Salmon River Watershed Natural Resources Assessment

Compiled by Gregory G. McGee

State University of New York College of Environmental Science and Forestry
Syracuse, NY
6/30/2008

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

TABLE OF CONTENTS

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:

John Bartow, New York State Tug Hill Commission
Paul Baxter, Salmon River Council of Governments
Kristin France, The Nature Conservancy, Central and Western New York Chapter
Linda Garrett, Tug Hill Tomorrow Land Trust
Linda Gibbs, New York State Tug Hill Commission
Jennifer Harvill, New York State Tug Hill Commission
Dave Hertzler, Oswego County Environmental Management Council
Tim Howard, New York Natural Heritage Program
Jane Jones, Cooperative Tug Hill Council
Amy Mahar, New York State Department of Environmental Conservation
Katie Malinowski, New York State Tug Hill Commission
Michelle Peach, The Nature Conservancy Eastern Lake Ontario-Tug Hill Office
Mary Penney, New York Sea Grant
Peter Rosenbaum, State University of New York at Oswego
Dan Sawchuck, New York State Department of Environmental Conservation

Doug Thompson, The Nature Conservancy Eastern Lake Ontario-Tug Hill Office
Molly Thompson, New York Sea Grant
Tracey Tomajer, New York State Department of Environmental Conservation
David VanLuven, New York Natural Heritage Program
Fran Verdoliva, New York State Department of Environmental Conservation

John Bartow and Linda Gibbs of the New York State Tug Hill Commission administered the grant and facilitated the public participation and local government outreach. Michelle Peach of The Nature Conservancy also provided valuable guidance in organizing public input throughout the process. Deborah Forester, Engaging People, facilitated the three public workshops.

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.

PRIMARY PARTNER CONTACTS

New York State Department of Environmental Conservation
Tracey Tomajer, Division of Fish, Wildlife and Marine Resources
USNFWS-DEC Grant Coordinator and Project Overseer
tmtomaje@gw.dec.state.ny.us; 518-402-8877

Fran Verdoliva, Salmon River Coordinator
fjverdo@gw.dec.state.ny.us; 315-298-7605

Tug Hill Tomorrow Land Trust
Linda Garrett, Executive Director
thomorr@northnet.org; 315-779-8240

Oswego County Environmental Management Council
Dave Hertzler, Chair
cathertzler@earthlink.org; 315-963-8525

New York Natural Heritage Program
Tim Howard, Ecologist and Program Scientist
tghoward@gw.dec.state.ny.us; 518-402-8935

The Nature Conservancy
Michelle Peach, Tug Hill Project Director, Central &Western New York Chapter
mpeach@tnc.org; 315-387-3600

SUNY College of Environmental Science and Forestry
Gregory McGee, Adjunct Assistant Professor in Residence, SUNY-ESF
ggmcgee@esf.edu; 315-470-6792

SUNY Oswego
Peter A. Rosenbaum, Professor, SUNY Oswego
par@oswego.edu; 315-312-2775

New York Sea Grant
Mary Penney, Eastern Lake Ontario Dune/Salmon River Steward Coordinator
mp357@cornell.edu; 315-312-3042

NYS Tug Hill Commission
Linda Gibbs, Natural Resources Specialist
gibbs@tughill.org; 315-785-2380

LIST OF FIGURES

LIST OF TABLES

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 maintaining 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 have the potential to profoundly affect the condition of the conservation targets.

- *invasive species*, including several aquatic and terrestrial plants and some fish (gobies, carp, lamprey);
- *regional and global issues*, 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;
- *altered hydrology* 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;
- *land cover/land use changes*, 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;
- *physical habitat disturbances*, 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;
- *pollution and sedimentation* 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;
- *pests, pathogens and diseases* 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.

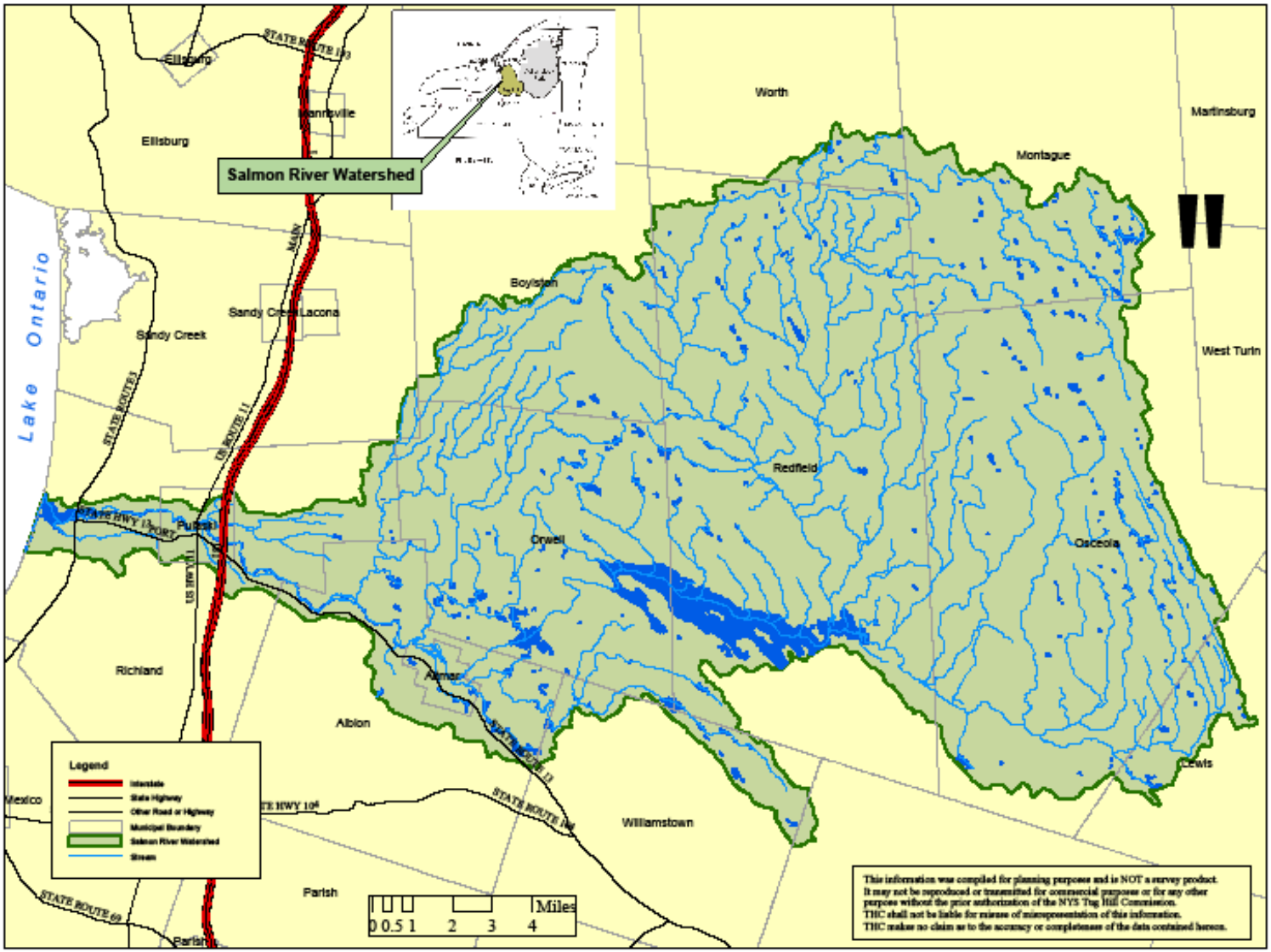

Figure 1. Salmon River Watershed Study Area.

