Sandy Creeks Watershed Inventory and Landscape Analysis

New York Natural Heritage Program

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A report prepared by the

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For the

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Report Summary

The purpose of this project was to provide the Tug Hill Commission (THC) and its communities with a clearer picture of the biodiversity and ecological patterns of the 284,000-acre Sandy Creeks Watershed. We wished to help identify natural areas in the watershed that are vital to protecting the landscape character and biodiversity of the region including the relative ecological quality of subwatersheds.

There were four phases to this project: 1. develop a list of rare species and natural communities known from or with the potential to be found in the Black River and Sandy Creeks Watersheds and create their corresponding Element Distribution Models (EDMs); 2. overlay the EDMs and note where multiple species overlapped, indicating a potential biodiversity "hotspot" in the Black River and Sandy Creeks Watershed; 3. Analyze the quality of the sub-watersheds using a suite of GIS layers in the Sandy Creeks Watershed; and 4. Conduct field inventories and document locations of rare plants, rare animals, and significant natural communities in the Sandy Creeks Watershed.

Field inventories from 2009 along with previous known locations resulted in 170 new and updated locations for rare species and significant natural communities: 53 rare plant occurrences, 90 rare animal occurrences, and 27 significant natural community occurrences. Certain areas within the watershed have high concentrations of these rare species and significant natural communities including the Gulf areas (Totman, Shingle, Bear, Inman, and Lorraine), the Lake Ontario shoreline, and the summit forests, streams, and wetlands of the Sandy Creeks Watershed.

The analysis of the overall quality of the subwatersheds within the entire Sandy Creeks Watershed revealed a few high-quality areas (areas with the most intact landscape). These areas include many of those already identified as areas of high biological diversity including the lakeshore, gulfs, and the remote headwaters at the summit of the Sandy Creeks Watershed.

This project identified two new areas that met the criteria as "Special Areas" under the Tug Hill Reserve Act of 1992. These areas were the Plum Tree Road-Pigeon Creek wetlands and the Adams wetland complex. Some of these areas occurred within lower quality landscapes but contained higher quality and/or rare natural community types. One other site, Butterville Alvar, occurs outside the Tug Hill Region boundary and is included here as a distinctive natural community (alvar grassland) due to its status as a state and globally rare natural community type.

A positive outcome of this project was that we identified many areas of high biodiversity on private lands. We were fortunate that we were granted access to many of these areas which resulted in the documentation of new significant natural communities and rare species in the Sandy Creeks Watershed. However, many of these identified areas were not surveyed due to lack of access permission. All landowners who did grant us access received thank-you letters and were notified if something of significance was found on their land.

The results from this project including species and natural community modeling, results of field surveys, and the landscape quality assessment, can be used by the THC, its communities, and other partners to plan and implement conservation strategies for the Sandy Creeks Watershed. This report can also be used as a baseline for future work in the watershed including aquatic studies, fish and fisheries surveys, and additional wetland inventories particularly in areas already designated as high quality landscapes. New alvar grassland locations should also be surveyed to better document the total extent of the community and for populations of grassland bird species.

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INTRODUCTION

Purpose and goals

The purpose of this project was to provide the Tug Hill Commission, its communities, and partners with a clearer picture of the biodiversity and ecological patterns of the 284,000-acre Sandy Creeks Watershed. We wished to help identify natural areas in the watershed that are vital to protecting the landscape character and biodiversity of the region. In addition, this project provides the initial modeling and analysis for future work in the significantly larger Black River Watershed (see Appendix 5).

There were four phases to this project. The first phase involved developing a list of rare plant and animal species and natural communities known from or with the potential to be found in the Watersheds (both Sandy Creeks and Black River Watersheds were included in this phase). This phase also included creating Element Distribution Models (EDMs) for these species and natural communities. The second phase involved overlaying the EDMs and noting where predictions for multiple species overlapped, indicating a potential biodiversity hotspot. In the third phase, we analyzed the overall quality of the subwatersheds using a suite of GIS layers to key in on landforms, areas of continuous forest cover, and other physical features such as steep slope areas, indicating ravines or bedrock outcrop areas that are unique to the Watershed. The fourth and final phase consisted of field inventory and documentation of rare plant and animal species, and significant natural communities in the Sandy Creeks Watershed. In addition to documenting rare species and natural communities, the final inventory phase allowed us to conduct field work to assess those areas we identified in the third phase as potential "Special Areas" (New York State Tug Hill Commission 2009) within the Watershed, or areas that are vital to protecting landscape character, whether or not they contain NY Natural Heritage tracked rare species or significant natural communities.

Waterfall in Totman Gulf

This multi-tiered approach to organizing the survey within such a large and diverse landscape was critical in terms of maximizing our search efforts for rare species and natural communities, and ensuring that we gave the area a complete, objective look in identifying critical areas for conservation. This report provides a list and description of areas of high biodiversity, areas with high conservation value, and areas that could be designated as "Special Areas" by the Tug Hill communities.

OVERVIEW

Definitions of terms used

We have applied a consistent terminology appropriate for various landscape scales and biodiversity features.

Element: each plant species, animal species, and unique ecological community type is an element of biodiversity, or element.

Element Occurrence: The documented location of a rare plants, rare animal, or significant natural community.

Element Distribution Model (EDM): A map showing locations where a species or natural community is likely to occur. An EDM is a computer-generated model that uses statistics to examine known species or community locations and then find other, similar locations across the landscape. The final model reports a probability that a location contains a similar habitat to that occupied by the targeted rare species or natural community.

HUC: Hydrologic Unit Code. This term refers to the USGS numbering system of dividing river and steam drainages into Watersheds of varying sizes. The higher the HUC number, the smaller the watershed size. http://water.usgs.gov/GIS/huc.html

Natural Community: an assemblage or group of plants and animals that share a common environment (Edinger et al. 2002). These assemblages usually occur repeatedly across the landscape. NY Natural Heritage follows the community classification as defined by Ecological Communities of New York State (Reschke 1990, Edinger et al. 2002).

Significant Community Occurrence: Community occurrences worthy of tracking in NY Natural Heritage Biotics databases because of their state and/or global importance to biodiversity conservation. Each occurrence rank is derived from three ranking factors: size, condition, and landscape context.

Study Area: the primary “study area” or “project area” for this inventory represents the entire Sandy Creeks Watershed (Figure 1).

Subwatershed: Refers to the 462 SALSA subwatersheds (Salmon river and Sandy creeks Watersheds) determined by US Geologic Survey (USGS 2009) and is the main unit of comparison within the basin .

Overview of the Sandy Creeks Watershed

Location

This watershed is located in New York State north of the cities of Utica, Rome, and Syracuse and south of the Saint Lawrence Seaway and the Canadian border (Figure 1). It is bordered by Lake Ontario to the west and it extends eastward toward the Tug Hill Plateau to just over the Lewis County line into the town of Pinckney. To the south, the watershed extends just into Oswego County near East Boylston and the towns of Sandy Sandy Creek and Richland. The largest population center is the community of Adams Center nearly in the center in the Watershed. The Sandy Creeks Watershed encompasses a series of smaller streams that drain into Lake Ontario including Stony Creek, Sandy Creek, South Sandy Creek, Skinner Creek, Little Sandy Creek, and Deer Creek.

Landscape/land use/ecoregions/ecozones

The landscape and land use for the Sandy Creeks Watershed are diverse. Although the entire area can be described as rural, the lake shore consists of marsh lands, dunes, and beaches while the mid-section is

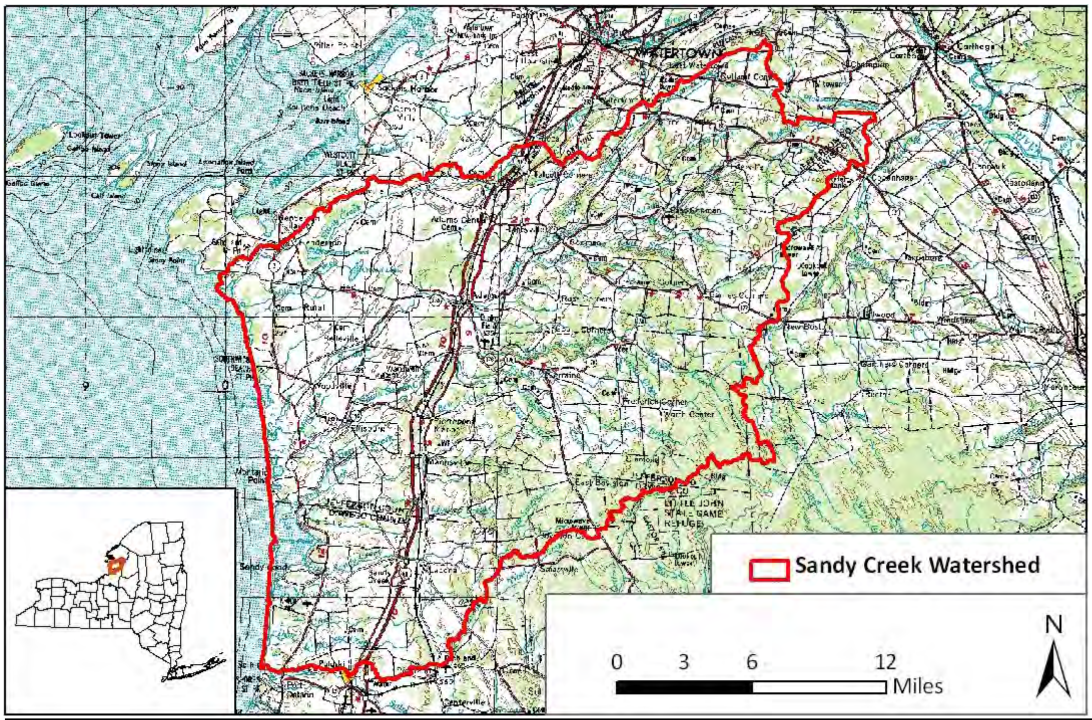


Figure 1. The Sandy Creeks Watershed study area.

farmland with agricultural land accounting for about 47% of the total land cover of the Watershed (Cornell IRIS 2008). The easternmost section, at the highest elevation, is largely forested with a long history of logging. Forests here are mid- to late successional and are predominantly beech-maple mesic forests. Higher elevation forests have more red spruce and may be classified as red spruce-northern hardwood forests (Hunt & Lyons-Swift 1999, Muench et al. 1974, Lyons-Swift 2000, State University of New York College of Environmental Science and Forestry 1974). The Watershed covers parts of four Sub-Ecozones as described by New York State Department of Environmental Conservation (NYS DEC) (Dickinson 1983, Will et al. 1982). Starting at the Lake Ontario shoreline in the west and moving to the Tug Hill plateau to the east, the watershed passes through the Eastern Ontario Plain Sub-zone, the Tug Hill Transition Sub-zone, the Black River Valley Sub-zone, and the Central Tug Hill Sub-zone. Likewise, the Sandy Creeks Watershed occupies the Eastern Ontario Lake Plain Subsection of the Great Lakes

Ecoregion; the Black River Valley Subsection of the St. Lawrence-Champlain Valley Ecoregion; and the Tug Hill Transition and the Tug Hill Plateau Subsections of the Northern Appalachian/Acadian Ecoregions (Bryce et al. 2010) (Figure 2).

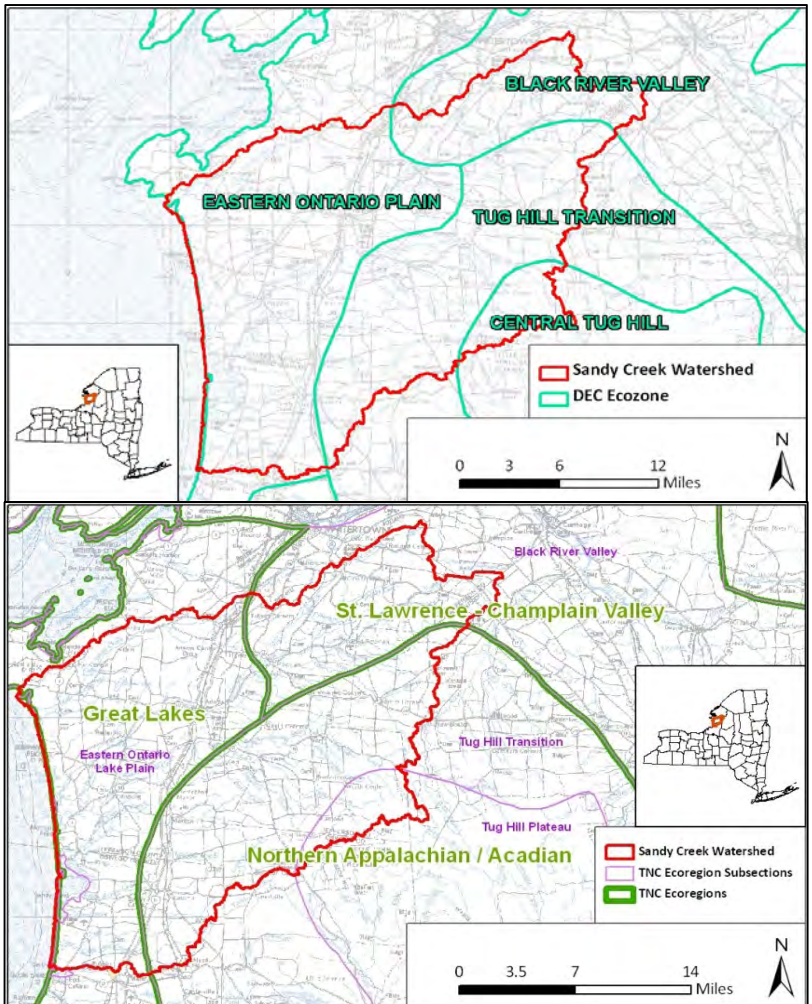


Figure 2. Ecozones (top) and Ecoregions (bottom) of the Sandy Creeks Watershed

Bedrock and surficial geology

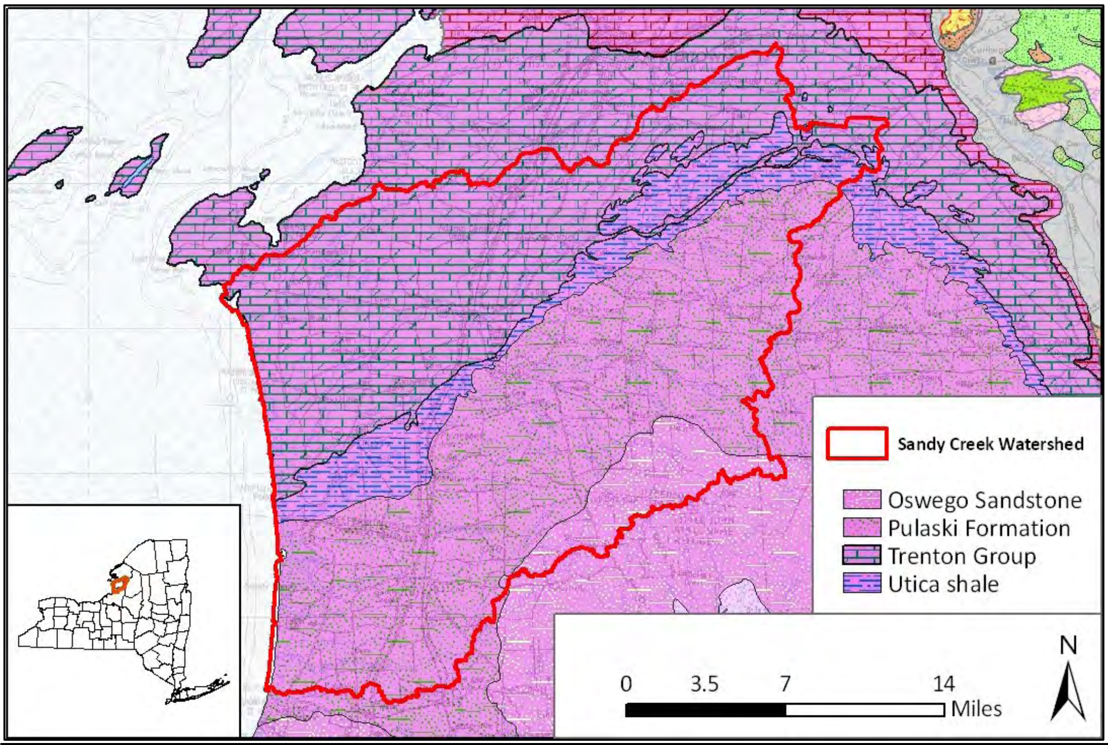


Figure 3. Bedrock geology of the Sandy Creeks Watershed

The bedrock geology of the Sandy Creeks Watershed changes slightly from north to south (Figure 3). The northernmost section near Little Stony Creeks and Sandy Creeks is underlain by the Trenton Group of limestones and shales with a significant occurrence of Galoo limestone at Adams Center. South of that, near South Sandy Creeks, is an area underlain predominantly by Utica Shale, a formation that also contains natural gas. From here to the southern border of the Watershed is underlain by the Pulaski formation consisting of siltstones, shales, and light gray sandstone (New York State Museum 1999a). The limestone in this area results in a richer substrate environment with a higher probability of rare plant species and unique natural communities.

