklen
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Amy Mahar
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Town of Williamstown

Chuck Parker
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Michelle Peach
The Nature Conservancy

Mary Penney
NY Sea Grant

Connie Rogers
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Fran Verdoliva
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The Nature Conservancy

Fran Yerdon
Town of Osceola

Appendix Two– Workshop Evaluation Results

Salmon River Watershed Natural Resources Assessment
Workshop 3—Strategies

June 21, 2007

Evaluation of Workshop Content

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	16.7%	66.7%	16.7%	0	0
I understand what the **purpose** of the SRWNRA* is	50.0%	37.5%	8.3%	0	4.2%
I understand the SRWNRA* **process**	37.5%	45.8%	16.7%	0	0
The process for identifying objectives and strategic actions was useful	25.0%	50.0%	20.8%	4.2%	0
I understand how the products of the workshop will be used	20.8%	50.0%	20.8%	4.2%	4.2%
Participating in this workshop increased my knowledge of conservation in the Salmon River Watershed	34.8%	47.8%	8.7%	8.7%	5%
My participation in this workshop was valuable to the process	16.7%	62.5%	20.8%	0	0
My time today was well spent	25.0%	62.5%	12.5%	0	0

*Salmon River Watershed Natural Resources Assessment

How might you and/or your organization use the results of the Salmon River Watershed Natural Resources Assessment?

- development of management plans
- greater awareness of issues
- implementation of appropriate local actions and informed support for regional/state/federal-international level action
- incorporate into technical assistance provided to local municipalities during planning processes
- incorporate the results into the DEC Watershed Action Plan for the Southeast Lake Ontario Watershed for species of greatest conservation need
- interpretive manual
- model SW grants program watershed team to this format
- outreach and education
- planning and prioritizing projects
- reference in unit management plan process
- to keep current about changing conditions, opinions and changes in Tug Hill
- tool in support of program proposals

Evaluation of Workshop Logistics

Please fill in the blank in each sentence by checking the appropriate box.

	Excellent	Very Good	Good	Fair	Poor	
Advance Materials						**Comments**
In general, the materials sent prior to the workshop were ______.	21.1%	42.1%	31.6%	0	5.3%	______________________
Workshop						
The facilitators did a(n) _____ job of keeping to the agenda.	25.0%	60.0%	15.0%	0	0	______________________
The workshop was ______ for identifying objectives and strategies.	5.0%	60.0%	30.0%	5.0%	0	______________________
Logistics						
The meeting room was ______ for this workshop.	10.0%	45.0%	30.0%	10.0%	5.0%	____________
The food and drink was __________.	55.0%	35.0%	10.0%	0	0	___________

APPENDIX 4
Expert Working Groups

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.

<u>Forests:</u>
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

<u>Wetlands:</u>
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

<u>Aquatics:</u>
Dan Bishop, NYSDEC
Mike Connerton, NYSDEC
Frank Flack, NYSDEC
Michelle Henry, USGS, Tunison Lab
Jim Johnson, USGS, Tunison Lab
Roger Klindt, NYSDEC
Amy Mahar, NYSDEC
Dick McDonald, NYSDEC
Jim McKenna, USGS, Tunison Lab
Andy Noyes, NYSDEC
Neil Ringler, SUNY-ESF
Larry Skinner, NYSDEC
Howard Simonin, NYSDEC
Fran Verdoliva, NYSDEC

APPENDIX 5
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