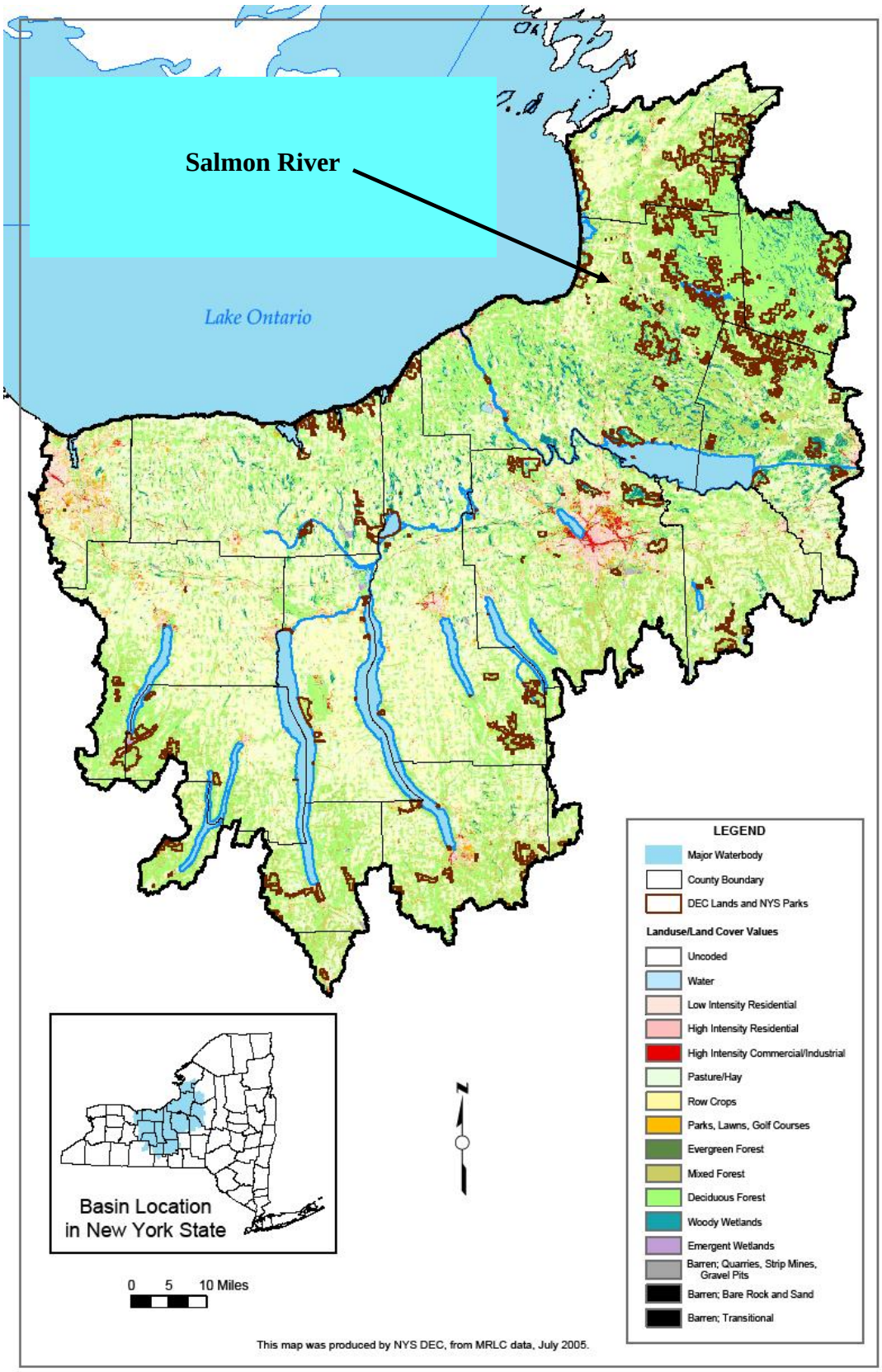

Figure 2. Southeast Lake Ontario Basin (Source: NYSDEC 2006)

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).

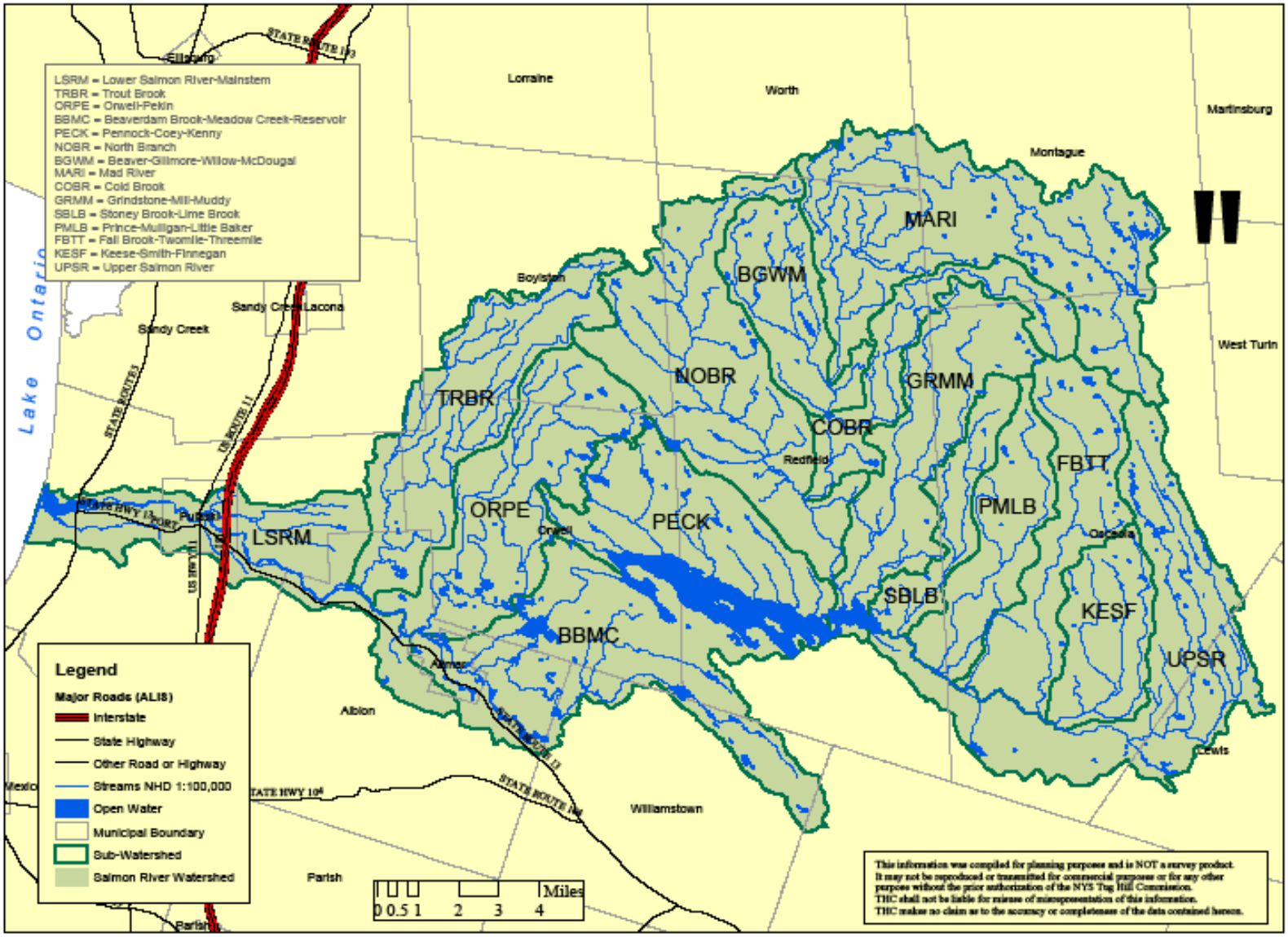

Figure 3. Location of fifteen sub-watersheds within the Salmon River watershed (from Howard 2006).

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.

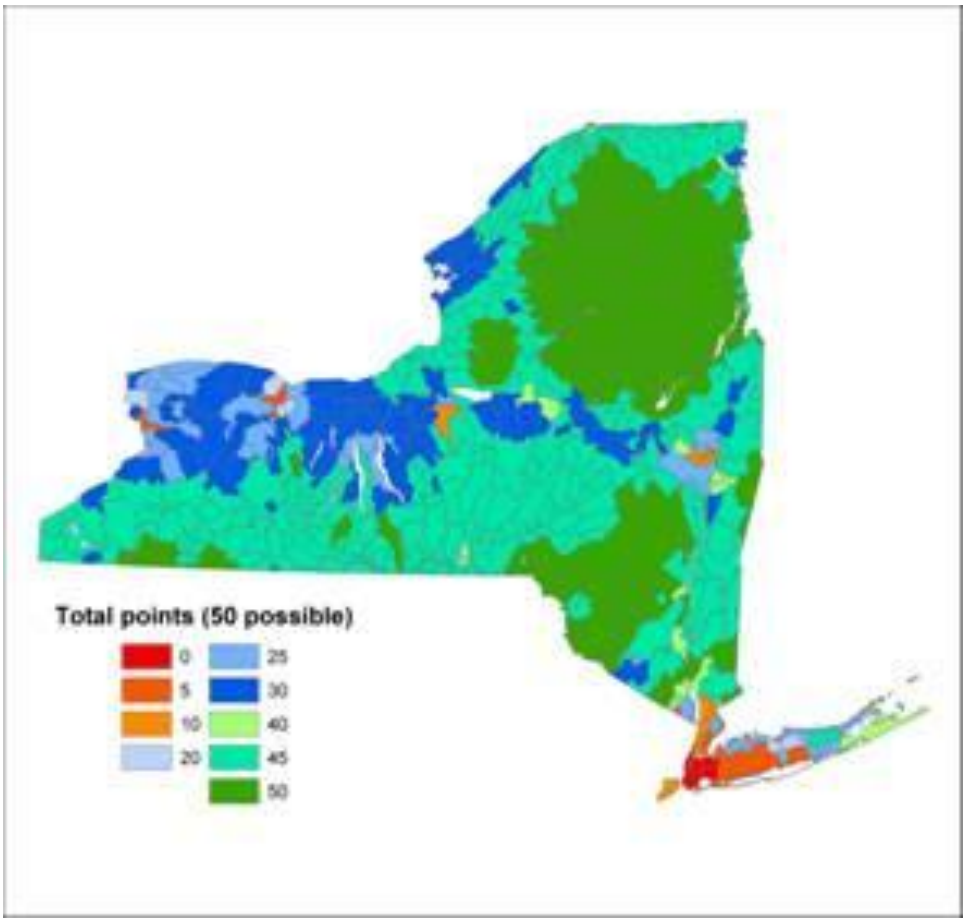

Figure 4. Statewide ranking of predicted surface water resources based upon analysis of impervious surfaces and forest cover (T. Howard, NY Natural Heritage Program, unpublished data). Key: red shades indicate impaired watersheds, greens indicate high quality watersheds.

