City of Kingston, NY
Natural Resources Inventory

2018

Mayor Steven T. Noble

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The City of Kingston, NY - Natural Resources Inventory, 2018, was prepared by John Mickelson, from Geospatial & Ecological Services, consultant for the City of Kingston.

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Executive Summary

The City of Kingston has devoted nearly a decade to the development of a Natural Resources Inventory (NRI) to steer planning and conservation for the municipality. Through the diligent work and contributions of dozens of dedicated staff, volunteers, commissioners, consultants and generous stakeholder groups, a wide array of data, reports, maps, topical and spatial information has been assembled. While each section of the material would take volumes to fully consider and explore, this report catalogs and summarizes the core of the work and provides access via online links to make much of the source material more easily available.

This current project, begun in 2016, focused on several core tasks. First was to recover and standardize the process for changing, updating and adding to the extensive map library that the CAC had developed with the City of Kingston. This will help greatly in keeping the reference maps, central to the NRI process, current, accurate and dependable. Secondly was enhancing and making fuller use of modern geospatial technologies (e.g. Google Earth). These powerful, simple and free spatial tools allow easy access by all to the data used for the NRI, across scales and dimensions that paper maps don't. Old data can be updated and new layers added.

The Project Team met frequently from October 2016 through June 2018 to review the data, goals and strategies of the project. Much of the first year focused on spatial information; on compiling, cleaning, documenting (metadata) and converting over 100 layers into Google Earth format. These layers were included within two half-day Google Earth trainings (early 2017) for the CAC and other City of Kingston board members and staff.

The Team considered a broad array of natural resource, cultural and open space features that the NRI might include. The full extent was distilled to a comprehensive list, which forms the outline of this report. Sections are included for systems and features relating to: biophysical resources (geology, soils, terrain), hydrological resources (water and aquatic habitats), biological resources (vegetation, habitats, flora, fauna), recreational resources, urban agriculture, historical and cultural resources and climate.

Early analysis of the NRI layers confirmed what biotic assessments by Hudsonia Ltd. and the NYSDEC Hudson River Estuary Program suggested: that much of the high-value terrestrial biodiversity resources fall within three "large natural areas" remaining in Kingston. The first falls within the coastal and upland regions adjacent to the Hudson River shoreline. The second region contains the floodplain forests, riparian zones, marshes and adjacent grasslands along the Esopus Creek. Thirdly, are the large forested areas within the southwestern corner of Kingston, within the Twaalfskill basin. From the aquatic perspective, the Hudson River and the Rondout Creek contain much of the rare, endangered and special concern species. Fisheries here are very significant regionally, both from an ecological as well as a recreational perspective.

An Open Space Index (OSI) was developed, which provides a breakout of some 25 important natural resource and open space variables, summarized using tax parcels as the unit of analysis. This will provide insight into efforts to proactively protect important conservation features, at the parcel level. It can also inform potential developments, by highlighting what important features might occur within the proposed development area.

The consultant proposes that next steps focus on three important systems in Kingston: the urban forest, urban agriculture and safeguarding the rivers, creeks, streams and associated wetland systems found within.

Establishing effective protections for these three features will carry forth overlapping benefits for a wide range of the other important natural and open space resources.

Introduction

Protecting collective open space and natural resources is one of the most important tasks a community can undertake. With the complexity and rapid pace of our modern lives, the demands and pressures that we place on the systems that sustain us too often degrade and compromise those very resources, challenging their sustainability. Taking the time to inventory, assess, summarize and understand impacts, patterns and trends can allow a municipality to effectively plan for ways to ensure that these vital resources and services remain in place for current and future generations.

The City of Kingston has been earnestly engaged in this work for more than a decade. Led by staff specialists in conjunction with the Kingston Conservation Advisory Council (CAC), dedicated and concerned citizens have been spearheading efforts to better understand, collect vital information and ultimately help safeguard the city's important resources. The mission of the Kingston CAC is to "*Ensure the conservation of the City of Kingston's natural resources and the enhancement and protection of its environment while fostering unified action on environmental matters*" [1]. These actions have considered and addressed a wide and important range of significant topics to date, including: climate and energy matters, sea level rise and flooding, air quality and wood burning and drinking water supplies as well as aiding the update to the current comprehensive plan, to name but a few. This current Natural Resources Inventory (NRI) represents just one in that series of efforts and has its roots in an ongoing process that began more than seven years ago. This NRI serves as the foundation for an Open Space Plan for the city, which is being developed by Behan Planning and Design and is slated for a 2019 completion. Combined, they will help develop a blueprint for preserving, enhancing and prioritizing open space and natural heritage resources for protection. Of primary importance to both projects will be biological, historic, natural, and cultural features, water resources, parks and other important open space features promoted to help ensure the city will be on a path of sustainable development.

Scope of Work & Notes

Background

This NRI project and resulting report was initiated in 2016 at the request of the city and focused on acquiring, updating, synthesizing, analyzing and formatting existing in-depth data, reports, digital and tabular spatial information that the CAC and city has been compiling [Appendix A & B]. Led by the Project Team (see Acknowledgment section) the information has been combined with the collective experience and lessons learned to date by the CAC and city into a single, coherent inventory and natural heritage\open space database. The format included convening the NRI Project Team regularly to review, consider, condense and develop a cohesive body of conservation information, maps and geospatial data. Such a resource will ideally support and help inform the planning decisions that the city can make relative to the conservation of the city's natural heritage and open space

resources. In addition, the work has been geared to facilitate the development of an upcoming Open Space Plan by the city, for which grant funding has already been obtained. To this end the project helped recover and "day light" (make available to current and future stakeholders) the underlying GIS software project files used to construct dozens of preliminary NRI map compositions. Developed largely with the aid of interns, the CAC currently uses these as their primary spatial guides and planning tools. Recovering the files and the linkages to the various GIS layers will greatly enhance current and future map reprints, edits and updates and ensure that future GIS operators would have easy access to the comprehensive and fundamental map library. To augment and expand the utility of these primary aids, the vast majority of layers that went into constructing each map were converted to KML format, for use within Google Earth. With the addition of a series of Google Earth trainings, the hope is to make the information, currently locked in static paper form, much more available, queryable and ultimately, useful to a wide range of city and stakeholder groups.

Map-centric Approach

Discussions herein have been drawn from the major maps, reports and physical, aquatic and biological assessments known to have been conducted to date near or within the Kingston limits [2], [3] ,[4], [5],[6], [7], [8]and [Appendix A and C]. Nearly all habitat assessments have focused within the larger, more intact natural areas and regions that might be expected to contain viable populations of important habitats and associated plant and\or animal species. It must be mentioned that additional species and supporting "*pocket habitats*" may still be discovered in Kingston that should be included within any natural resource assessment.

Organizationally, it should be noted that, among the major natural resource and open space categories that were adopted, there is frequently great component overlap between any two groups and, not uncommonly, among several. We use the groupings as a method for presenting and discussing both the open space (cultural) and the natural and biotic side of things, and don't suggest any unique, static or quantifiable membership. The major familiar groupings that have been adopted for this NRI include (in random order):

- Biophysical resources
    - Geology – bedrock and surficial
    - Soils
    - Terrain
- Hydrological resources
    - Surface water systems
        - Rivers, streams, creeks - tidal & freshwater
        - Ponds
    - Subsurface water systems
        - Aquifers
        - Wetlands & hydric soils
        - Vernal pools
    - Drinking water systems
- Biotic features & systems
    - Land cover
    - Habitats
    - Flora & fauna

- Recreational resources
- Urban agriculture
- Historical & cultural resources
- Scenic resources
- Climate & potential impacts

System Overlaps

In considering many of these, it's easy to question why any single component, such as urban forests, would be listed under one category and not another. The brief answer is that: *it's easier* and we freely offer, for example, that trees serve a wide range of functions that could rightfully fall under several categories. Trees cool cities with shade from canopy cover, contribute important ecological functions as habitat, food, nesting and shelter, significantly enhance local water quality, especially within riparian (stream-side) areas and have contributed greatly to cultural (quality of life) and historical patterns (champion trees). The same can be said for water resources, since they can both provide an irreplaceable commodity as our drinking water supply and also help form the habitat foundation for plants and animals tied to aquatic habitats and wetlands. We have adopted the flexible approach that the shared spatial extent and geographic "footprint" of the systems, when considered jointly, can simplify the consideration of the conservation of any system. For instance, protecting the plants and trees that fall within the riparian zone of a stream will both protect those plants as well as the water quality within the stream. Downstream flooding and pollution can also be mitigated since sediments and run-off can be absorbed within the vegetated riparian zone.

Open Space Index

One of the more important analytical GIS products developed for this NRI took the form of an Open Space Index (OSI) or a simple overlay where some twenty-five natural resource and\or open space variables were "burnt into" the most current (2017) tax parcel layers (*Appendix D*) . The final matrix which contains each of the 8,502 City of Kingston tax parcels based on 2017 data, also contains the area (acres) and percentage (of each parcel) that each of the twenty-one OSI layers represents within each parcel. The input layers were chosen so as to provide insight into the spatial dimensions for selected important features relating to natural resources (e.g. riparian zones), open spaces (e.g. parks) or spatial metrics (parcels greater than 5 acres). This allows a simple database (Excel) query which can bring up, for example, all of the parcels owned by the City of Kingston that are over 5 acres and greater than a quarter mile away from a park. Such parcels might represent opportunities for establishing parks within underserved areas. The OSI is designed to be used both proactively as well as reactively by city planning, zoning and conservation staff, among others. It can be used to identify the areas or parcels containing features which may present important conservation opportunities. Or conversely, should a development project be proposed, a simple and rapid query can provide a detailed assessment of the contents of the parcels that such a project might extend to.

Geospatial Caveats

And lastly, as a great majority of this work has been conducted using a geographic information system (GIS), a few precautions should be included with the work. GIS involves a process and a system whereby features on the nearly-spherical earth are transformed through mathematical functions to be projected, viewed and analyzed within the 2D world of a computer screen. Because these functions all contain a level of error and because, despite our best efforts, all data recorded for use within a GIS contain errors as well, not all features will appear to "line up" or overlay perfectly with layers and data from other projects and purposes. For this reason, features

representing entities such as towns and cities can appear to vary in size, with measurements of their areas varying by as much as 5+ percent. For example, the number of acres contained within the City of Kingston is reported to range from ~5,300 acres up to ~5,700 acres, depending on the layer considered (e.g. tax parcels, habitat field surveys or satellite-based land cover studies). All reasonable efforts and current best standards have been taken to reduce avoidable errors in the work contained within. However, because data from dozens of sources, designed to be used at a wide range of accuracies and scales are used, the user is cautioned to use the information in a general planning capacity only. There is never a substitute for detailed field verification performed by trained professionals.

Value of Natural Resources in Urban Settings

Americans are becoming more and more city-dwellers, as are people around much of the world. Currently some 81% of the US population lives within cities, up from 75% in 1990. By 2050 some 87% of us are projected to live within urban settings. Globally the current statistic is lower, 54%, up from 30% in 1950; though the trend remains the same [9]. Cities are typically characterized by reasonably high population density (New York City, has over 27,000 people per square mile) and with the competition for space being strong, it's not surprising when a 4-20 story office or apartment structure is built on an available open lot, versus say a pocket park or a community garden. Forward looking city managers and planners recognize the importance of preserving adequate amounts and distributions of parks, green and open space, historical and cultural features, and even small amounts of remnant habitats and natural features as important for a variety of reasons.

Studies over the past decade have shown that living in close proximity to and\or having regular access to parks, green-space and natural settings offers significant benefits to citizens, in a number of ways. A recent team at the Harvard School of Public Health found that women living in the greenest areas of a city tended to be 34% less likely to die from respiratory illness that women living in the areas with the largest percent of impervious surfaces [10]. They were also some 13% less likely to die of cancer. It has been shown not only to help people feel overall happier and healthier but also to live longer. Rates of depression and anxiety disorders tended to be measurably lower, especially within children in lower income brackets. Studies in Europe have found that, among people living near parks, some 15 of the monitored 24 health conditions were lower, with some of the strongest relationships appearing within respiratory diseases such as COPD, upper respiratory infections and asthma [11].

People's self-reported quality of life indicators tended to be measurably higher within groups living near and having easy access to greenspaces that were ideally within a 10-minute walk (~1/2 mi) of their homes. It is well known that real-estate prices tend to be higher for houses located close to greenspace and that people living near such areas tended to be more social. Positive benefits have been shown for such broad indicators as: stress reduction, creativity, improved mindfulness and general mood and attitude. Exercise tends to be easier to engage in and people living near such places tend to have a lower body mass index (BMI) [12].

Green and undeveloped open space and natural habitat also deliver a wide range of very valuable "ecosystem services". Such services take a variety of forms, including: economic, human health, cultural-social and ecological [13]. Forests and street trees, cultivated lands and gardens, fields, streams and rivers, riparian zones and wetlands all serve a range of functions delivering benefits to people living within the region. Benefits can include: improvements in air and water quality, mitigation of stormwater run-off related pollution, flooding and property

damage, local aquifer regeneration, carbon sequestration, lower ground-level temperatures and cooling energy bills in summer, dampening of ambient noise and overall perceived elevation in the quality of life. Socially, and from a health-related perspective, as suggested above, greenspace can help reduce tension and anxiety, as well as promote increased physical and mental health and community cohesion. Ecologically, while remnant habitat and natural systems tend to be fragmented and measurably degraded, they still serve a multitude of important functions. In addition to helping to preserve and even restore the important life-giving services they deliver (as above) there remains strong arguments of preserving urban ecosystems and the resources provided to both local resident fauna as well as migratory species (birds and insects). Such small "stepping stone" patches can serve as spot corridors and provide important resources to passing animals as they venture to or return from important breeding and nesting areas. Such features can add significantly to local climate resilience, as plant communities struggle to keep pace with rapid changes in temperature and precipitation patterns.

And lastly, maintaining and even restoring representative sections of native plant communities and ecological systems can provide an irreplaceable natural schoolroom where a community's youth might experience nature first hand. In our modern, digital, 2D world, a wide range of studies and books highlight the learning and developmental dangers of leaving our children indoors for long periods; spending hours on end, distracted by their video games and devices. Outdoor play has been shown to calm children with attention deficit and hyperactivity disorder [14]. And in the same way that it can for adults, unstructured play time in streams, forests and wetlands can both help establish a sense of calm and centeredness, allowing a child's naturally inquisitive nature to explore the wonders of the natural world. Such time immersed climbing trees, exploring uncharted woodlands, collecting frog eggs to watch them hatch into tadpoles, can all help them develop a lasting ecological literacy. Through becoming personally familiar with and imprinting upon the natural world, they can come to feel that they are not only part of that world but may therefor care about and want to help protect it. How else can we ever hope that they, as adults, may one day become stewards of the very systems that keep us all going?

City of Kingston: Setting & Systems

As a small city with a population of some 23,900 people, Kingston supports a population density of ~3,200 people per square mile [15] (Figures 1 and 1a). The area of the municipality (~8.77 sq. mi. or ~5,613 acres) includes some 7.5 sq. mi of land (~85%) and being bounded by three rivers: the Hudson, the Esopus and the Rondout, there are some 1.3 sq. mi (~15%) of open water systems within the city bounds. Kingston falls within the *Hudson Limestone Valley* sub-region of the *Lower New England\Northern Piedmont* ecoregion province (Figure 2), though given its proximity and stunning views, it shares a great deal culturally with the Catskill ecoregion as well.

Geophysical: Geology, Soils, Terrain

The bedrock of the Kingston region (Appendix C, Image 16) is uniquely and predominantly limestone and represents materials of the Onondaga and Glenerie formations. This historically valuable natural resource, which extends from High Falls to Kingston, helped foster a rich and important regional concrete industry running from the 1820's until the advent of Portland cement nearly a century later. Centered mainly near Rosendale, for which

the very high-quality concrete is named (it was used as the foundation for the Statue of Liberty) concrete production was important in and near Kingston for an extended period. Ecologically the calcium rich bedrock, which is prone to dissolution by acidic surface water infiltration, gave rise to abundant caves and karst topological features across the region. Caves, regionally and in Kingston, still serve as important hibernaculum (nesting\roosting sites) for bats, though utilization of the features have ranged from mushroom farming to planned below-ground cooling systems for computing arrays. In addition, the carbonate layers contributed significantly as parent bedrock material to rich and productive soils systems in the area. Farming still serves as a foundation of much of the region's economy, focused especially on apple orchards, vegetables, nursery crops and berries. Surficial geology of the city consists largely of bedrock and a range of glacially and water arranged materials (till, kame, lacustrine and alluvial deposits) and much of the city is covered with very thin bedrock-influenced soils.

The differentially weathered bedrock materials have given rise to some fairly strong relief and diverse, steep regions surrounding flatter, fertile basins within Kingston. (Figure 11) Some hold that the steep, hilly terrain (cont.)

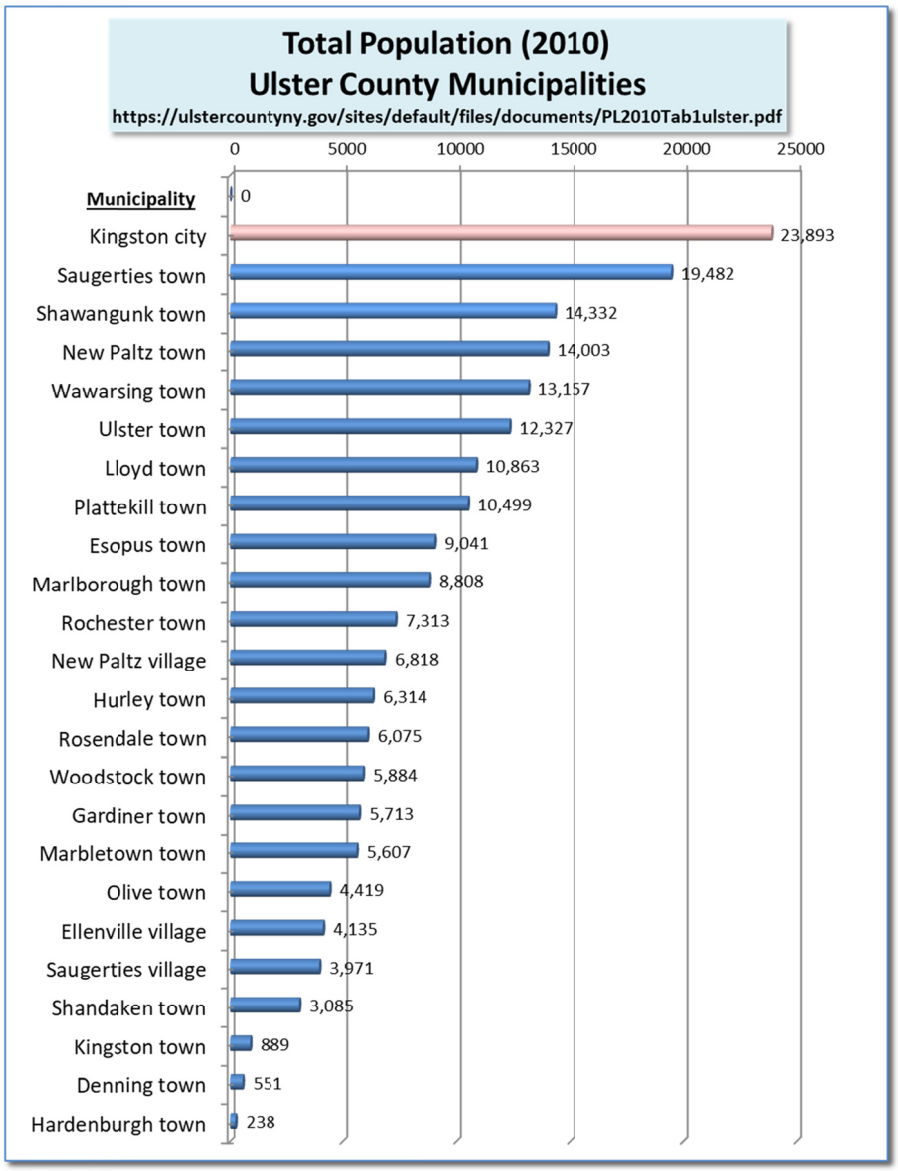

Figure 1. Population of Ulster County Municipalities – Total Ulster County Pop (2010) 182,493
Source: https://ulstercountyny.gov/demographics-population

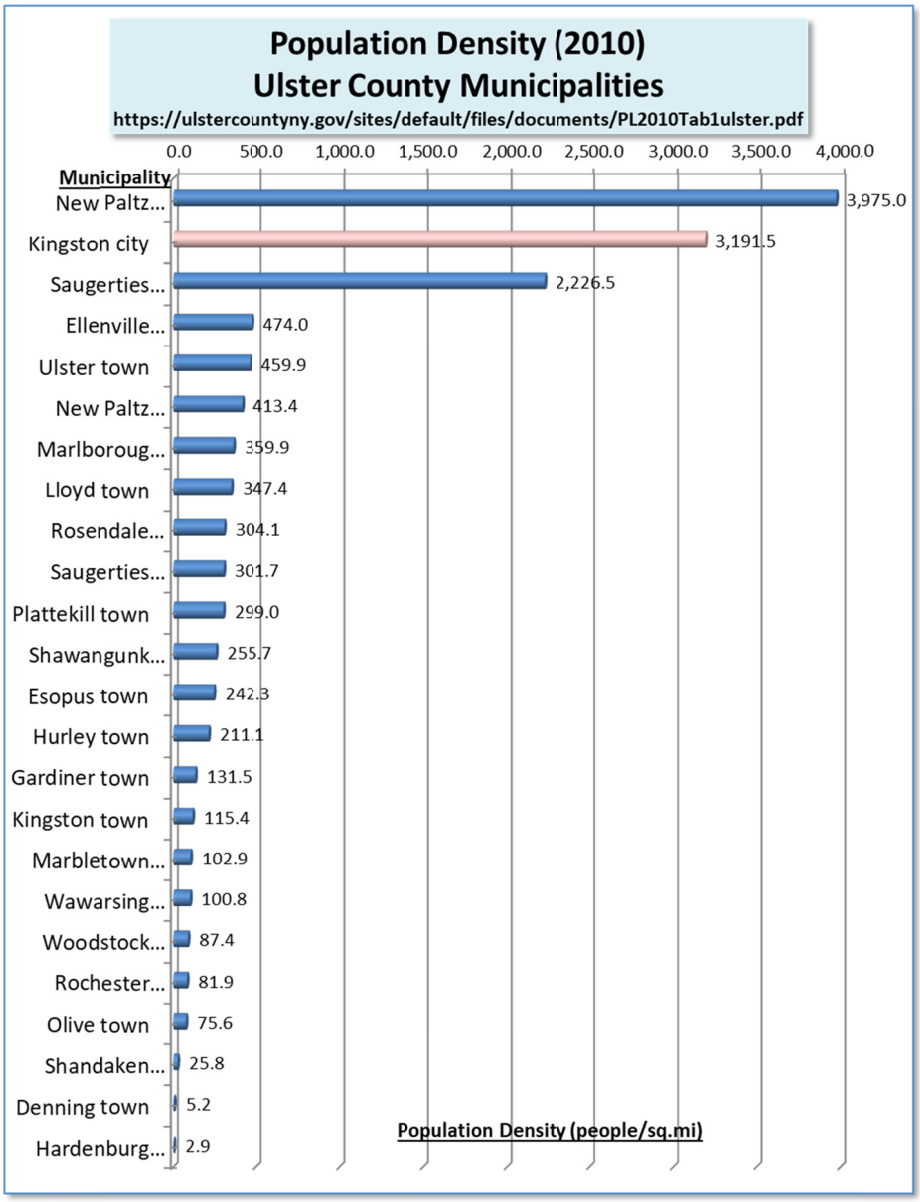

Figure 1a. Population Density of Ulster County Municipalities – (# of people/Sq. Mi) Average density/town 162 persons/sq. mi. Total Ulster County area (2010) 1,124 sq. mi. Source: https://ulstercountyny.gov/demographics-population

of the southwest section of Kingston represents the northern tip of the Marlboro Mountains to the south, trending northeast from the Shaupeneak Ridge. But having been isolated for potentially millions of years by the traversing Rondout Creek and differing geologically, it is not unlikely that the two regions have expressed somewhat varying ecological patterns and\or processes.