The surficial geology of the Sandy Creeks Watershed is divided into four distinct regions (New York State Museum 1999b). The northwestern part of the Watershed is predominantly lacustrine silt and clay while the southwestern section is mostly lacustrine sand (quartz sand). Inland sand dunes are found in this area. The northeastern section is predominantly glacial till deposited by a terminal moraine that ranges from silt to boulders while the southeastern section, at the top of the plateau, is mostly ablation moraine (deposited by melting glacial ice) that also varies from silt to boulders.

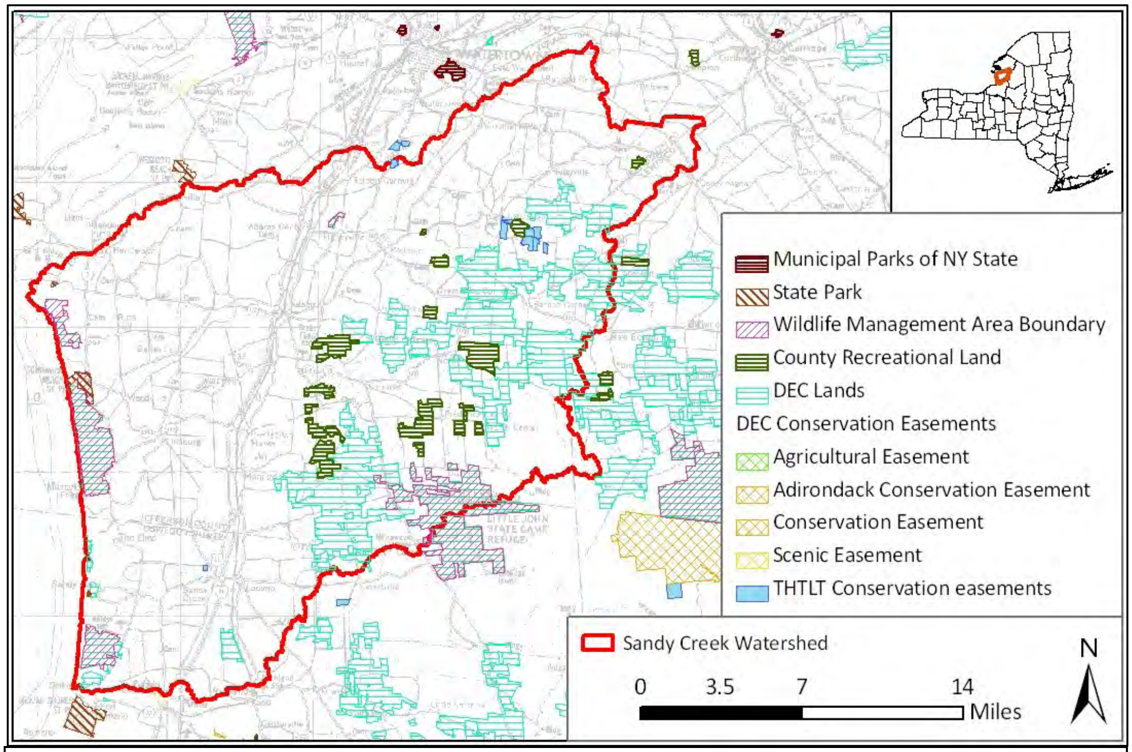


Figure 4. Protected areas in the Sandy Creeks Watershed

Protected areas in the Watershed

Protected areas in the Watershed occupy a little over 25% of the overall land area. Included in this calculation are conservation easements, NYS DEC lands including Tug Hill and Winona State Forests, Wildlife Management Areas (WMA) including Little John WMA and Lakeview Marsh WMA, county and municipal forests and New York State Parks such as Southwick and Sandy Beach State Parks (Figure 4).

METHODS

Natural Heritage Methodology

The Natural Heritage Methodology was developed by NatureServe, a non-profit conservation organization. They represent an international network of biological inventories-known as natural heritage programs or conservation data centers-operating in all 50 U.S. states, Canada, Latin America and the Caribbean. The New York Natural Heritage Program is part of this network and operates in New York State as a partnership with the NYS Department of Environmental Conservation. NatureServe has spent more than two decades helping to develop and refine the inventory methodology used by Natural Heritage Programs.

The coarse filter/fine filter

Natural Heritage inventory methodology works by focusing on the identification, documentation, and mapping of all occurrences of rare species and significant ecological communities. We use a "coarse filter/fine filter" approach to identify and prioritize the protection of these significant biological resources. Ecological communities as defined in Reschke (1990) and Edinger et al. (2002). represent a "coarse filter" aggregate of biodiversity at a scale larger than the species level. Their identification and documentation can be used to describe whole assemblages of plant and animal species, both common and rare. The conservation of the best remaining examples of natural communities ensures the protection of most of the common species that make up the biological diversity of the state. Rare animals and plants often have narrow or unusual habitat requirements. These species may fall through the coarse filter, and are sometimes not protected within representative communities. Identifying and documenting viable populations of each of the rare species serves as the fine filter for protecting the state's biological diversity. This coarse filter/fine filter approach to a natural resources inventory has proven to be an efficient means of identifying the most sensitive animals, plants, and ecological communities of an area. A complete description of NYNHP methodology including methods for ranking rarity and assessing quality are included in Appendix 1.

Element Distribution Modeling

Element Distribution Modeling is the process that maps the environments predicted to be suitable for occupation by a particular species or natural community (Beauvais et al. 2004). Also described as habitat modeling, this method is receiving more and more attention as desktop computers become more adept at handling large data sets and complex algorithms (Guisan & Zimmerman 2000). A detailed description of element distribution modeling is beyond the scope of this report. Detailed methods were written for NY Natural Heritage's Salmon River Watershed project and are available online at http://www.tughill.org/SRW_Report_OnscreenViewingVersion_NYNHP.pdf. At their most basic level, Element Distribution Models (EDMs) evaluate a set of environmental variables (e.g., mean summer temperature, percent slope, and surrounding forest cover) at each known location for a particular species or natural community and then use statistical procedures to find other locations with similar environmental characteristics. The resulting map depicts the probability that the habitat at each location is appropriate for the species or natural community. The variables used for this analysis as well as a more detailed description of the EDM process can be found in Appendix 2.

Models as a part of the landscape assessment

We used the EDMs as part of the overall landscape assessment. For this assessment, we wanted to split the continuous prediction map into a predicted/not predicted map (see Figure 5). Although turning a continuous surface into only two classes results in a loss of information (and is sometimes considered inappropriate; see Royston et al. 2006), it is not an uncommon task in habitat modeling. For our purposes, the main reason to do this was to synthesize across the many EDMs and create a layer showing the number of predicted species across the landscape. Thus we needed each EDM to show either yes, appropriate habitat for the species is predicted, or no, appropriate habitat is not predicted for the target species.

In order to create a predicted/not predicted EDM map, we needed to determine the appropriate cutoff value for each EDM. To determine the appropriate percentage we used receiver-operator characteristics (ROC) coding in R (R Development Core Team 2005) that assessed the success of the model to correctly predict known present and absent locations. For example, setting

the entire study area to "present" would successfully capture all the known present locations (100% correct positives), but also capture all the "absent" locations as present (0% correct negatives). We chose an analytic routine that maximizes correct positives and correct negatives at the same time.

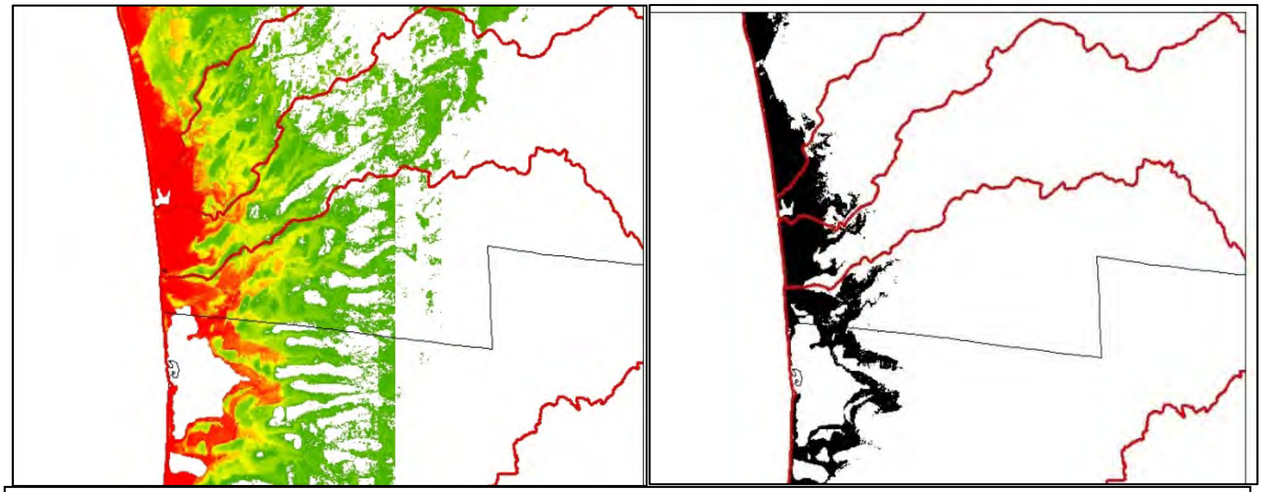


Figure 5. Black Tern EDM along the Lake Ontario shoreline. Left: continuous prediction. Right: present/absent prediction.

Element Distribution Model Overlays for "Hotspot" analysis

The EDM overlays are a group of data layers that depict areas of predicted habitat for rare species in New York. The overlays combine the results of multiple Element Distribution Models (see section on Element Distribution Models above). A total of 316 statewide EDMs each representing presence or absence of predicted suitable habitat for individual rare plant and animal species on a pixel-by-pixel basis, were created by NY Natural Heritage between fall 2004 and spring 2009. Then all 316 EDMs were added together (essentially stacked on top of each other) to produce the comprehensive statewide raster dataset. This process aggregates all of the individual rare plant and animal EDMs and retains tabular presence/absence predictions of suitable habitat for each species at the individual pixel level.

Pre-inventory methods: Landowner permissions

During the spring of 2009, we identified priority, private landholdings for field inventories. We felt that these private parcels had a high probability of having rare species or rare natural communities based on expert opinion and the EDMs layers described above.

At the THC offices in Watertown, we met with regional experts and THC staff to delineate priority areas for field inventory. We used large, printed, base-layer maps of the Watershed with the "hotspot' layer (see above) over the DOT planimetric layer to visually locate priority areas and hand-draw those in on the maps. From these hand-drawn delineations we used GIS to create a list of landowners and their contact information. With the help of the Tug Hill Tomorrow Land Trust, we sent letters requesting permission to conduct inventories to the majority of these landowners. Some of the priority areas that were of higher quality than others where landowners did not initially respond, were sent follow up letters or they were called directly.

Rare animal and plant inventory methods

Rare animals

For rare animals, we focused inventory effort on documenting new occurrences as well as updating the status and condition of existing occurrences. To accomplish this we used EDMs, contacts with local naturalists, and other methods of remote assessment (i.e. aerial photos and maps) to identify potential locations of new rare animal occurrences. In addition, we visited some existing occurrences to update their status and condition. Most surveys targeted particular species depending on the habitat type and likelihood of encounter. The survey methods were appropriate for targeted species and their activity period.

Upland Sandpiper: from NYNHP Image database.

When a rare species was encountered, we recorded location, size, extent, and condition of the population, as well as data on the immediate habitat. Observations on disturbances and threats to the persistence of the species were also recorded. These data were added to the Biotics database maintained by NY Natural Heritage. We photographed rare animals when possible to document their occurrence.

Rare Plants

For rare plants, a NYNHP botanist focused on potential survey sites east of Route 3, prioritizing areas with historical rare plant records, or extant records more than 10 years old. We also made targeted *de novo* searches in areas that aerial photo interpretation and/or EDM data suggested had high potential for discovery of new rare plant populations.

Yellow Mountain Saxifrage. Photo: Troy Weldy

During each visit, the botanist recorded a list of all plant species identified during the course of the survey. These data were grouped by survey area and GPS points were taken at each survey area and at other points of interest. Species lists for these visits are kept in an in-house observations database. When a rare plant species was discovered or updated, specimens were photographed and/or collected, and additional information about the habitat, surrounding landscape, the health and vigor of the population was recorded. These data were added to the Biotics database maintained by NY Natural Heritage.

Ecological Community Inventory Methods

General field methodology

We conducted natural community inventories within the context of the community classification and community descriptions found in Ecological Communities of New York State (Edinger et al. 2002). Inventories focused on palustrine (wetland) and terrestrial natural communities. Field visits were made to sites where EDMs produced relatively high predictions for rare natural communities and/or where manual GIS assessment indicated a high potential for significant natural communities.

This study used standard inventory methodology developed by The Nature Conservancy, NatureServe, and the Natural Heritage Network, and refined by NY Natural Heritage (Edinger *et al.* 2000). General survey methodology for natural communities involves collecting data on all or most of the following for each targeted community occurrence: plant species composition and structure in all strata, unvegetated ground and water surfaces, soil properties, slope, aspect, elevation, geology, and hydrology (Edinger et al. 2000). These data allow an accurate identification of each community surveyed. We also collect and record information on occurrence size, maturity, level of disturbance, abundance of exotic species, threats, and landscape context. These data allow us to compare the quality and assess the viability of each community occurrence in relation to others throughout the range of the community, both within and outside of New York State.