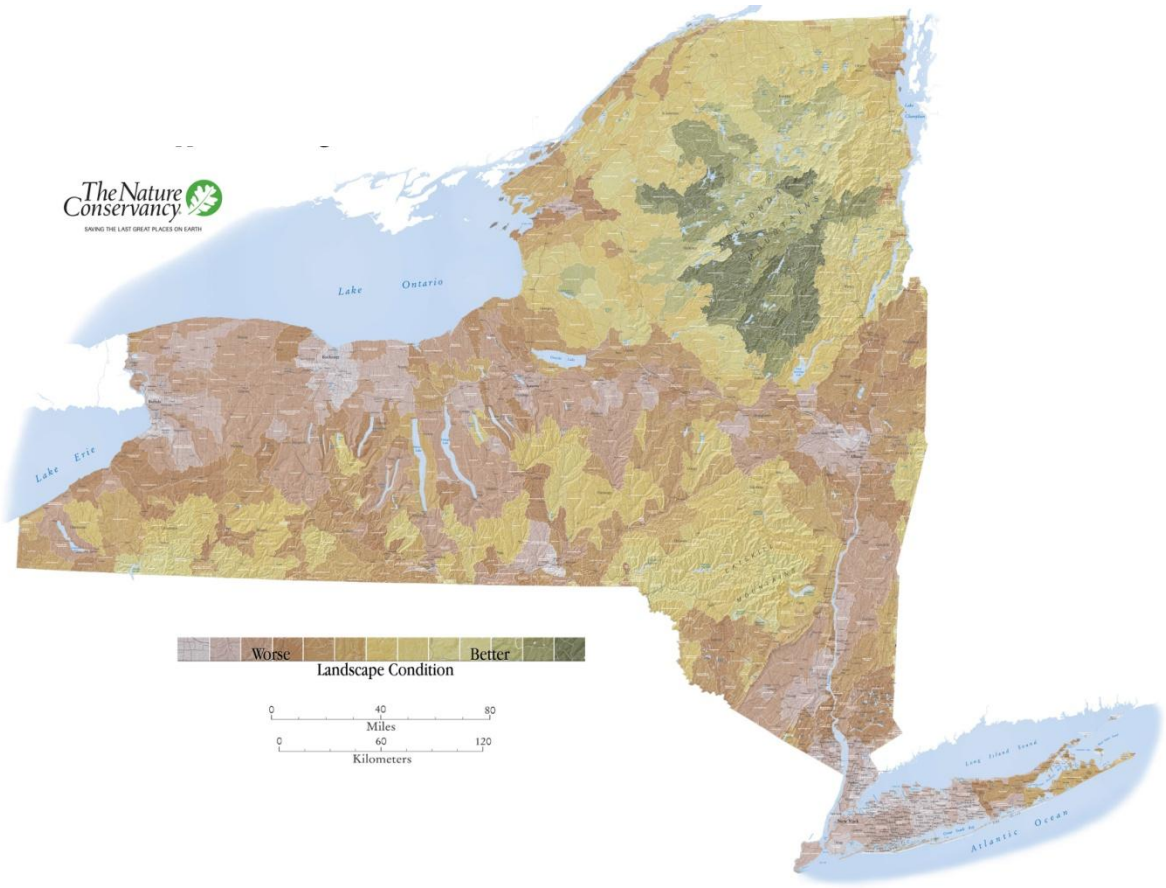

Figure 5. Summary of regional landscape conditions in New York (Source: Nature Conservancy).

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).

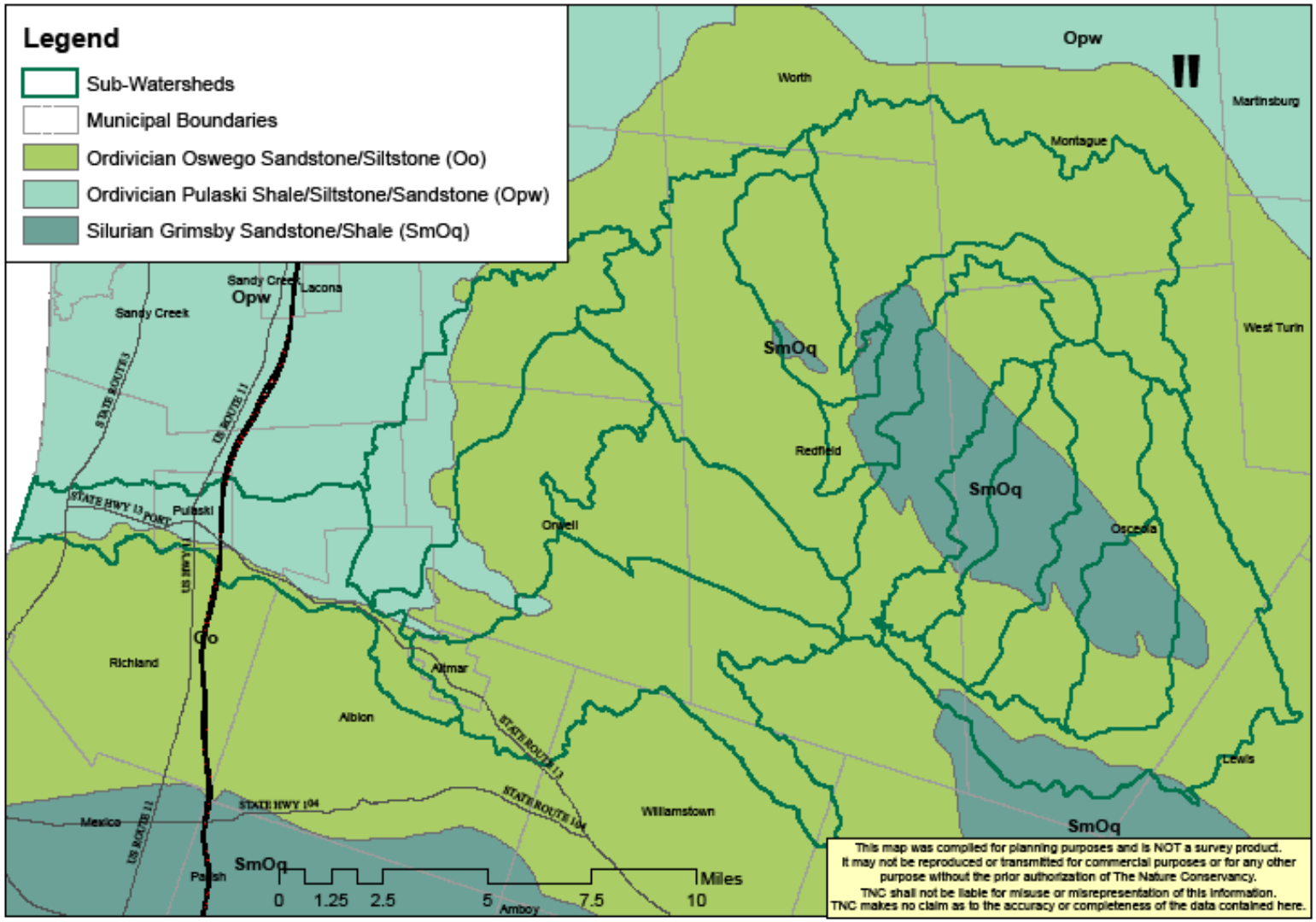

Figure 6. Bedrock geology of the Salmon River Watershed.

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.

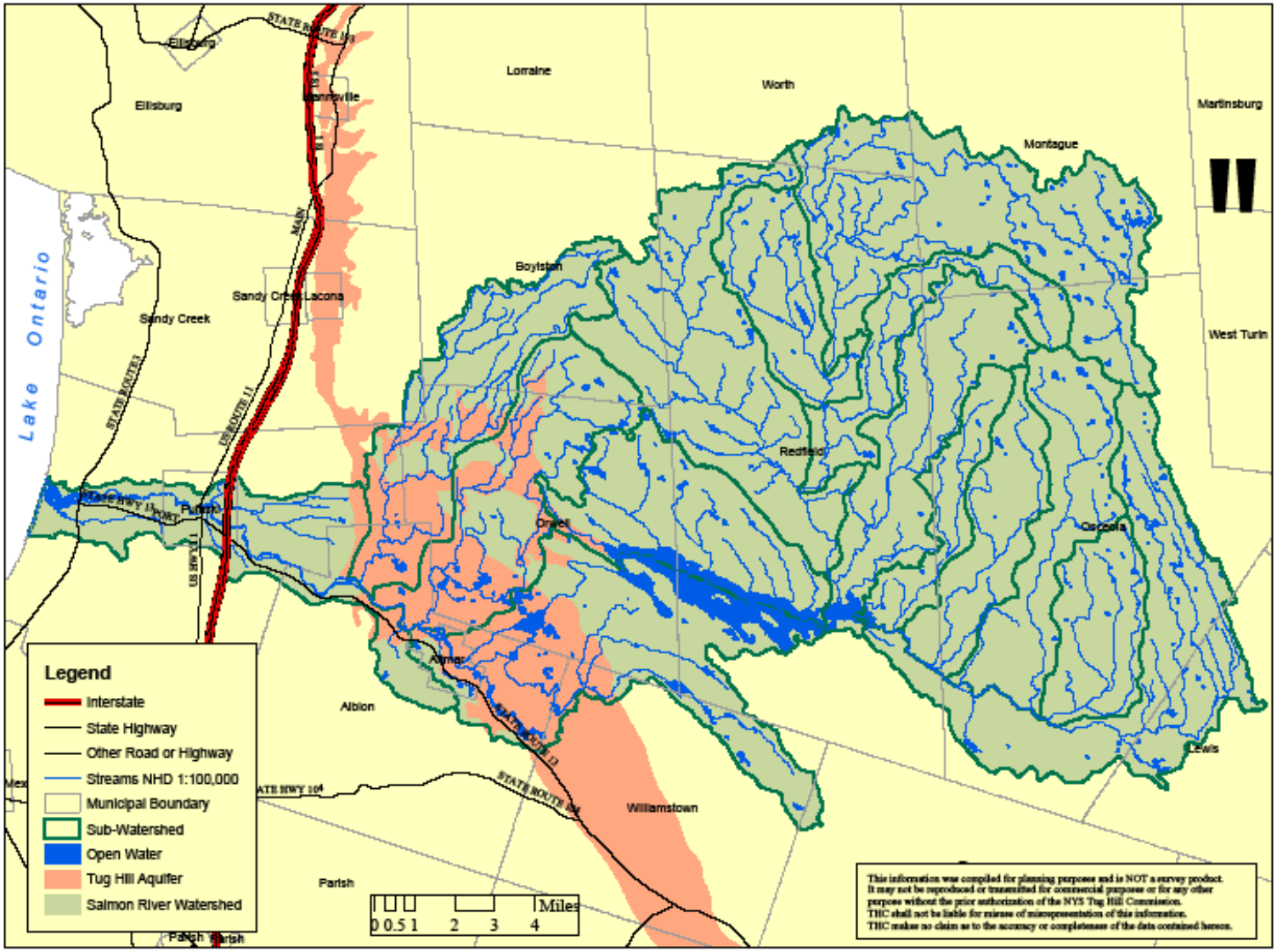

Figure 7. Location of the Tug Hill Aquifer.