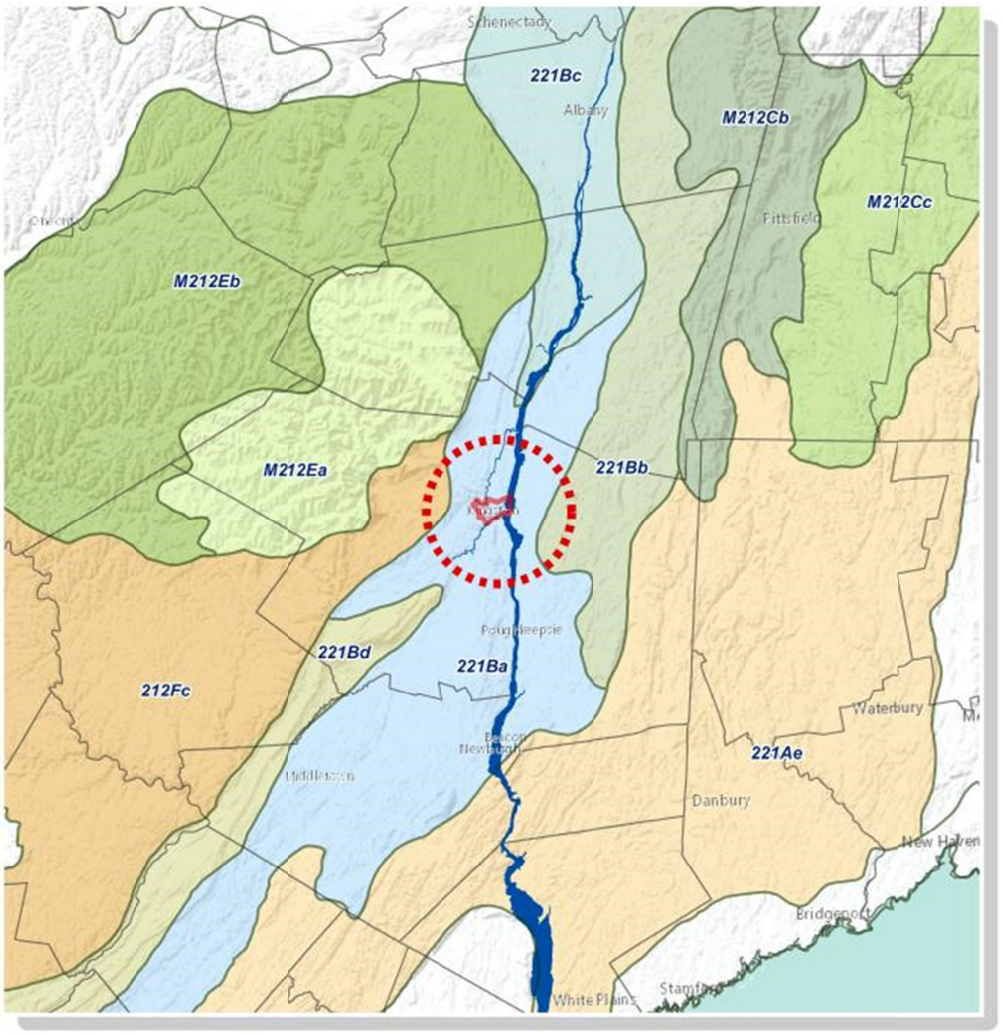

*Figure 2. Kingston falls within the Hudson Limestone Valley **subsection** of the Hudson Valley **section** within the Lower New England/Northern Piedmont **province** of The Nature Conservancy regional ecosystem taxonomy.*

MUID	PU_NAME	NAMEMUID	LANDFORM	AVPRECIP_IN	DOMVEG1
212Fc	High Allegheny Plateau	Eastern Allegheny Plateau	Open high hills-ground moraine	46.00	Oak-Hickory-Ash Dry Forest
221Ae	Lower New England/Northern Piedmont	Hudson Highlands	Open hills steep sided valleys	46.00	Hemlock-White Pine/Red Oak-White Pine/Sugar Maple-Chinquapin Oak Forest
221Ba	**Lower New England/Northern Piedmont**	**Hudson Limestone Valley**	**Rolling hills-glaciated-iced-molded**	**46.00**	**White Pine-Red Pine Forest**
221Bb	Lower New England/Northern Piedmont	Taconic Foothills	Foothills-glaciated-ice-molded	36.00	Northern Hardwoods/Sugar Maple-Chinquapin Oak Forest
221Bc	Lower New England/Northern Piedmont	Hudson Glacial Lake Plains	Level to rolling glacial lake plain	41.00	Sugar Maple-Chinquapin Oak Forest
221Bd	High Allegheny Plateau	Kittatinny-Shawangunk Ridges	Steep Ridges	45.00	Oak-Heath Dry Forest
M212Cb	Lower New England/Northern Piedmont	Taconic Mountains	Low mountains-ice-scoured	42.00	Red Spruce-Balsam Fir Forest
M212Cc	Lower New England/Northern Piedmont	Berkshire-Vermont Upland	Open low mountains-ice-scoured	48.00	Sugar Maple-Birch-Beech/Red Spruce-Balsum Fir Forest
M212Ea	High Allegheny Plateau	Catshill Mountains	Open low and high mountains	60.00	Red Spruce-Balsam Fir Forest
M212Eb	High Allegheny Plateau	Catskill Highlands	Open low mountains-ground moraine	42.00	Sugar Maple-Birch-Beech Forest

Much still remains to be known and verified regarding the detailed patterns of the important limestone geology of Kingston. Some research has been conducted though has not to date been shared with public agencies. Regions containing karst topography carry with them enhanced water pollution vulnerability, since any introduced pollutants can move much more quickly through any large, dissolved spaces and inherent to the feature is the relative lack of natural filtration systems.

Land Cover & Biotic Systems

Land Cover

Analysis conducted by the author of detailed (1m) 2013 land cover data [16] revealed that Kingston currently sustains some 40-43% of its area in tree canopy cover. (Figures 3 and 4). Of this amount, the vast majority (40%) falls within reasonably contiguous blocks, (hardwood, softwood, floodplain forests, parks, vacant lots, etc…) representing over 2,100 acres (out of the entire total 5,316 for the city). The remainder (~3%) falls within previously unmapped categories: Trees Overhanging Structures, Trees Overhanging Roads and Trees Overhanging Other Impervious Surfaces (e.g. driveways, parking lots etc…). (Using high resolution (1-meter) digital air photos and 1-meter LiDAR elevation enabled features and categories to be mapped which have been unobtainable using lower-resolution imagery.)

A Low Vegetation class comprises another ~15% of the city, though, upon inspection, we see that this mostly includes lawns and other vegetated near-residence systems; little in the way of "natural" field or meadow habitats seem to be captured. Looking at impervious surface cover, (Figure 5) the combined classes of: Roads, Structure (buildings) and Other Impervious Surfaces (parking lots etc…), indicate that nearly 25% of the land area (~1,320 acres) of Kingston are currently either paved or covered with a hardened surface. Such comparatively large amounts are said to indicate the potential for wide-spread water quality degradation, by the Non-point Education for Municipal Officials (NEMO, 1994) program of the University of Connecticut.

"….many studies are finding a direct relationship between the intensity of development in an area - as indicated by the amount of impervious surfaces - and the degree of degradation of its streams. These studies suggest that aquatic biological systems begin to degrade at impervious levels … above 15%, or at even lower levels for particularly sensitive streams. As the percentage of imperviousness climbs above these levels, degradation tends to increase accordingly".

LandCover Class	PCT	ACRES (GIS)	GROUP_PCT
Tree Canopy	40.06	2129.76	
Tree Canopy Over Roads	1.47	78.18	
Tree Canopy Over Other Impervious Surfaces	1.23	65.44	
Tree Canopy Over Structures	0.37	19.63	**43.13**
Low Vegetation	15.15	805.15	
Scrub-Shrub	0	15	**15.42**
Water	14.45	768.23	**14.45**
Other Impervious Surfaces	12.16	646.20	
Structures	6.93	368.15	
Roads	5.77	306.59	**24.85**
Barren	1.26	67.12	**1.26**
Wetlands (emergent)	0.88	46.74	**0.88**
TOTAL	**100**	**5316**	**100.00**

Figure 3. Table of Detailed Land Use/Land Cover Classes (2013) of Kingston. Hi-Res (1m) data by Shippensburg Univ. PA

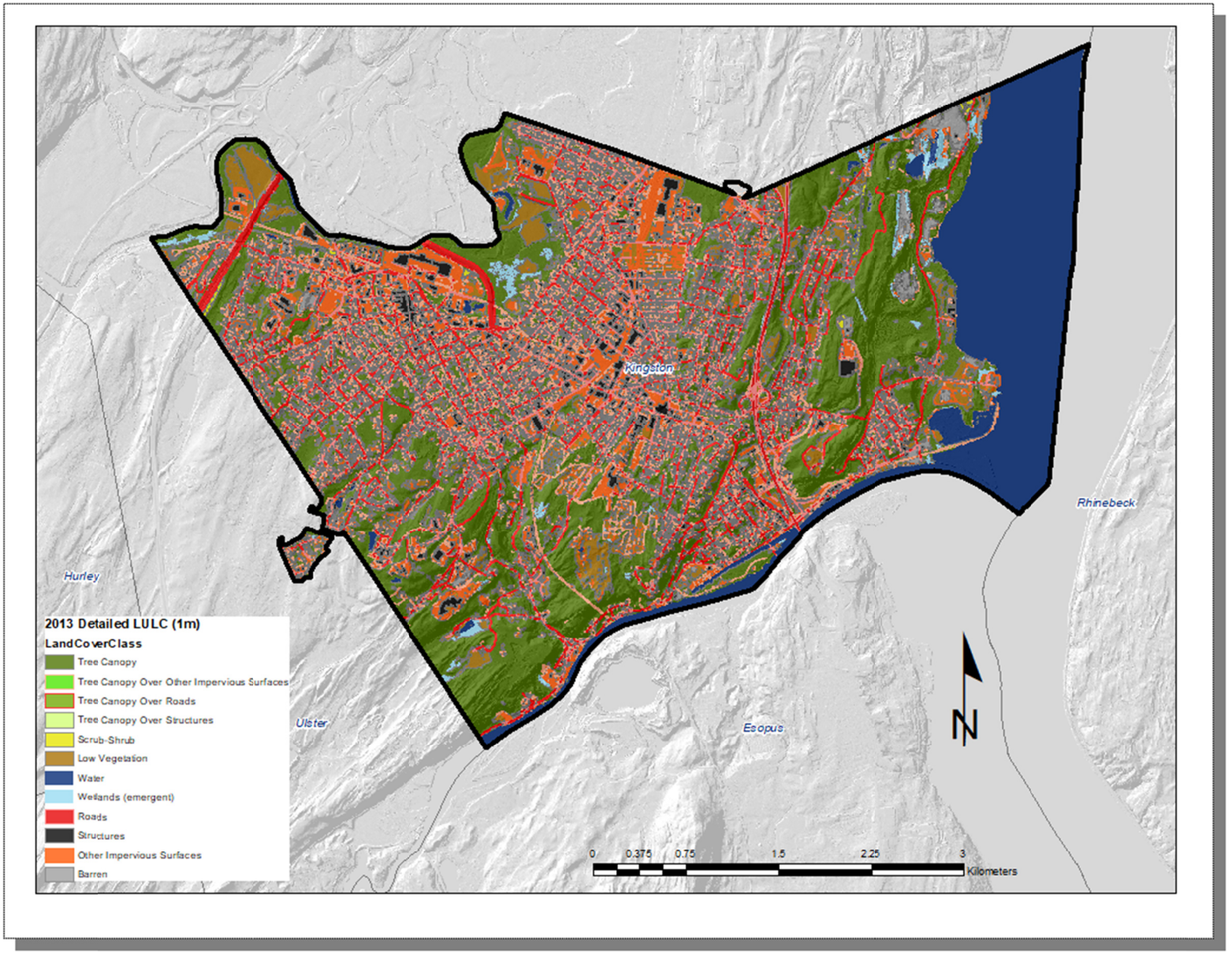

Figure 4. Detailed (1m) Land Use\Land Cover (LULC) Imagery for Kingston. High-resolution (1m) aerial imagery merged with 1m LIDAR (University of Shippensburg, PA)

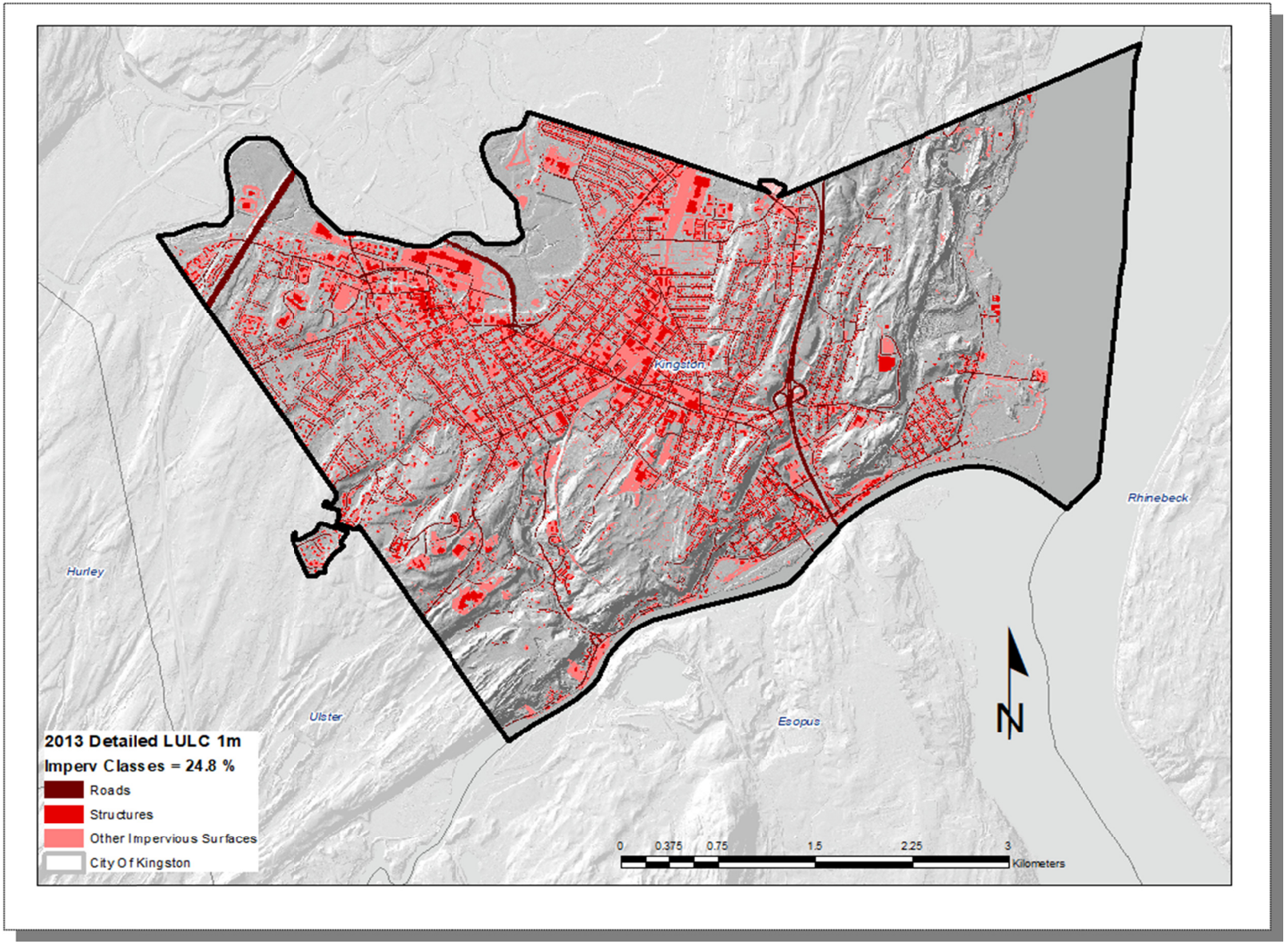

Figure 5. Detailed (1m) Impervious Cover Imagery for Kingston. Hi-resolution (1m) aerial imagery merged with 1m LIDAR. (University of Shippensburg, PA)

Open Water comprises some ~15% of the area within the Kingston boundary, though with municipal property boundaries extending to the center-line of the Hudson River (which varies from .7 – 1.3 miles across), a simple map inspection clarifies that most of this falls within the river. The Esopus Creek and Rondout Creek do contribute to this cover class, although Kingston contains relatively few large pond or lake bodies. Several land cover categories are likely under or misclassified in the study and include ones that are commonly missed due to the changes they exhibit across the growing season: Wetlands (emergent & forested) which were reported to span less than 50 acres (.9%) city-wide and Scrub-Shrub (field, pasture) for which only 15 acres (.3%) are listed. And while both likely occur to a much wider extent, other studies have suggested that their role in the ecological diversity of the city does tend to be small.

Habitat Studies

In May of 2014, supported by funding from the Hudson River Estuary Program, the Kingston CAC and the City of Kingston engaged the environmental firm Hudsonia Ltd to perform a survey of the significant natural habitats of the city. The project grew out of a biodiversity assessment training that a collection of Kingston and Town of Ulster volunteers participated in in 2009, led by Hudsonia [17]. This group, as part of their training effort, identified and mapped the locations and distribution of some 3,200 acres of habitat centered around the Esopus Creek in northern Kingston. Hudsonia staff, as part of the subsequent project, expanded these areas to include two other regions in southwest and eastern Kingston, where reasonably intact habitat could still be found.

The overall mapping delineated a total of nearly 2,500 acres (~41% of the city) using a combination of remote sensing and field verification. Some 21 significant habitats were identified and delineated, (Figures 6 &7)

Habitat Type	Acres (GIS)	%	Acres (Sub-group)	Pct (Sub-group)	
Unmapped	2203.82	38.30			
Developed	1161.31	20.18			
Waste ground	140.37	2.44			
Rock barren	1.58	0.03	3507.07	60.95	Non-habitat
Cultural (including cemeteries)	185.11	3.22	185.11	3.22	Urban habitat
Constructed Pond	20.59	0.36			
Hudson River	715.07	12.43			
Open Water	4.10	0.07			
Stream	209.61	3.64	949.38	16.50	Aquatic habitat
Tidal marsh	36.22	0.63			
Marsh	13.51	0.23			
Wet meadow	24.98	0.43			
Wet clay meadow	1.92	0.03			
Intermittent Woodland pool	3.39	0.06	80.02	1.39	Wetland habitats
Upland meadow	140.52	2.44	140.52	2.44	Upland habitats
Floodplain forest	84.71	1.47			
Hardwood & Shrub Swamp	57.38	1.00			
Upland hardwood forest-swamp	6.76	0.12			
Upland shrubland	37.60	0.65			
Upland conifer forest	12.86	0.22			
Upland mixed forest	88.67	1.54			
Upland hardwood forest	603.89	10.50	891.87	15.50	Forest habitat
	5753.97	**100.00**		**100.00**	

Figure 6. Table of Habitat Types from Hudsonia Ltd. Analysis of Significant Habitats in Selected Areas of Kingston (2013).

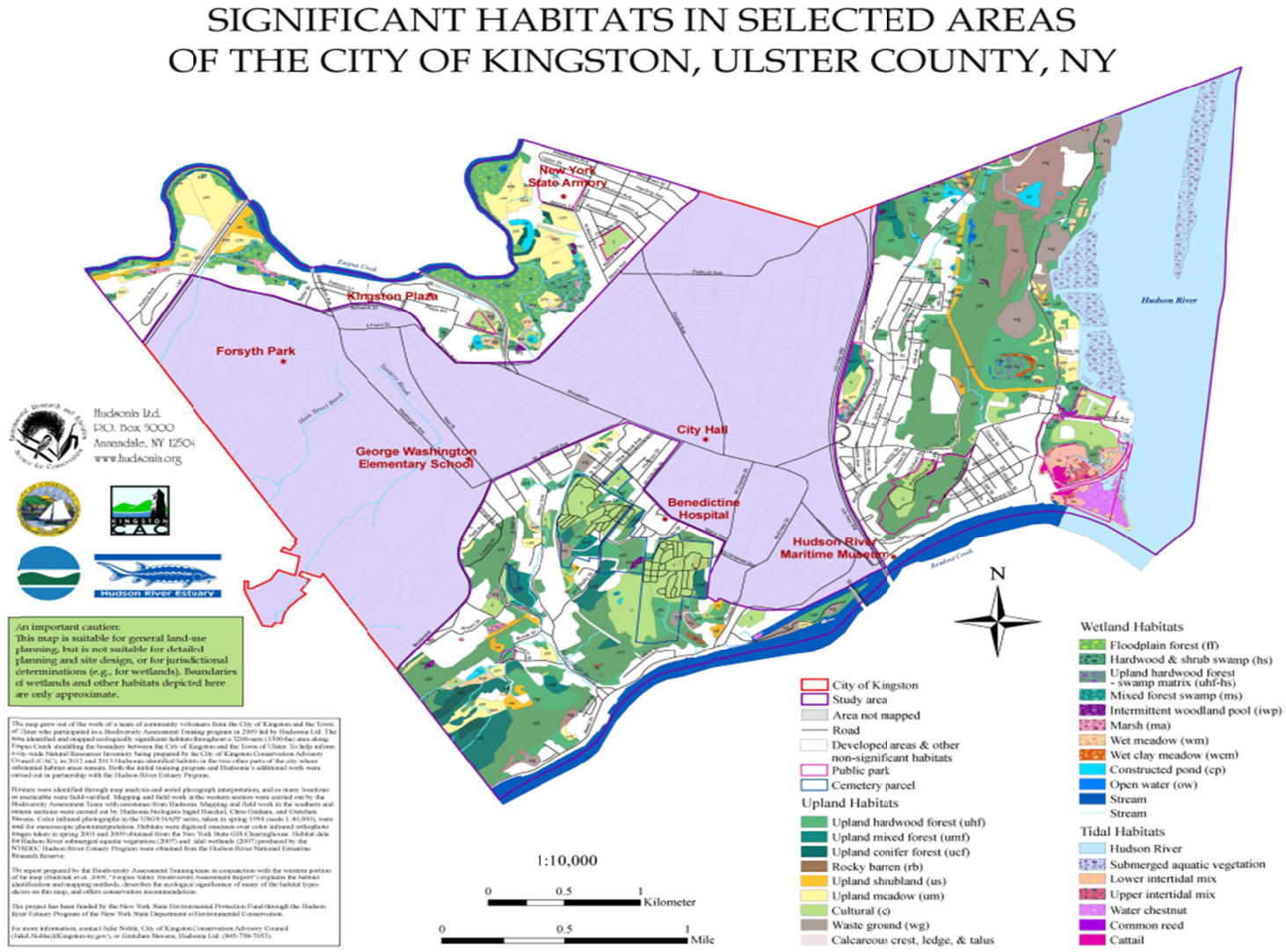

Figure 7. Map - Hudsonia Ltd (2013) Significant Habitats of Kingston. Note three main "large natural area" regions.

(cont.) loosely clustered around three main areas. The first was the wetland\floodplain dominated regions of the Esopus Creek (northwestern Kingston bordering Ulster), the eastern most upland and tidal areas adjacent to the Hudson River and the southwestern area of the city surrounding the Twaalfskill Creek, along the Rondout Creek where large tracts of intact upland forest can still be found. These three zones contain a great deal of the remaining intact upland habitat within Kingston, though the forest matrix spans the entire municipal area. As noted on the maps, many important biotic systems reside in the aquatic region and, according to the New York Natural Heritage Program, support nearly a dozen rare, threatened, vulnerable and endangered species and habitats.

A third significant biological assessment for the city was contributed in 2014 by Laura Heady of the New York Department of Environmental Conservation, Hudson River Estuary Program. This Habitat Summary [2] reviewed, compiled and summarized much existing information for the city and adds a great deal of both context and integration for the CAC. The summary includes maps, tables and written descriptions of the major ecological systems (Appendix C, Figures 21, 22, 35, 37-40), Appendix E, Section 1) including: streams, forests, wetlands, shoreline habitats and other areas of biological value. Given that the material was gathered and integrated without the benefit of field verification, it was designed to generally help forward the efforts of the city in planning for effective protection of important open space and biological resources. But given the depth and breadth of the content, it provides a broader framework combined with suggested conservation measures from which local conservation planners can better understand the important systems. The summary reinforces the location and value of the same three main biodiversity areas in Kingston as the Hudsonia study, containing a large amount of its unbuilt natural habitats. (Figures 8 and 37) Summarized here simply as "large natural areas" they effectively capture the collective footprints which, if protected, would go a long ways toward preserving some of the most important biological resources of Kingston. This important work, which remains highly valuable today, also brings to bear the internal experience and expertise of the NYSDEC and helps leverage decades of analysis, study and understanding regarding regional patterns of:

- hydrology, water quality and watersheds
- climate change and sea level rise
- tidal wetlands and migratory fish spawning habitat
    - habitat integrity, fisheries and aquatic ecology
- benthic and coastal inventories including
    - submerged aquatic vegetation
- upland systems
- local urban forests and regional forest corridors
- soils and bedrock geology
- Rare, Threatened, Endangered, Vulnerable and Special Concern Species found within Kingston, including:
    - Habitats and communities
    - Animal assemblages
    - Plant species
    - Animal species

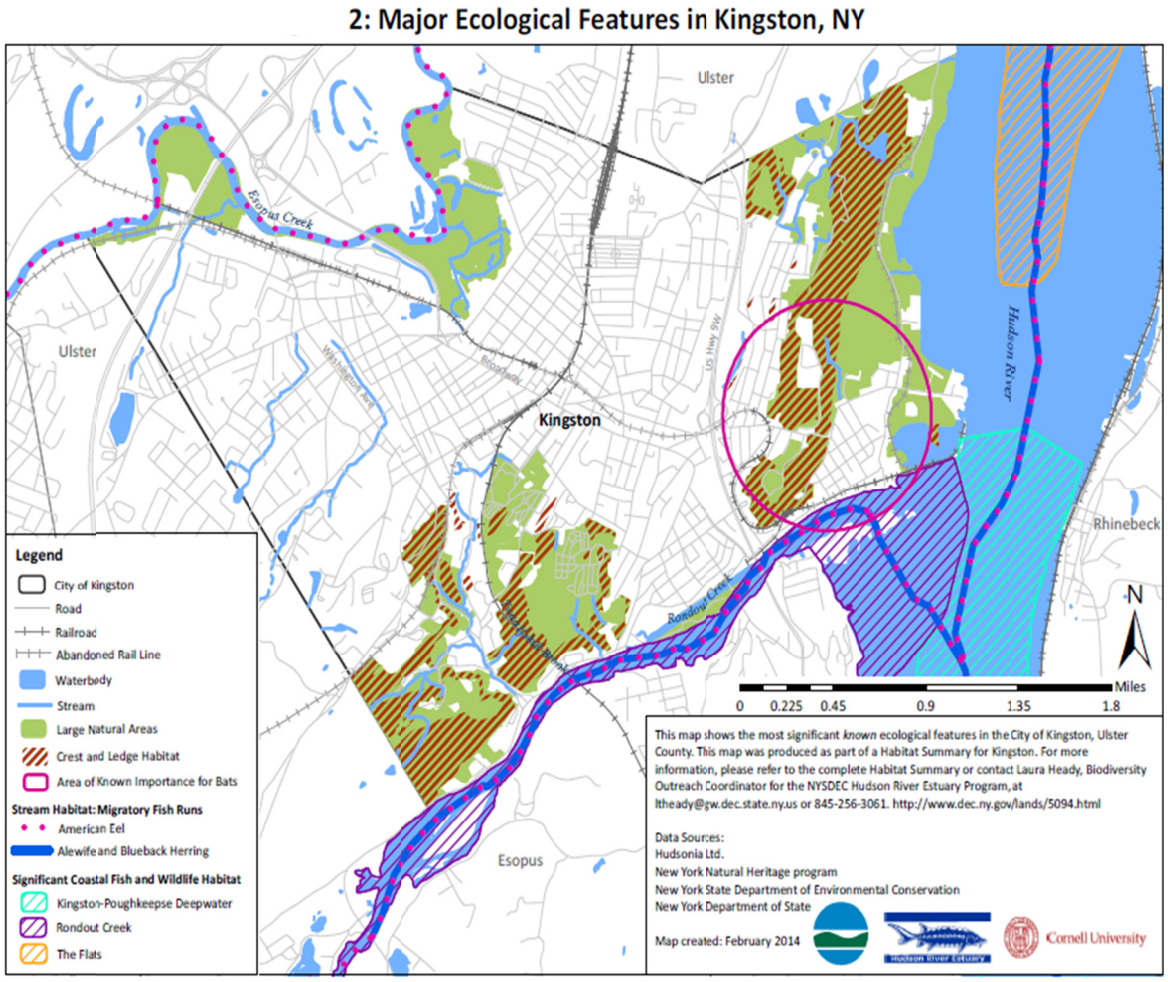

Figure 8. Major Ecological Features in Kingston (2014) Habitat Summary – L. Heady NYSDEC. See also : Appendix D. Figure 37

Kingston Habitats & Open Space:

Urban Forest: the Ecological Matrix of the City

In considering the combined biological footprints of the above-mentioned assessments, it is immediately clear that forest resources remain among the more important ecological features within Kingston. Both for its area and extent, Kingston's urban forest contributes greatly to a number of overlapping resource and open space categories. As was previously mentioned, urban trees, whether they occur along streets, within parks or within remaining private forests and woodlots, contribute greatly through the ecosystem services they affect, including, among others:

- air quality – through removing pollutants, ground-level ozone and particulates

- water quality and flooding – by slowing precipitation and run-off down, stabilizing soils and slopes, taking up nutrients and allowing water to recharge local aquifers, before sediment-laden run-off contributes to the stormwater system and local streams
- energy consumption – by helping to keep local areas cool, thereby mitigating "urban heat islands" in summer
- climate change – through carbon uptake and sequestration both above and below ground
- human health and well-being – both physical and mental, they lessen ambient noise, add to scenic and aesthetic beauty and add an overall enhanced sense of quality of life
- critical habitat, food and biodiversity resources - for both resident and migratory birds and mammals and important pollinator insects

Contemporaneously with this NRI, a street and park tree inventory has been completed and is available on the city's website (https://www.kingston-ny.gov/Trees, [18], Figure 9). The inventory provides a great deal of useful information regarding the species, sizes and status of much of the city's urban forest. Such information can form the baseline of an *urban forest information system,* to help: record, keep track of and increase efficiency of the efforts to monitor and ensure the overall health, integrity and status of the resource. The project summary report suggests that, using the i-Tree STREETS application, the total estimated replacement cost of the 3,110 trees surveyed could approach nearly $13,000,000. Species composition of those trees trend strongly toward commonly used, though aggressive or potentially invasive specimens such as: Norway Maple (10%), Callary Pear (7 %) and Honey Locust (8 %). Areas in need of trees or maintenance, the location and details of new tree plantings every year and any streets in need of tree removal can all be much more easily identified and managed, with results, future year projections and associated costs all recorded and archived.