Plot and observation point sampling

For each suspected new element occurrence discovered in the field we strove to collect at least one detailed releve plot and additional observation points scattered throughout the occurrence. Plots were placed via a random direction and distance into the natural community. They were typically 20 m × 20 m in size in forested communities and 10 m × 10 m for wetland and non-forested terrestrial communities. Plot data collection followed Edinger (2000). We also captured a digital photographic record of each plot and for most observation points. These photos are stored in the NY Natural Heritage digital images database and referenced in the observations database at the appropriate locations.

Bear Gulf. Photo: Jennifer Harvill

In order to capture the variability throughout a natural community occurrence, we strove to collect observation points throughout the occurrence. These points describe the dominant species in each vegetation stratum with enough information to classify the community and help evaluate the quality and viability of the entire community. Observation points may be completed much more quickly than plots, however, allowing us to visit much more of the site given a defined amount of time.

Information processing and mapping

NY Natural Heritage ecology staff followed standard methods for documenting rare species and natural community occurrences determined to be significant from a statewide perspective. All plot and observation data were collected with digital technology and spatially located using a global positioning system (GPS). More specifically, we have built a data-entry database for use on a hand-held PDA (personal digital assistant). This database is built in VisualCE (Syware Corp.) and greatly speeds data transfer into our in-house observations database and data synthesis and compilation into the Biotics database maintained by NY Natural Heritage. GPS points at plots and observation points were collected with a GPS unit (Garmin 60cx, Magellan or other) or a Trimble Nomad (with a Garmin 10X external antenna). We collected GPS-averaged positions of at least 100 seconds whenever possible. Botanical surveys were also conducted using GPS and, in part, using the electronic handheld data recorders and electronic database.

Zoological site survey forms, rare species forms, and negative survey forms, when appropriate, were completed for all zoological inventories. All botanical and ecological data were uploaded or entered into the Biotics database maintained by NY Natural Heritage. For each botanical survey, we created general survey forms with species lists and rare species forms where appropriate, for each inventory day. For ecological inventories, we completed plots and observation point field forms with associated locator maps and for each significant community we completed community ranking forms that include a community description, ranking analysis, observed disturbances, stresses and anticipated threats, and associated management and protection recommendations. These forms are archived electronically in the NY Natural Heritage office.

We created digital maps of all rare species and significant natural community occurrences. For natural communities, we displayed all observation points and plots in a GIS, with digital topographic images, high-resolution digital ortho-images (from 2000-2006), and other relevant GIS layers. The final delineations were drawn at a scale of 1:24,000 or a finer resolution.

Watershed Integrity Analysis Methods

Analysis units

The goal of the integrity analysis was not to compare the Sandy Creeks Watershed to other basins in the state, but to evaluate the relative quality of places within the Watershed. The first step in comparing the relative quality within a single, large watershed is to determine the unit of comparison. There are many different possible ways to split a basin into smaller units for comparison. Rather than using a political (e.g., town) or regular (e.g., the breeding bird atlas grid) set of divisions, we chose to split the Watershed into smaller drainage units.

The Sandy Creeks Watershed is composed of four 10-digit Hydrologic Units, as available from US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (Figure 6), based on the NRCS Hydrologic Unit Code (HUC) system. The four 10-digit HUCs can be further divided into 17 smaller 12-digit HUCs. These units were still too large for meaningful comparison of the subwatersheds so a new layer from the USGS was used to further divide these Watersheds into 462 subwatersheds that USGS refers to as stream segment 'catchments' (McKenna 2009). This smaller, stream segment subwatersheds will be referred to as SalSa subwatersheds (Salmon River and Sandy Creeks) in this report because, at the time, they were only completed for these two larger watersheds. The 462 subwatersheds vary from 0.5 acres to 4482 acres. The map showing the delineation of these much smaller subwatersheds is shown in Figure 7. Once subwatersheds were identified as high quality we then looked for areas in the larger watershed where these tended to group or cluster together. These groups or clusters of high-quality areas were then described as focus areas for conservation planning.

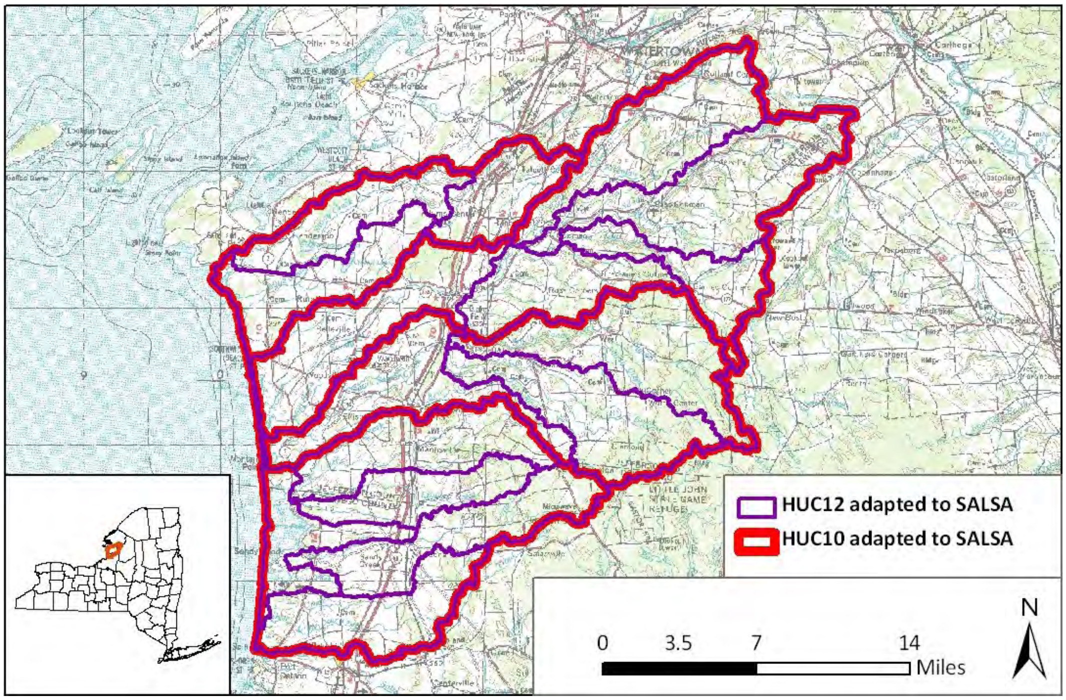


Figure 7. Map of the four larger 10-digit HUC watersheds that comprise the Sandy Creeks Watershed subdivided into the smaller 12-digit HUC subwatersheds (USDA).

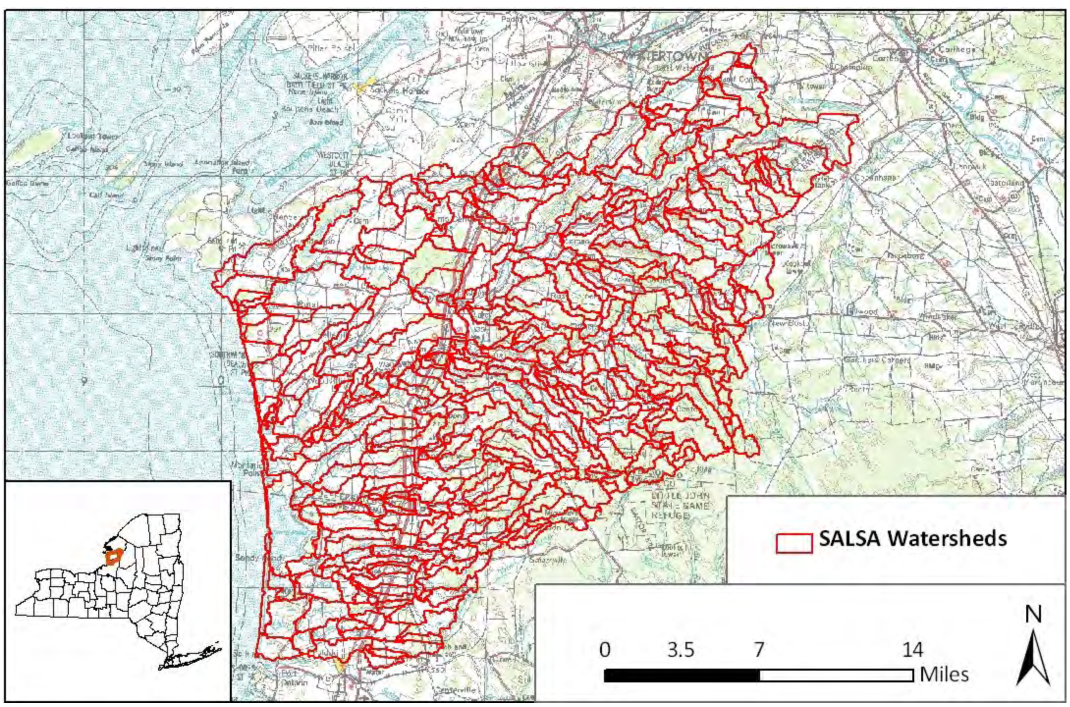


Figure 6. 462 SalSa subwatersheds (Salmon river and Sandy Creeks Watersheds) determined by USGS (McKenna 2009) used for landscape quality analysis in this study.

Watershed analysis model development

We conducted a detailed GIS analysis of the 462 SALSA subwatersheds to help guide conservation efforts in the region. This analysis followed the model initially developed during the Lake Erie Gorges Biodiversity Inventory (Hunt et al. 2002) and further refined for the Tug Hill Stream System Inventory (Hunt et al. 2005). This analysis was further refined in 2005 for the Salmon River project (Howard 2006). This NY Natural Heritage landscape integrity model uses methods for 1) ranking the integrity of watersheds and functional landscapes, and 2) determining the location of relatively unfragmented stretches of water and relatively unfragmented patches of forests, thus comparing the relative conservation importance of watersheds and stream systems across a given area. This prioritization considered parameters with parallels to 1) factors used in the ranking of community occurrences at NY Natural Heritage, and 2) the watershed integrity and diversity indices developed by The Nature Conservancy's Eastern Conservation Science office.

Ecological parameters

We began with the list of parameters selected for the final analyses of Tug Hill stream systems (Hunt et al. 2005) and added additional parameters appropriate for this analysis. The Tug Hill streams assessment was based on earlier work in the Saint Lawrence/Champlain Valley (Hunt 2001) and the Lake Erie Gorges (Hunt et al. 2002, Howard 2006). The final set of parameters used, we believe, contains the most important in ranking landscape integrity among those readily available for GIS analysis. Parameter availability (or ease of parameter creation from available data) is an important component to this assessment for both full transparency of our process and for ease of transfer to other basins. The parameters analyzed in this effort are described in Appendix 3.

Our evaluation of subwatersheds considered several factors related to the distribution and density of natural cover, cultural barriers to native species and ecological processes (e.g., dams, cleared stream buffers), and disturbance corridors for exotic species and anthropogenic processes (e.g., roads, cleared stream buffers). Key ranking parameters sought for the watershed integrity analysis for the study area were classified into five general categories: 1) biological condition, 2) flow alterations (i.e., dams and diversions), 3) land cover, 4) roads, and 5) water quality. Land cover is further divided into Watershed land cover and stream buffer land cover characteristics. When applied, assessment of the condition or integrity of each individual subwatershed and stream system was based on existing data on the number and capacity of dams, percentage of developed or agricultural lands and their distribution relative to streams, the density of roads and their distribution relative to streams (Figure 8), and water quality.

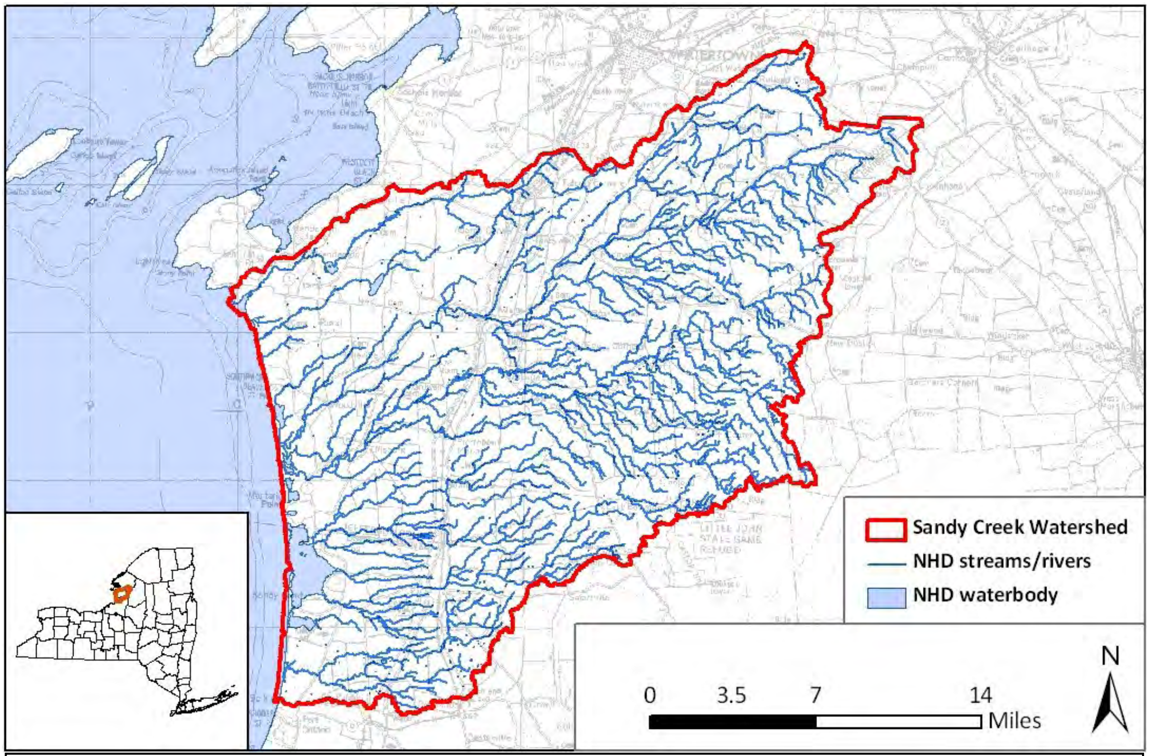


Figure 8. Streams and attached waterbodies in the Sandy Creeks Watershed

We included a new metric that provides a roadless block score that varies with roadless block size. The original metric, which we also include in the analysis, measures the percentage of each watershed occupied by roadless blocks over 300 acres. The value of roadless blocks varies by size, however (e.g., Anderson 1999, Kennedy et al. 2003), and a metric that takes this into account is more meaningful. We outline the method for generating this metric in Appendix 3.

Finally, we include known and predicted estimates of rare species richness (numbers of species) in the analysis. Known rare species occurrences are based on the NY Natural Heritage Biotics database. Estimates of rare species richness are based on the EDMs generated for this project.

Ecological data layers

NY Natural Heritage staff continued research on GIS data availability for key ecological parameters that were used to produce integrity indices for comparing the subwatersheds of the study area. Information on GIS data that were used in the analyses and map production is detailed in Appendices 2 and 3. We sought consistent and uniform data layers that were feasible to assess comprehensively throughout the study area and also contained appropriate resolution to evaluate at the subwatershed scale. The Breeding Bird Atlas, for example, is an excellent dataset and very useful at small scales, but the blocks are slightly too large to incorporate into an assessment of the targeted subwatersheds in this study.