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.

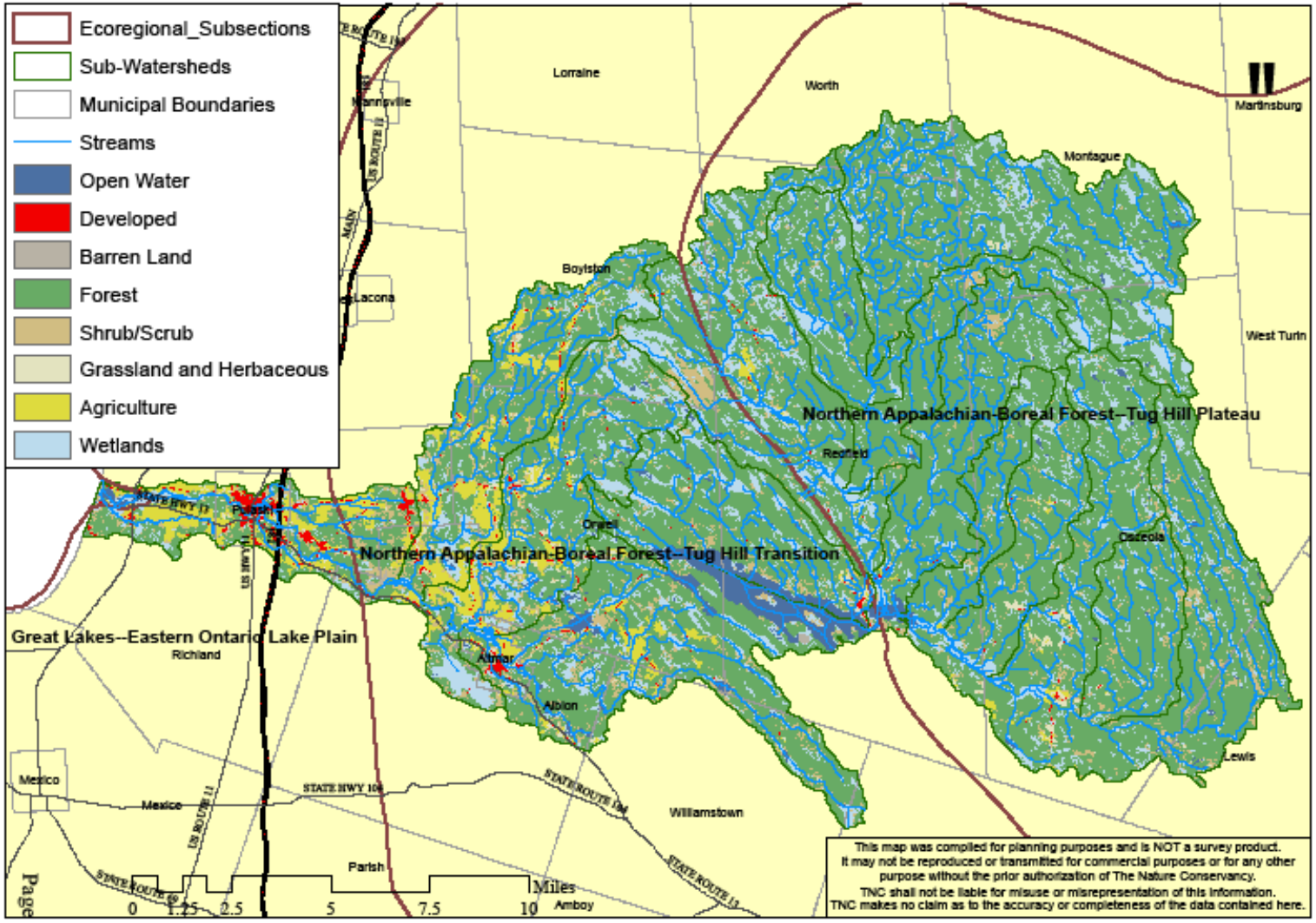

Figure 8. Land cover-types of the Salmon River Watershed.

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).

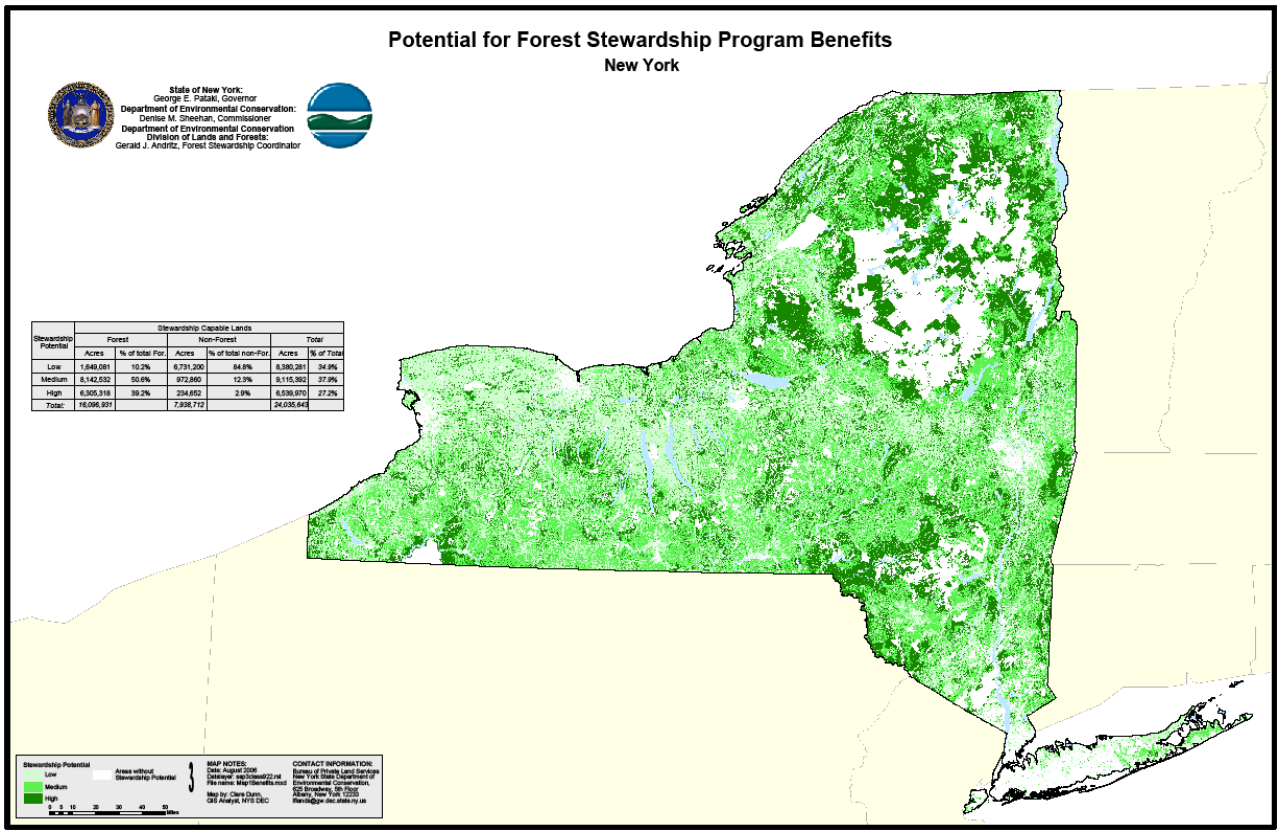

Figure 9. Potential for Forest Stewardship Program benefits in New York (Source: NYSDEC).

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).

- Riverine wetlands (~130 acres) are associated with the river channels. Segments of river channel are periodically dredged to maintain a stable, navigable channel (FERC 1996).
- Emergent marshes (~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.
- Woody wetlands (~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.