Few conservation efforts would mean as much to Kingston as protecting and effectively stewarding its urban forest. Kingston's 2016 Comprehensive Plan [19] clearly promotes the development of an Urban Forestry Master Plan and such an effort could simultaneously accomplish a wide range of overlapping plan goals, such as protecting open space, providing for climate resilience, promoting a bikable and walkable city and at the same time enhancing stormwater management. The city could be cooler, greener and support both physical and mental health within the municipality.

A large percent of Kingston's forest resource resides within privately held forest lands. Such resources will require creativity to protect and help maintain within coming years. They should all be field surveyed and inventoried in a manner and format which can be integrated with that of the recent 2018 Street and Park Tree Inventory. Understanding the current composition, structure, condition, age and health will be important components in establishing an adequate snapshot of the city-wide forest. Protecting such resources can take a range of approaches. Parklands can be established, and conservation easements can help both protect important resources, while providing private owners rewards and incentives for their contribution to the community. Abundant collaboration opportunities exist with agencies such as the Kingston Land Trust and the Arbor Day Foundation, with which Kingston has already established itself as a "Tree City USA" city. Both the United States Forest Service (USFS) and the New York State Urban Forest Council (NYS-UFC) provide abundant and explicit aid, guidance, grants and technical support to municipalities wanting to establish and expand programs supporting their important green spaces.

- Urban forest: stresses & threats
    - Proper design, species and site selection, installation, maintenance and ongoing stewardship is critical to the life of an urban forest. From when young trees are planted, to when they require pruning, to when they come to the end of their life cycle and must be removed, effective management can greatly affect the value derived from each tree and minimize the hazard or dangers they present to the public.
        - The city would benefit greatly from the development of a Kingston *Master Urban Forest Plan*, undertaken by a dedicated person, group or agency, to manage, survey, inventory and establish regular and routine maintenance, monitoring and care of these important resources. Taking for granted or ignoring the values and very real and abundant services contributed by the systems can only serve to undermine the integrity of this very real core of public health infrastructure.
        - With the advent of high-resolution remote sensing, whereby features in the range of single meters can be delineated, there may be support options that can aid regular synoptic assessments on the status of the city's forests.
    - Ground level ozone from automobiles and the burning of other fossil fuels can damage the leaves and health of urban trees.
    - Improper planting or lack of maintenance can find street trees growing up under or around sidewalks, which can eventually girdle and kill the tree, not to mention compromise the integrity of the sidewalks. Planting trees in undersized pits, where water resources can't enter, can also permanently hinder the growth of a tree.
    - Drought stress can appear much earlier in urban trees than those in natural settings, due to lack of ability to establish and send forth rooting systems.
        - Trees, especially newly planted stems, require a great deal of water within the first and second years of their lives; regular watering can significantly improve their chances of growing to ripe old ages, providing cooling shade and attractive greenery to the neighborhood.
    - Forest and tree pests and pathogens such as the Asian long-horned beetle or the emerald ash borer can quickly decimate the trees in a given region. Catching infestations and outbreaks can effectively limit the damage and save large numbers of trees and their associated value. Also, taking care to diversify species composition with new tree plantings, to minimize monocultures susceptible to disease, can help ensure population resilience in the face of pests or pathogens.

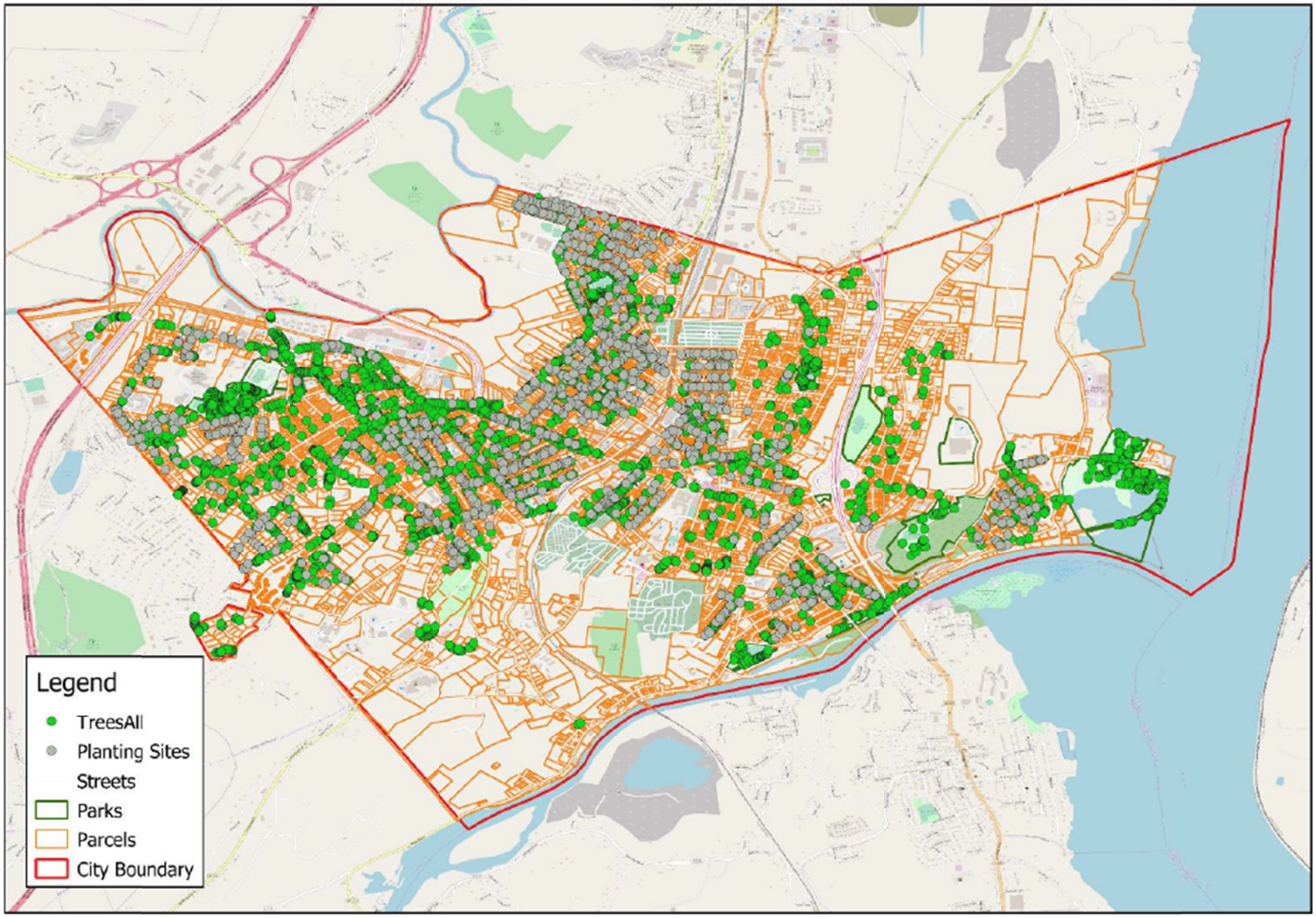

Figure 9. Street & Park Tree Survey (2018) by Arbor Pro. Some 4,406 sites and 3,119 trees were inventoried.

Hydrological Systems, Features & Aquatic Habitats

Hudson River, Rondout Creek and Esopus Creek

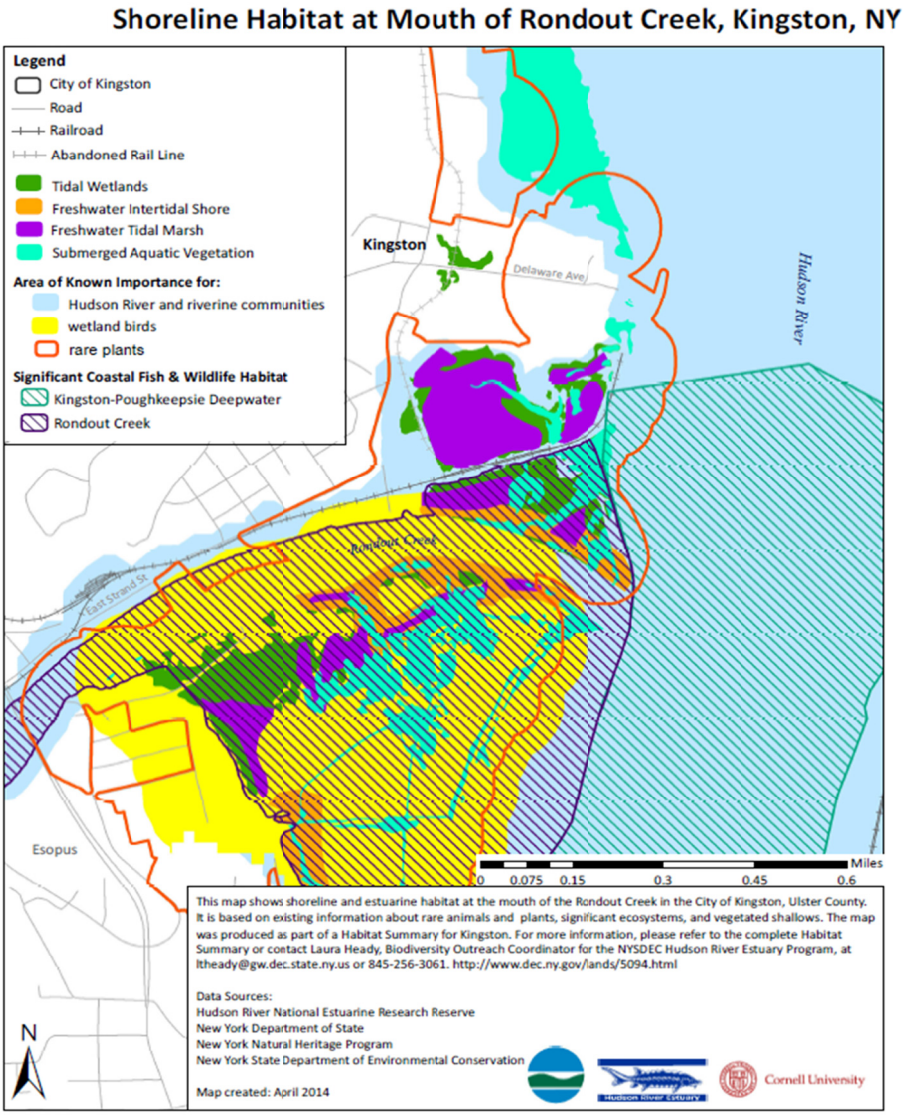

Figure 10. Important Aquatic Habitats of Kingston. L. Heady, NYSDEC

Kingston derives a great deal of its cultural identity from the three major rivers and creeks that flow past its boundaries. The city is divided hydrologically and, drains surficially into watershed basins for each: the Hudson River, the Rondout Creek and the Esopus Creek. These aquatic systems also contain and influence a great deal of the important habitats and rare biodiversity resources that remain within the city limits. Important deep open-water, tidal and inter-tidal mudflats, shoreline habitats and submerged aquatic vegetation communities (Figure 10)

are home to some of the more rare and significant species in Kingston. These include the rare and vulnerable plants: Franks' sedge, heart-leafed plantain, and the Delmarva beggar-ticks.

The region at the confluence of the Hudson River and Rondout Creek serves as important year-round spawning, breeding and seasonal corridors for valuable anadromous (migratory) fish species [4]. Short-nosed and Atlantic sturgeon, striped bass and American shad breed here as do alewife and blueback herring. The migratory American eel, which breeds in the Atlantic Ocean, spends its adult life in these and other coastal rivers and streams. A wealth of resident sport and pan fish (e.g. small-mouth and large-mouth bass, pickerel, among others) congregate in relative density here and in neighboring tributaries [4] making the four-mile tidal section of the Rondout a notable habitat as well as sought-after fishing destination.

The biological richness attracts a threatened wetland bird in NY (least bittern) as well as rich shorebird communities (herons, ducks, waterfowl, shorebirds), especially in winter. Kingston Point Park and surrounding areas have become a birding hot-spot for regional bird lovers [4], [20], [21]. Submerged aquatic vegetation beds in the Hudson proper are considered areas of primary productivity helping to support fish assemblages in the river. The vegetation is thought to affect oxygen levels in the river as well as sustain unique macroinvertebrate populations, primary food sources and protection areas for a range of small and juvenile fish species. Likewise a ~6 mile long, deep-water section of the Hudson from Kingston, south to Poughkeepsie, is known to be rare in the eastern US [22]. Since the deeper sections can hold heavier saline waters, it is important for both short-nose and Atlantic sturgeon.

In 2015 the engineering firm of Malone & MacBroom, at the behest of the city, drafted a very valuable assessment report, the *Tidal Rondout Creek Watershed Management Plan* for the tidal section of the Rondout Creek [5]. In addition to reviewing and summarizing the regulatory and non-regulatory frameworks affecting visions and planning of the stream, it also includes very useful analysis of stormwater and land management, point and non-point source pollution prevention, and stream and wetland habitat protection. The report notes many of the important recreational uses of the lower Rondout, which, even though bestowed with a Class "C" rating ("for waters suitable for fisheries or non-contact activity", NYSDEC), range from swimming to fishing to rowing and kayaking. The firm reinforced the value and importance of the Rondout for fisheries and fish habitat and related the integrity and health of the local populations, especially small and large mouth bass. Integrated and comprehensive management strategies are offered which the city would benefit greatly from in developing its Open Space Plan.

To the north of Kingston, runs the Esopus Creek defining a section of the city boundary as it streams north towards Saugerties. This area comprises a broad, flat basin containing rich alluvial soils that supports an abundance of agricultural and farming operations. Several Ulster County agricultural districts occur just across the river in the neighboring Town of Ulster. The nutrient-laden sediments, deposited each spring with the flood melt, have long made this system prime for active farming, though much of it has been built-out on the Kingston side. The low, flat area adjoining the Esopus is prone to flooding and contains wide sections of designated FEMA flood hazard zones (*Figure 12*). Not surprisingly, unmanaged regions contain common riparian zone vegetation, including flood plain forests, marshes and wet meadows. The open, managed areas are commonly farmed, though a few dryer, upland meadows still persist.

The Esopus Creek increasingly supports recreational paddle sports as well as sport fishing. The river is dammed upstream at the NYC Ashokan Reservoir, forming a large floodplain at Kingston and flows north to Saugerties where it enters the Hudson. In Saugerties the Esopus is only tidal for a mile stretch to the large Cantine dam. There is a series of low, broad waterfalls at Glenerie, with a cumulative drop of some 45'. Miraculously a

great many of the very young, elver or "glass" stage of the migratory American eel are able to breech both the dam and the waterfalls and are found abundantly within the lower Esopus. They will live their 5-20 year lives within these freshwaters to maturity, until they return to the Sargasso Sea in the lower Atlantic, to spawn before passing away. The non-tidal Esopus supports a wide range of sport and pan fish, including: large and small-mouth bass, chain pickerel, perch, blue gill, pumpkin seeds, redbreast, crappie and rock bass. The creek has a fairly low, slow gradient here and the water quality tends to be poorer. Riverkeeper has been monitoring water quality across the Hudson region and notes that between 2010 and 2016, water quality metrics failed EPA standards for enterococcus (a fecal indicator bacteria), some 33% of the occasions that sampling was conducted (out of a total of 402 samples) [23] . The segment between Hurley (to the south) and the Sawkill Creek (to the north) is considered one of the problem areas of the creek and it is assumed that runoff from agricultural operations and urban septic systems may be underlying sources.

Riparian Zones

As has been noted in the extensive 2015 *Tidal Rondout Creek Watershed Management Plan* [5], many stream systems and associated riparian zones (areas between uplands and open water systems), historically winding their way across the city, have been buried in culverts or channelized to run quickly through neighborhoods, via concrete ditches. The need to control rain, runoff and flooding has resulted in the current stormwater management systems, which seeks to collect and quickly disperse surface water, frequently through engineered below-ground catch basins, pipes and culverts. Frequently, stream systems, serving as natural drainage features are bypassed or even buried. With streams and their resource functions out of view, there has been little in the way of oversight or management of the streamside buffer zones that conventionally help keep sediment, pollution and run off from entering the traditionally vegetated systems. Such a background is useful in considering the "detailed" GIS stream features compiled a few years ago by the Ulster County Department of the Environment (2015). The seemingly random scattering of isolated sections and arcs of visible features (Appendix D, Figure 56) appear puzzling, compared to a more conventional and visually complete hydrological *network*. The simple reason for such apparent "dangling" arcs is that streams are usually mapped visually, with experts photo-interpreting high-resolution air photos to trace the apparent headwaters, length and mouth of a watershed stream system. As is fairly common in urban areas, where streams appear to "disappear" the photogrammatrist simply leaves off, since they can only map features that they can see.

Within the basins of the three major Kingston drainages: the Hudson River, the Rondout Creek and the Esopus Creek, a few semi-intact sections of surface stream features remain. The few officially named streams by the United States Geological Survey (USGS), include the: Main Street Brook, Tannery Brook and the Twaalfskill systems. (Figure 11). The Main Street and Tannery Brooks, each run some .9-1.3 mi. above ground across northwestern Kingston, before disappearing into underground pipes, which channel them to the Esopus Creek. Current research assesses land use history patterns and processes around the Tannery Brook (http://www.tracingtannerybrook.com) and provides context and applied relevance to managing urban stream systems. Principal investigator, Emily Vail, suggests it is important to look at the entire watershed, at both above and below ground components, when managing urban streams. She suggests that street trees and related infrastructure serve riparian buffer-like functions, diverting stormwater, nutrients and sediment. that might otherwise end up below ground in culverts, to local swales and soil beds. Residents near the Main Street Brook are reportedly participating in NYS the DEC tree giveaways ("Trees for Tribs" program, https://www.dec.ny.gov/animals/77710.html), in an effort to improve water quality and flooding patterns along that stream.

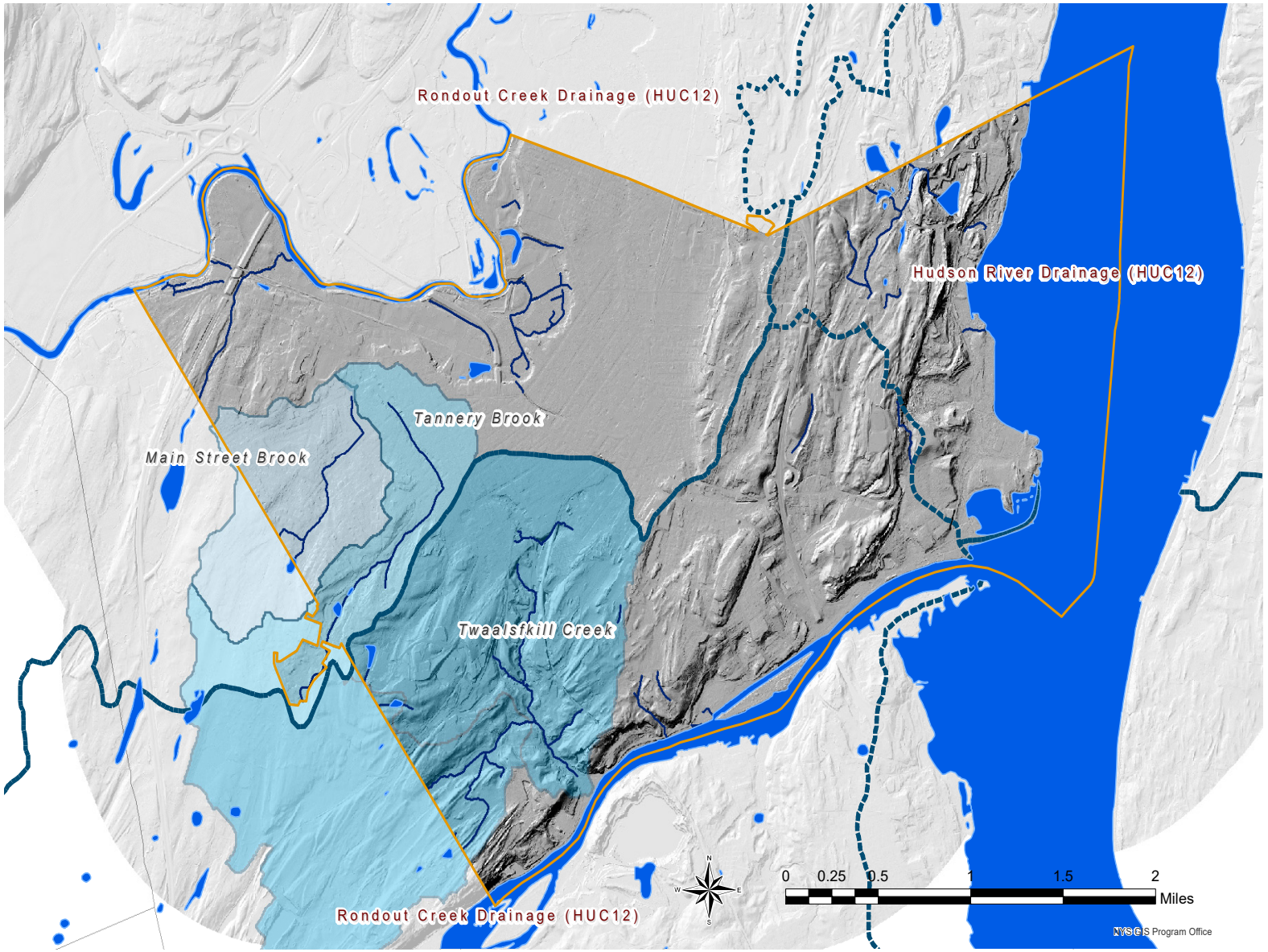

Figure 11. Major Drainages (Hudson River, Rondout Creek, Esopus Creek) of Kingston plus focus stream basins: Main Street Brook, Tannery Brook and Twaalfskill Creek.

The Twaalfskill Creek drains a much larger basin (Figure 11) and large sections remain above ground nearly to the Rondout Creek. This stream, discussed in detailed within the Milone and MacBroom watershed management plan, presents a valuable riparian restoration opportunity for the city. The plan calls specifically in the first goal to "restore tributary streams and enhance riparian vegetation along tributary streams." Several specific plan examples of remediation opportunities within the Tannery Brook and Twaalfskill systems should make near-shovel-ready restoration projects easy to identify. In protecting, preserving and restoring such systems, the city has to gain the overlapping services and functions of the habitat, food, cover and biodiversity value of the open water and riparian zones, as well as improvements in stormwater, water quality and flood control enhancements.

Much of the Hudson River riparian zone along the Kingston waterfront is slated for development, encompassed within the ongoing Hudson Landing project. Wise planning and design can help mitigate negative impacts on the river and the sensitive submerged aquatic vegetation beds just off shore. Effective and monitored stormwater, run-off, sediment and nutrient programs can keep pollutants from entering and harming the river's systems. Much of the Kingston bank of the Rondout Creek was settled centuries ago and now contains a rich and thriving waterfront commercial zone. Sea level rise will continue to pose a threat here, though the city remains steadfastly engaged with considering and weighing tradeoffs and options. The remaining unbuilt shorelines such as around Kingston Point and the very important tidal wetland complexes must be considered as a priority should any development in or around these areas be considered.

The streamside systems of the Esopus Creek hold conservation protection opportunities, as floodplains within the FEMA flood hazard program. Nearly a mile of the 3.4 mile Esopus floodplain and shoreline running by Kingston is currently developed (Figure 12). It has been pointed out that demands for recreational access to the Creek are growing and a new boat\kayak launch was recently installed (2016) for the benefit of boaters. Such support needs to be met with coordinated and collaborative efforts to also help keep the creek accessible, especially in the face of the number of strong storm events the region has been experiencing. Large limbs and trees can prevent navigation of the waterway and ideally a shared and collective effort or watershed group can entertain regular monitoring and maintaining the stream to better promote access.

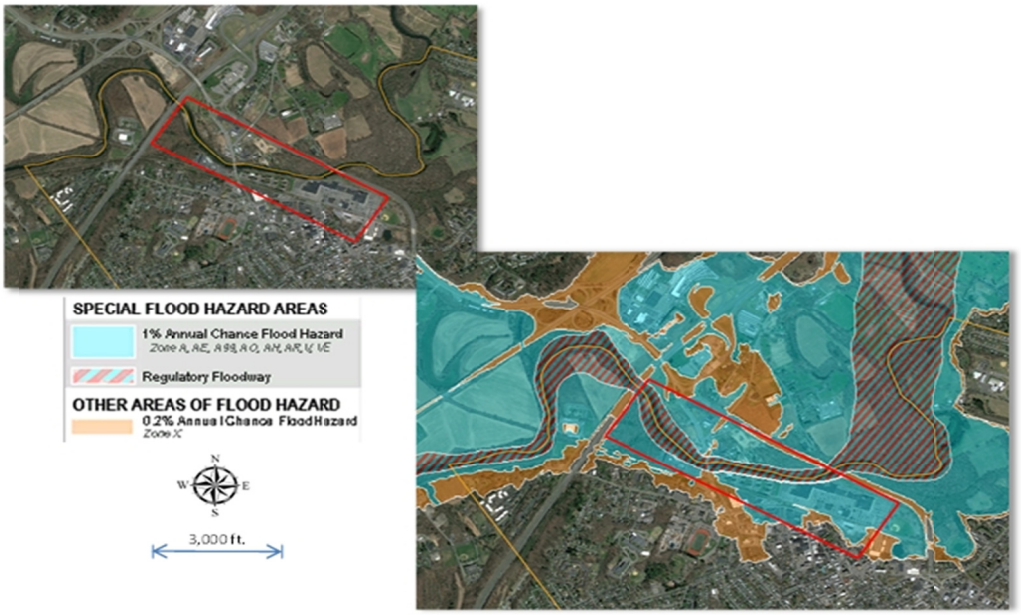

Figure 12. Esopus Creek and FEMA Flood Hazard Zones (note built commercial centers along Kingston frontage; south shore highlighted in red. FEMA Floodway (striped), 100 year flood hazard zone (blue) 500 year flood hazard zone (orange) FEMA https://hazards.fema.gov/femaportal/kmz/FEMA_NFHL_v3.0.kmz)

Surface Ponds

Kingston contains no sizable lakes and the few ponds (~7 or so) range in size from a fraction of an acre to one or two right around five acres (*Appendix D, Figure 59).* Many of these are apparently man-made and seem to serve largely storm water retention functions. A few smaller ones within more natural settings appear as though they could hold diverse biota and no doubt support some arrays of amphibians. Conducting a field survey of the smallish water bodies and potentially vernal pools to assess current status, structure and system viability might be useful to better understanding aquatic systems and habitats in the city.