Most data used in the analyses were available from the NYSDEC, an agency that has acquired a variety of data from multiple sources, with the exception of the Point Source Discharges data layer. This data layer was acquired from EPA's BASINS (Better Assessment Science Integrating Point and Non-point Sources) program. BASINS emphasizes watershed and water quality-based assessment and integrated analysis of pollution sources. It integrates GIS with national watershed data and modeling tools. Land cover, roads, and dams data layers available from the NYSDEC are at a more precise scale, or level of detail, than that available from the EPA.

Much water quality data is available on GIS layers. Examples of water quality parameters found as EPA BASINS data layers, but not considered temporally or spatially uniform for the study area, included toxins, phosphorous, nitrogen, fecal coliform, and pesticides. The one water quality parameter analyzed, number of permitted point source discharges per Watershed, was considered comprehensively available throughout the subwatersheds. This dataset was derived by appending EPA BASINS GIS coverages of Toxic Release Inventory Site for Water Releases (TRI) and Permit Compliance Systems for Permitted Discharges (PCS).

Numerous parameters were available for flow alterations (i.e., land cover, dams and diversions, and road distribution). The land cover data layer used in the preliminary analyses was the NOAA Coastal Change Analysis Program (C-CAP) dataset (see http://www.csc.noaa.gov/digitalcoast/data/ccapregional/). It was the most recent (2005) and most precise (30-meter cell scale) land-cover dataset that covered the entire study area. Land-cover characteristics were assessed for entire watersheds and within 100 meters of streams. The streams data layer is a digital version of the streams shown on USGS 1:24,000 quadrangle maps. Flow alteration parameters were available only for dams. Road distribution parameters focused on a combination of road density and the proximity of roads to streams.

Data interpretation

Raw data on landscape features were converted into ecologically important metrics and indices for broad categories of landscape parameters following the GIS model of the Lake Erie Gorges and Tug Hill Aquatics projects (Hunt et al. 2002, Hunt et al. 2005, Howard 2006). The goal of this analysis was to compare all of the subwatersheds with respect to the parameters available in GIS, and determine the subwatersheds of highest relative integrity within the Sandy Creeks Watershed. For each subwatershed metric (e.g., 'percent natural land'), raw values were converted to a scale of 0-100 (i.e., the raw value of highest integrity for a given parameter received a 100). Then an Index was created for each subwatershed integrity category by averaging the metrics within that category. For example:

Land Cover Index = (PercentNaturalLand + PercentWithin>300acNaturalBlocks) / 2

This was done for each metric and category. Each index was calculated based on one to four parameters. For instances where the metric was considered to affect the subwatershed negatively (such as pollution points and dams), the same 0-100 scale was incorporated except it was reversed so as to scale all indices the same: 0 values had the least integrity, and 100 had the highest integrity. Once this was completed, all categories were averaged into the final Overall Index. The Overall Index is a ranking value that compares subwatersheds with respect to all the parameters studied. There was no weighting of any metrics or indices.

Special Area analysis

In addition to the use of clusters of subwatersheds as conservation areas based on overall landscape quality, this project also looked at those areas that meet the definition of "Special Area" as outlined by the Tug Hill Commission Special Area Guidelines Workbook (NYS Tug Hill Commission 2009). These areas might actually occur in places in the subwatershed that are of lower quality due to the presence of roads, dams, agriculture, or other features. The Tug Hill Commission uses many criteria to define a Special Area. For the Sandy Creeks Watershed project, we evaluated areas based on the following characteristics: gulf area; important habitat area; large, contiguous forest area; core forest; major river and stream corridors and important headwater wetland areas. Not all of these criteria were applicable to all sites but special consideration was given to those sites where multiple criteria applied.

RESULTS AND DISCUSSION

Priority Species and Selected Survey Sites

A complete list of all rare species (plant and animal) as well as natural communities for both the Sandy Creeks and Black River Watersheds is included in Appendix 4 (EDM list). Initially, we focused on 253 rare species and natural communities (59 rare animals, 59 natural communities and 135 rare plants). Ultimately, we produced over 300 Element Distribution Models (EDMs) representing species and natural communities from all the counties included in the Sandy Creeks and Black River Watersheds. Because of the large size of the EDM data, a digital version was supplied to the THC previously on a portable hard drive. The EDM overlays of rare species and significant natural communities resulted in the selection of about 50 sites for potential field inventory.

Landowner Contact

Marsh and headwater stream at watershed summit

Over 600 parcels of varying sizes overlapped with the selected survey areas. All landowners were sent letters requesting permission for access to their properties. Of these letters, 183 responses were received (57% of total requests), with 104 landowners (17% of the total requests) granting permission to survey their property. As we were also conducting inventories on public land, we had to prioritize our visits into the field. Therefore, field inventories were not conducted on all private properties that gave us access permission.

Many of the landowners requested a follow-up letter providing information on what we found on their property. Landowners whose property contained occurrences of rare species or natural communities were sent a letter letting them know what was found. Landowners whose property did not contain occurrences were sent a letter notifying them of this and thanking them for their cooperation. The conclusion of this study will be publicized generally in a future edition of the existing Sandy Creeks Watershed newsletter, produced by the Tug Hill Commission.

Inventory Efforts - Field Inventory

Combined inventory efforts for rare species and significant natural communities resulted in a total of 161 observation points throughout the entire Watershed (Figure 9). Ecological, zoological, and botanical inventories are discussed in more detail below.

NYNHP ecologist, Greg Edinger, in Adams Swamp

Ecology

NY Natural Heritage ecologists spent approximately 18 days in the field conducting inventories throughout the Sandy Creeks Watershed on selected sites. Inventory efforts focused on private lands where permission was granted and public lands. Ecological observation point locations, including detailed plots, are shown in Figure 9. In all 5 plots and 110 observation points were collected during the 2009 field season.

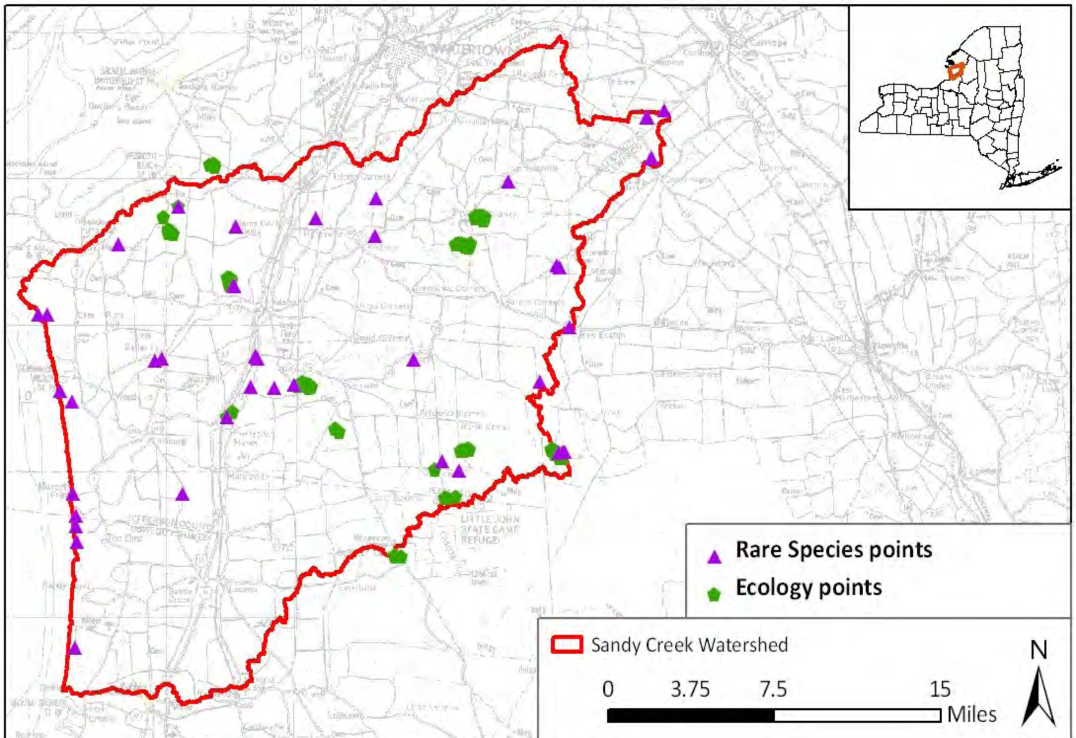


Figure 9. Survey Sites for rare species and natural communities in the Sandy Creeks Watershed for the 2009 field season.

Botany

A NY Natural Heritage botanist spent 15 days in the field conducting rare plant inventories (29 survey sites). Four new locations for Hill's pondweed (*Potamogeton hillii*, Rare: S2) were found during this survey at Adams Swamp, Barnes Corners wetlands, Plum Tree Road wetlands and Wilder Road Swamp. This rare aquatic plant is usually found in shallow, generally calcareous or high pH wetlands, and populations may respond positively to temporary impoundments and flooding by beaver dams (New York Natural Heritage Program 2009b).

Zoology

Heritage zoologists spent 15 days in the field (22 survey sites) primarily looking for tracked grassland birds and odonates (damselflies and dragonflies).). Most notably, we found that known breeding locations for state-threatened, grassland-dependent Upland Sandpipers (*Bartramia longicauda*) near Pleasant Lake, and northern Harriers (*Circus cynaeus*) in the town of Worth remain extant. We also found significant new locations for the S2S3 Mottled Darner (*Aeshna clepsydra*) dragonfly and S1 Hairy-necked Tiger Beetles (*Cicindela hirticollis*) at healthy sand dune communities near Renshaw Bay.

New and updated locations for the rare species and significant natural communities inventoried as a part of this project are described briefly in the next sections. All these localities were predicted at some level by the computer models.

Inventory, Known Occurrences, Assessment Metrics

Many rare species and significant natural community occurrences (= "Element Occurrences") were already known for the Sandy Creeks Watershed before our inventory efforts for this project. Most of these occur along the Lake Ontario shoreline (Lyons-Swift 1991). Appendix 5 provides a complete list of all element occurrences with more detailed information about each along with corresponding maps. In all, there are 170 different occurrences of rare species and significant natural communities within the entire basin. Ninety of these are rare animals, 53 rare plants, and 27 significant natural communities (Figure 11).

"Hotspot" analysis using overlays of EDM s

Figure 12 shows the results of overlaying EDMs for all species (plant and animal) expected to occur within the Sandy Creeks Watershed. Darker red colors indicate a greater number of predicted species. Areas with the predicted highest concentration of species are the Lake Ontario shoreline and the gulfs of the region.

Alvar Grassland at Butterville

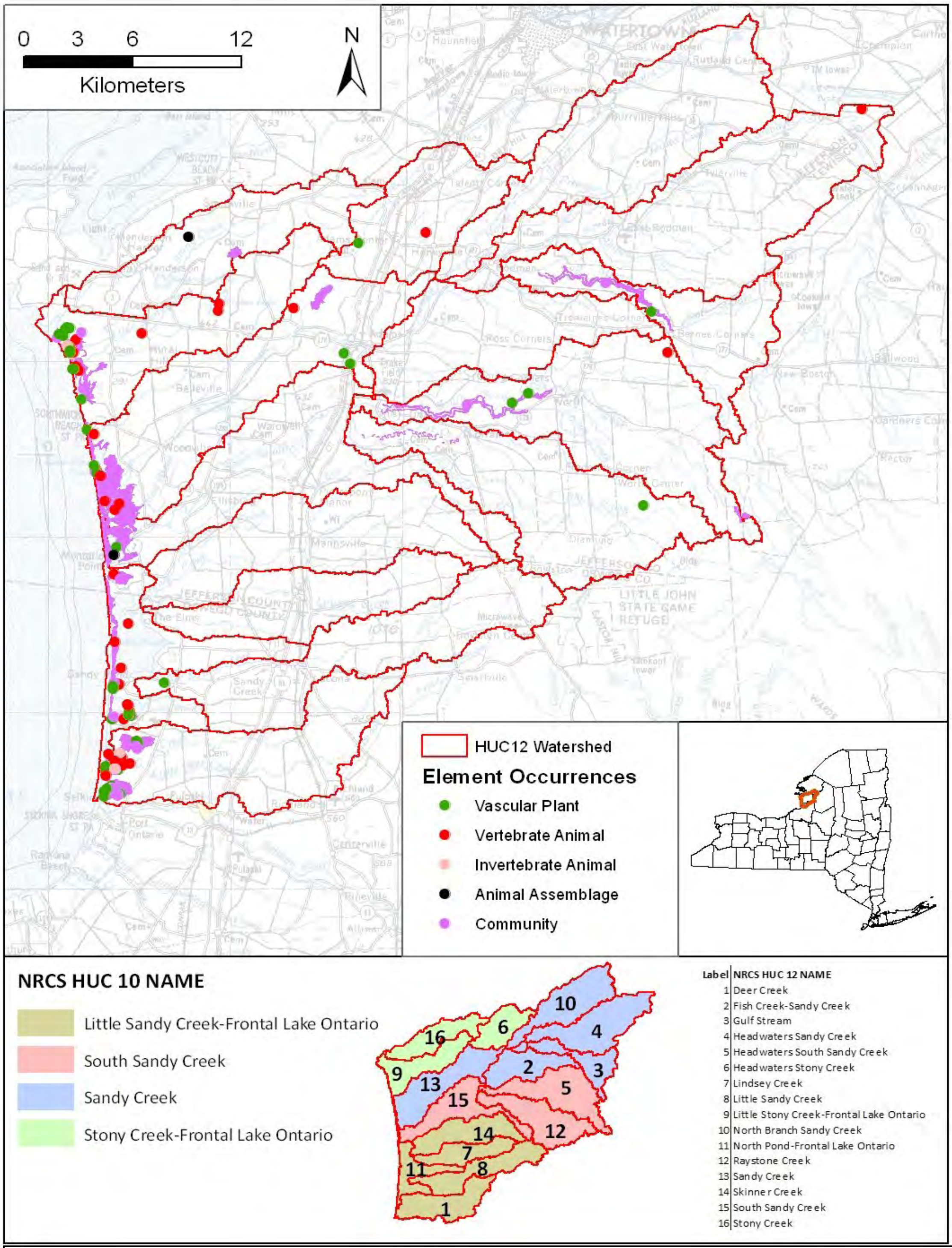


Figure 10. Locations of all rare species and significant natural communities in the Sandy Creeks Watershed.