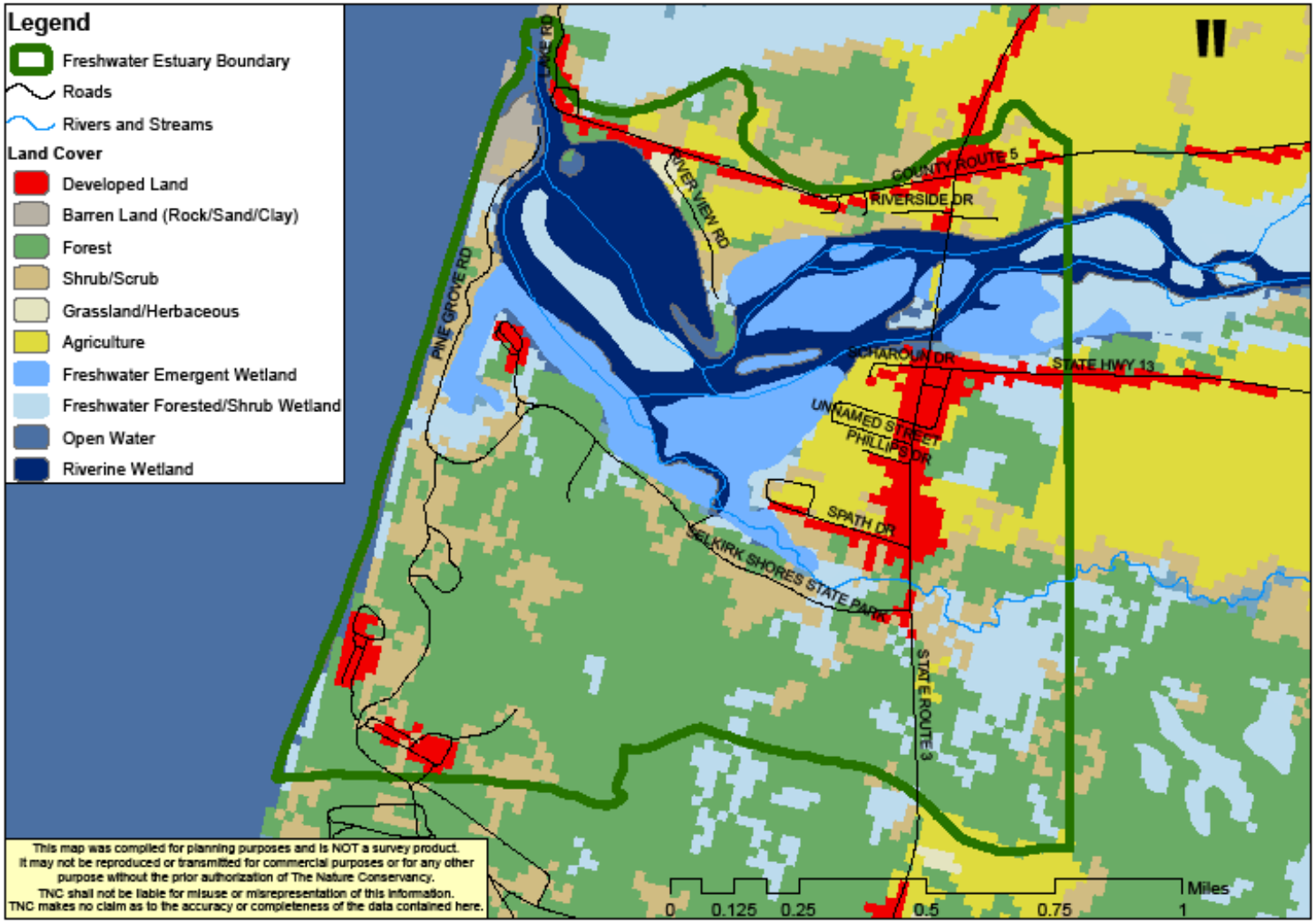

Figure 10. The Salmon River freshwater estuary and local sub-watershed.

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.

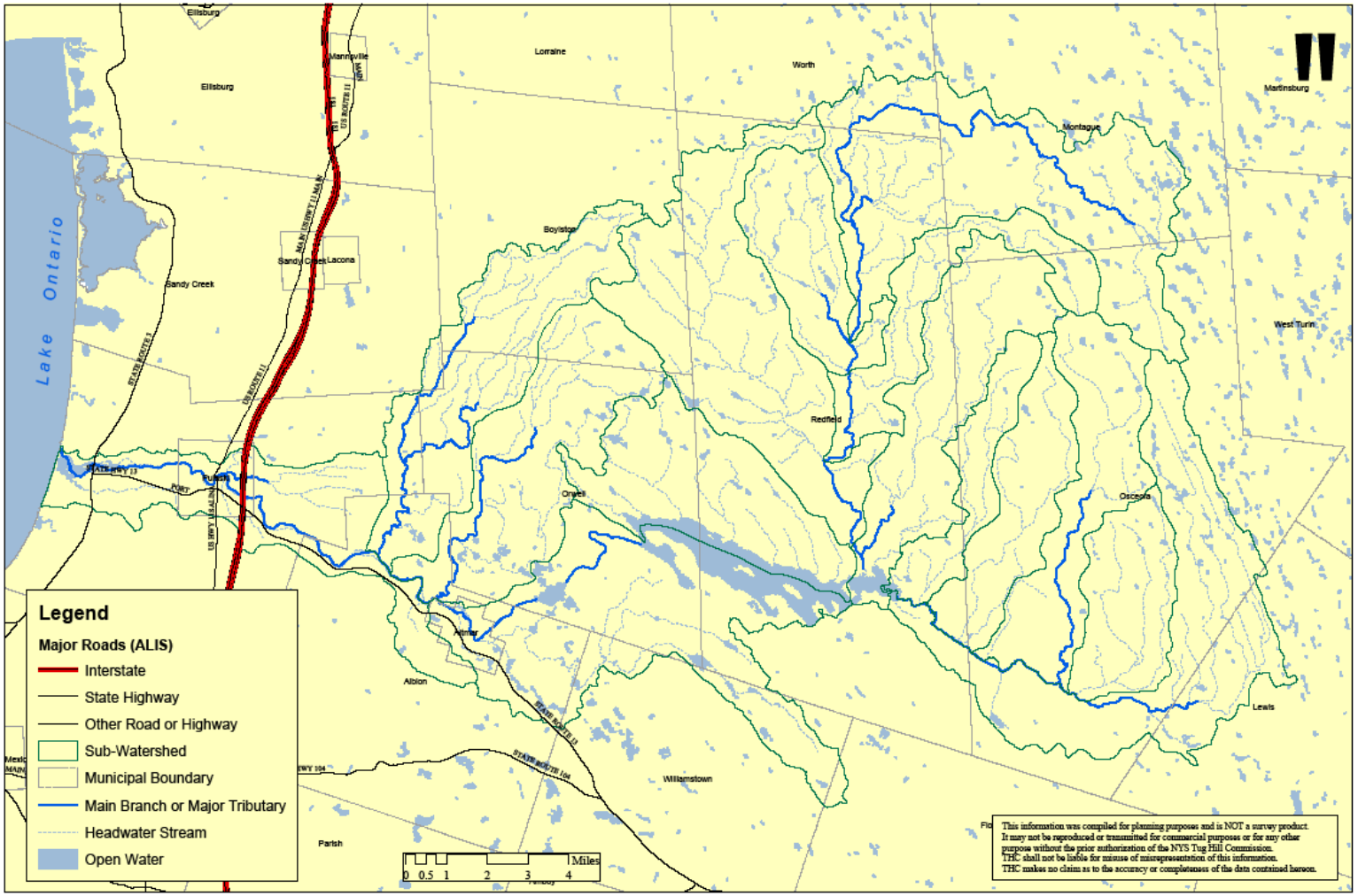

Figure 11. Main Branch and major tributaries of the Salmon River.

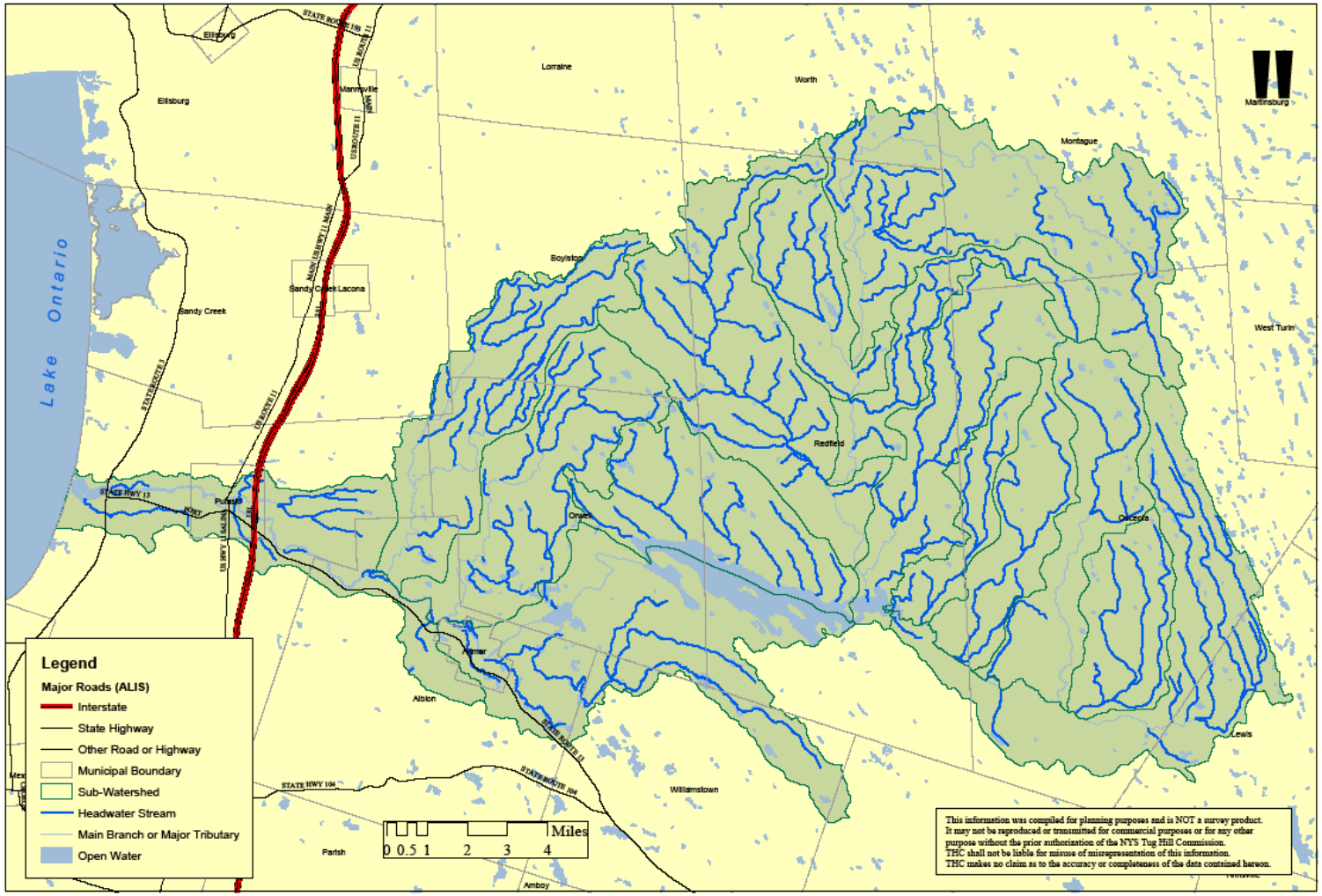

Figure 12. Perennial headwater (1st- and 2nd-order) streams of the Salmon River Watershed.