Human - Drinking Water Supply

For other municipalities, many natural resource inventories focus intensely on the importance of preserving local wells, surface water features and processes occurring above aquifers or below-ground recharge areas; all common components of a community's drinking water supply. Like New York City, while a few private wells are found, the main City of Kingston drinking water resources come from off-site features and systems, which are piped in from a distance. Cooper Lake, outside of Woodstock, NY, receives water pumped in from regional streams and basins and then is ported to the Binnewater Reservoir in the Town of Ulster, just outside of Kingston. Discussions with Kingston Water Department officials revealed that also like NYC, much of the protection of this precious commodity is achieved by careful land use planning and conservation of the upslope basins and contributing areas of the various surface water components.

Such approaches and policies will remain valuable for protecting Kingston's remaining above and below ground on-site water resources, regardless of their final destination and use. Likewise, the unconsolidated aquifers that currently fall within the Kingston limits (Appendix D, Figure 16) from which neighboring communities may depend should be considered. The karst topological deposits underlying the city (which remain to be accurately mapped) can quickly and unexpectedly transport a pollutant or chemical spill in manner and direction unlike that in more common fractured bedrock areas. Neighboring communities' aquifers or water supplies could be polluted rapidly, with remediation or even discovery falling too late to provide opportunities to respond. Below-ground, soil-based (telluric) water transport can provide unseen portals of pollutants or contaminants into local streams, rivers or ponds, without leaving traceable, above-ground routes to help track. In effectively managing stormwater, run off, sedimentation and other potential pollutant sources, especially within un-paved natural or semi-natural areas, water quality and down-stream flooding control can be enhanced using a variety of methods.

The burgeoning field of "green infrastructure" is rapidly expanding to help replicate nature-like processes within stormwater systems of urban areas. Features like berms, rain gardens, pervious and semi-pervious parking areas help slow water down, giving it, and any sediment or pollution loads that it might carry, the opportunity to settle. In simply "keeping water onsite", or minimizing the transfer of water from local to offsite systems, local aquifers can re-charge and soil and geologic systems can filter and purify water as it percolates through the region. Such an approach can alleviate pressures on stormwater and sanitary sewer systems as well as the receiving treatment plants downstream.

- Stresses and threats to hydrological systems can be categorized into the following causes:
    - Land use
    - Pollution

- Invasive species
- Climate

Land use in the watershed of water bodies and especially in riparian or buffer areas directly affects water quality and habitat potential of the waterbodies. These include:

- Filling and degrading of wetlands and stream-side areas
- Paving and hardening surfaces: applying impervious surfaces to: streets, parking lots and built areas; allowing lawns, and playing fields to become compacted through frequent use, which reduces infiltration and permeability
- Diverting streams into pipes and other below-ground systems
- Hardening stream banks for working waterfronts or to protect property and infrastructure

Pollution

- Potential sources of pollution include temperature, toxic chemicals, nutrients, sediment, sewage, pharmaceuticals and personal care and legacy pollutants (PCBs, coal tar) can be categorized both by type or by the way they enter the waterbody.
- Point sources: stormwater outfalls and the four combined sewer overflows (CSOs) within Kingston need special attention
    - As in most urban areas on the Hudson River, Kingston wastewater systems were designed (*https://www.dec.ny.gov/chemical/48595.html*) to receive and combine both sanitary (sewer) and stormwater inputs; these are referred to as combined sewers. Stormwater outflows commonly carry dirt, litter, automotive fluids and other yard and garden chemicals and sanitary systems typically contain both biological (viruses, bacteria, protozoa) and chemical contaminants from household waste sources. During and following heavy precipitation events, the sewage treatment plants are commonly overburdened and raw sewage, mixed with collected stormwater can flow into waterbodies in an untreated state. Such is the case with the Hasbrouck CSO in Kingston (*https://kingston-ny.gov/cso*), overflows of which are commonly known to enter the Rondout Creek.
- Non-point sources of lawns, fields, yards, roads, parking lots, etc… can all contribute overland run-off containing road salt, sediment, litter, auto fluids, pesticides and fertilizer. These can all be transported during precipitation events, into urban streams, ponds, intermittent drainages or soil systems.
- Legacy pollutants can include: PCBs, coal tar, heavy metal and chemical contaminants from brownfield sites and junk yards.
- Groundwater can become polluted by releases of toxic chemicals or other pollutants by operating or abandoned facilities such as dry cleaners, underground petroleum storage or junk yards.

Green infrastructure can be used to help mitigate pollution by directing stormwater into local ground water recharge areas where it can be filtered as it percolates through the soil and subsurface sediment rather than moving directly to storm and combined sewers.

Some pharmaceutical and personal care products are removed by the city's waste water treatment facility prior to the treated water being discharged into the Rondout Creek, but others cannot be effectively treated by current removal technologies. This issue, now being more commonly studied, has resulted in widespread introduction of household substances such as caffeine and contraceptive pharmaceuticals being introduced into regional water systems. [24]

Invasive Species

- Invasive species can both outcompete and displace native aquatic plants and animals, affecting patterns from biodiversity to power generation
- Local aquatic invasives range from – water chestnut, zebra mussels, rock snot, Eurasian water milfoil to Phragmites
- Terrestrial/riparian: Japanese knotweed (can affect streambank stability, is visible along Main Street Brook and Twaalfskill and their tributaries) and (Mile-a-minute vine, which is found in the southern part of Town of Esopus), emerald ash borer and other insects such as the Hemlock woolly-adelgid also cause wide-spread forest damage.

Climate

Waterbodies and systems are affected by climate and these effects will be intensified by climate change.

- Larger and more frequent storms will:
    - tax existing stormwater systems, especially in areas with high impervious surface cover – this helps make the systems "flashier" whereby larger amounts of runoff is more quickly introduced into the system, in a larger "slug".
    - likewise also impact flooding and erosion patterns.
- Drought
    - The likelihood of which is thought to increase in coming decades, will affect many systems, both human and natural
        - Street trees and other urban trees commonly live in a delicate balance with water, since their root systems are typically restricted. Droughts can commonly stress and kill such trees. The same goes for most urban upland plant species.
- Heat
    - Hotter climates will both change the rates at which plants respire as well as how waters in reservoirs evaporate.
    - We are already seeing an increase in algal blooms in many of our stream systems and warmer temperatures will tend to increasingly favor the promulgation of aquatic algae.
- Intense storms
    - Many climate models predict an increase in the frequency and impacts of large tropical storms during the hurricane season
        - Such events impact hydrological regimes through erosion and scouring as well as affecting damage to systems such as submerged aquatic vegetation

(SAV) beds. Studies following Hurricane Sandy showed that many SAV beds were either buried by sediments or significantly disturbed.
    - Vegetated habitats and the flora and fauna components that depend on them are clearly affected during large wind and storm events. Windthrown trees open the canopy allowing more light which invasive plant species have shown a heightened ability to make use of. Birds and tree-nesting mammals all need to locate new homes and nesting sites.
- Sea level rise
    - Kingston's tidal wetlands and mudflat systems are both important in and of themselves as habitat examples as well as for the species of greatest conservation need (SGCN) that they support. Sea level rise may pressure the wetlands to find new geographic locations (migrate inland) to continue functioning property, potentially affecting human settlements and structures.

Flora & Fauna: Habitats, Plants & Animals

As noted within the habitat summaries, Kingston still sustains pockets of valuable habitat types and associated species. Many of the notable, state rare communities or species of conservation concern in the city bounds occur in or around the biologically rich tidal areas of the Hudson River and Rondout Creek ([1], [2] Appendix E). The habitats: *freshwater tidal marches* and *freshwater intertidal shore* are themselves globally rare and several plants of conservation concern are found near here (Appendix E). In addition the NYS DOS 2012 Coastal Fish and Wildlife Rating Form [4] for the Rondout Creek also lists the marshes and mudflats as important for plants such as: spongy arrowhead, Franks' sedge, winged monkey flower, and Southern estuary ticks. Including all systems and the tidal portion of the Rondout Creek, there are more than 520 acres of important fish, plant and wildlife habitat in Kingston.

The tidal Rondout Creek, from its mouth at the Hudson to some four miles upstream, is notable as supporting important seasonal fish assemblages [4] as well as nesting sites for threatened and special concern species such as bald eagles, ospreys, American and least bitterns. The Rondout portion is one of five known sites within the Hudson Estuary that serves as overwintering habitat for adult large and small-mouth bass. The extensive mudflat areas around Gumaer Islands and Sleightsburg Marsh in the Rondout Creek serve as an important nursery and spawning area for several kinds of herring and sports fish populations [4] as well as for nesting and migratory resources (spring & fall) for many kinds of waterfowl. Many types of songbirds, shorebirds and wading birds nest and feed along the banks [20],[21],[22]. Water celery and other submerged aquatic plants serve as food and refugia (hiding) for fish and macro-invertebrates and waterfowl depend on them as important parts of local food chains. Amphibians of concern in the area include the spotted turtle, the wood turtle and the Blue spotted salamander [4].

The Esopus Creek to the north of Kingston supports important migratory American eel populations as well as many species of sport fish [25]. The floodplains and riparian zones along this section represent important opportunities to help protect some of the last remaining natural flood plain forests, wet meadows and, potentially, unmapped vernal pools that occur within the city. The rich farmlands that extend from Marbletown along the Esopus all the way to Saugerties are reported to have been farmed for more 700 years and the sweet corn farmed today still represents a major and growing regional commodity.

The Kingston floodplains, along the Esopus Creek, represents excellent opportunities for open space, parks and natural areas development. Birds, fish, amphibians, reptiles and even mammals often find the stretches immensely valuable as a water source and for nesting, feeding, breeding and as refuge from the busy city. Restoring the non-vegetated sections of the broader riparian zones, such as achieved with the "Trees-for-Tribs" program, can help improve water quality along sections where agricultural practices degrade the buffer areas.

While the few remaining woodland regions in Kingston still support important forest and urban forest habitats, the smaller sizes and level of fragmentation will likely limit utilization of these areas by interior bird or mammal species. From a water quality perspective, the interception and water quality functions of these areas are of great utility and importance to the city as well as to the ecological integrity to the Esopus Creek and Hudson River. The recent Kingston Street and Park Tree Inventory should help form the basis for an Urban Forestry program for the City of Kingston. Stewarding this important resource can do as much as any other options to help keep Kingston cool, attractive and liveable for future generations.

While a list of the specific bird or pollinating species utilizing Kingston forests would need to be field checked, a 2010 "preliminary biodiversity atlas" for the neighboring Town of Ulster, can provide a useful guide to some of the "birds of conservation concern" that will very likely also appear in Kingston [20], [21]. Likewise the very beautiful *A Journey Through the Lower Esopus Creek* [25] published by the Lower Esopus Creek Watershed Partnership contains a vast wealth of contextual natural history, biodiversity and historic materials, that will greatly aid the understanding of natural systems in Kington.

Many of the resident flora and fauna that call Kingston home fall within a class of *generalist* plants and animals that can thrive within a very broad set of wide-ranging conditions. Many have actually adapted to do quite well in the kind of "edge habitats" that cities like Kingston contain. Though typically fragmented and degraded, remnant patches of habitats that centuries ago used to cover Kingston: forest, fields, stream corridors, wetlands, etc… still exist. They provide sustaining food, shelter, nesting and breeding resources to a range of plants and animals, both resident and migratory. Ulster County and the greater mid-Hudson Valley contains rich biological diversity, and agencies such as the John Burroughs Natural History Society and the New York Audubon have been documenting regional species such as bird occurrences for many years [20], [21]. Species such as raccoons, red and grey squirrels, opossums, skunks and white-tailed deer have found that their natural predators tend not to frequently venture into areas with lots of human activity. With the combination of low pressures and adequate food and shelter, urban areas are increasingly home to plants and animals that are comfortable with adapting to urban environments.

Unfortunately, we are finding that growing proportions of the arrivals are not native and so can lack any natural predators. Dozens of non-native invasive plant species now call Kingston home and many possess the ability to out-compete native residents for resources such as sunlight. Rapidly growing invasive plants such as: garlic mustard, Japanese stilt grass, Japanese barberry, tree of heaven, Japanese knotweed and multiflora rose can quickly dominate or shade out native plants in remaining riparian zones and natural areas, thereby greatly reducing biological diversity and habitat quality. NYSDEC lists threats posed by several invasive wetland plants as impacting important habitats in the Rondout Creek (https://www.dec.ny.gov/animals/265.html). From house sparrows to emerald ash-borer insects to black swallow-wort to the fungal oak-wilt disease, the introduction of alien species is causing extensive damage to our region.

Fortunately, much can and is being done across the state and region, to better understand and monitor the problems and impacts and seek solutions. The New York State Department of Environmental Conservation has divided the state into a series of regions, called Partnerships for Regional Invasive Species Management (PRISM). (https://www.dec.ny.gov/animals/47433.html). These collaborative groups are tasked with coordinating

activities and resources across their region and enlisting professionals and volunteers, educating and training citizen scientists and attempting to prevent or minimize the harm caused by invasive species. Kingston falls within the Lower Hudson PRISM (https://www.lhprism.org/) which annually offers funded grant programs to assist agencies and those invested with the stewardship of outdoor places to establish ways to manage their natural resources.

And lastly, understanding the regional ecological context that Kingston falls within, can aid the vision, design and establishment of ecological corridors for the city and the region. Analysis of the Hudsonia Ltd survey shows that some 1,300 acres, nearly 30% of the land area of the city (including Cultural features such as cemeteries) (Figure 7.) currently fall within the three "large natural areas" of Kingston. And while each is made of smaller patches, individually as well as collectively they represent important and useful resources that migrant birds and butterflies will use as they travel from and to summer and winter homes. In addition, these areas will serve as corridors, both patch and "stepping stone" versions, helping to support the translocation of species. As climate forces change both preferred and acceptable conditions in habitat and resources, many species will need to find new homes in order to maintain viable populations. Providing the opportunity for such shifts through ecologically connected systems, can also help a species maintain populations through keeping genetic stocks mobile and diverse.

- Stresses and Threats: to local flora and fauna
    - Physical changes: terrestrial
        - Habitat loss, fragmentation, disturbance and degradation
    - Physical changes: aquatic
        - Bottom dredging of streams and estuaries
        - Burying or piping streams below ground
            - Resulting in loss of effective aquatic, riparian and flood zones and associated habitat
        - Construction and "smoothing or hardening" of naturally textured shoreline habitat substrates
        - Occupation and construction in wetlands
            - Marinas etc… (~10 % of Rondout Creek tidal shoreline [2])
    - Pollution
        - Chemical, thermal, nutrient (wastewater)
    - Hydrological changes (wetland and aquatic systems)
            - Droughts, municipal withdrawals, low flows
    - Invasive and Nuisance species
        - Competition for limited habitat area and resources
            - Sunlight, water, nutrients
        - Loss of resources as alien species kill or consume important features (e.g. killing of trees and shrubs by invasive vines, non-native insects and pathogens.)
        - White-tailed deer are having significant impacts on forest regeneration and species compositions across the region. By preferentially consuming large numbers of seedlings and saplings now, the deer are affecting what the forests will look like and how they will function in coming generations. Deer can also consume and damage urban ornamental and vegetable gardens.

- Climate change
  - Facing changes in preferred habitat and resource availability and conditions
  - Missed phenological timing due to seasonal changes such as early spring insect hatches, flower and pollen emergence. Phenology is the study of cyclic and seasonal natural phenomena, and is an opportunity for citizen-scientists to observe changes related to climate change.

Recreational Resources

Parks serve few more important roles than as havens and solace from the pressures and intensity of modern urban life. They provide wide arrays of resources and services across the spectrum of human and natural lives. As cultural and social centers as well as open and green spaces they offer destinations where we gather, meet, share, garden, recreate, exercise, walk our pets or allow kids to release some steam. For many, the opportunity to relax alone and enjoy some sun on the face and the fresh air of a warm day in spring ranks as one of life's great pleasures. Aspects as amorphous and intangible as *beauty* and *quality of life* are commonly associated with abundant green and open spaces, which, while challenging to define, can make higher community standards very real.

The City of Kingston Parks and Recreation Department and other organizations such as the Kingston Land Trust and YMCA offer a rich and growing year-round assortment of programs both indoor and out, for people and residents of all ages. There are some 40 different recreational facilities (Appendix C, Figures 13 and 24) encompassing more than 460 acres of mixed forest, fields, lawns and managed sites such as ball courts, fishing docks, playing fields and indoor amenities in Kingston. For the consideration of open and greenspace, we include the six cemeteries found within Kingston: St. Peter's, St. Mary's, Sharpe, Mt. Zion, Wiltwyck and Montrepose, both for their dedicated green and open space and for the reality that many people jog, walk and ponder history and life at such locations.

Of these, the vast majority of out-of-door venues contribute significantly to the local ecosystem services budget. With some ~220 acres of combined tree and forest cover, they share in the collective urban forest support of the types mentioned earlier. Air and water quality, stormwater systems, seasonal flooding patterns, regional habitat, climate and biodiversity systems all benefit from these forest components, large and small. Cultural components such as environmental justice, walkable streets, environmental education and even collective urban agriculture stand to gain, as these areas are sustained and flourish. As local rivers and streams are made accessible to paddlers and sportspeople, aquatic systems and the areas contributing to them are both more fully used as well as appreciated; thereby adding to the likelihood that they'll be well stewarded and preserved. The many agencies dedicated to cleaning up the Hudson River are seeing real successes and beaches, such as Kingston Point Beach, are seeing resurgence in residents seeking relief on hot summer days.

Linear parks, hiking, biking and rail-trail networks are actively being developed both within Kingston and across the region. An active partnership between the Kingston Land Trust, Ulster County and the City of Kingston, known as the Kingston Greenline, has envisioned and designed "*a network of urban trails, complete streets, bike lanes, and linear parks in the City of Kingston. This infrastructure will connect to a county network of rail trails and become a hub for non-motorized transportation and tourism from four different directions in the county. It will also be part of the Hudson River Valley Greenway and the recently proposed Empire State Trail.*" (https://www.kingston-ny.gov/kingstongreenline). Such a network will provide a rich and remarkable system linking residents from one neighborhood to the rest of the municipality and the city to the region, all via foot or

bicycle. It is being designed to help foster both greener and more accessible streetscapes as well as reduce fossil fuel emissions by encouraging walking and bicycle riding. It seeks to connect existing features such as old railroad beds, hiking trails and scenic street segments with planned endeavors such the O&W Rail Trail (running across Ulster County) to the proposed riverfront esplanade at Hudson Landing (Appendix D, Figure 51).

Given the strongly riverine nature of Kingston, sailing, rowing, boating, canoeing, kayaking, and fishing are enjoyed by a great number of outdoor enthusiasts. New dock facilities along the Rondout waterfront area provide easy access to canoe and kayak enthusiasts. Kingston Parks and Recreation offers a wide range of kayaking programs, for beginners, guided wildlife tours and even an opportunity to explore the region by kayak with the Mayor! The entire tidal Rondout Creek supports rich, regional fisheries and recreational paddle destinations, from the mouth at the Hudson River upstream to the Eddyville dam. Some eight marinas between Kingston and the dam provide services to power boat owners and fisherman. Spring (for herring and bullheads) and summer (for small and large-mouth bass) finds fisherman traveling from across the region to enjoy the bounty. It is important to ensure the health and cleanliness of the water bodies so that these recreational resources remain viable (see recommendations section).

The Eddyville dam in the Towns of Ulster and Esopus has been a hotly-debated feature for decades. Fisheries biologists envision the tremendous extension of and benefits to migratory fish passages should the dam be removed. Local sport fisherman, on the other hand, have expressed resistance to dam removal, since it would likely change the tight packing that schools of fish create as they encounter the barrier.

Figure 13. Parks and Recreational Resources of Kingston

PARK	PARK
Academy Green*	Kingston Point Beach and Boat Launch*
Andretta Pool*	Kingston Point and Rotary Park*
Andy Murphy Midtown Neighborhood Center*	Loughran Park & Playground*
Barmann Park*	Montrepose Cemetery
Block Park and Playground*	Mt Zion Cemetery
Cornell Park*	Murray St. Basketball Courts*
Dietz Stadium*	Peace Park*
Everette Hodge Center*	Rickel Knox Playground*
Fireman's Park*	Rondout Neighborhood Center & Playground*
Forsyth Park & Playground*	Sharpes Burial Ground
Forsyth Nature Center *	St Mary's Cemetery
Fourth Ward Memorial *	St Peter's Cemetery
George Washington School Playground	T.R. Gallo Park and Maurice Hinchey Promenade*
Hasbrouck Park & Playground*	Twaalfskill Golf Club
Hutton Park and Playground*	Van Buren St. Playground *
J.R. Schulz Complex *	Wiltwyck Rural Cemetery
Kingston Armory Ball Fields	YMCA Playground
Kingston Plaza Ballfield	* denotes public park

Recreational and Park: Stresses and Threats

- Lack of funding for appropriate maintenance
- Invasive species, insect infections, diseased species (see sections above)
- Lack of or inadequate landscape and tree maintenance\silvicutural stewardship
- Improper landscape management techniques, toxic landscape management
- Use of toxic pesticides in landscape management
- Over use, vandalism, littering
- Night lighting pollution from sports leagues

Urban Agriculture

The City of Kingston sustains a great deal of the "right stuff" to have fostered a highly viable farming community: highly productive soils, easy access to water, good climate and adjacency to markets. Even with the current residential housing and commercial density and extent, the opportunity for urban agriculture remains. A healthy and vigorous urban agriculture community can:

- Feed the city with fresh, high quality farm produce and products at reasonable prices
- Reduce concerns about drought, food transportation, quality or access concerns inherent in food obtained from long distances away
- Help alleviate food expenses incurred through shipping and transport, thereby also reducing the local carbon footprint
- Contribute to local community cohesion, social bonds, shared sense of place, scenic values, integrity, pride, physical and mental health and well being

Simultaneous to the NRI process, there has been a separate and ongoing Urban Agriculture initiative underway [26]. A jointly-convened Urban Agriculture committee consisting of a number of regional agencies was formed, including: the Kingston Land Trust, the Cornell Cooperative Extension, the YMCA Farm Project, Hone Strategic, Family of Woodstock and Larrecca Music. Inc., among others. The project website notes:

> *"The Urban Agriculture Committee (UAC) is charged to promote community-based, small-scale, entrepreneurial farming by providing education and technical assistance to people interested in urban farming through research and policy development aimed at making urban farming an integral part of a lively and viable cityscape, and through working with our community to embrace and support urban farms." (*https://grow-kingston.org/urban-agriculture-committee-2/*)*

This committee has and continues to compile baseline information, applied analysis, assessments of opportunities, barriers and detailed proscriptions as to how the City of Kingston might support and develop a much broader realized urban agricultural industry. An Urban Agriculture Planning and Zoning Study has been developed which has focused on:

1. Establishing a bibliography of background information on urban agriculture in Kingston and its food related systems.
2. Surveying properties using GIS and tax parcel data to consider and classify potential suitable agriculture locations.
3. Establishing a resource base of best management practices (BMPs), support and education literature and references to guide urban agriculture projects.
4. Submitting language for the recent comprehensive plan to help the city focus on, support and increase local food production.
5. Considering updates to Kingston zoning codes that would help encourage and remove any obstacles to urban agriculture.
6. Combining the above into a comprehensive guidance document for urban agriculture in Kingston.

Phase 1 of this project has been released (http://grow-kingston.org/wp-content/uploads/2014/04/final-urban-ag-package-phase-1.pdf) and Phase 2 is nearing completion, after publication of this final document.

- Urban Agriculture: Stresses and threats
    - Lack of secure access or tenure by growers to productive lands and\or gardens
    - Scarcity of information, financial training or support for those wishing to become new farmers
    - Concerns of growing livestock (i.e. chickens, rabbits) or bees within city limits
    - Concerns about possible pests or farm debris

Historical & Cultural Resources

Research and fieldwork has indicated that native peoples may have occupied the City of Kingston and vicinity prior to the Archaic Period approximately 2500 B.C.E. or even considerably earlier perhaps to the Paleoindian Period circa 10,000 B.C.E. Several known pre-contact Native American sites are known and were investigated by Dr. Joseph Diamond, Hartgen Archeological Associates and others.

The first permanent European settlement occurred in a period during which the area was under the jurisdiction of the Dutch West India Company with Thomas Chambers arriving in 1652. Other settlers arrived thereafter and settled in a variety of locations in the area, which was then known as Esopus, creating an agricultural and trading community. By 1658, the director the Dutch colony of New Netherland, Peter Stuyvesant ordered the construction of a stockade in what is now uptown Kingston and the removal of the settlers to houses therein for safety and to end conflict with the local Esopus Indians. Conflicts with the Native Americans continued with the First Esopus War in 1659-1660 and the Second Esopus War in 1663-64 resulting in the ultimate defeat of the Esopus Indians. New Netherland fell to the English in 1664 and except for a brief period in 1673-74 remained under British control until the American Revolution. Kingston Corporation was granted a patent by the New York colonial government in 1687 with the uptown stockade and nearby areas remaining the area of principal settlement. Kingston thereafter in the colonial period became a center of an agricultural economy. The most fertile lands were in the plains along the Esopus Creek. The areas between the Rondout Creek vicinity and the Stockade as well as the northerly section of what is now the city, were sparsely settled with an area known as the Armabowery, considered less suitable for agriculture due to steep slopes and rocky soils.

During the American Revolution, Kingston served as the first capital of New York State and was attacked and burned by the British on October 16, 1777. At that time most houses were located in the Stockade vicinity with only a few houses located in the Rondout–Ponckhockie-Wilbur area that was rural. Rondout served as a shipping point for agricultural goods to be shipped on the Hudson River. Moses Cantine operated a cross-Hudson ferry from Kingston Point prior to that time. After the Revolution, the lands of the Kingston Corporation, first patented in 1687, were sold with other towns created out of the Corporation lands including Saugerties and Esopus. At about this time two financially unsuccessful schemes to develop Ponckhockie and Rondout occurred, the scheme by Moses Cantine to develop water lots near his ferry at Kingston Point and the Ulster and Delaware Turnpike led by Frederick DeZeng which ran through the Kingston area along Broadway and down Delaware Avenue to Kingston Point. In the late 1820's, the Delaware and Hudson Canal arrived in Rondout to carry coal from Pennsylvania to market in New York City via Kingston heralding the industrial period. The presence of limestone used in natural cement in the Rosendale and Kingston, NY area was a key factor in the construction of the canal.