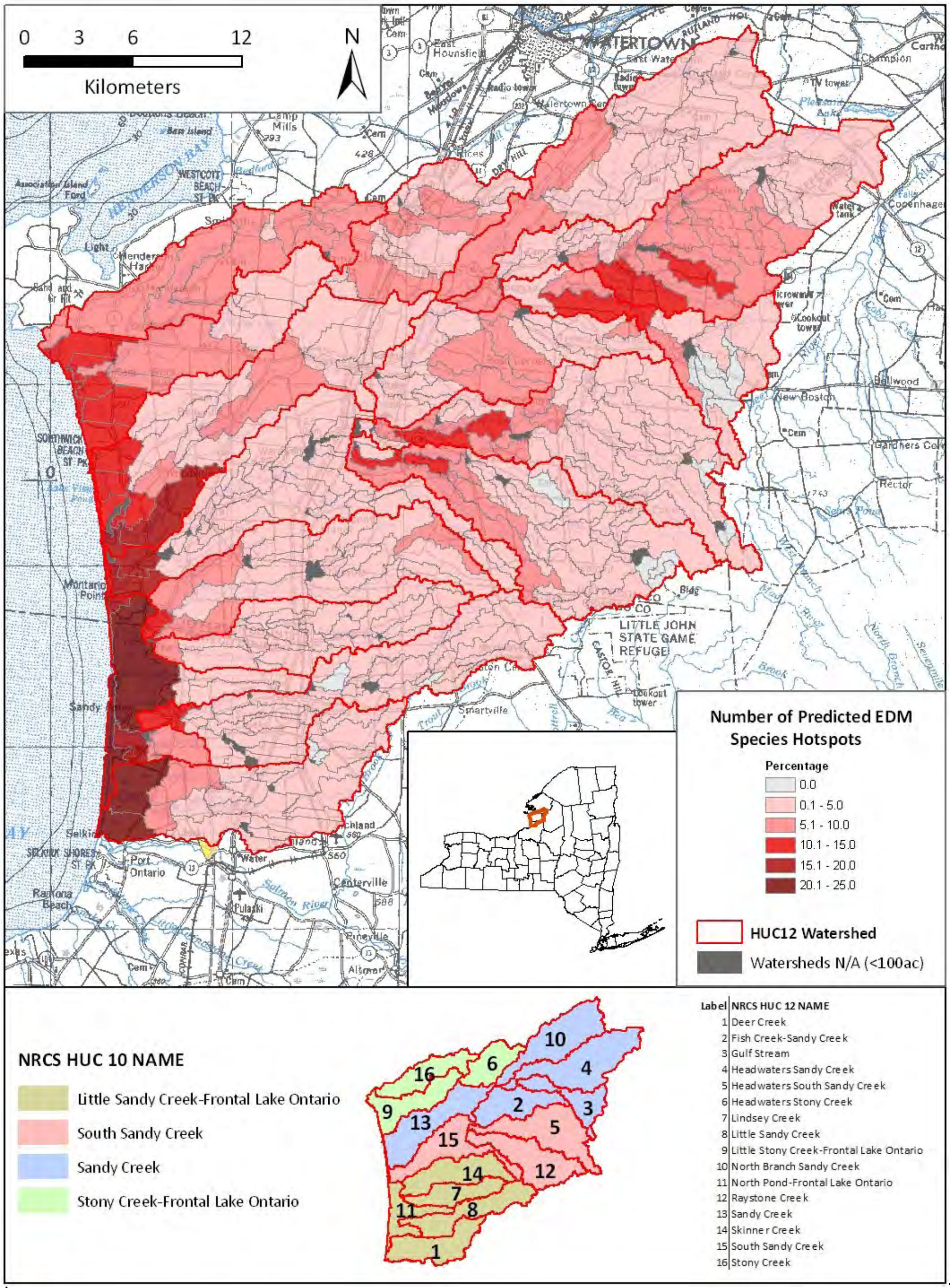


Figure 11. Overlaying EDMs for all species (plant and animal) expected to occur within the Sandy Creeks Watershed. Darker red colors indicate a greater number of predicted species. Areas with the predicted highest concentration of species are the Lake Ontario shoreline and the gulfs of the region.

Subwatershed analysis

Each of the 462 subwatersheds SalSa (determined by McKenna 2009) was given an overall quality rank. These ranks are based on a relative scale of 0-100 with 100 being the highest quality. Figure 12 is a graphical representation of this assessment. The entire data table of raw values, metrics, and rank number and their corresponding maps was too large to be included in this written report. They are supplied in digital format on the DVD that accompanies the report.

Overall index numbers, from best to poorest quality, are shown in the lower left hand corner of the figure. These numbers are represented by color on the map with the darkest shade of green being the highest quality subwatershed and the darkest shade of purple being the lowest quality subwatershed. Since these subwatersheds are small, they can be used to locate areas where there is a high probability of finding good quality headwater streams which are one of the "Special Areas" described by the THC.

We noted that high quality "green" subwatersheds tended to cluster in certain areas of the watershed. These areas will be described individually below.

Areas of clustering of high quality subwatersheds

As mentioned in the Methods section, we anticipated that high-quality subwatersheds would tend to cluster together and that these clusters could be used as a unit for conservation planning. This clustering is evident on the map of the Sandy Creeks Watershed of the overall quality index for each subwatershed (Figure 12). The highest quality subwatersheds has the highest quality index number and vice versa. The map below shows distinct areas where the good quality watersheds cluster together with the darkest shade of green indicating the best quality subwatershed and the darkest shade of purple the poorest quality.

These clusters of subwatersheds are described in detail below. Figure 13 is a map of the whole Sandy Creeks Watershed with just those areas highlighted. The clusters of high-quality Watersheds can be broadly defined as:

1. The Sandy Creeks Watershed Summit Forest
2. The Gulfs Areas
   a. Shingle, Bear, and Inman gulfs
   b. Lorriane and Totman gulfs
3. The Lake Ontario Shoreline
   a. Northern section
   b. Southern section

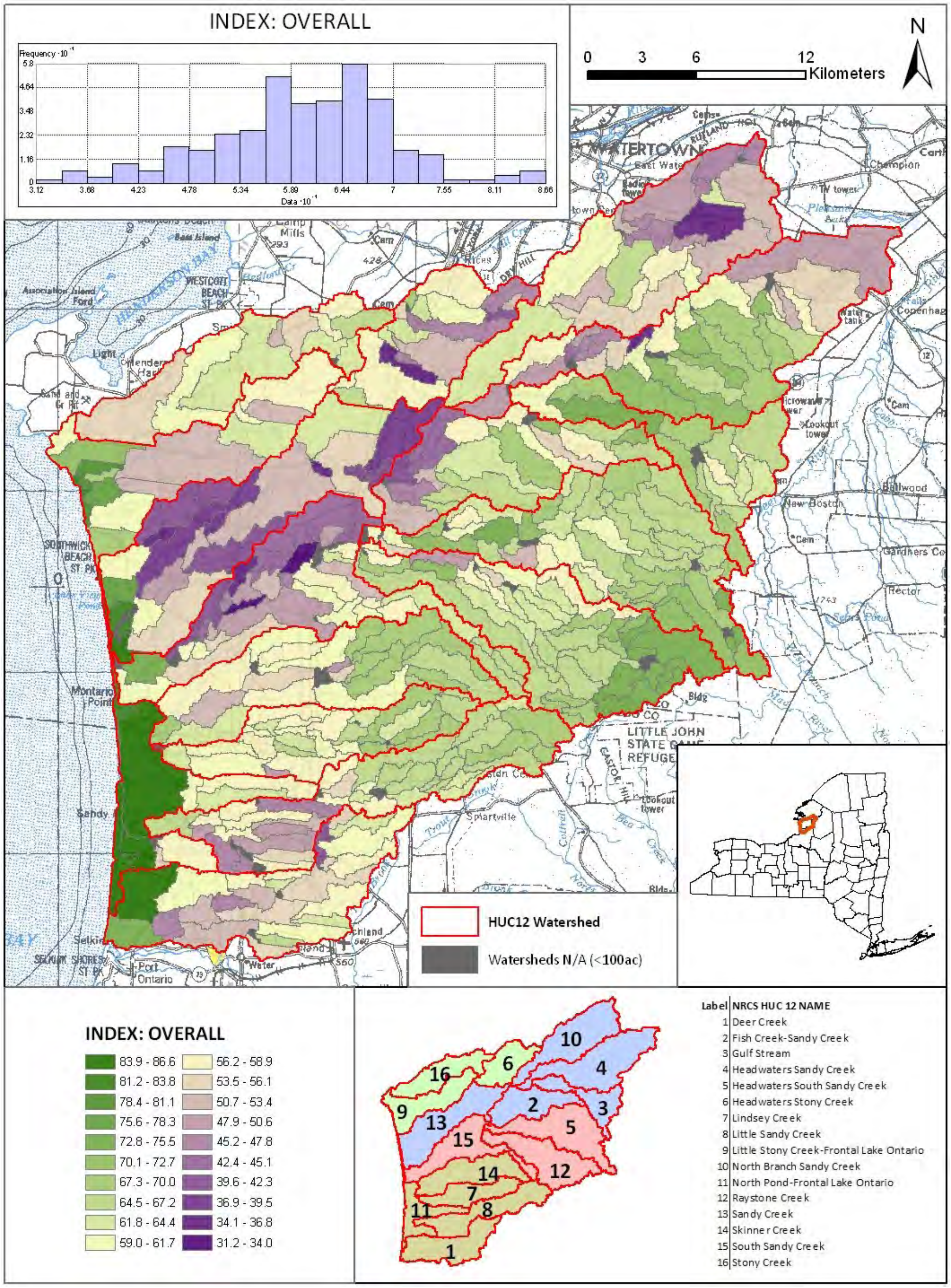


Figure 12. Map showing the overall landscape quality (index) for the entire Sandy Creeks Watershed. The darkest shade of green indicates the highest quality subwatershed while the darkest shade of purple indicates the poorest quality subwatershed

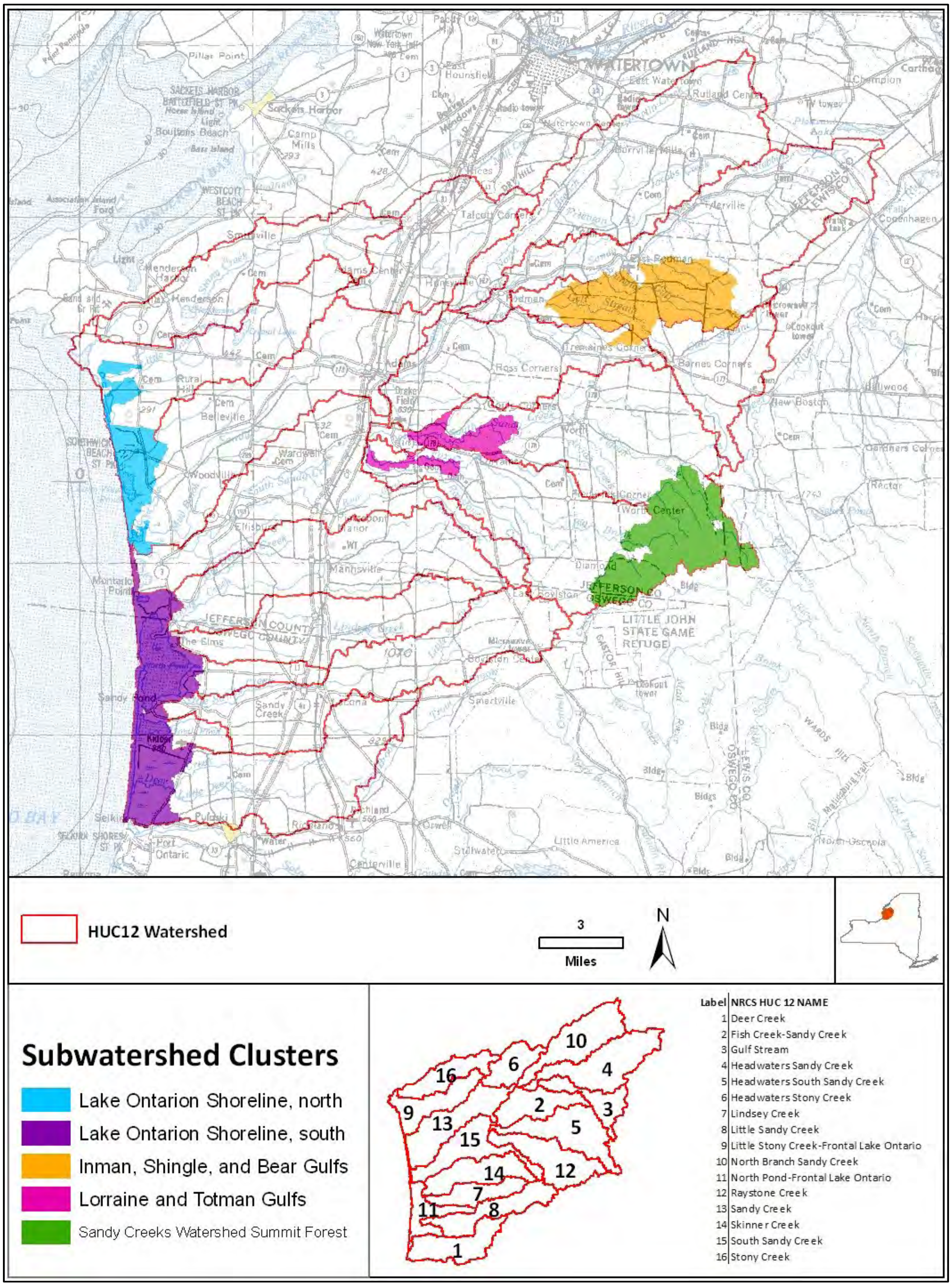


Figure 13. Map showing clusters of high-quality subwatersheds in the Sandy Creeks Watershed.

1. Sandy Creeks Watershed Summit Forest Cluster

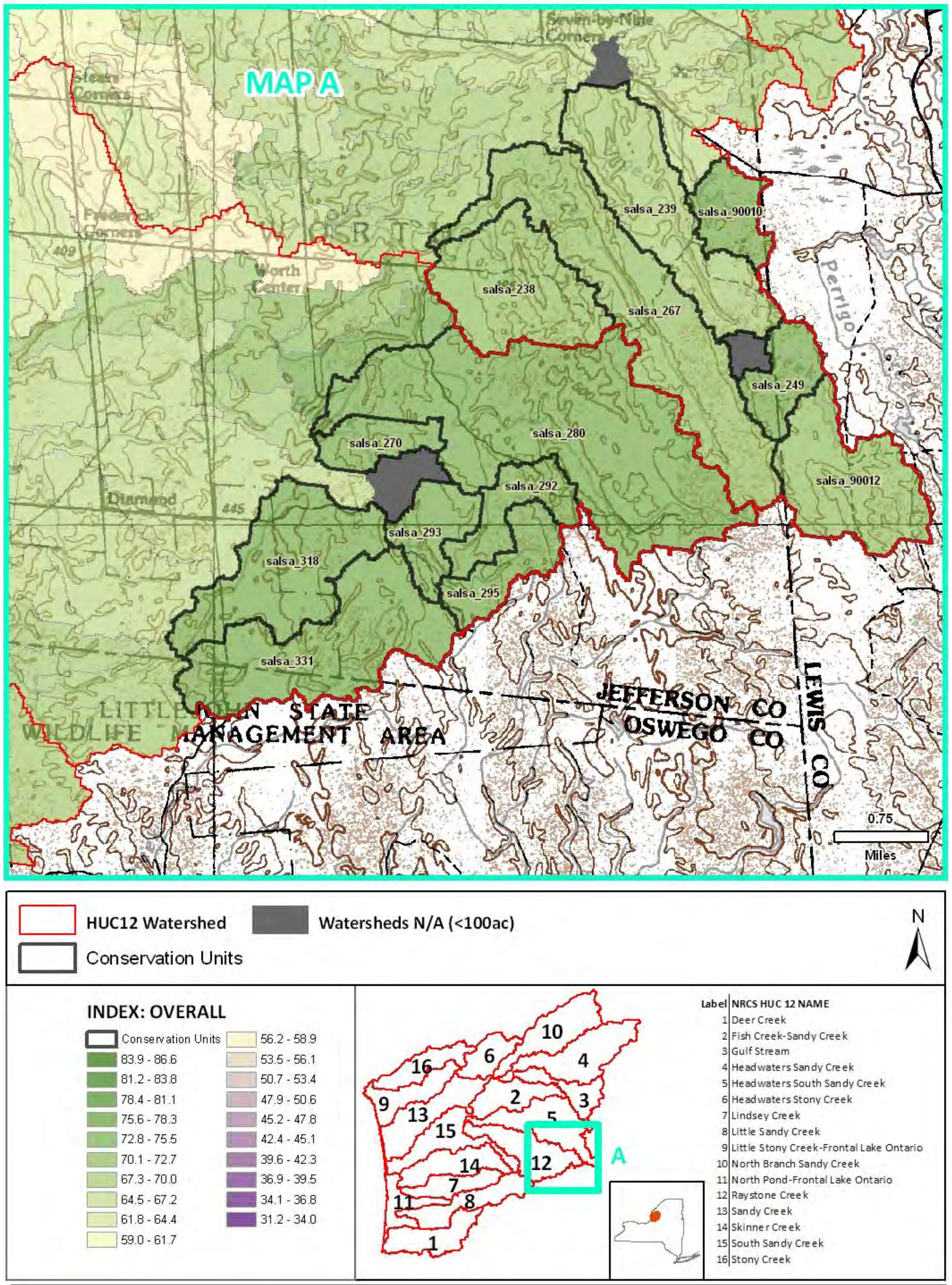


Figure 14. Map of zoomed in section of the larger landscape quality map showing the summit of the Sandy Creeks Watershed.