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)

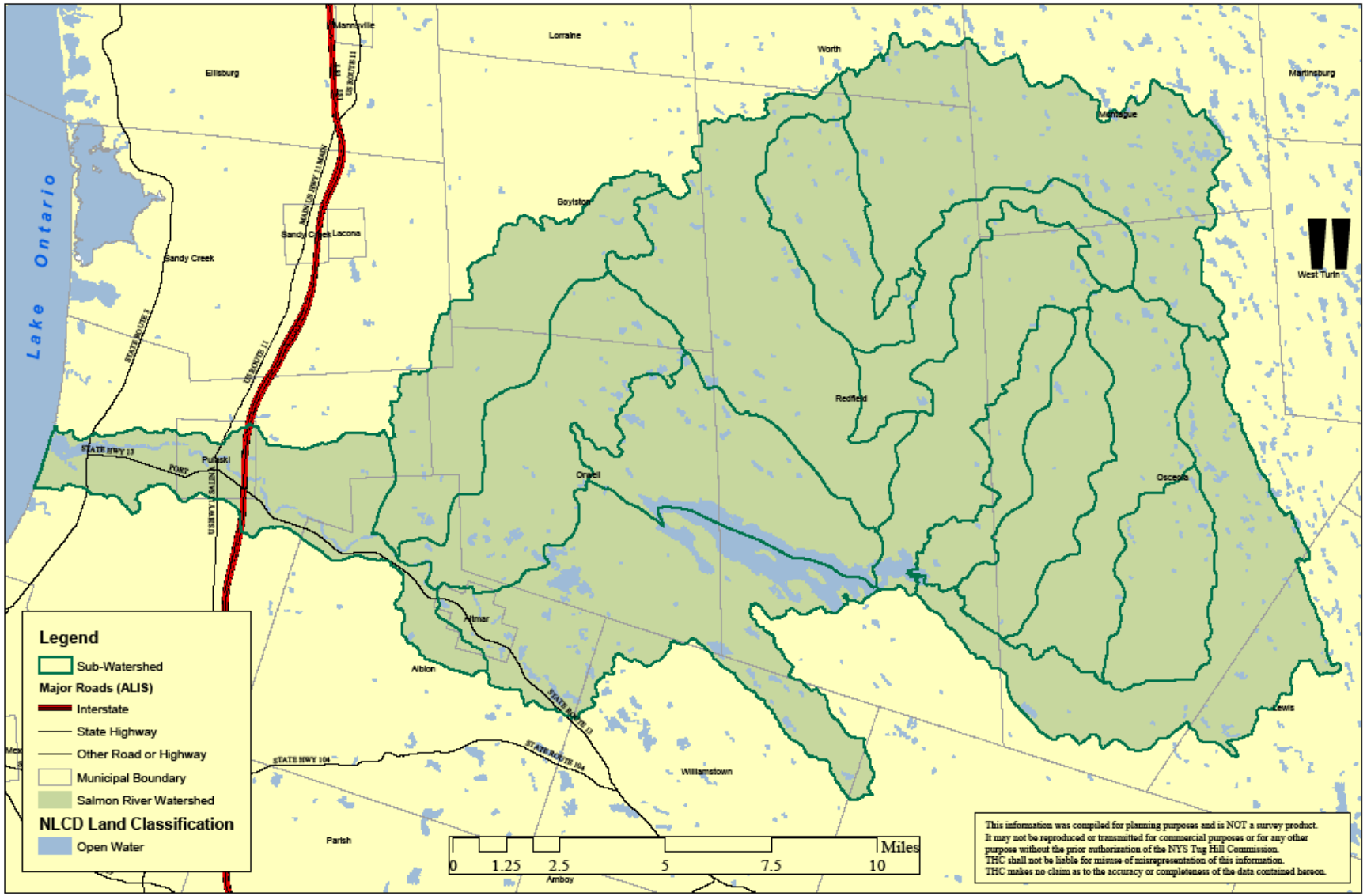

Figure 13. Open Waters of the Salmon River Watershed.

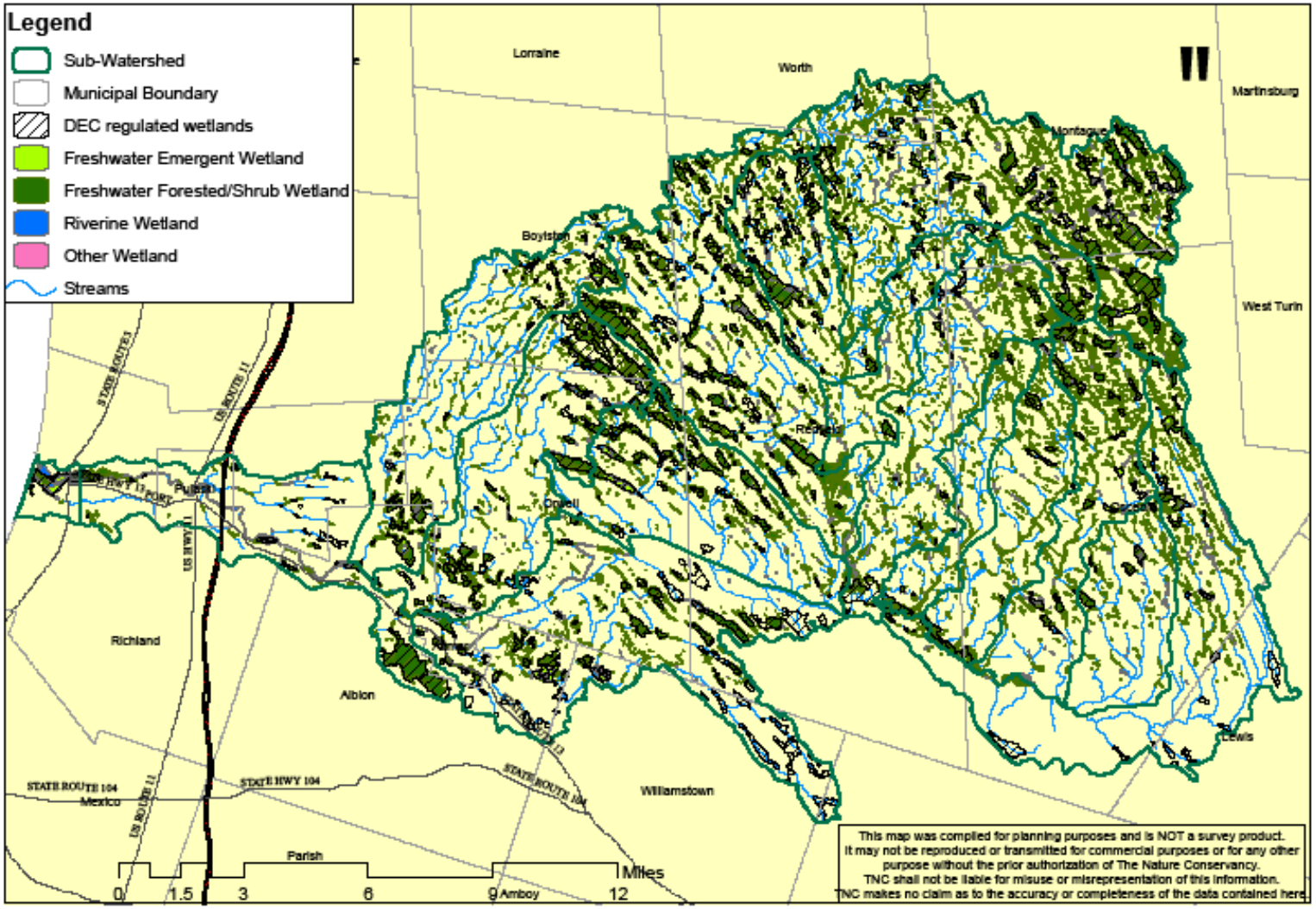

Figure 14. Palustrine and riverine wetlands in the Salmon River Watershed. Data are from the National Wetlands Inventory and the New York State Department of Environmental Conservation.

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.