Steam powered shipping, ship building, railroads, ice trade, bluestone trade from nearby quarries and quarrying of limestone for cement manufacturing and clay for brick manufacturing became important activities in Rondout, Wilbur and the vicinity along the Hudson River. By the 1840's the Newark Lime and Cement Manufacturing Company established cement works with brick makers following in the next decades. The Newark Lime and Cement Manufacturing Company was the largest property owner in this vicinity and the largest of the Ulster County cement manufacturers. The City of Kingston became incorporated in 1872 by merger of the Villages of Kingston and Rondout with James G. Lindsley, a cement company official, being elected the first mayor. The adjacent Town of Ulster was recognized in 1879, while the remnant of the Town of Kingston, after removal of the City of Kingston and Town of Ulster, was left with a small jurisdiction at Jockey Hill, west of present day Kingston. The great industries of Kingston closed one by one in the 20th century with the natural cement industry being replaced by quicker drying Portland cement and the brick industry declining due to depletion of raw material and market conditions. In the 1950's IBM located in the adjoining Town of Ulster, filling the regional economic void left by the closing of manufacturing industries from the 1950's to 1990's. Today, Kingston's economy is diversified among services, government, trade, communications, marketing, the arts, transportation, education, healthcare, non-profit and a small manufacturing sector. There is an emerging focus on green jobs involving renewable energy, energy efficient retrofits, recycling and creating green infrastructure.

Historic and cultural resources are among the crucial factors with respect to community identity and quality of life. The preservation of places of historic value, including resources of historic significance, is a key to community well-being as well as economic stability and development.

Historic preservation in Kingston is presently overseen by two different commissions operating under different mandates. The first is the Historic Landmarks Preservation Commission (HLPC), first established in the 1960's during a period of threats to historic preservation resources resulting from urban renewal and demolition of significant buildings. The HLPC, since 1986, has been part of the NYS Certified Local Government (CLG) program, and conducts architectural, and appropriateness reviews affecting local landmarks and the landmark districts. Standards used by the HLPC are derived from the US Department of the Interior for this program. The second commission is the Heritage Area Commission, which advises on matters within the Kingston Heritage Area and operates under the NYS Heritage Area System (formerly known as the Urban Cultural Park System), a state-local partnership established to preserve and encourage economic development to urban areas that have special significance to New York State. The Heritage Area Commission has been charged by the City of Kingston with regulating the Broadway Overlay Design District. While not a formal historic district, but instead a *zoning* district,

this feature mainly covers Midtown Kingston and the associated Kingston Local Waterfront Revitalization Program (LWRP) coastal reviews, under a NYS Department of State program.

Historic districts in Kingston include the Stockade Historic District (*Appendix C, Figure 29*) with significant structures dating from the 17th to 19th century, the Rondout Historic District (*Appendix C, Figure 28*), and the Chestnut Street Historic District (*Appendix C, Figure 28*) both with significant 19th century structures. These three districts are all listed on the National and State Historic Registers and listed locally through the Historic Landmarks Preservation Commission as local landmarks while the Fair Street Historic District, with significant 19th century structures is a local landmark district only. The Old Dutch Church, located in the Stockade Historic District, is a National Landmark. Numerous significant structures dating from the 18th to early 20th Centuries are listed either on the National and State Historic Registers and/or recognized locally through the Historic Landmarks Preservation Commission as local landmarks. In addition, reconnaissance level and intensive level local historic resource surveys, and inventories at the NYS Historic Preservation office have identified resources that have not been listed but are eligible for historic listing. Other historic resources have been identified locally which are not listed but appear eligible for historic listing.

For the purpose of the Natural Resources Inventory Map (*Appendix C, Figure 30*) , only listed historic resources are shown merged as historic without regard to whether the listing is National, State or local.

- Stresses & Threats to Historical Resources
    - Typical stresses and threats that affect historic preservation are inappropriate or incompatible development inconsistent with design standards and/or nearby historic or onsite resources, demolition, as was common during the urban renewal era in Kingston, and failure by property owners to follow appropriate design standards resulting in code compliance issues and/or diminution of the cultural resource or resources affected.
    - The economic effects of these stresses and threats can be significant as inconsistent actions can result in degradation of cultural sources and the cultural fabric of the community. Owners of National and State Historic Register listed properties may qualify for historic tax credits which can help pay for qualifying improvements and construction thereby preserving community character.

Climate & Potential Environmental Changes

The City of Kingston has invested a great deal of time and effort exploring the nature, range of impacts and possible mitigation efforts that city residents and their agencies might take to increase resilience to potential climate impacts. Kingston is a Silver Climate Smart Certified Community, a Clean Energy Community, has conducted a baseline energy assessment, and has developed several guidance documents including the *Kingston Climate Action Plan and Planning For Rising Waters: A Final Report of the Tidal Waterfront Flooding Task Force.* (Appendix A) Many activities, of necessity, have focused on built systems and threats to commercial and residential structures, especially along Kingston's tidal waterfront. They take very seriously the challenge to reduce greenhouse gas emissions (GHG) as well as the threats that changes such as sea level rise can have on Kingston.

The Natural Resources Defense Council (NRDC) suggests that the Northeastern US is already the fastest warming region in the lower 48 states, (https://www.nrdc.org/stories/northeast-fastest-warming-region-lower-48)

and that by the time the world sees an average 2 degree warming, the Northeast will already be over 3 degrees warmer.

It should be said that, even though since 1990 the spatial resolution (or average size of a climate model "cell" being modeled) has increased from ~500km (311 miles) to ~80 km (50 miles) (smaller being more detailed), the ability to predict, with much accuracy, what exactly may or may not happen for a city the size of Kingston is still fairly variable. (https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/ClimAID/2014-ClimAid-Report.pdf)These tools are designed to help us better understand patterns at the scale say of Ulster County, though generalizations and local estimates will still remain important and, in many cases, critical to consider.

As tidal levels, temperatures and large precipitation events in the estuary are projected to rise by next century, [27][28] both the vibrant Kingston water front, shoreline facilities as well as upland systems will likely be impacted. *Planning for Rising Waters*, the final 2013 report from the Tidal Waterfront Flooding Task Force (Appendix A) , included clear recommendations to, among 23 other general recommendations , "Reduce stormwater, upland flooding and combined sewer overflows through green infrastructure and best stormwater management practices". Such efforts can help alleviate one of the major pathways that projected climate changes might impact the upland regions of a city like Kingston as well as aquatic resources. According to reports compiled by the US Climate Change Research Program [27], Union of Concerned Scientists [28], and Scenic Hudson and Cornell University [29], changes in regional climate patterns around the mid-Hudson region may affect Kingston natural areas in the following ways listed below. This section covers potential climate change effects on the natural systems of Kingston.

Nature of Potential Climate Changes (by 2050-2100)

- Changes in precipitation
    - This will likely include both How Much: *Quantities* and When*: Timing*
        - Annual amount likely to increase slightly, though there is the expectation of
            - Increasing frequency of short, seasonal droughts and
            - Less winter snow resulting in lower snow packs, lower levels of snow melts feeding local water supplies, which many of them were specifically designed to assume contributions from. Similar impacts on streams and wetlands.
        - Timing (seasonally)
            - Potentially a bit more precipitation in winter and spring (though more as rain)
            - Fair possibility that summers and falls will be drier
                - Except for the increased likelihood of more frequent large tropical storms or hurricanes (late summer\early fall)
            - Short-term droughts more likely
- Changes in temperature
    - Overall temperatures
        - Noticeably warmer
            - Potential tripling of number of summer days hotter than 90 degrees F by mid-century in urban areas

        - With higher emissions scenarios, large Northeast cities will likely experience >20 days/summer with temperatures above 100 deg. F (by the end of the century)
    - Seasonal temperatures
        - Warmer, earlier springs (up to 3 weeks)
        - Summers coming 3 weeks earlier in spring and lasting 3 weeks later in fall.
        - Falls likely ~3 weeks later
            - Typical fall low-flow stream levels will further stress fish, aquatic species (macro-inverts, etc…) by longer, lower, low-oxygen levels
            - Fall farm harvests likely to suffer; strong assumptions that farmers will adapt with earlier spring planting schedules
- Storm impacts
    - Total number of storms, especially large storms, likely to increase
        - Intensity and damage caused by each more likely
        - Frequency – likely more often
    - Hurricanes Irene and Lee had significant impacts on SAV beds in Hudson River
    - Stream flashiness and flooding
- Overall Potential Changes in Ecosystems and Vegetation
    - Higher temperatures, rainfall and CO2 could act as "fertilizer" effect for crops and vegetation, generally
    - Trees, shrubs and grasslands could grow more and faster (including poison ivy)
    - Growth of invasive plants expected to grow faster and exert stronger pressures
    - Expected more rapid spread of insects such as southern pine beetle
    - Greater projected abundance of deer ticks
    - Changes in species shifts and migratory patterns
    - Increased pressures on entire populations (e.g. birds) due to "missed connections" ex. As flocks arrive earlier in spring to find out that their main insect food source has not yet hatched out: phenology
    - Loss of many species (sugar maples, fir trees, especially those needing cooler temperatures)
    - Economic impact of changes in season length for availability of crops (i.e. maple syrup production)

Projections have been uncertain if rising tides and sea level will "flood", damage or overwhelm tidal wetland systems. Being underwater more regularly or continuously will likely change or eliminate many of these systems. In flatter shoreline areas with shallow, open and undeveloped slopes, some wetlands may be able to "migrate" inland, as tides advance. And increased, gradual sedimentation rates may actually help the wetland to keep up with sea level rise. However, communities with wetlands adjacent to built systems or steep slopes may likely lose those wetlands. In addition, increasingly storms and associated flooding may cause damage or uproot plants and deposit sediments which can affect light penetration or bury SAV beds. Studies by agencies such as the Cornell University, Hudson River National Estuarine Research Reserve (HRERR) and Scenic Hudson [31] have indicated that there may be a net gain of tidal wetlands, across the Hudson River Estuary. This could mean a wetland gain of from 1,100 to over 3,900 acres. Those wishing more information as well as visual projections of potential wetland shifts (losses, gains, movements) can visit https://scenichudson.maps.arcgis.com/apps/MapSeries/index.html?appid=9190b7560a574ad69cd91b43e383b203

Areas or Topics Where More Work or Study is Needed

It is suggested that the city would benefit from undertaking studies to further explore and quantify patterns, processes and data related to:

- Urban Forestry Master Plan
    - Lead an urban forest management program to include a full, city-wide inventory as well as a planting, management, health assessment and stewardship plan
- Scenic Resources & Gateway Study
    - Identify current scenic vistas (looking from) and destinations (features which can be seen from various vantage points) as the foundation
    - Assess, create and implement practices and ordinances to help conserve and maintain those aesthetic resources
    - Consider the underlying "look, feel and sense" of what people arriving to Kingston are presented with and consider ways to either protect or help enhance those features
- Flooding & Green Infrastructure Assessment
    - Integrate with stormwater and riparian zone management
    - Perform detailed assessment of those specific areas that are or have been prone to flooding (i.e. Main Street Brook, Tannery Brook and other areas)
    - Evaluate options and solutions in a city-wide plan
- Groundwater & Karst Systems
    - Work with local geologist and geohydrologists who have been actively engaged with the features, to establish an equitable solution so that existing work becomes a public resource
    - Expand and refine the knowledge base and mapping endeavors
    - Use the above to protect karst formation and groundwater supplies
- Urban Agriculture (~2018)
    - Work with existing Kingston Urban Agriculture collaboration to help support and promote city-wide gardens and farms
    - Help remove obstacles that might block or slow appropriate green food resources
- Water Quality
    - While the City of Kingston obtains it's drinking water supply from off-site sources (Cooper Lake), the trends provided by agencies such as: Riverkeeper, NYS DEC and EPA report that much improvement can be made regionally for recreational and fisheries purposes.
    - Kingston contributes some sewage pollution through its four CSO outfalls into the Rondout Creek, though much of the pollutant loading into the Esopus Creek and Rondout Creek occurs from upstream sources, and in up and downstream sources for the Hudson River
    - Quantifying historical and current sampling results, for all immediate and regional point and non-point sources, could form the nucleus of a useful remediation project.

Next Steps

- This NRI project has been designed and developed to establish both a coherent and robust data and information resource to help guide the city, its agencies, volunteer corps and engaged stakeholders in effective conservation for years to come. While the assembled digital maps and cartographics were gathered to aid that resource, it was also a major focus of this work to help improve and *extend access to and ideally understanding of* the individual systems, layers and components going *into* the historical maps. For this reason, significant time and effort went into researching, recovering, formatting and converting older map compositions and data layers. These resources will hopefully serve city planners, staff, the CAC and other commissions for years to come, in the form of both MXD (ESRI GIS project files) and KML (Google Earth) formatted layers. While the GIS files should benefit dedicated GIS staff, the KML layers will be accessible and useable to all persons owning a current home computer with internet access. The individual transformed layers can be easily changed, updated, shared or retired in a way that paper maps simply cannot. And with KML now an international geospatial data standard, with billions of dedicated users, access to the data should remain safe and secure.
    - Google Earth provides 3-D (terrain) and 4-D (changes in time) access to our world, all within the click of our mouse. Users with little to no training can zoom across landscapes, from continents to backyards, while draping custom layers for features such as ecoregion, wetlands and tax parcels. Data from inexpensive, hand-held GPS units can be quickly and easily imported, transforming field surveys of invasive species, water quality sampling or favorite fishing spots into simple and sharable maps.
    - Most of the geospatial data acquired so far by the CAC and the city will be transformed into KML format and formatted within a geospatial data catalog, for use by city agencies. These data can provide a single, central, cataloged data repository for use by city staff and commissions, both now and in years to come.
- While a wide array of options could be taken from this work, the author suggests that the city would benefit from focusing next steps on three main priority areas or systems:
    - Urban Forests
        - Clearly, the most important ecological system for the future of Kingston spans the canopies of its urban forest. Establishing an effective urban forestry department, guided by a coherent and comprehensive urban forest master plan can have long-term, city-wide and cascading benefits. Designing, planting and stewarding a healthy forest will aid a broad spectrum of other important natural and open space components. Stormwater systems, riparian zones, regional aquifers, wildlife populations, air quality and overall quality of life will be boosted. Streets will be greener and more pleasant, prompting more people to walk and bike. Lose the urban forest and Kingston will be a very different place.
    - Urban Agriculture
        - While the success of such a program ultimate rests with the individuals who chose to engage and make a go of it, city officials can do a great deal to support and encourage participation and investment. Realizing robust and well-developed sources of food, flowers and fiber within the city could, once again provide benefits to many individuals as well as the collective. Fresh, high-quality produce had easily and at a fair price can support both improved nutrition as well as cultural engagement. As children of all ages, neighborhoods

and agencies start their own collective garden plots; the city becomes both greener and more socially engaged. People have more and better food, can save money, and can gain the personal enrichment of participating in the miracle of life from dirt.

- Hydrological and Aquatic systems
  - Lastly, with water holding such primacy to the city and its identity, keeping both the major and minor aquatic and hydrological systems healthy and safe will remain important. Many of Kingston's rare, endangered and species of concern occur within land\water habitats of the Hudson River and Rondout Creek. The fisheries contained are regionally important both ecologically (as spawning areas and nurseries) and culturally, recreationally and economically as important as sport fishing destinations. Work to achieve the protections will require collaborations with other regional stakeholders. But as each party works to protect and restore local riparian areas and improve the quality of water entering local systems, the impact on the collective will grow. Stormwater management agencies should be aware of the prospects that changing climate patterns could exert on systems that might not be designed to handle those changes. The role of tidal and inland wetland and riparian areas should be stressed as buffers to significant storm events.

- Open Space Plan
  - The City of Kingston has initiated work on an Open Space Plan which will ideally integrate the substantial data, report and resource holdings that have been compiled to date. The hope will be to work with local citizens, agencies, stakeholders and city managers to refine and develop a conservation blueprint for the future.

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Appendices

Appendix A. List of Important Online Reference Materials

TITLE	~DATE	AGENCY\SOURCE	URL
Comprehensive Plan for City of Kingston – 2025	2016	City of Kingston	https://kingston-ny.gov/2025
Parks and Recreation Master Plan City of Kingston	2013	City of Kingston – Parks and Recreation Department	https://www.kingston-ny.gov/parksandrecreation
Climate Action Plan City of Kingston	2011	City of Kingston	https://www.kingston-ny.gov/filestorage/8463/10953/10960/Kingston_Climate_Action_Plan_FINAL.pdf
Final Report: Urban Agriculture: Planning & Zoning Study – Phase #1	2014	Kingston Urban Agriculture Committee	http://grow-kingston.org/update-kingston-urban-ag-zoning-project-cok-resolution-and-materials/
Final Report: Urban Agriculture: Planning & Zoning Study – Phase #2	2014	Kingston Urban Agriculture Committee	http://grow-kingston.org/update-kingston-urban-ag-zoning-project-cok-resolution-and-materials/
Habitat Map and Habitat Summary: Planning Tools for the City of Kingston	2015	NYDEC Hudson River Estuary Program: Laura Heady	https://www.kingston-ny.gov/nri
Kingston Greenline	2015, 2018	City of Kingston in collaboration with Kingston Land Trust and other regional agencies.	https://www.kingston-ny.gov/Kingston-Greenline https://www.kingston-ny.gov/filestorage/8395/16365/18847/Rondout_GreenlineMap_ProjectsStatus_v9-11x17.pdf
Kingston-Ulster Biodiversity Assessment Training 2009 Final Report	2009	Cities of Kingston and Ulster, as part of Hudsonia Biodiversity Assessment training.	By request
Lower Esopus Creek Book	2012	Lower Esopus Watershed Partnership	http://www.loweresopus.org/downloads/
Natural Areas and Wildlife in Your Community: A Habitat Summary Prepared for the City	2014	NYDEC Hudson River Estuary Program: Laura Heady	https://www.kingston-ny.gov/nri

of Kingston			
Planning for Rising Waters: Waterfront Flooding Task Force Report	2013	City of Kingston: Waterfront Flooding Task Force	https://www.kingston-ny.gov/waterfrontfloodingtaskforce
Preliminary Natural Resource Review by E. Hauser and the Kingston CAC	2013	Kingston CAC	https://www.kingston-ny.gov/nri
Kingston Heritage Area and Local Waterfront Revitalization Plan (LWRP)	2008	City of Kingston	https://kingston-ny.gov/filestorage/8391/8415/UCP_LWRP_MAP_2008_REVISION_Model_(1).pdf
River Reconnaissance Report for Sustainable River Management: Lower Esopus Creek	2009	Milone & MacBroom Inc. for Lower Esopus Watershed Partnership (LEWP)	http://www.loweresopus.org/download/River_Reconnaissance_Report_2009.pdf
Kingston Landmark District Maps	2011	City of Kingston	https://ecode360.com/attachment/KI0280/KI0280-405f District Maps.pdf
Significant Habitats in Selected Areas of the City of Kingston by Hudsonia Ltd (map)	2013/2014	Hudsonia Ltd. For City of Kingston CAC	https://www.kingston-ny.gov/nri
Tidal Rondout Creek Watershed Management Plan	2015	Milone & MacBroom for City of Kingston	https://kingston-ny.gov/Plans
Kingston Zoning	2017	City of Kingston	https://kingston-ny.gov/filestorage/8399/10789/AUGUST_14,_2018_Most_Current_Revised_Zoning_Basemap_600_scale_3x5_NO_street_key_3-23-17-Model-resized.pdf
Tracing the Tannery Brook	2018	Emily Vail	https://www.tracingtannerybrook.com
History of Ulster County	1881	Nathaniel Sylvester	https://goo.gl/owrJWV
History of Ulster County	1907	Alphonso T. Clearwater	https://goo.gl/pHpBnm

Appendix B. Timeline of Building the Natural Resources Inventory (NRI) in Kingston, NY

Since 2009 the City of Kingston and the Kingston Conservation Advisory Council have been embarking on a Natural Resources Inventory and Open Space Planning Project for Kingston.

The process began with several CAC members and city staff participating in the Hudsonia Biodiversity Assessment Training Course in 2009. Along with representatives from the Town of Ulster, this course initiated the process of mapping Kingston's significant habitats through training and direct mapping. This course culminated with Budziak et al. 2009, *Esopus Valley Biodiversity Assessment Report* and essentially, Kingston's first habitat map of a portion of the city and Town of Ulster comprising 3200 acres along the Esopus Creek. Subsequent to that training and

report, the city and CAC engaged staff from Hudsonia to identify and map significant habitats in two other parts of the city in 2012 and 2013. Both the training and the subsequent Hudsonia work were completed with support from the Hudson River Estuary Program.

In 2013, the Kingston CAC composed the Preliminary Natural Resource Review which includes a comprehensive approach to open space objectives and an open space preservation program made up of ten goals that considers water resources protection, preservation of wildlife habitat, the identification and retention of historic resources and the management of parks and recreation facilities and the management of community and urban forestry and agriculture. The goals were included on page of the 2025 Comprehensive Plan (2016);

Goal 1: Preserve and enhance the natural and cultural features that form Kingston's unique qualities.
Goal 2: Promote a land use development pattern that is consistent with the carrying capacity of natural resources and the ability to provide services.
Goal 3: Ensure the quality of Kingston's water resources.
Goal 4: Protect and promote urban agriculture, community and urban forests and forested land.
Goal 5: Retain forested areas, stream corridors, wetlands and other open spaces to the maximum extent practical, so as to establish and preserve buffers between developed areas.
Goal 6: Provide increased protection for environmentally sensitive areas such as wetlands, floodplains, steep slopes, ridges, wildlife habitat areas and corridors, and unique geological formations and features.
Goal 7: Preserve the character of historical sites and structures.
Goal 8: Protect, expand, connect and create active and passive recreational facilities and opportunities.
Goal 9: Identify and protect scenic views as seen from roadsides, parks, waterfronts, and other areas frequented by the public.
Goal 10: Preserve and enhance entryways or gateways to Kingston.

In 2014, led by Laura Heady, of the NYSDEC's Hudson River Estuary Program and Cornell University's Department of Natural Resources, created *Habitat Map and Habitat Summary: Planning Tools for the City of Kingston* based on existing information available, as an overview of significant ecological systems present in Kingston, as a precursor to a formal and comprehensive Natural Resources Inventory. As part of this summary, eight habitat maps and two tables of lists of known species and habitats of conservation concern for Kingston were created for the City of Kingston including:

<u>Maps</u>

- Regional Context of Kingston, NY
- Major Ecological Features in Kingston, NY
- Streams and Watersheds in Kingston, NY
- Wetlands in Kingston, NY
- Large Forests (≥ 200 acres) in Kingston, NY
- Hudson River Shoreline Habitat in Kingston, NY
- Hudson River Shoreline Type in Kingston, NY
- Shoreline Habitat at Mouth of Rondout Creek in Kingston, NY

<u>Tables</u>

- State Rare Plants, Animals, and Ecosystems in Kingston, NY

- Significant Birds in Kingston, NY

In the Spring of 2015, the City of Kingston, with the CAC, hosted a GIS Intern from SUNY New Paltz, Matthew Akin, who advanced the project by gathering natural resource data, compiling maps, interpreting maps and data. At the completion of the formal internship, the Kingston Land Trust hired Matthew as a consultant to continue the work until July 2017. Many of the original map compositions, data layers and initial scoping were done as part of his work. In the spring of 2016, a second SUNY New Paltz Intern, Krista Micelli, was hosted through the fall of 2016 to help advance the project.

In 2015, the City of Kingston, with the Kingston CAC, was successful in securing funding to advance the Natural Resources Inventory process with grant support from the NYSDEC HREP through the 2015 Hudson River Estuary Grants for Local Stewardship Planning Round 14.

With this funding support, the city hired John Mickelson, from Geospatial and Ecological Services, as a consultant to compile, assess, catalog and document existing materials and develop new geospatial layers. In addition, John expanded the realm of the project from that of a paper map-centric focus to more fully include the digital geospatial realm. These efforts captured, revised and ensured that the extensive map GIS-derived library could be revised, refined and updated, in coming years. In addition, a majority of the NRI layer holdings were converted into KML format, for use within Google Earth. City staff were provided two half-day Google Earth trainings (2017), to learn how to fully utilize the data, to be hosted in a new central, online Geospatial Data Catalog.

In 2016, the City of Kingston, with the CAC, was successful in securing funding to take the NRI process to the next phase of creating an Open Space Plan for Kingston. Grant support was secured from the NYSDEC HREP through the 2016 Hudson River Estuary Grants for Local Stewardship Planning Round 18. With this funding support, the city hired Behan Planning and Design as a consultant, who will execute the next phase of the project.