Description

The Sandy Creeks Watershed Summit site includes a cluster of 13 high-quality subwatersheds (Table 2) in two different 12-digit HUC watersheds (headwaters of South Sandy Creeks and Raystone Creeks). This cluster covers about 8,674 acres at the highest elevation for the Sandy Creeks Watershed. This site has a high forest cover, few roads, and many natural streams. On the negative side, this area has a very low biodiversity score which could be due to lack of inventory because of the remoteness of the area.

Pitcher Plant at Plum Tree Road Bog, Photo:Richard Ring

Much of this area was actively logged and is in a mid-successional forest stage. Some of the area is still actively logged. Forests here are mostly a successional northern hardwood type with deciduous trees dominant in the canopy including American beech, sugar maple, white birch, black cherry and others. Historically though, this area was forested primarily with coniferous trees with red spruce being dominant. Foresters in this area note that the first red spruce trees logged off of here had diameters of over three feet (Munk 2009). Presently, there is a significant amount of red spruce in the understory layers suggesting that this forest may eventually succeed to a spruce-northern hardwood forest type.

Field work in this area found pristine sedge meadows (New York Natural Heritage Program 2009c) along slow flowing marshy headwater streams, kettle hole type bogs (inland poor fen) and a rare plant species, Hill’s pond weed, (*Potamogeton hillii*). A rare willow (G5S3), balsam willow (*Salix pyrifolia*), that is currently on the NY Natural Heritage watch list, was also located in this area. A very rare (S1) broad-lipped twayblade (*Listera convallaroides*) (New York Natural Heritage Program 2009a) is noted from this area but was not found at his time (Table 1). Field work at this site also noted a distinct lack of invasive species.

Element occurrences

Table 1. List of rare species and significant natural communities in the Sandy Creeks watershed summit forest cluster. Element type: A= animal, C = natural community, P= plant. Viability Rank refers to the NYNHP quality rank defined in Appendix1.

Element	Last Observed	Viability Rank	Element type	EO_ID
Black spruce-tamarack bog	2009-08-27	B	C	13408
Inland poor fen	2009-08-27	B	C	13409
Sedge Meadow	2009-08-27	A	C	13410
Broad-lipped Twayblade	1927-06-29	F	P	6150
Hill's pondweed	2009	B	P	13387

Inland poor fen near Plum Tree Road

Subwatershed analysis

Table 2. Subwatershed numbers (SalSa), acreage, landcover index, landcover in stream buffer index, stream barriers/point source pollution index, roads index, biodiversity index, and the overall quality index for the Sandy Creeks Watershed summit forest cluster.

Salmon-Sandy Subwatershed number	Area in Acres	Land Cover Index	Land Cover in Stream Buffer index	Stream barriers/point source pollution index	Roads index	Bio-diversity index	Overall Quality Index
SalSa_280	1996	100	100	100	94.26	6.15	75
SalSa_90010	240	100	100	100	97.64	4.62	75
SalSa_270	201	100	100	100	95.21	3.08	75
SalSa_249	240	100	100	100	100.00	0.00	75
SalSa_292	275	100	100	100	96.45	0.00	75
SalSa_293	256	100	100	100	100.00	0.00	75
SalSa_295	276	100	100	100	100.00	0.00	75
SalSa_331	939	100	100	100	96.67	3.08	74
SalSa_318	762	100	100	100	88.87	4.62	73
SalSa_238	696	100	100	100	87.21	6.15	71
SalSa_90012	661	100	100	100	90.28	4.62	71
SalSa_267	1298	100	100	100	96.20	3.08	71
SalSa_239	834	100	100	100	93.41	4.62	70

2. The Gulfs

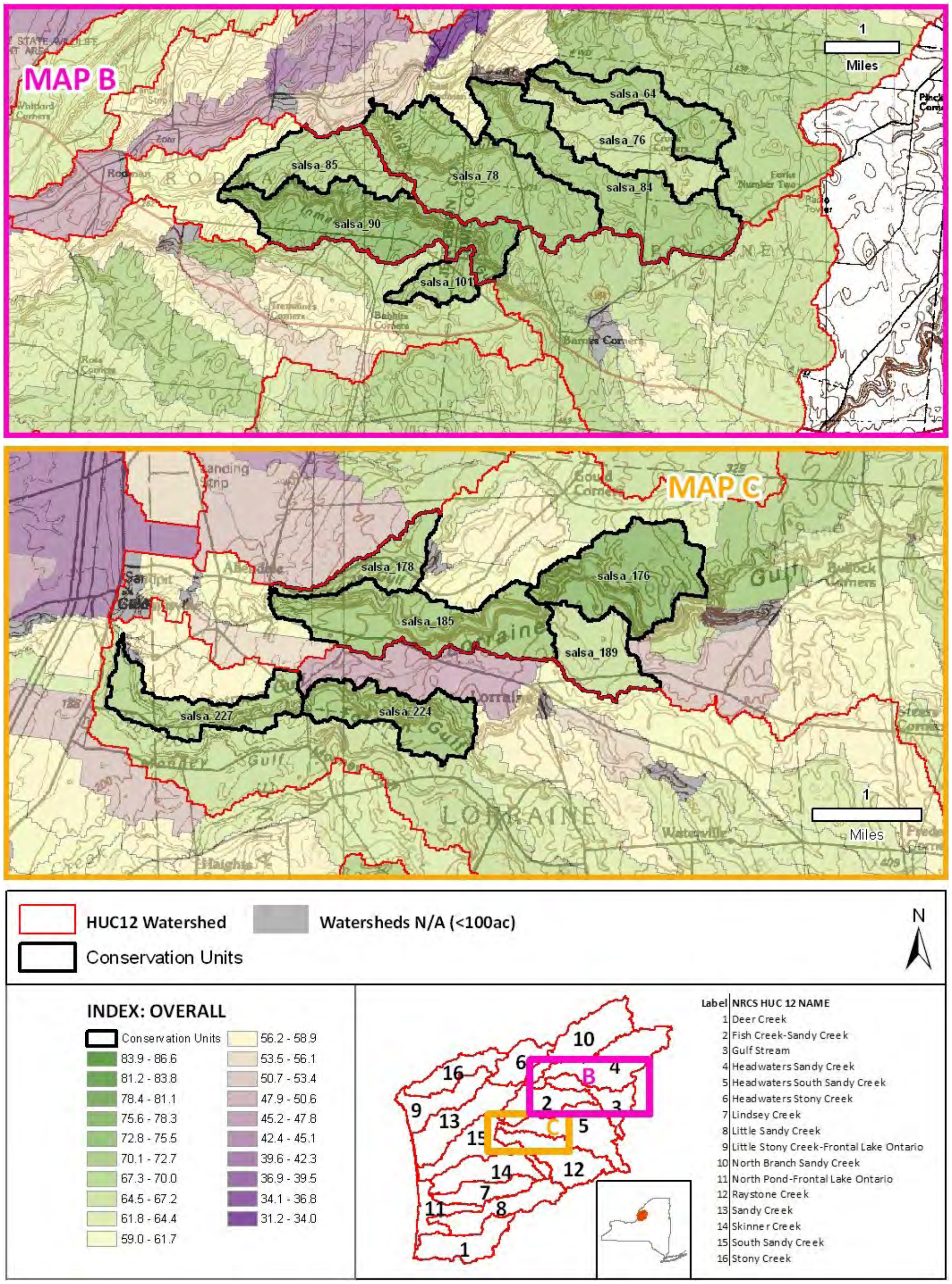
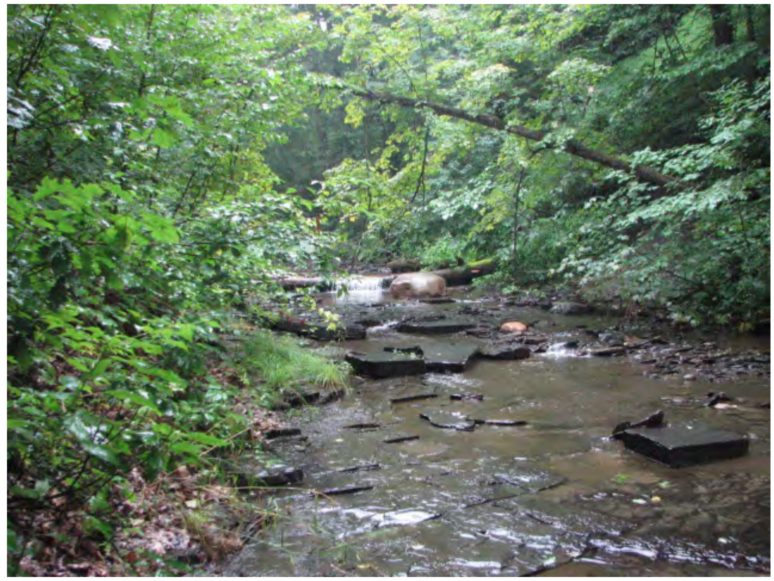


Figure 15. Map showing zoomed-in section of the larger landscape quality index map. Top map shows Inman, Shingle, and Bear Gulfs. Lower map shows Lorraine and Totman Gulfs.

Inman, Shingle, and Bear Gulfs subwatershed cluster

Description

This cluster of subwatersheds includes Inman, Shingle, and Bear Gulfs (Figure 15, Map B). There are seven subwatersheds here totaling 8,205 acres in two different HUC 12 watersheds (Gulf Stream and Fish Creek). Table 4 shows a list of these subwatersheds. For the most part, these subwatersheds have high-quality streams, few dams, low point-source pollution, and few roads. This area also has high biodiversity. The gulfs in and around the Tug Hill have long been known for their unique habitat and relatively high number of rare species. Many of these gulfs have been well surveyed. Earlier studies (Muench et al. 1974) have noted the unstable shale cliffs and the forested slopes. Bird's-eye Primrose was not found during this survey but was found in 2007 (Table 3). Shingle Gulf had excellent habitat for bird's eye primrose and yellow mountain saxifrage but there are no historical records for either species there and they were not found during this survey. Field work by NY Natural Heritage Program staff and THC/THTLT personnel noted that this group of smaller gulfs is relatively free of invasive species.



Bear Gulf

Element occurrences

Table 3. Rare species and significant natural communities of the Inman, Shingle, and Bear Gulfs subwatershed cluster. Element type: A= animal, C = natural community, P= plant. Viability Rank refers to the NYNHP quality rank defined in Appendix1.

Element	Last Observed	Viability Rank	Element type	EO_ID
Shale Cliff and Talus Community	1993-08-29	AB	C	2166
Bird's-eye Primrose	2007-05-24	AB	P	1637
Hill's Pondweed	2009-08-06	B	P	13386

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Subwatershed analysis

Table 4. Subwatershed numbers (SalSa), acreage, landcover index, landcover in stream buffer index, stream barriers/point source pollution index, roads index, biodiversity index, and the overall quality index for the Inman, Shingle, and Bear Gulfs subwatersheds.

Salmon-Sandy subwatershed number	Area in Acres	Land cover index	Land cover in Stream buffer index	Stream barriers/point source pollution index	Roads index	Bio-diversity index	Overall quality index
SalSa_90	1675	92	97	100	95.27	56.92	75
SalSa_78	1970	86	90	100	93.15	46.15	71
SalSa_64	795	98	99	100	91.72	33.85	71
SalSa_101	318	100	100	100	93.37	29.23	71
SalSa_84	1735	92	93	100	90.17	41.54	70
SalSa_85	889	77	90	100	90.59	33.85	67
SalSa_76	1107	77	84	100	86.84	44.62	66

Lorraine and Totman Gulf subwatershed cluster

Description

Although separated by a lower quality subwatershed, these two gulfs were clustered together because of their proximity to one another (Figure 15 Map C). The streams flowing through these two gulfs ultimately join downstream from the gulf areas. All together, the six subwatersheds here occupy about 2,780 acres in two different HUC 12 Watersheds (South Sandy Creeks and Raystone Creeks) (Table 6). Similar to the other cluster of gulfs described above, this group of subwatersheds has good landcover values. Indices for stream buffers, roads, and dams also indicate a high-quality landscape. In addition, these gulfs also have a high biodiversity. Lorraine Gulf, in particular, has been well surveyed and documented over the years with the first documented rare plant occurrence in 1927 (Table 5). Unfortunately, a substantial amount of invasive species were noted in these gulfs. In particular, Japanese knotweed (*Polygonum cuspidatum*) has become the dominant streamside vegetation in many places. Rocky islands midstream as well as the cliff walls are seeing an increase in coverage of this species. It has spread far up of the steep riversides until the instability of the rock and talus make further advances impossible.

Cliffs in Totman Gulf area

Element occurrences

Table 5. Rare species and significant natural communities from Lorraine and Totman Gulfs subwatershed cluster. Element type: A= animal, C = natural community, P= plant. Viability Rank refers to the NYNHP quality rank defined in Appendix1.

Element	Last Observed	Viability Rank	Element type	EO_ID
Calcareous Cliff Community	2009-09-13	B	C	13384
Shale Cliff and Talus Community	1993-09-20	A	C	5479
Bird's-eye Primrose	2007-06-28	A	P	1126
Yellow Mountain-saxifrage	2007-06-28	AB	P	1451

Subwatershed analysis

Table 6. Subwatershed numbers (SalSa), acreage, landcover index, land cover in stream buffer index, stream barriers/point source pollution index, roads index, biodiversity index, and the overall quality index for the Lorraine Gulf and Totman Gulf watershed cluster.