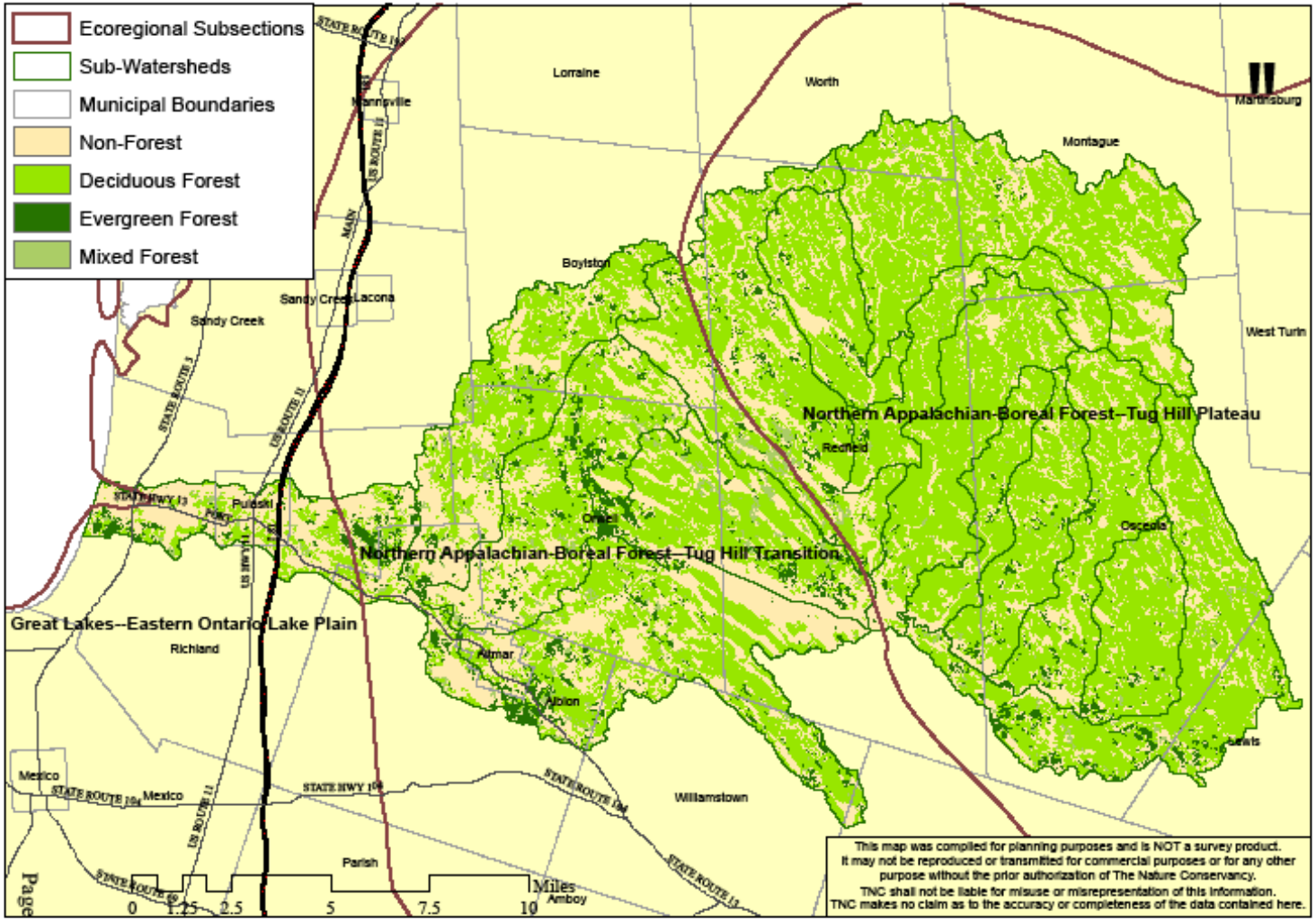

Figure 15. Matrix forests and ecoregional subsections of the Salmon River Watershed.

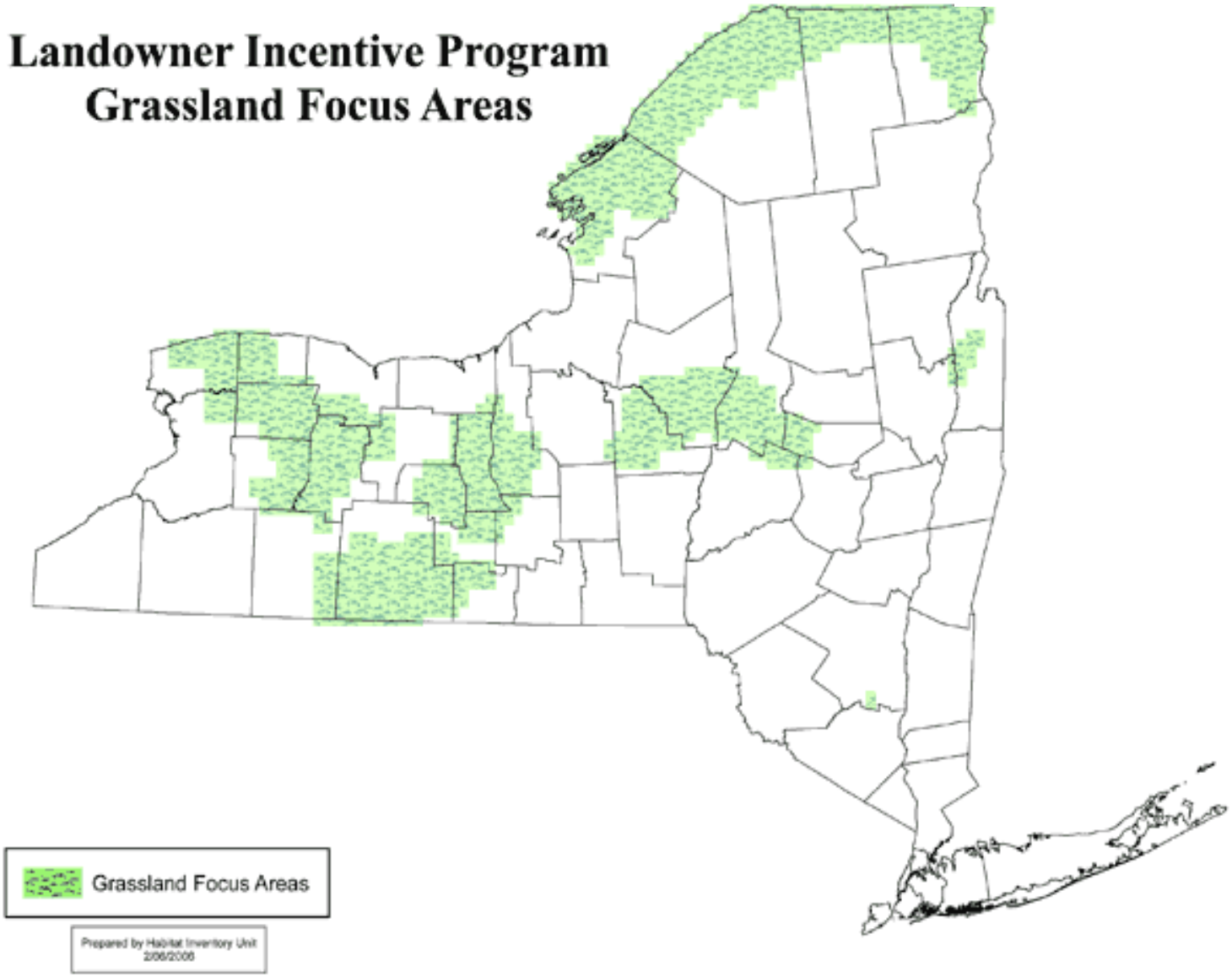

Figure 16. Locations of Grassland Bird Focus Areas in New York. These areas have been defined by the National Audubon Society as having the greatest likelihood of supporting grassland bird species. (Source: Audubon, New York).

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.

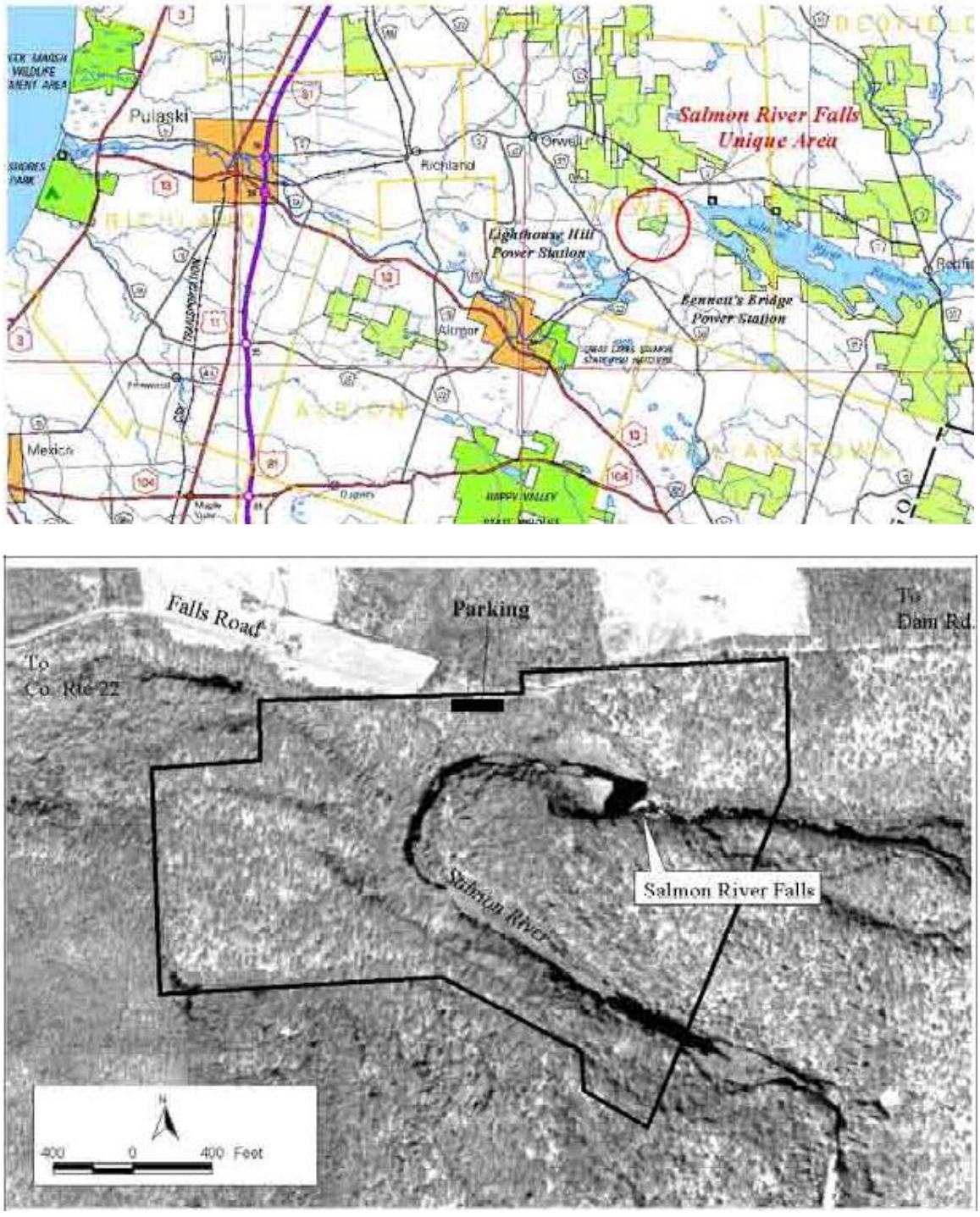

Figure 17. Site location map and aerial view of the Salmon River Gorge (From Sawchuck, 2006).