Project Public Meetings and Trainings

May 2014-Public Meeting
January 2015- Joint Planning Board and CAC NRI Training
January 2016- Public Meeting
January 2017- Public Meeting
January 2017- Google Earth Training
March 2017- Google Earth Training
June 2018- NRI Final Pubic Meeting

Appendix C. City of Kingston: NRI Core Map Library Index

INDEX	Map Name
Figure 14.	Elevation Contour Map of Kingston, NY
Figure 15.	Aquifers of Kingston, NY
Figure 16.	Bedrock Geology of Kingston, NY
Figure 17.	Surficial Geology of Kingston, NY
Figure 18.	Soils and Hydric Soils of Kingston, NY
Figure 19	Regional Watersheds & SubWatersheds of Kingston, NY
Figure 20.	Streams and Watersheds in Kingston, NY
Figure 21.	Wetlands in Kingston, NY
Figure 22.	Forest Cover in Kingston, NY
Figure 23.	Recreational Amenities in Kingston, NY
Figure 24.	Forsyth Park and Dietz Stadium of Kingston, NY
Figure 25.	Hasbrouck Park, Kingston, NY
Figure 26.	Kingston Point Park Complex of Kingston, NY
Figure 27.	Rondout and Chestnut Historic Districts
Figure 28	Stockade and Fair Historic Districts
Figure 29	Historic Assets of Kingston, NY
Figure 30.	Kingston Greenline
Figure 31.	City Owned Properties of Kingston, NY
Figure 32.	Vacant Parcels of Kingston, NY
Figure 33.	Potential Environmental Justice Areas of Kingston, NY
Figure 34.	Impervious Surfaces of Kingston, NY
Figure 35.	Regional Context of Kingston, NY
Figure 36.	Significant Habitats in Selected Areas of the City of Kingston
Figure 37.	Major Ecological Features in Kingston, NY
Figure 38.	Hudson River Shoreline Habitat in Kingston, NY
Figure 39.	Hudson River Shoreline Type in Kingston, NY
Figure 40.	Shoreline Habitat at Mouth of Rondout Creek, Kingston, NY