Salmon-Sandy subwatershed number	Area in Acres	Land cover index	Land cover in steam buffer index	Stream barriers/point source pollution index	Roads index	Bio-diversity index	Overall quality Index
SalSa_176	666	99	99	100	100	44.62	75
SalSa_224	424	83	98	100	94.35	47.69	72
SalSa_185	788	72	97	100	94.17	53.85	71
SalSa_227	404	86	93	100	83.75	49.23	70
SalSa_178	252	95	97	100	70.09	36.92	69
SalSa_189	343	69	94	100	93.85	23.08	65

3. The Lake Ontario Shoreline

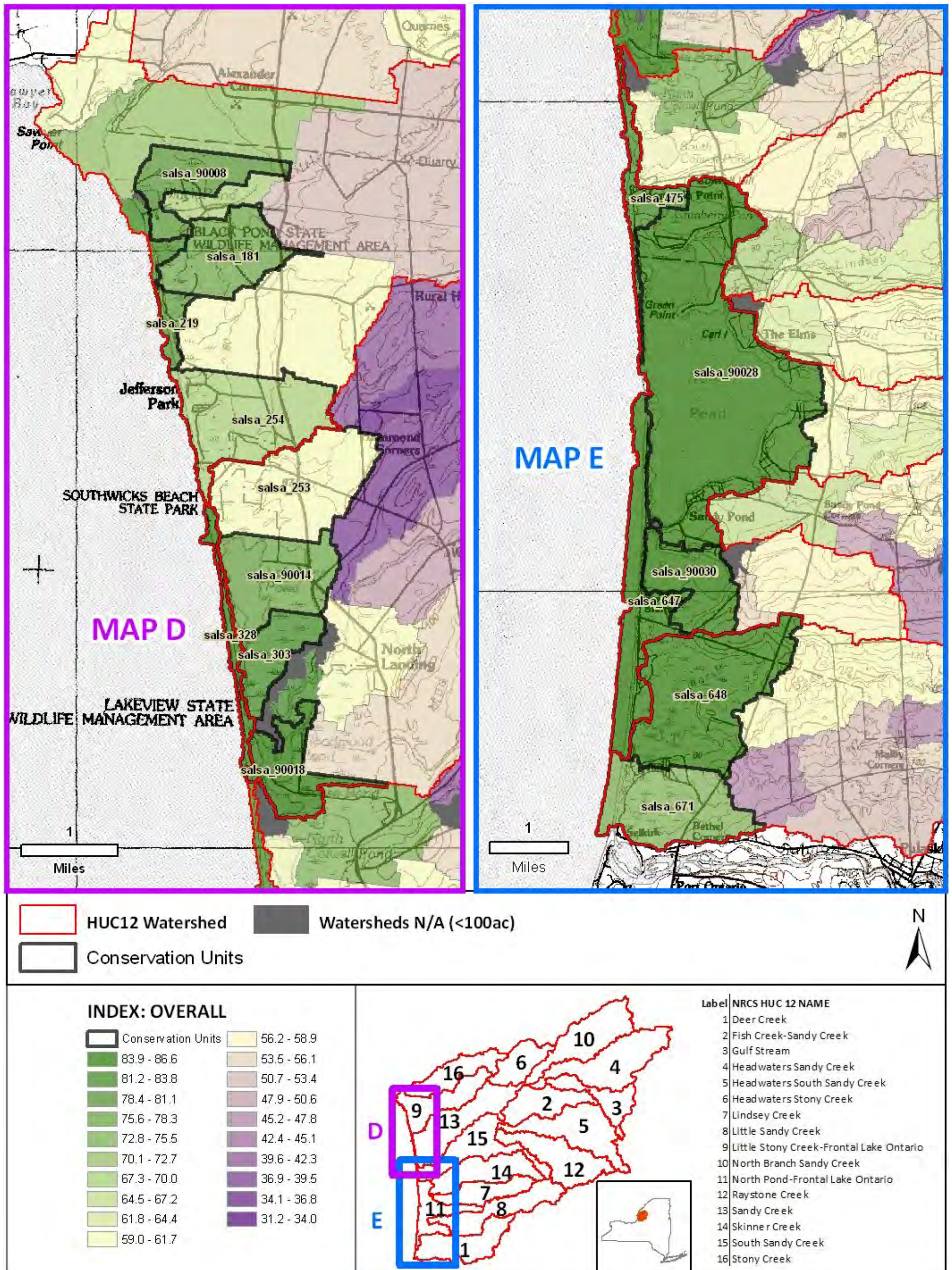

Figure 16. Map of the zoomed-in section of the Sandy Creeks Watershed along the Lake Ontario Shoreline. The map on the left shows the northern section of the shoreline. The map on the right side shows the southern section of the Lake Ontario shoreline

Lake Ontario Shore-North subwatershed cluster

Description

Because of previous, intensive surveys of this area, very little additional field inventory of this part of the Sandy Creeks Watershed was conducted for this project (Figure 16 Map D). This area has a very high overall quality index score (Table 8). For the most part, the subwatersheds in this cluster have a good landcover index, good quality stream, few dams and barriers, few roads, and very high biodiversity as evidenced by the high number of rare species and significant natural communities (Table 7).

Table 7. Rare species and significant natural communities for the Lake Ontario Shore-North subwatershed cluster. Element type: A= animal, C = natural community, P= plant. Viability Rank refers to the NYNHP quality rank defined in Appendix1.

Element	Last Observed	Viability Rank	Element type	EO_ID
A Noctuid Moth	1992-09-27	E	A	11294
Black Tern	1991-07-15	CD	A	6938
Black Tern	1992	CD	A	1545
Black Tern	2007-06	BC	A	4750
Blackchin Shiner	1997-07-12	CD	A	11389
Common Tern	no date	H	A	7687
Fawn Brown Dart	1988-08-22	AB	A	2600
Indiana Bat	2006-08-19	A	A	11657
Indiana Bat	2006-08-19	A	A	11657
Iowa Darter	2004-11-20	BC	A	11296
Iowa Darter	2001-04-14	E	A	12433
Least Bittern	1992-07-15	BC	A	11011
Least Bittern	2007-06-13	BC	A	11012
Least Bittern	2009-05-19	C	A	13362
Northern Harrier	2006-05-17	C	A	6567
Northern Harrier	1992-06-04	E	A	467
Western Pirate Perch	2003-07-16	E		11241
Calcareous Pavement Barrens	1997-08-22	D	C	2498
Calcareous Shoreline Outcrop	1995-08-04	C	C	3097
Great Lakes Dunes	2001-07-17	B	C	6727
Great Lakes Dunes	1995-06-03	B	C	1675
Sand Beach	2001-07-17	AB	C	3037
Shallow Emergent Marsh	1994-08-01	AB	C	4306
Silver Maple-Ash Swamp	1992-08-27	AB	C	535
Champlain Beachgrass	2000	E	P	2669
Champlain Beachgrass	2000-su	E	P	9190
Cork Elm	1995-06-03	CD	P	1835

Houghton's Sedge	1992-08-14	B	P	3779
Longstalk Starwort	2003-07-15	AB	P	13087
Low Sand-cherry	1995-06-03	A	P	160
Marsh Horsetail	1932-08-16	H	P	10488
Ram's-head Ladyslipper	2007-05-29	C	P	13086
Rough Avens	1991-08-13	E	P	6931
Sand Dune Willow	1994-07-06	BC	P	379
Sand Dune Willow	1995-06-03	AB	P	7610
Sand Dune Willow	2001-06-13	A	P	10089
Sand Dune Willow	1982-08-25	E	P	7264
Troublesome Sedge	1997-08-22	C	P	6375

Subwatershed analysis

Table 8. Subwatershed numbers (SalSa), acreage, landcover index, land cover in stream buffer index, stream barriers/point source pollution index, roads index, biodiversity index and the overall quality index for the Lake Ontario Coast-North watershed cluster.

Salmon-Sandy subwatershed number	Area in Acres	Land cover index	Land cover in stream buffer index	Stream barriers/point source pollution index	Roads index	Bio-diversity index	Overall quality Index
SalSa_328	158	100	100	100	100.00	61.54	85
SalSa_90018	393	100	100	100	100.00	56.92	84
SalSa_182	115	100	100	100	100.00	53.85	84
SalSa_303	318	98	100	100	98.99	49.23	82
SalSa_306	116	98	98	100	100.00	47.69	82
SalSa_90008	428	96	99	100	87.33	63.08	79
SalSa_90014	616	74	100	100	89.50	53.85	76
SalSa_181	546	93	95	100	89.51	50.77	76
SalSa_158	1241	78	95	100	88.19	60.00	71
SalSa_254	825	59	100	100	78.39	52.31	70
SalSa_219	114	73	84	100	83.84	10.77	60

Lake Ontario Shore-South subwatershed cluster

Description

The clusters of subwatersheds along the southern section of the Lake Ontario shoreline have long been known to contain a wide variety of diverse habitats from marshes to dunes (Figure 16 Map E). Because of the previous, intensive surveys of this area, very little additional field inventory was conducted for this project. This southern section alone has 70 known occurrences of rare species and significant natural communities (Table 9). Many of the areas are under some type of public/conservation protection as a wildlife management area or other designation as NYS DEC lands. The subwatersheds are also of good quality with a good landcover index, few roads, good stream quality and very high biodiversity (Table 10).

Deer Creek Marsh.Photo: Troy Weldy

Element occurrences

Table 9. Rare species and significant natural communities in the Lake Ontario Shore-South subwatershed cluster. Element type: A= animal, C = natural community, P= plant. Viability Rank refers to the NYNHP quality rank defined in Appendix1.

Element	Last Observed	Viability Rank	Element type	EO_ID
Black Tern	2007-06	BC	A	10414
Black Tern	2009-06-17	BC	A	7366
Black Tern	2002-06-05	D	A	352
Blackchin Shiner	2000-03-05	A	A	11387
Blackchin Shiner	1997-06-07	CD	A	11388
Blackchin Shiner	1939-06-27	H	A	11432
Blackchin Shiner	1939-06-13	H	A	11433
Bog Turtle	2005-06-25	AC	A	3077
Bogbean Buckmoth	2007-09-30	A	A	5393
Bogbean Buckmoth	2003-fa	F	A	270
Bogbean Buckmoth	2007-09-30	AB	A	3559
Bogbean Buckmoth	2007-09-30	A	A	10393
Bogbean Buckmoth	2007-09-22	CD	A	39
Common Tern	2001-07-15	D	A	5079
Common Tern	1957	H	A	3309
Iowa Darter	2000-09-18	E	A	12391
Least Bittern	2000-07-12	BC	A	2139
Least Bittern	1984-su	E	A	9882
Mottled Darner	2009-09-02	E	A	13364
Northern Harrier	2005-08-26	C	A	2779
Northern Harrier	1978	E	A	5687
Northern Harrier	2002-05-18	E	A	533
Pied-billed Grebe	1976-su	F	A	8720
Piping Plover	1984-su	E	A	8937
Sedge Wren	2002-05-25	E	A	5327
Waterfowl Winter Concentration Area	1992-01-12	E	A	3394
Western Pirate Perch	1962-08-05	F	A	3835
Dwarf Shrub Bog	2002-06-04	B	C	953
Great Lakes Dunes	1996-11-01	BC	C	3184
Great Lakes Dunes	2004-09-22	C	C	1398
Medium Fen	1997-09-13	AB	C	3944
Medium Fen	2002-06-04	B	C	1220

Element	Last Observed	Viability Rank	Element type	EO_ID
Medium Fen	2002-06-04	A	C	3777
Medium Fen	1998-07-30	A	C	8756
Medium Fen	2002-07-09	A	C	3030
Red Maple-Hardwood Swamp	1994-09-20	A	C	4827
Red Maple-Hardwood Swamp	2002-07-09	B	C	429
Red Maple-Tamarack Peat Swamp	1994-09-20	A	C	8173
Red Maple-Tamarack Peat Swamp	2002-09-02	AB	C	5671
Champlain Beachgrass	2000	E	P	7805
Champlain Beachgrass	2000	E	P	1442
Creeping Sedge	1994-06-21	AB	P	7588
Creeping Sedge	1996-10-01	C	P	8803
Creeping Sedge	2001-06-09	A	P	8598
Creeping Sedge	2006-05-30	A	P	711
Dragon's Mouth Orchid	1994-06-22	A	P	7714
Dragon's Mouth Orchid	2002-06-04	A	P	9409
Dragon's Mouth Orchid	2006-05-30	C	P	661
Houghton's Sedge	2001-06-09	A	P	9456
Houghton's Sedge	1985-06-06	B	P	1388
Large Twayblade	1994-06-22	C	P	758
Livid Sedge	2000-07-12	A	P	8812
Livid Sedge	2006-05-30	A	P	291
Low Sand-cherry	1991-05-20	CD	P	3620
Low Sand-cherry	2001-06-09	CD	P	6551
Low Sand-cherry	2001-06-14	CD	P	4349
Low Sand-cherry	2001-06-14	CD	P	4349
Low Sand-cherry	2001-06-14	CD	P	4349
Low Sand-cherry	2001-06-14	CD	P	4349
Northern Bog Aster	1996-09-20	A	P	58
Northern Bog Aster	1996-10-01	C	P	9832
Northern Bog Aster	1996-09-14	B	P	3982
Pod Grass	1998-07-28	BC	P	3687
Sand Dune Willow	2001-06-09	BC	P	6608
Sand Dune Willow	1996-05	CD	P	767
Sand Dune Willow	2001-06-14	CD	P	136
Slender Bulrush	1928-08-10	H	P	4499
Sparse-flowered Sedge	2006-05-30	E	P	12323
Swamp Smartweed	1902-08-23	H	P	686
Woodland Bluegrass	1992-08-25	BC	P	8291

Subwatershed analysis

Table 10. Subwatershed numbers (SalSa), acreage, landcover index, land cover in stream buffer index, stream barriers/point source pollution index, roads index, biodiversity index, and the overall quality index for the Lake Ontario Shore-South watershed clusters

Sandy-Salmon subwatershed number	Area in Acres	Land cover index	Land cover in stream buffer index	Stream barriers/point source pollution index	Roads index	Bio-diversity index	Overall quality Index
SalSa_647	932	98	100	100	88.18	93.85	87
SalSa_90028	4332	94	98	100	84.26	93.85	85
SalSa_648	1712	87	99	100	86.26	95.38	84
SalSa_90030	675	95	100	100	84.11	83.08	84
SalSa_475	394	99	100	100	89.80	72.31	81
SalSa_671	1041	67	100	90	74.85	100.00	73

Special Area designation

The Tug Hill Reserve Act of 1992 established guidelines for the designation of "Special Areas" within the boundaries of the Tug Hill region (New York State Tug Hill Commission 2009). Some of the categories used for Special Area designation include headwater steams and areas of unique habitat. The small subwatersheds that were used in this study will be useful as an overlay on topographic or planimetric maps to locate (relative) high-quality headwater streams within a given municipal boundary. The other category, unique habitat, can be used to designate areas within the watershed that may have been missed in the overall landscape quality assessment.