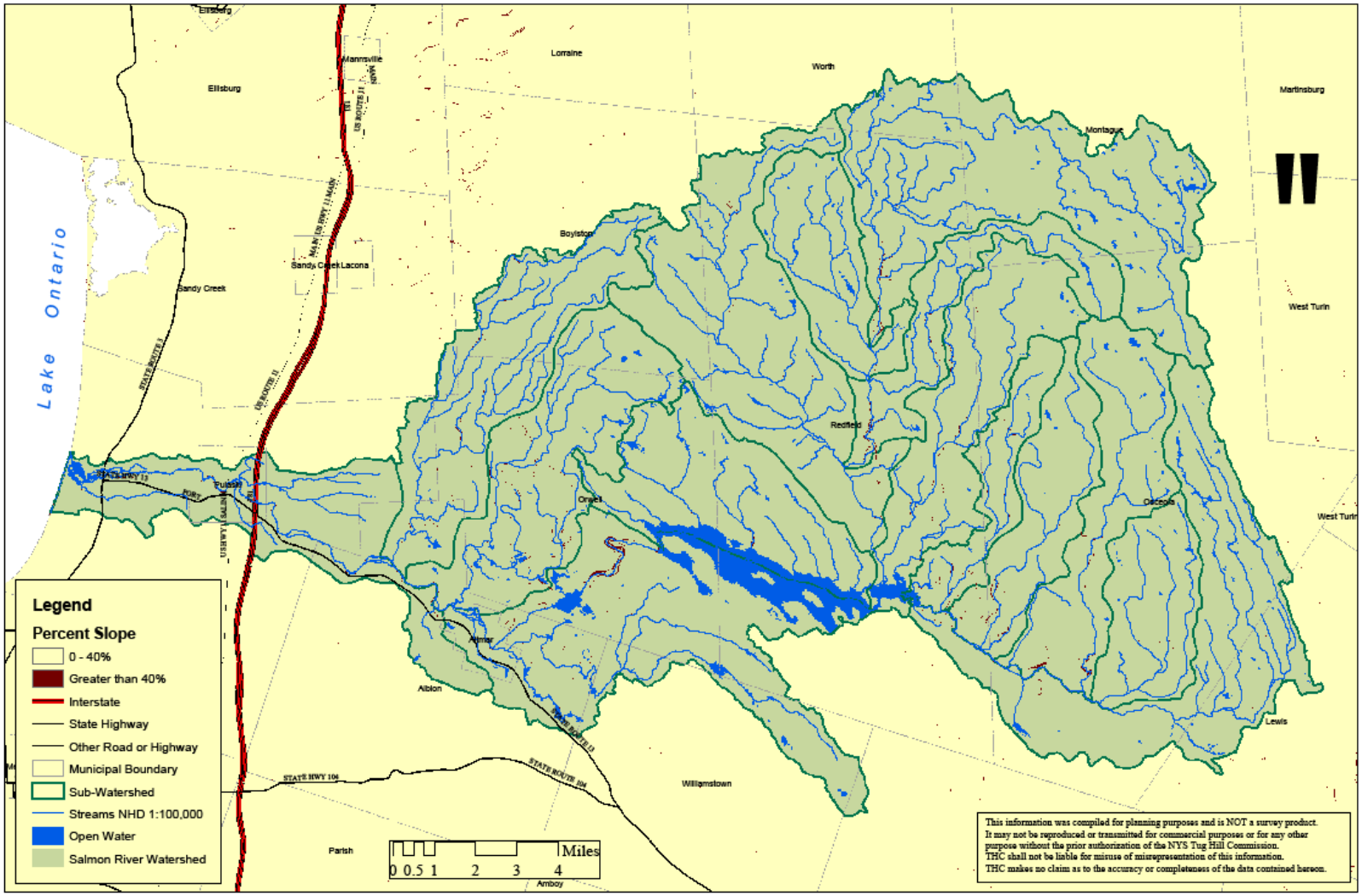

Figure 18. Distribution of landforms in the Salmon River Watershed having greater than 40% slopes.

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	♦														

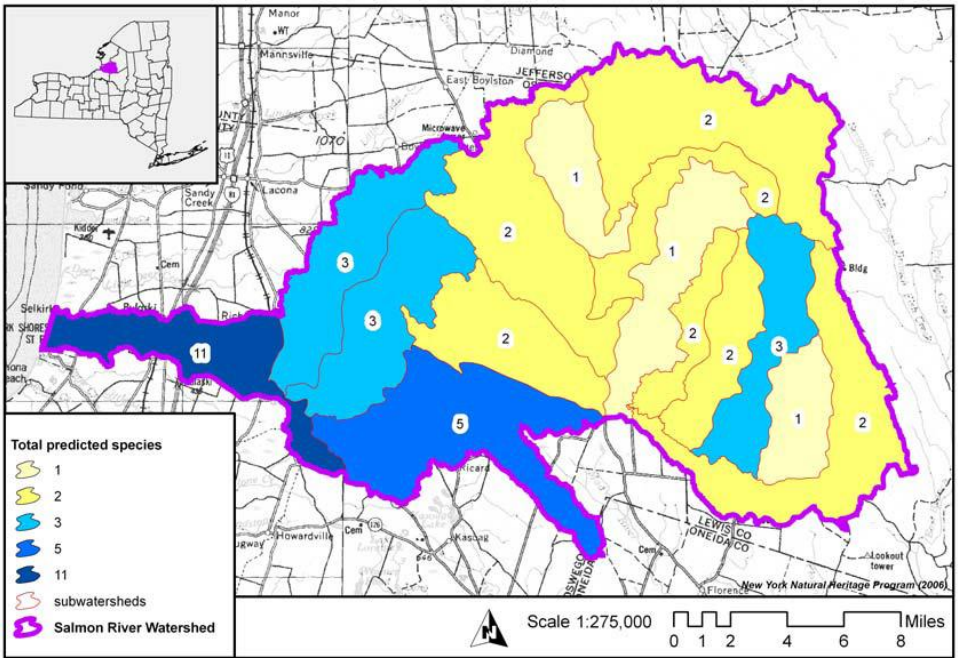

Figure 19. Element distribution model (EDM) of biodiversity 'hotspots' by sub-watershed, showing the number of predicted rare and endangered plant and animal species for respective sub-watersheds (Source: Howard 2006).

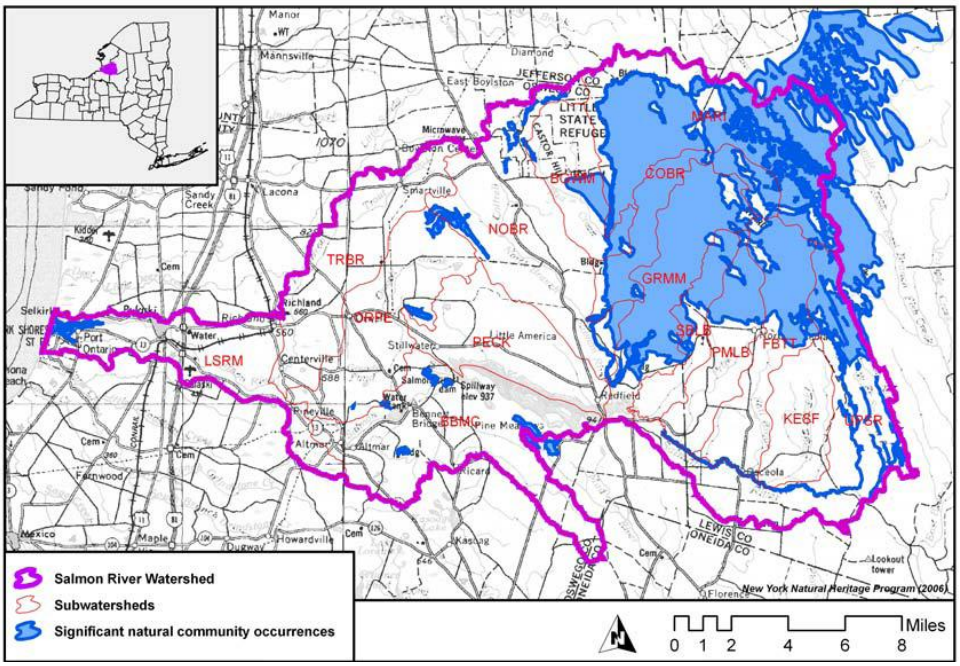

Figure 20. Significant community occurrences in the Salmon River Watershed (Source: Howard 2006).

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.