Appendix D. – NRI Core Map Library

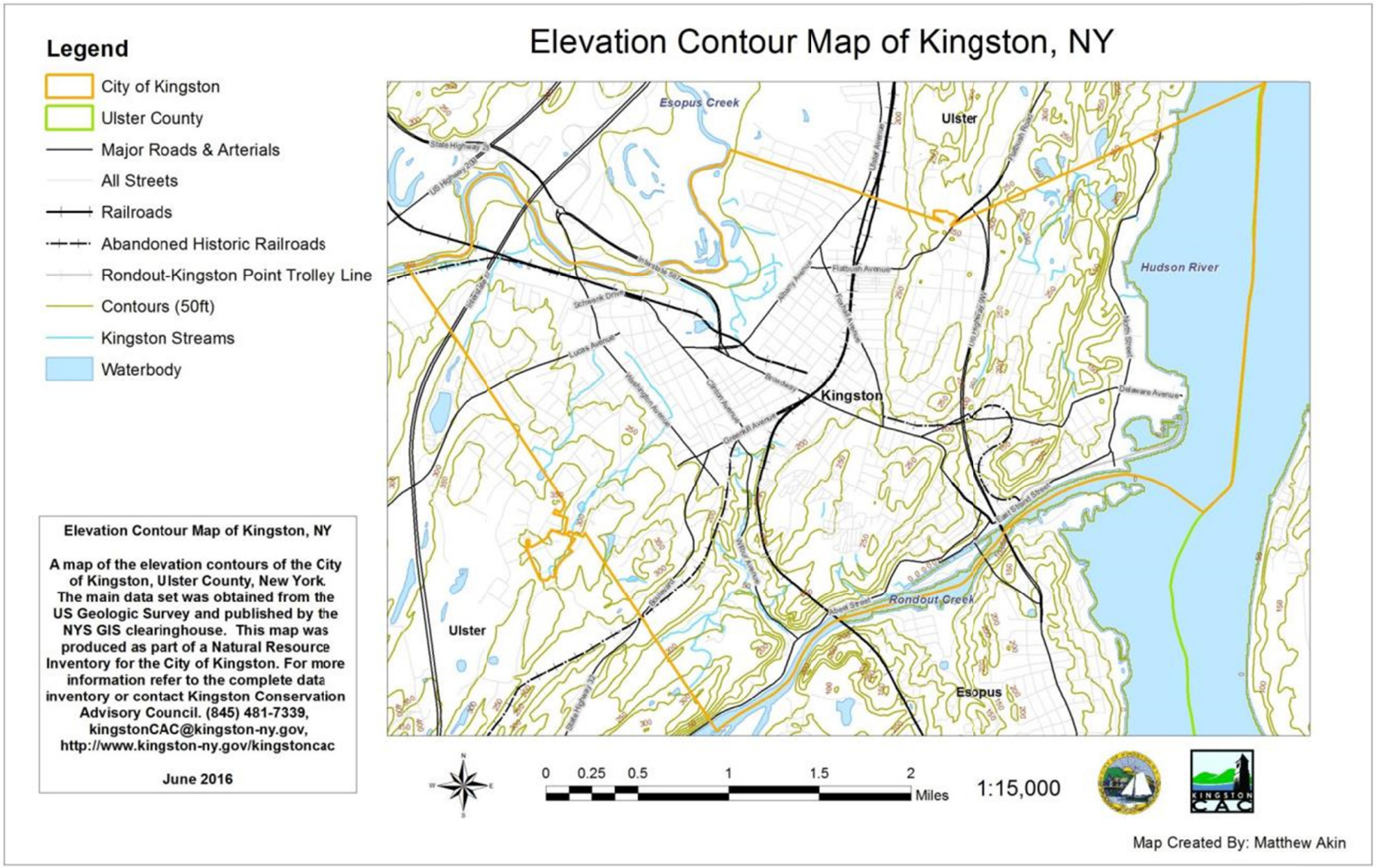


Figure 14. NRI Map - Kingston Topography

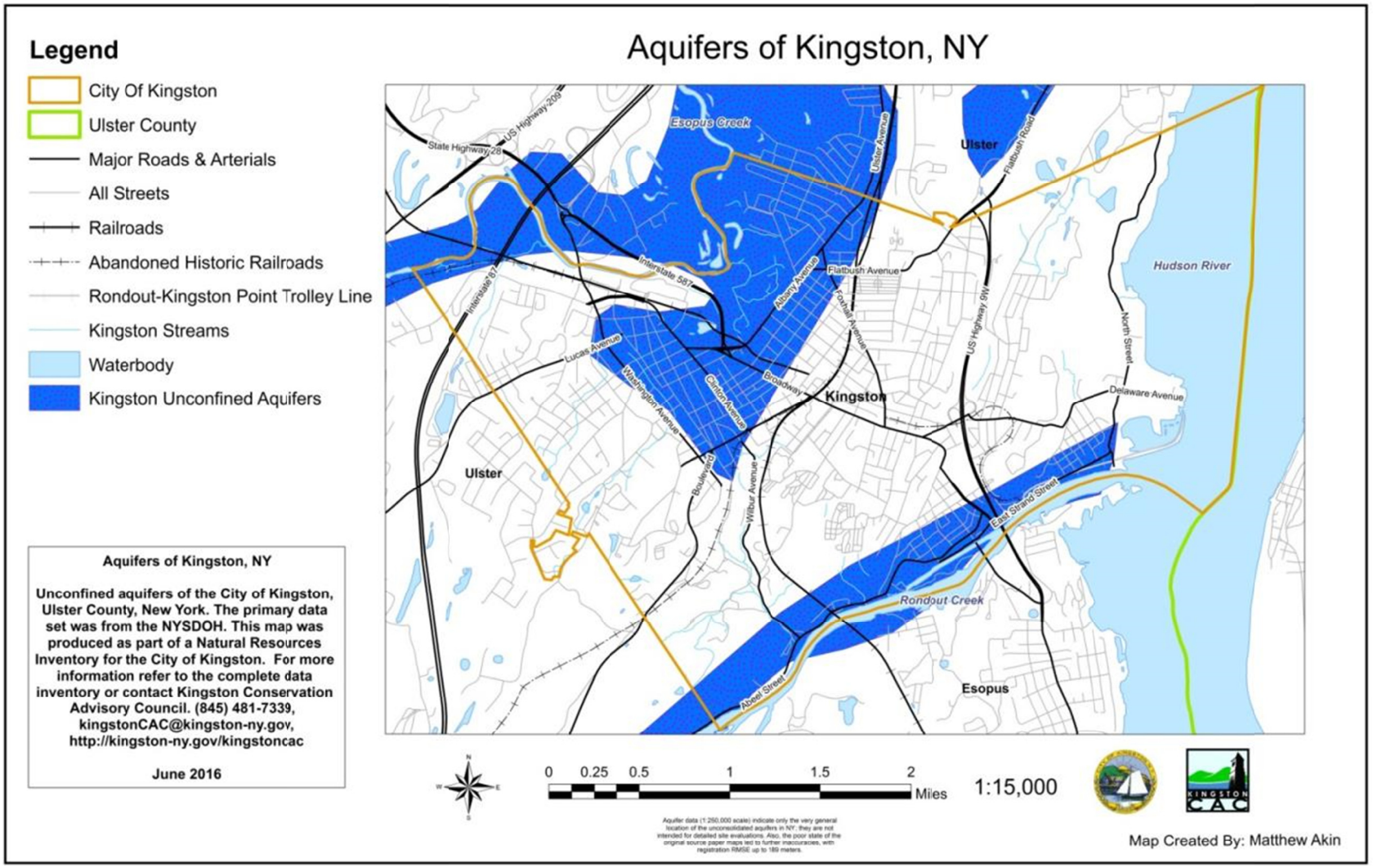


Figure 15. NRI Map - Kingston Aquifers

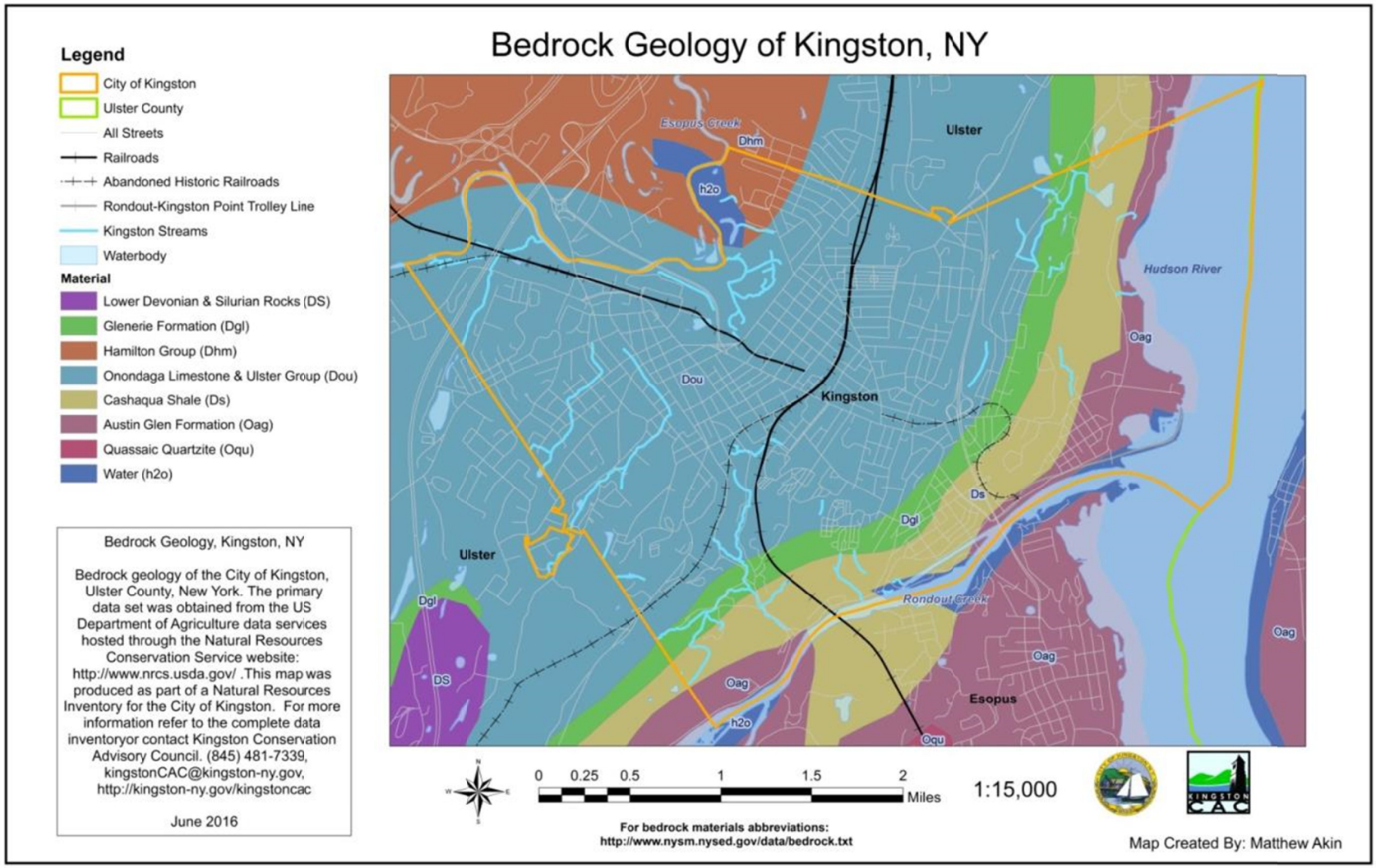


Figure 16. NRI Map - Kingston Bedrock Geology

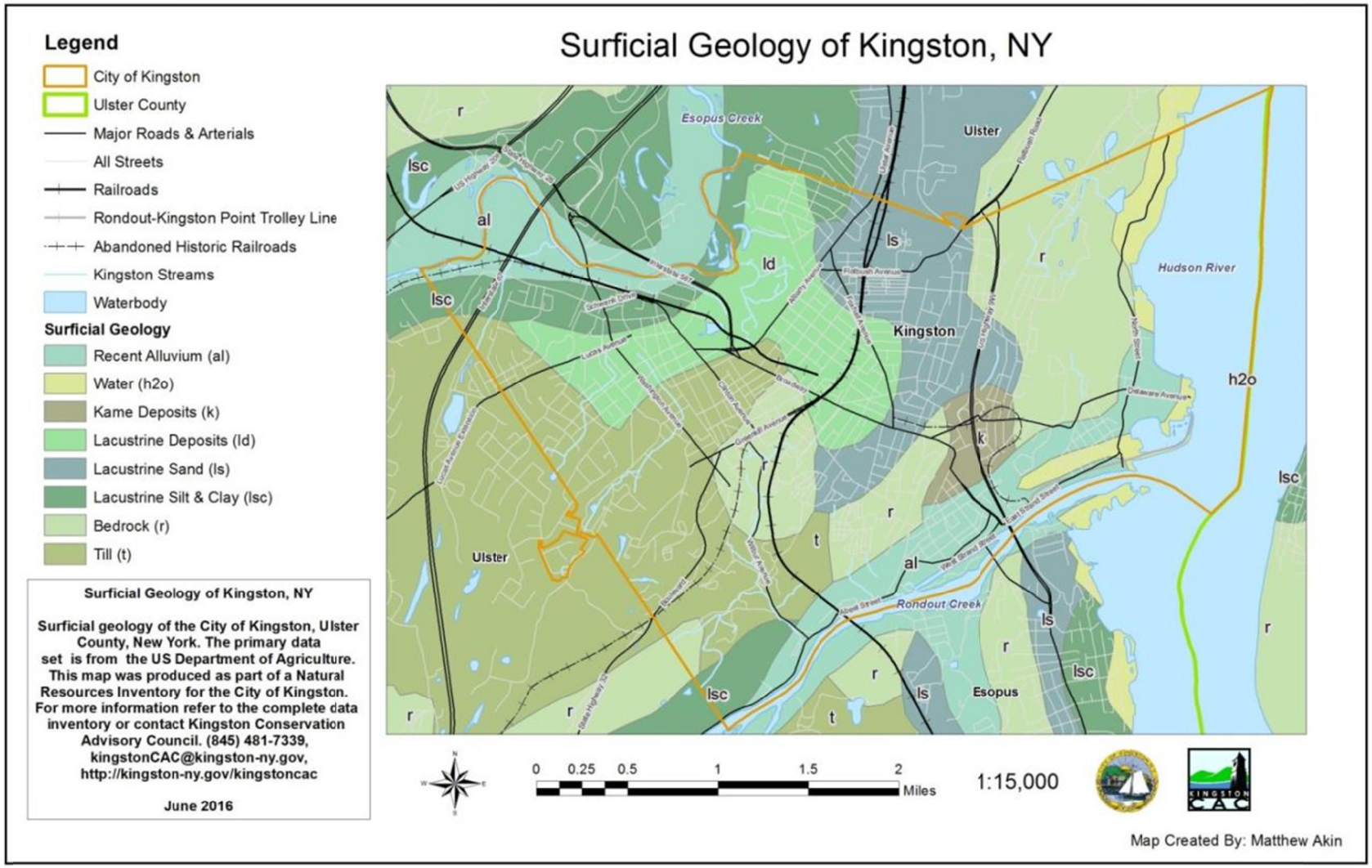


Figure 17. NRI Map - Kingston Surficial Geology

s

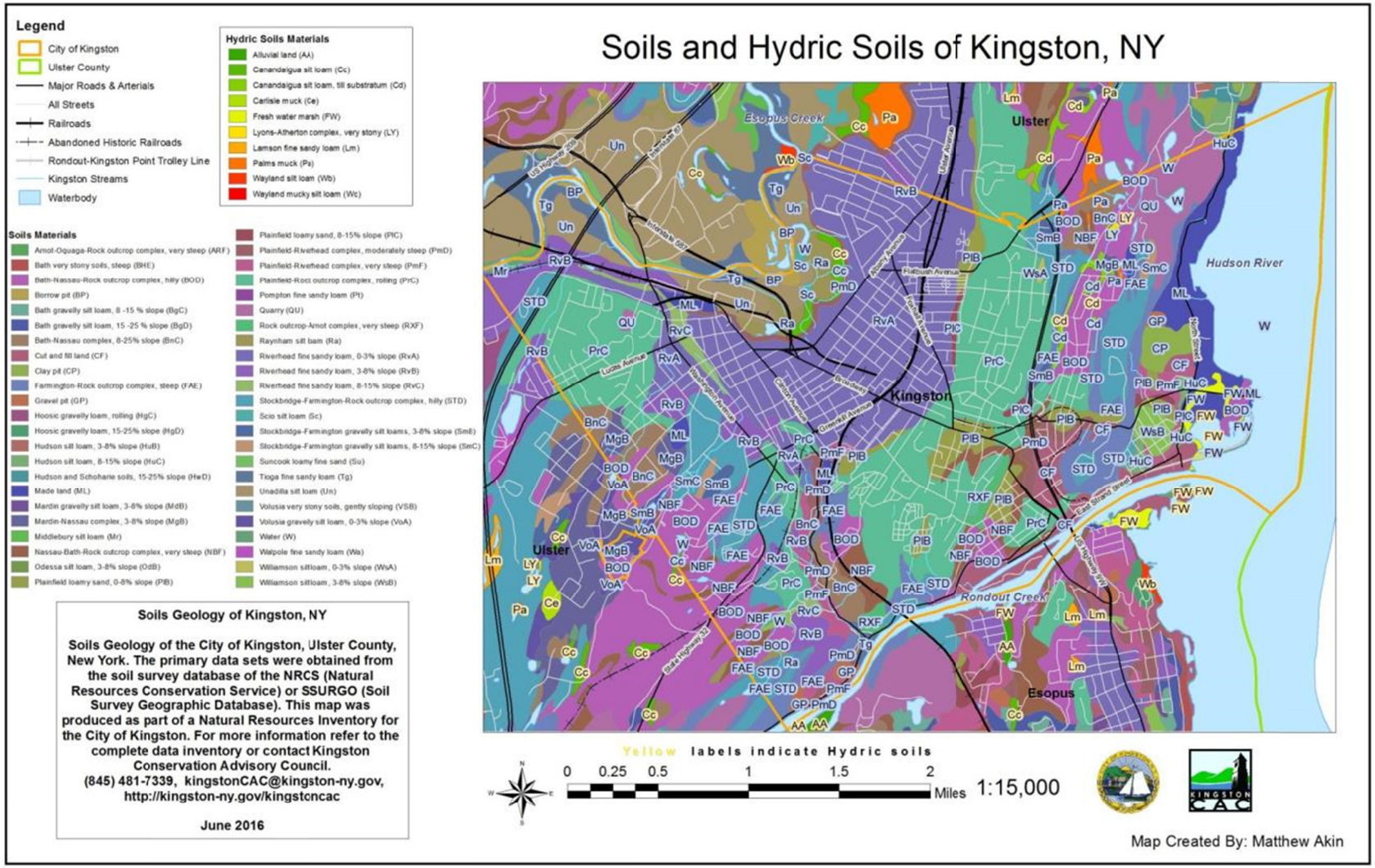


Figure 2. NRI Map - Kingston Soils including Hydric

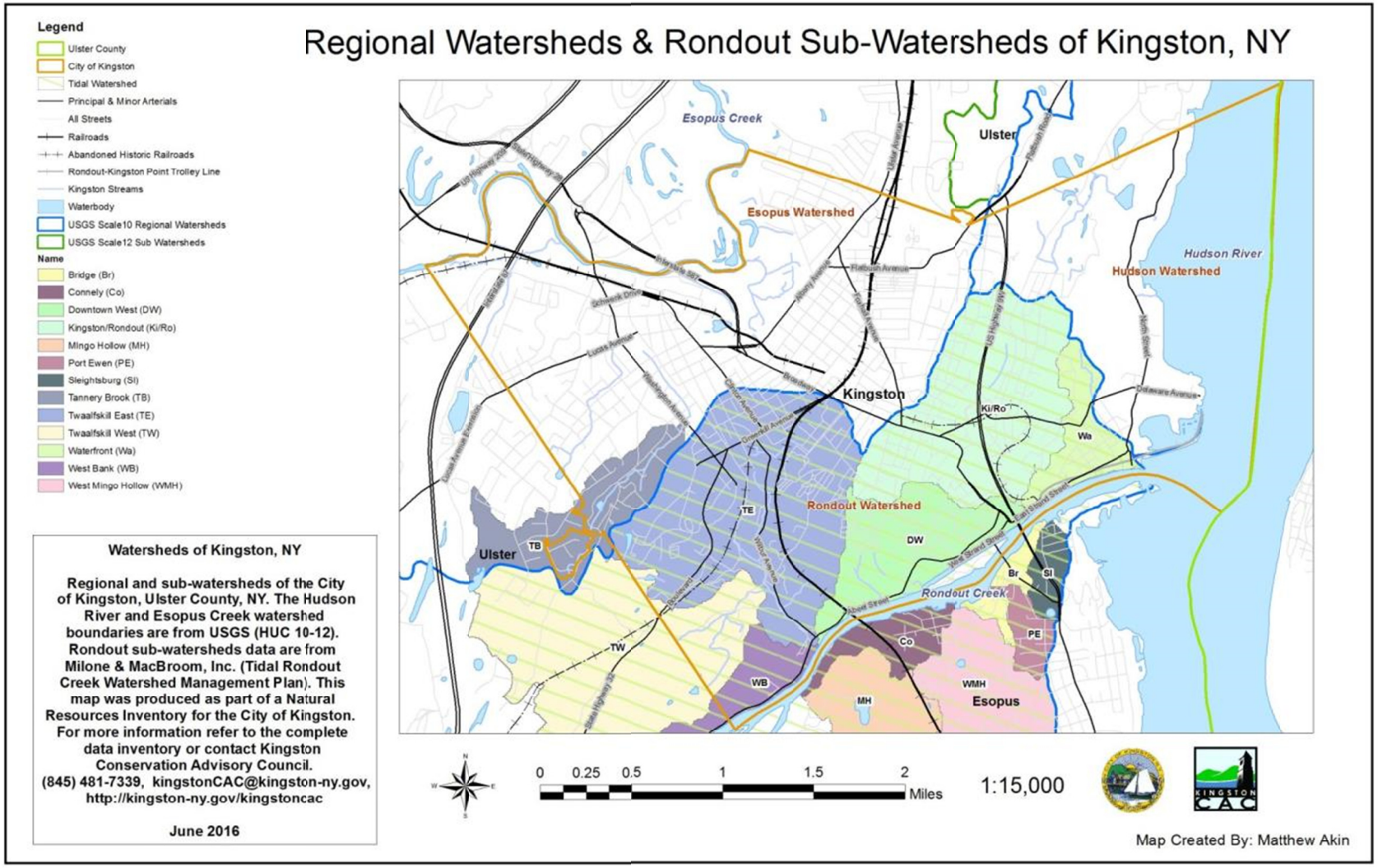


Figure 3. NRI Map – Regional Watersheds and Catchments

Figure 3: Streams and Watersheds in Kingston, NY

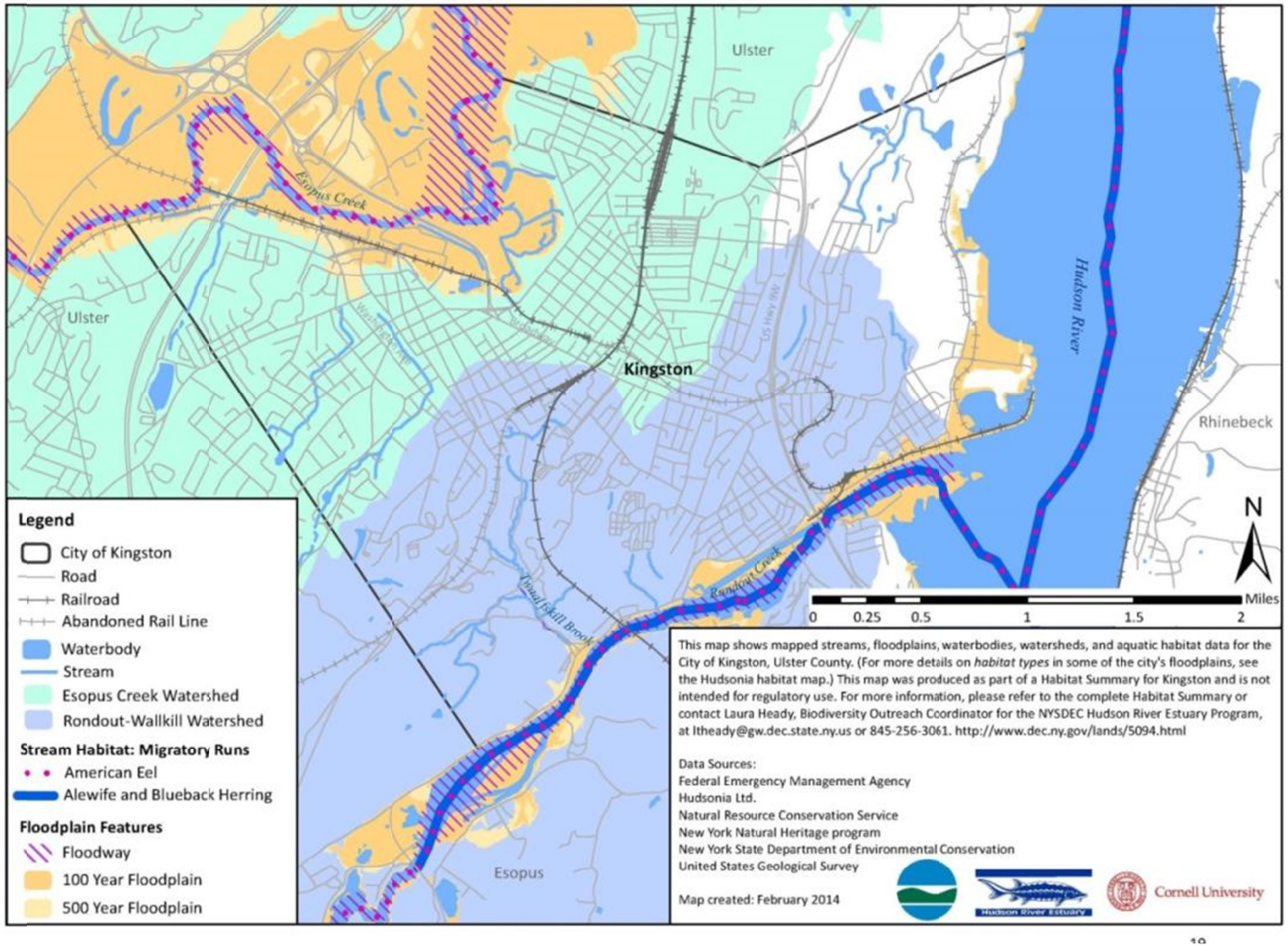


Figure 20. NRI Map (NYSDEC) - Streams and 'Watersheds in Kingston, NY

Figure 4: Wetlands in Kingston, NY

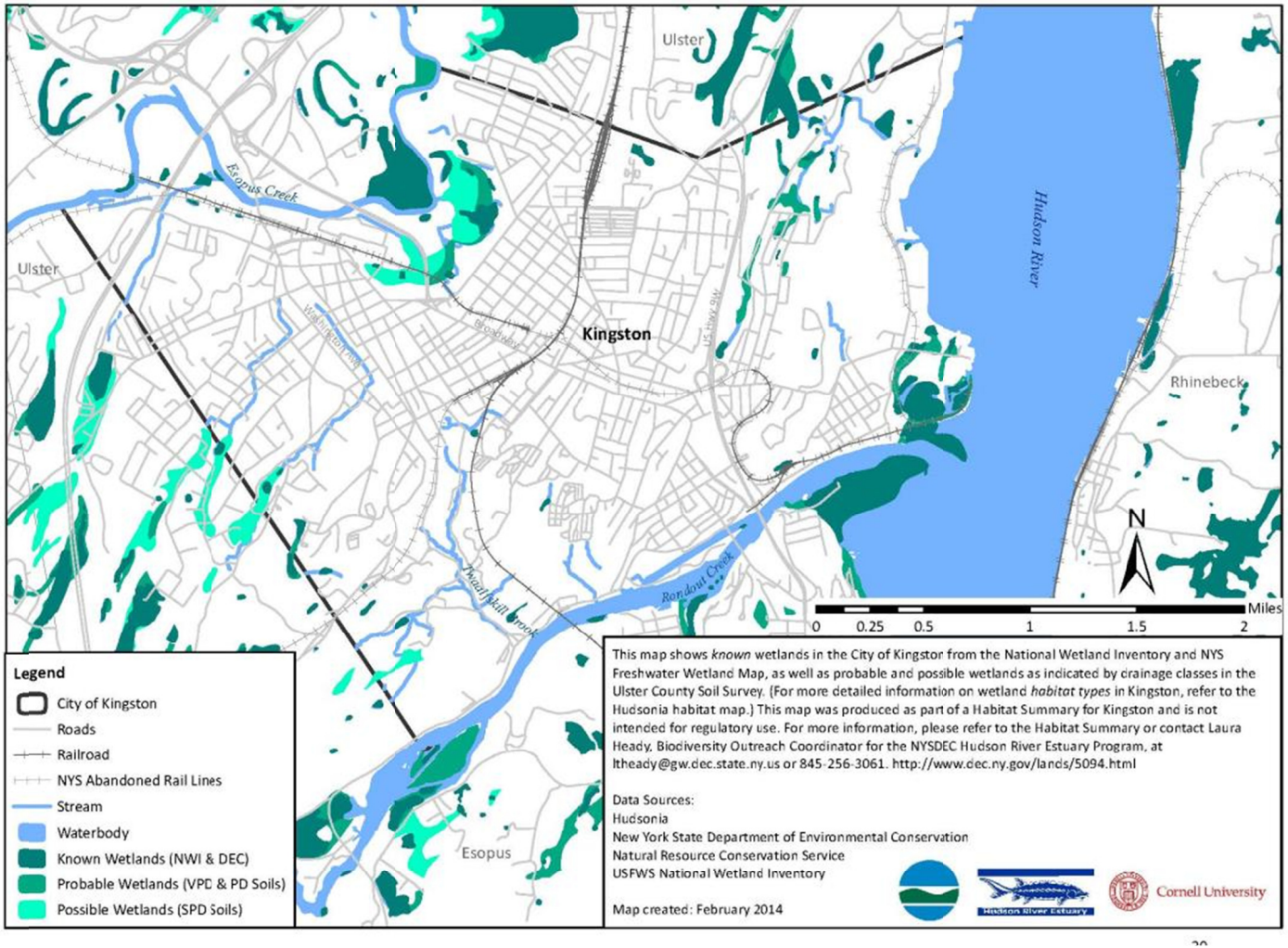


Figure 21. NRI Map (NYSDEC) = Wetlands in Kingston, NY

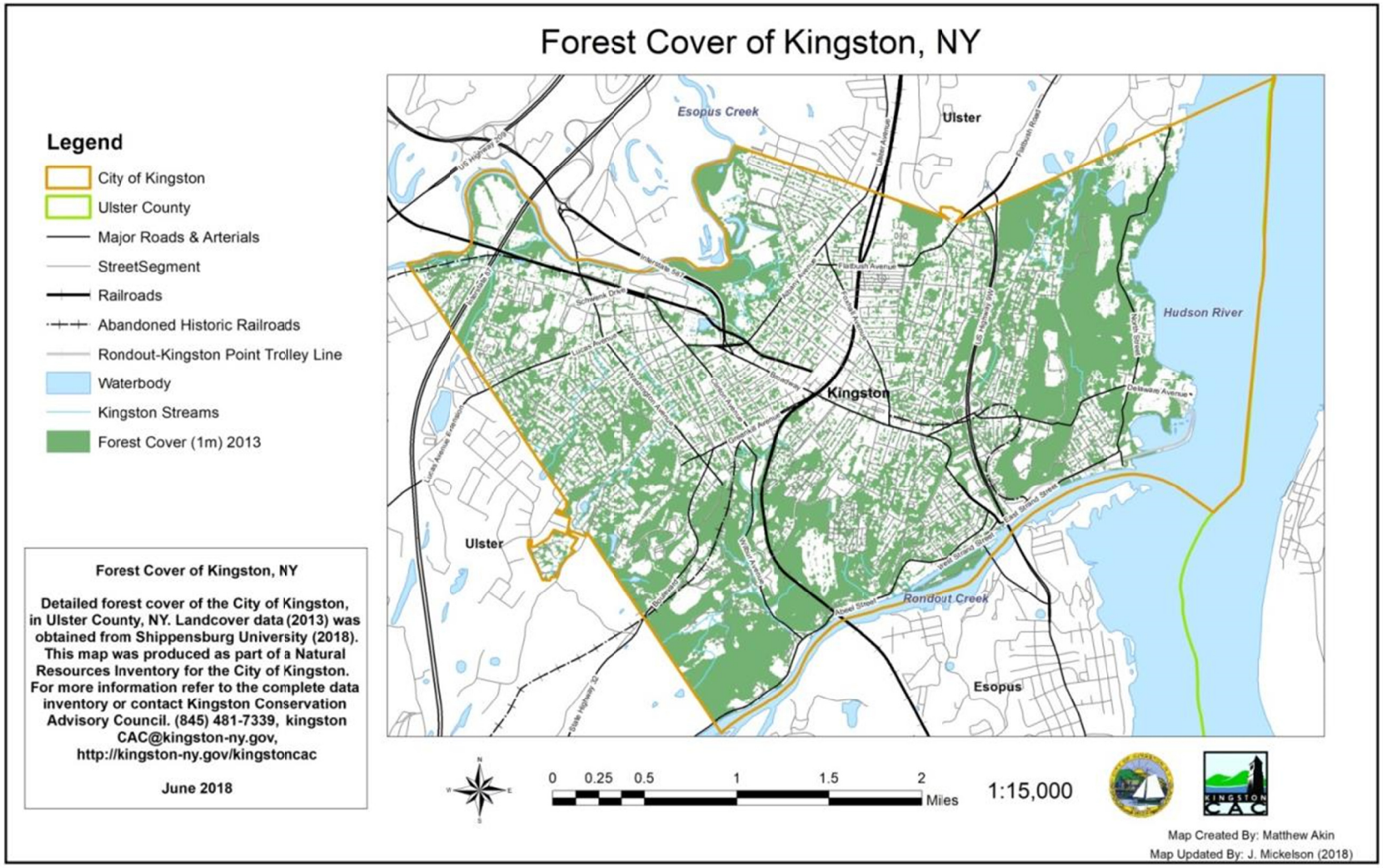


Figure 22. NRI Map - Forest Cover of Kingston, NY

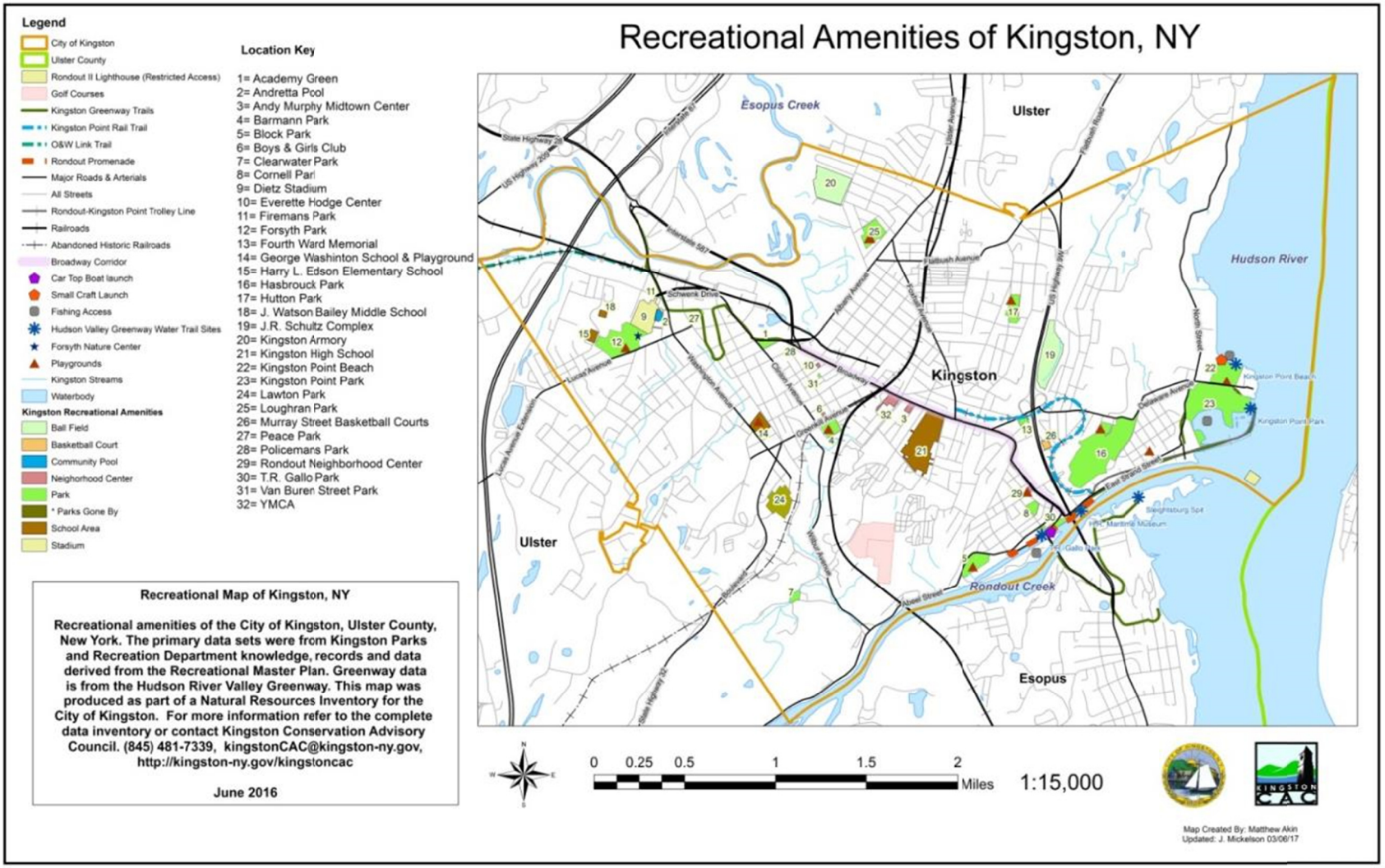


Figure 23 NRI Map - . Recreational Amenities of Kingston, NY

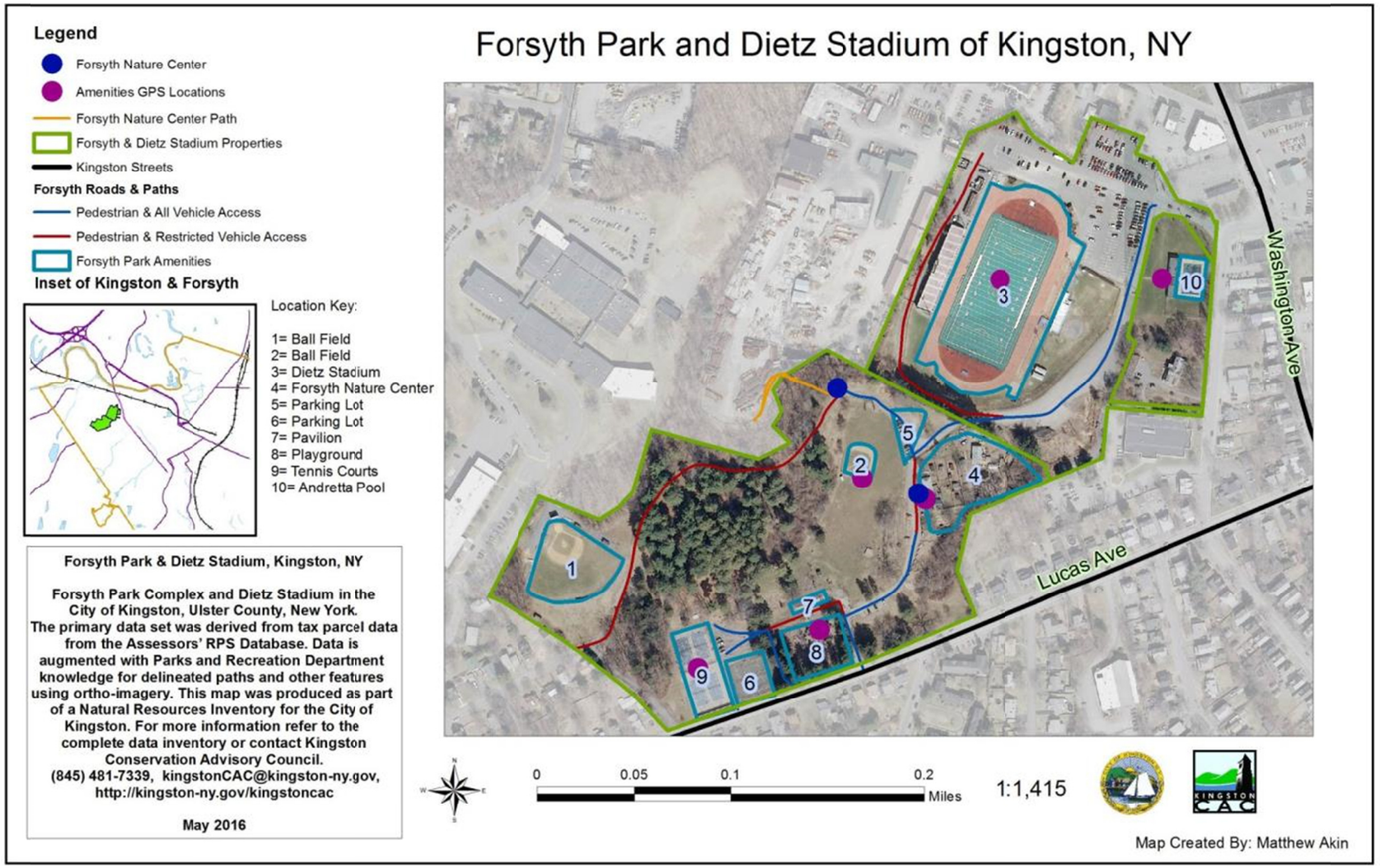


Figure 24. NRI Map - Forsyth Park & Dietz Stadium of Kingston, NY

Figure 25. NRI Map - Hasbrouck Park, Kingston, NY

Figure 26. NRI Map - Kingston Point Park Complex of Kingston, NY

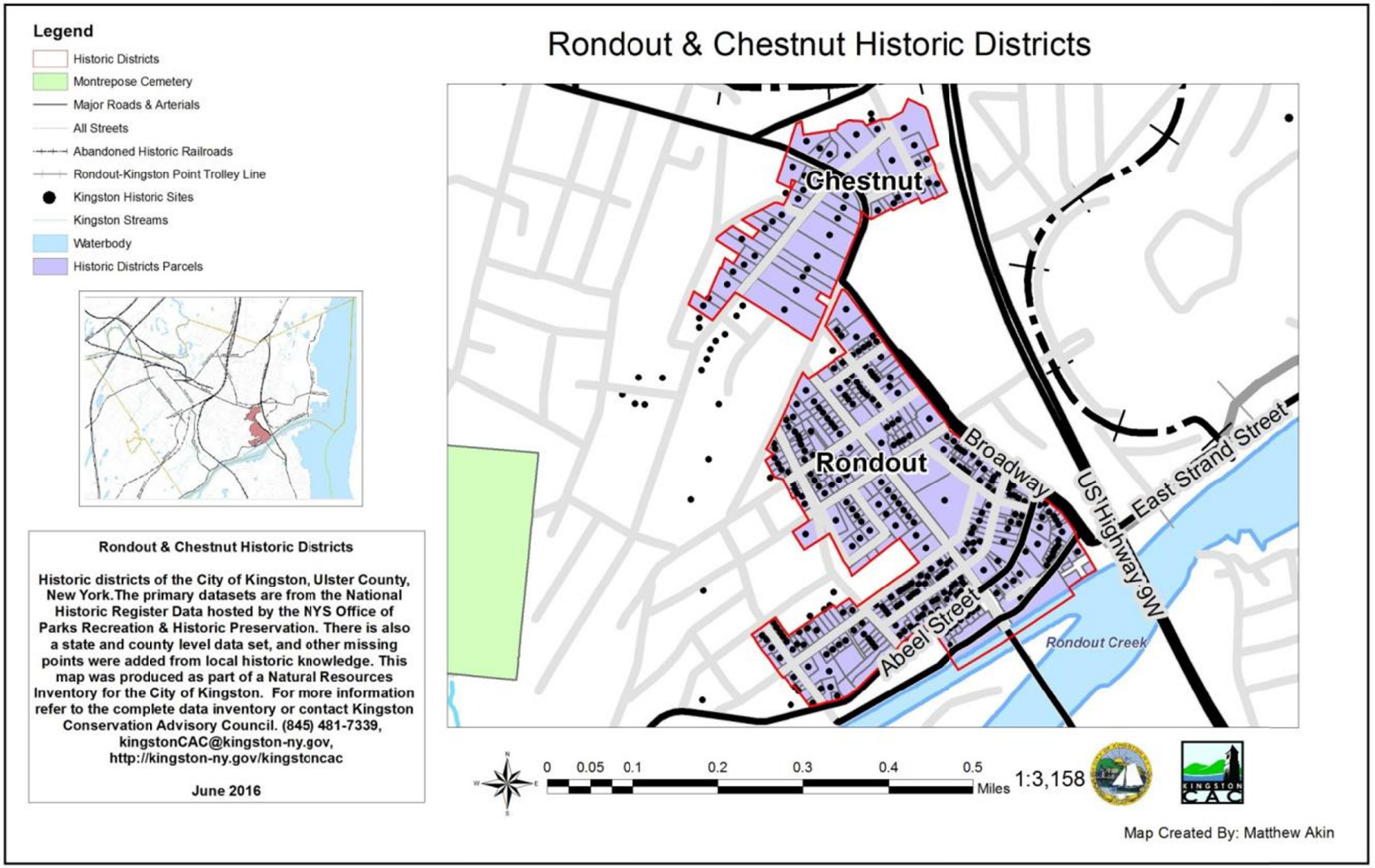


Figure 27. NRI Map - Rondout & Chestnut Historic Districts

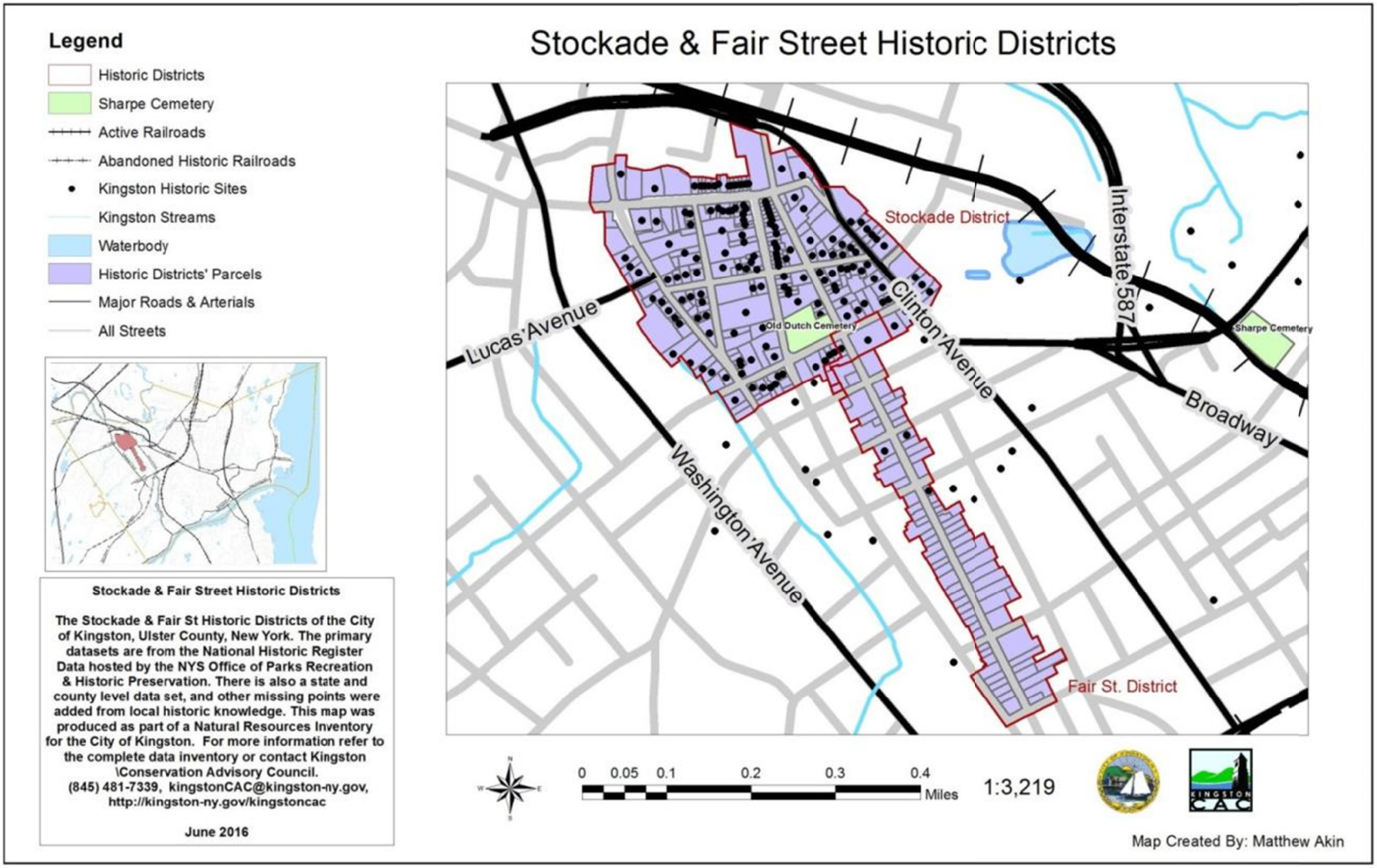


Figure 4. NRI Map - Stockade & Fair Street Historic Districts

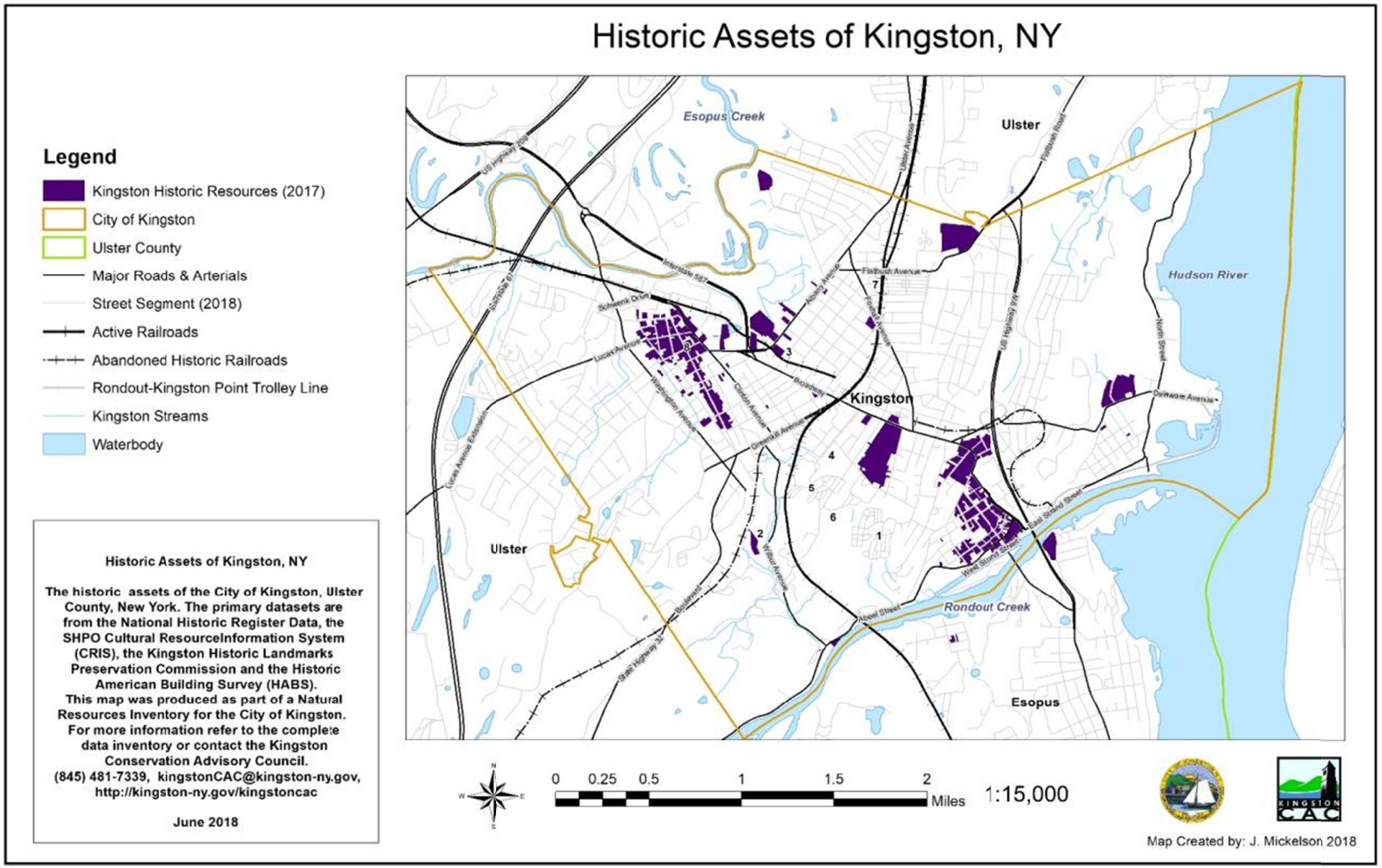


Figure 29. NRI Map - Historic Assets of Kingston NY (2017)