Adams Swamp successional swamp forest with black ash dominant

These potential Special Areas are described below and may occur within a subwatershed of fairly low quality because of the presence of roads, agricultural areas or other factors that would result in a lower "overall quality" score in the landscape analysis. Areas that were already discussed in detail previously in this report will not be included here. There are two new sites that will be discussed. Their locations are shown in Figure 17. All have unique habitats and meet more than one of the criteria for Special Area designation.

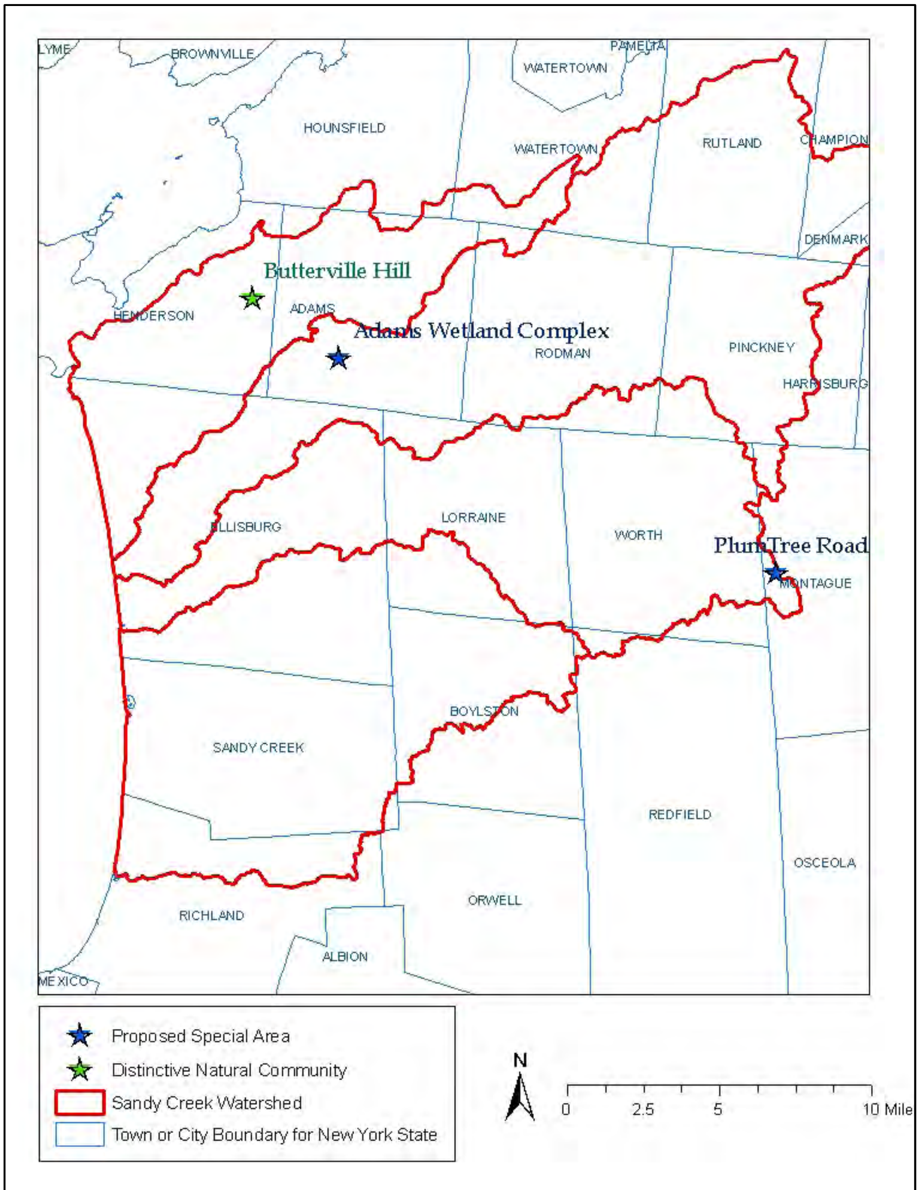

Figure 17. Map showing areas in the Sandy Creeks Watershed that meet certain requirements as "special areas" or distinctive natural community type.

Adams Wetland Complex and adjacent wetlands

Northern white cedar swamp with large cedar stump

This swamp is a large, recovering, northern white cedar swamp. The diameter of some of the old stumps found deep in the swamp exceeded 32 inches. Detailed geology maps show that this swamp and many in the surrounding area are underlain by limestone. These swamps are therefore richer and more diverse than other types of swamps in the Sandy Creeks Watershed. An EDM overlay did indicate the presence of a "richer" swamp type in these areas. Nearby Lyons Swamp was surveyed by the NY Natural Heritage botanist and found to be similar to Adams Swamp but at an earlier successional stage. A similar swamp at Sanford Corners was not surveyed but personal communication with area experts indicate that this is the same type of recovering, northern white cedar swamp. All of these swamps were historically logged for the valuable timber and all appear to be early to mid-successional. The dominant canopy tree species in Adams Swamp is black ash but understory trees, saplings, and seedlings are primarily northern white cedar. Adams Swamp is included as a potential Special Area because it is an "important habitat area" containing a significant natural community and a rare plant species, Hill's pondweed, as described by NY Natural Heritage.

Sedge meadow bordered by red spruce

Plum Tree Road Wetlands-Pigeon Creek

The description of the Plum Tree Road wetlands and surrounding forest can be found in the landscape-Watershed analysis of the Tug Hill Summit watershed cluster discussed previously in this report. This is a smaller area within that larger subwatershed cluster that contains good-quality wetlands including very high-quality marsh headwater stream flowing through a pristine sedge meadow. As a Special Area it meets the "important habitat" qualification by having significant natural communities and a rare plant species, Hills Pondweed. It also qualifies for Special Area status as a high-quality headwater stream and as a large, contiguous forest area (successional northern hardwood with some red spruce).

Other distinctive natural communities

Butterville Hill and adjacent "alvar" natural communities

Alvar grassland is a distinctive natural community that occurs on shallow soils over level outcrops of calcareous bedrock (limestone or dolomite), and is restricted to areas that are seasonally flooded in spring or after heavy rainfall, and seasonally dry by late summer. NY Natural Heritage ranks alvar grassland as rare, not only in New York, but globally as well (G2 S1). Presently, all documented occurrences of alvar grassland are from a small area northwest of Watertown near Lake Ontario. This summer, during a survey of the Sandy Creeks Watershed, we found previously undocumented locations of alvar grassland. The Galoo limestone formation, and the corresponding soil types that are necessary for the occurrence of alvar grassland, is quite widespread in the Sandy Creeks Watershed. Here, it occurs as hills or "plateaus" of un-eroded limestone which were used primarily for grazing animals because of the very shallow soils. One of these hills near Butterville in the town of Henderson appears to be recovering from historic grazing. Although most areas are still dominated by pasture species, some areas have a number of the native species typical to alvar grasslands, including troublesome sedge, flatstem rush, bluebell bellflower, Philadelphia panic grass, upland white aster, and the moss *Abietinella abietinum*. Eastern red cedar is also scattered throughout. Alvar grasslands are also considered excellent habitat for upland sandpipers and other species of grassland birds. The physical features typical of alvars are also present, including areas of open bedrock and the deep, vertical fissures in the bedrock known as "grykes." Other areas of alvar exist in the Sandy Creeks Watershed but were not surveyed during this project. This includes a large area near Adams Center known as Pine Hill. Landowners were contacted for theses sites but we did not receive access permission

Alvar grassland with exposed bedrock

Characteristic fissure or "gryke" in the Galoo limestone

CONCLUSION

Biodiversity

Field surveys for rare species and natural communities resulted in the discovery of new locations for rare plants and animals and significant natural communities. Presently, the watershed has 170 documented locations of these elements of biodiversity. It is highly likely that there are additional locations for element occurrences throughout the Sandy Creeks Watershed on private land and other locations we did not have time or the permission to survey. In addition, some taxonomic groups, such as aquatic species (fish, mussels, etc.) were excluded from this survey because they require more intensive field surveys, or the optimal season for field surveys conflicted with the project schedule. Figure 10, page 21, shows all the known locations of rare animals, plants, and significant natural communities for the entire Sandy Creeks Watershed. A complete list of all rare species and natural communities can be found in Appendix 4. Clusters of these elements can be found in the Gulf areas, the Lake Ontario shoreline, and at the summit of the watershed. The overlays of individual species Element Distribution Models (EDMs) also show the "hotspots" of biodiversity within the watershed (Figure 11, page 22).

High-quality subwatersheds

Figure 18 (below) is a simplified version of the landscape quality map found on page 24. The subwatersheds used in this project are the smaller subwatersheds developed by McKenna (2009) for the U.S. Geological Survey. They can be singled out on an individual basis to help locate high-quality headwater stream areas or they can be clustered together to form larger areas for conservation purposes. The clusters singled out in the report are the summit forest of the watershed, the Gulfs, and the Lake Ontario Shoreline. This map also shows distinctive landscape quality patterns. The easternmost part of the watershed has low development (low population) and shows up as a high quality landscape. The westernmost section also shows up as high quality primarily because of its high biodiversity. The middle section, in contrast, appears as lower quality because of its land use history.

Cotton Grass growing in a black spruce-tamarack bog

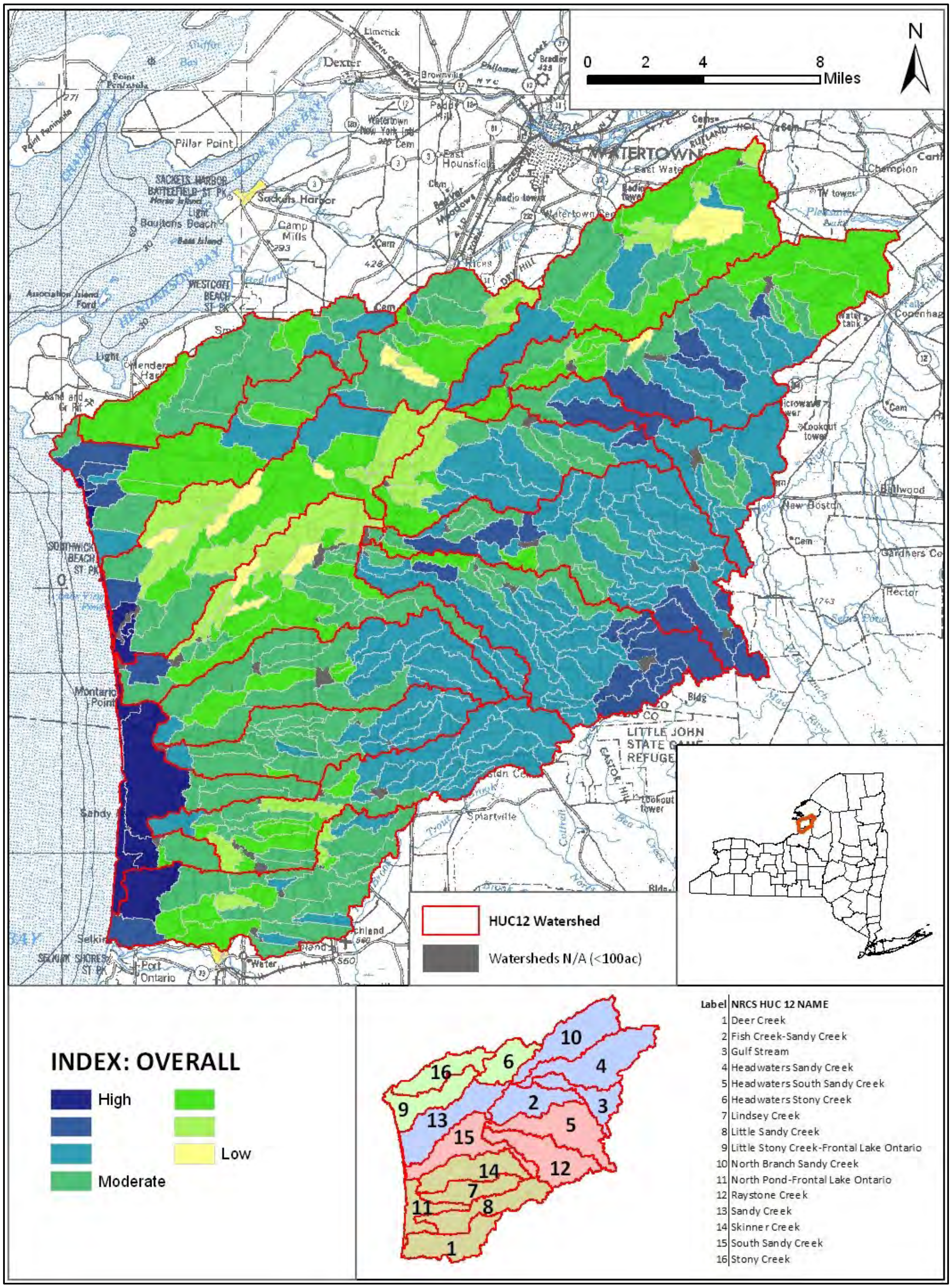

Figure 18. Map of the subwatersheds for the Sandy Creeks Watershed showing their overall quality index. This map was produced using all biodiversity and landscape data created for this report.

Potential "Special Area" designation

EDM and landscape analysis and field surveys during the summer of 2009 discovered two areas that the Tug Hill communities could designate as Special Areas within the Sandy Creeks Watershed (Figure 17). These areas are the Adams wetland complex and the Plum Tree Road-Pigeon Creek wetlands. These sites contain good examples of significant natural communities as well as rare species. In addition to these specific locations, landscape analysis of the small sub-watersheds revealed many high-quality subwatersheds that could be considered for Special Area (New York State Tug Hill Commission 2009) consideration as headwater steams.

Although not within the boundaries of the Tug Hill region, the alvar grassland communities at Butterville Alvar and adjacent alvar (Galoo limestone cap) areas could be considered as potential conservation sites. This distinctive natural community is rare both in New York and globally. Other areas of alvar exist in the Sandy Creeks Watershed, but were not surveyed during this project due to lack of access permission.

Future Needs

This report provides a foundation for future surveys in the Sandy Creeks Watershed. The streams, creeks, and rivers of this watershed have been known for high quality fisheries. Future work, therefore, should include aquatic surveys of fish populations (game species as well as rare species), other vertebrate species, and invertebrate species using the high quality subwatersheds documented in this report as a focus for research. In addition, inventory work should also focus on the larger creeks and rivers that flow through the lower quality landscape found in the middle section of the Sandy Creeks Watershed. The extent of natural riparian areas, particularly floodplain forests should be documented.

Other research priorities documented in this report include the newly discovered alvar grassland sites. The total acreage of this globally rare natural community as well as species composition needs additional documentation. Since these areas occur as natural open grassland areas they also serve as good locations to document new populations of grassland bird species. In addition to the alvar grassland areas, the wetlands around the Adams Center area should also be surveyed in greater detail. These wetlands are considered rich and are underlain by limestone bedrock.

In addition to research, landowner communication remains a critical issue for the Tug Hill area. Much of the area is in private ownership so access to private land is necessary to continue to document the biodiversity of the region.

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APPENDICES

1. New York Natural Heritage Program Methodology
2. Description of Element Distribution Modeling (EDMs) and the environmental variables that were used to create them.
3. Sandy Creeks Watershed landscape analysis - Background information
4. List of all EDMs created for the Sandy Creeks and Black River Watersheds
5. Landscape analysis maps