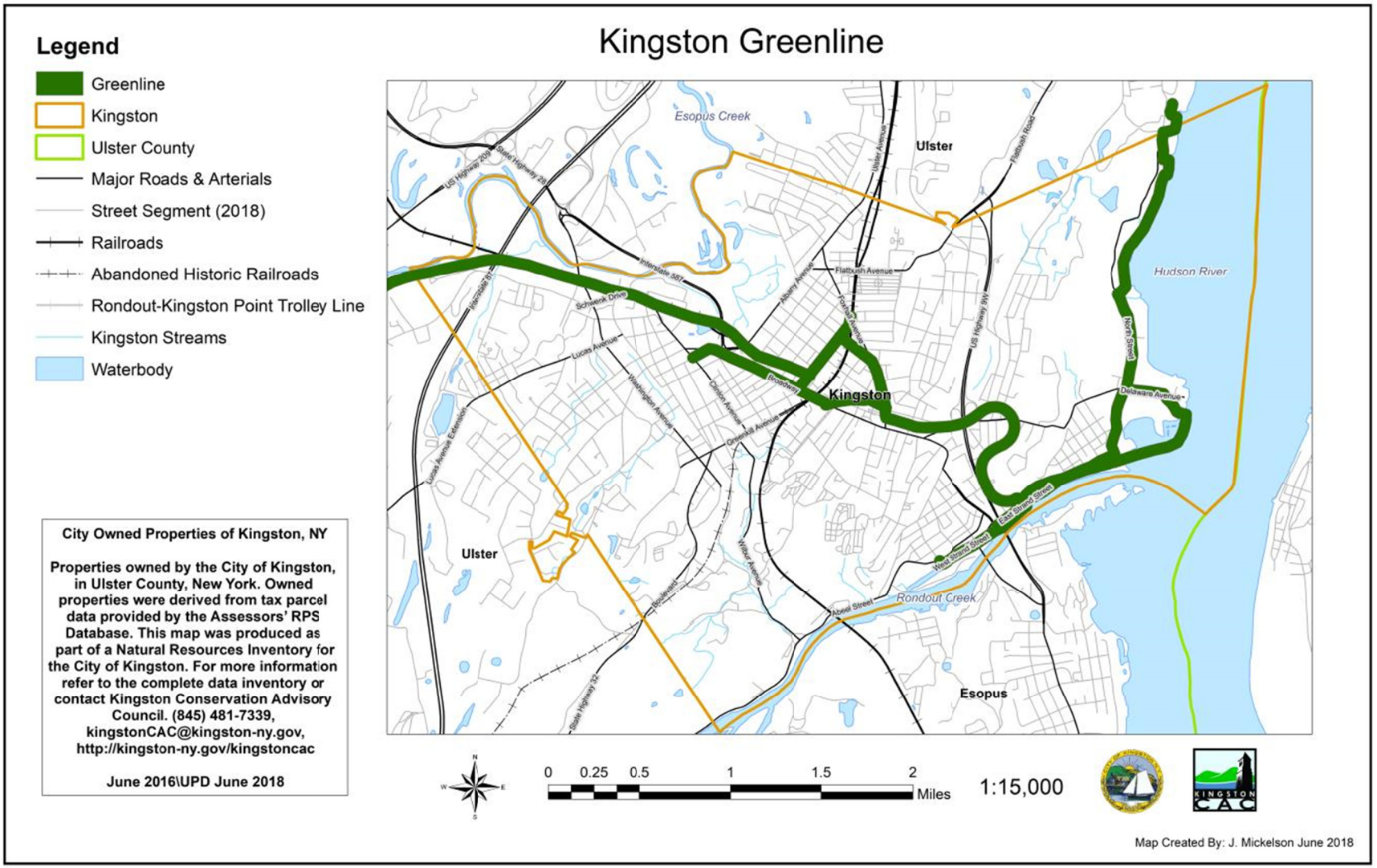


Figure 30. NRI Map – Kingston Greenline (linear parks) (2018)

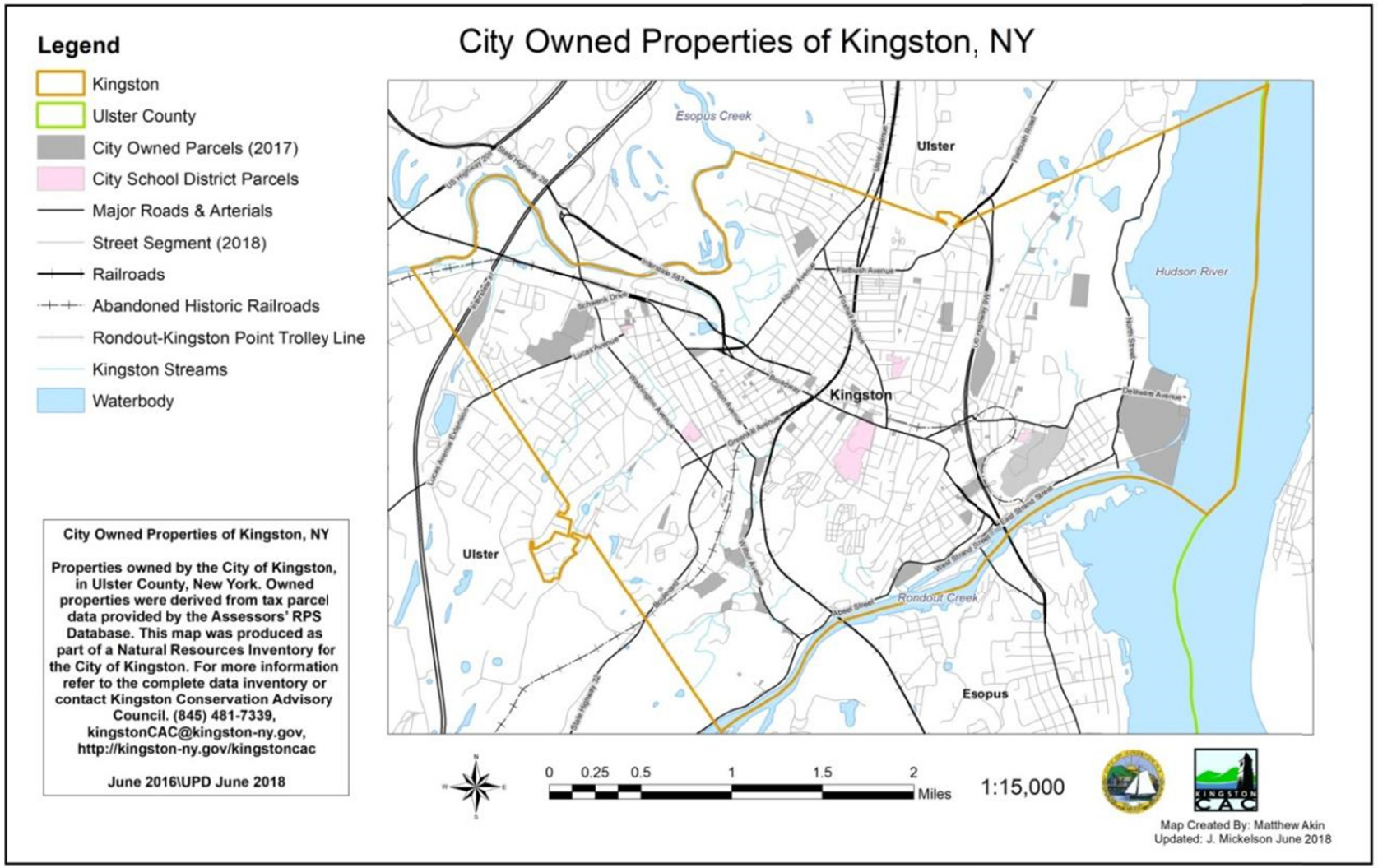


Figure 31. NRI Map - City Owned Properties of Kingston, NY (2017)

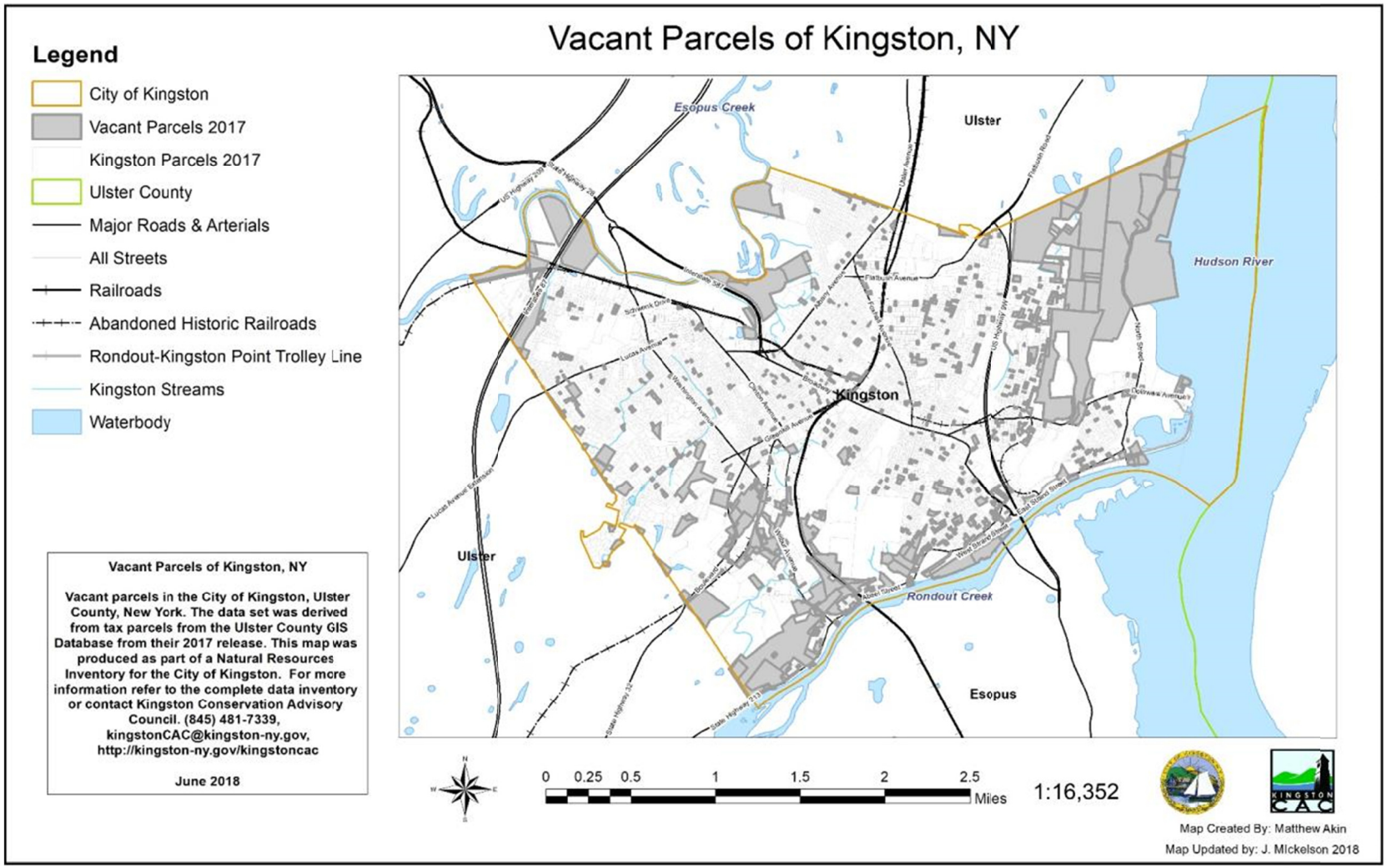


Figure 32. NRI Map - Vacant Parcels of Kingston, NY (2017)

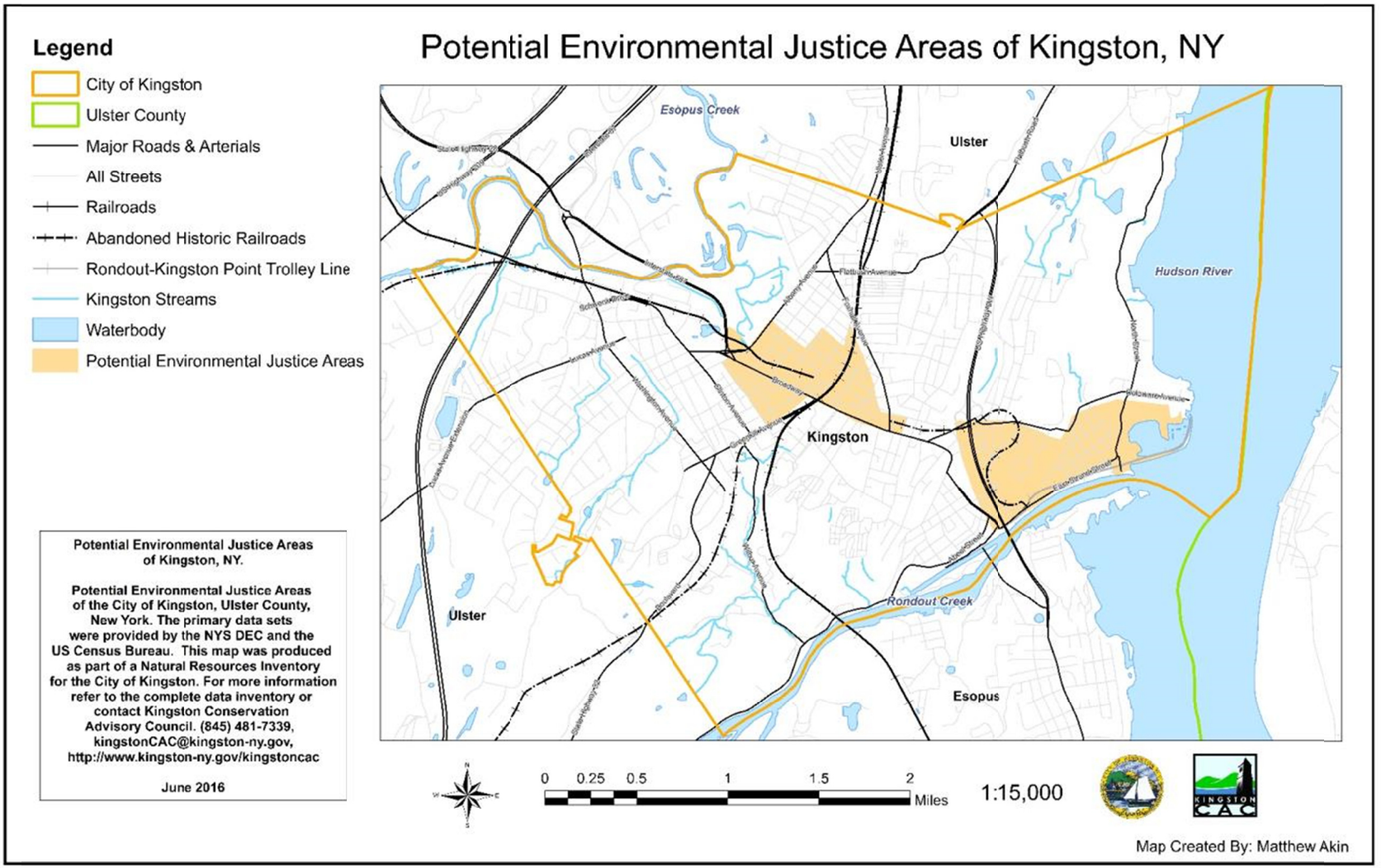


Figure 33. NRI Map - Potential Environmental Justice Areas of Kingston, NY

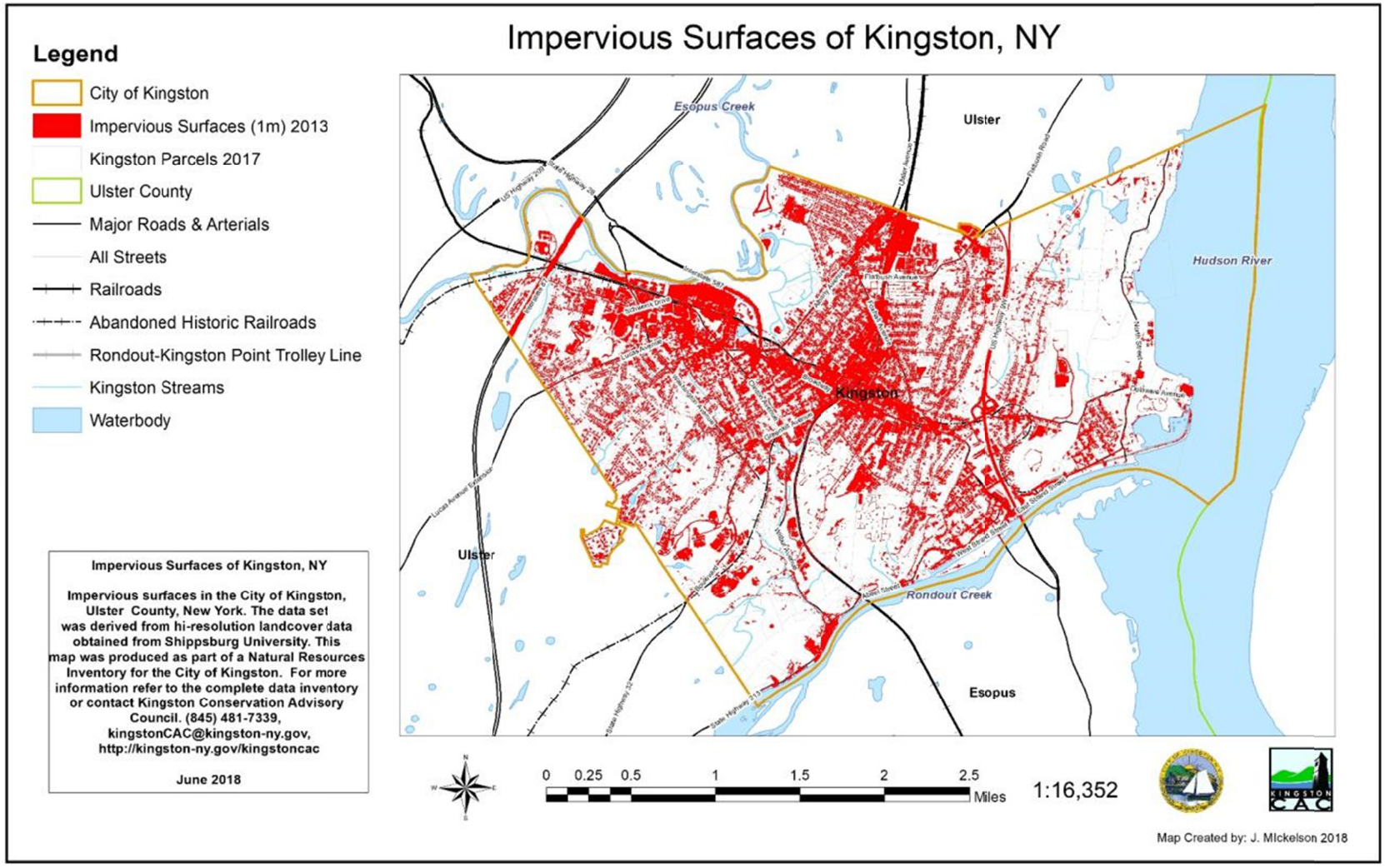


Figure 34. NRI Map - Impervious Surfaces of Kingston, NY (2013)

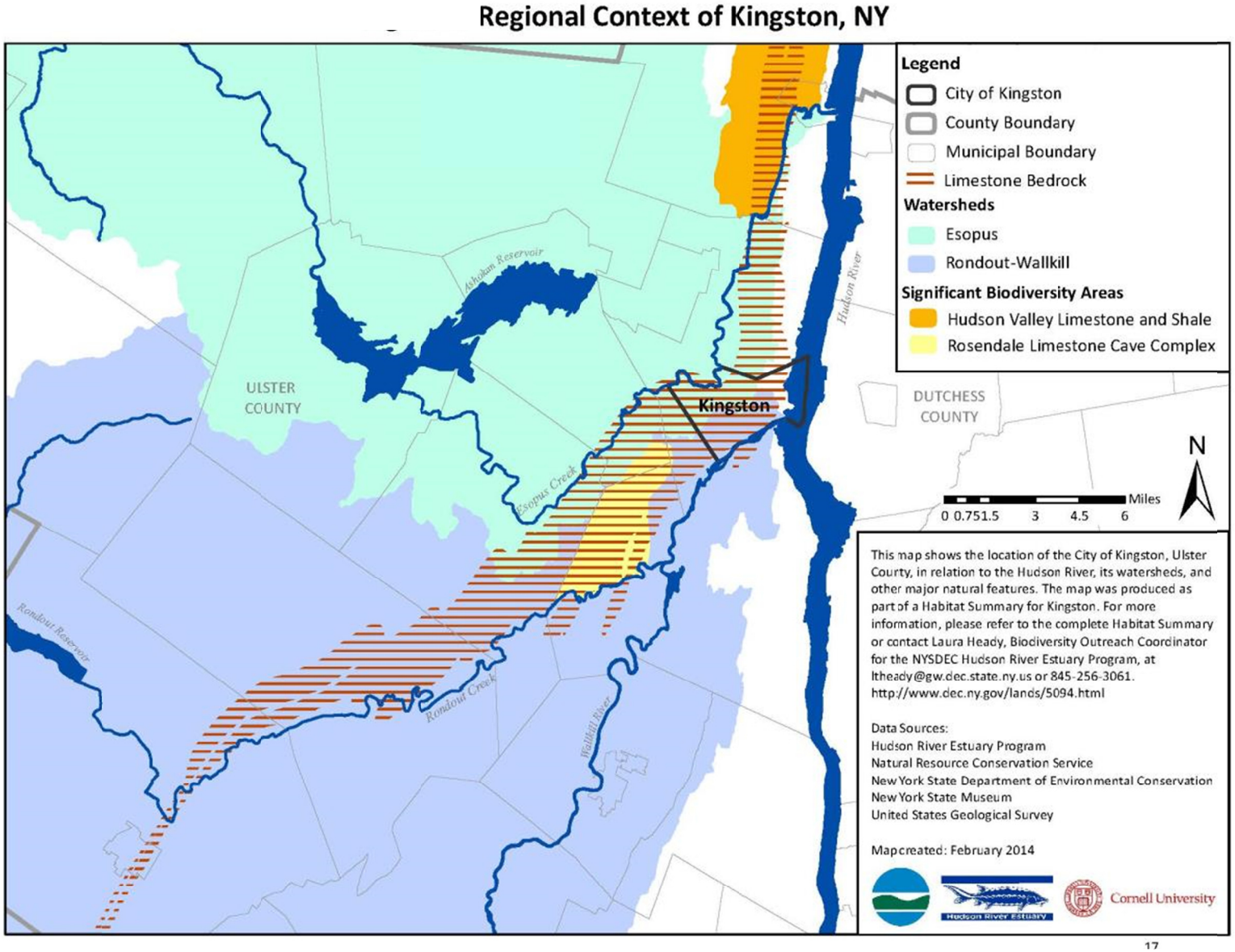


Figure 35. NRI Map - (NYSDEC) Regional Context of Kingston, NY

Figure 36. NRI Map - Hudsonia Ltd. Significant Habitats in Selected Areas of the City of Kingston

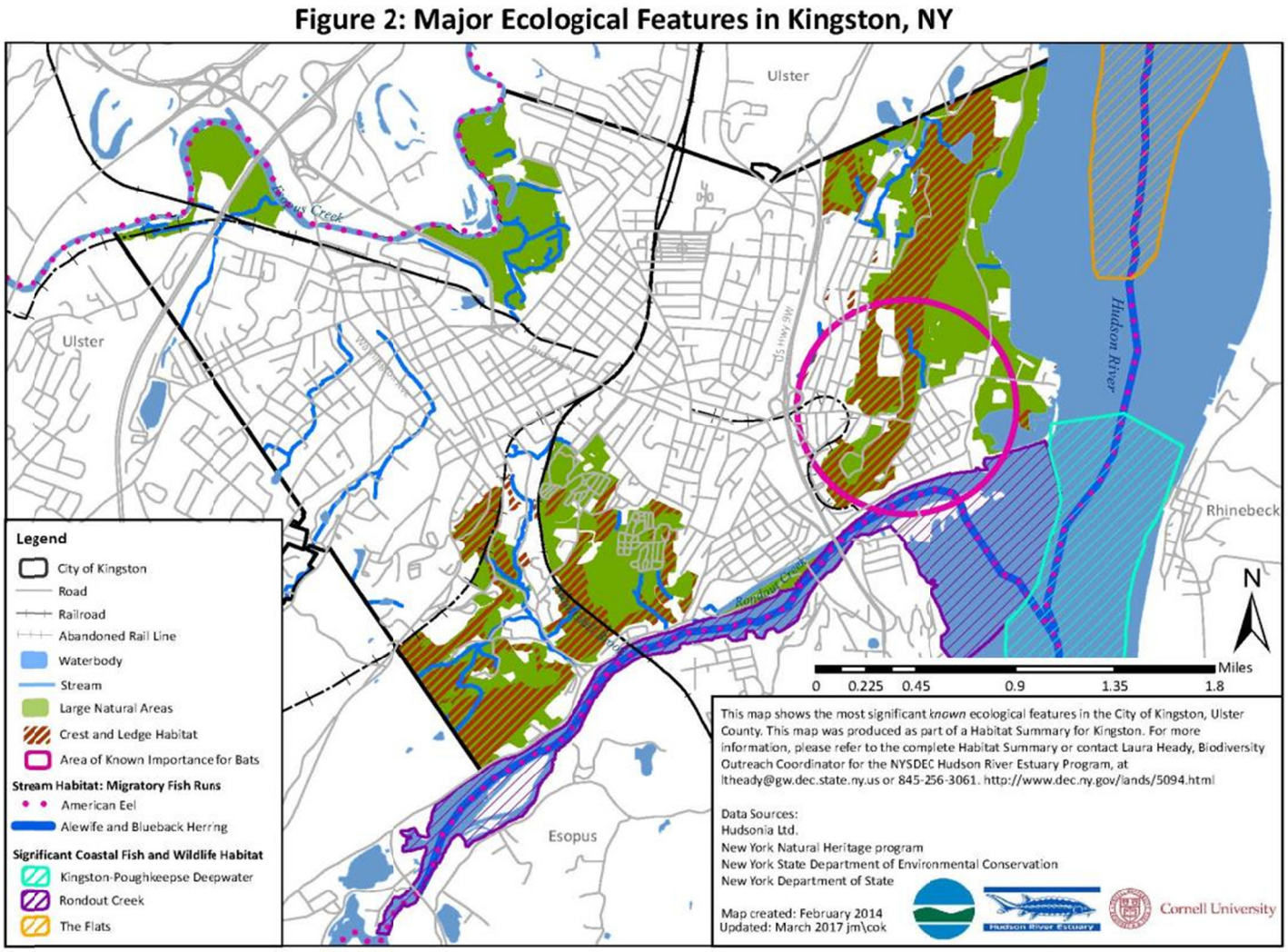


Figure 37. NRI Map - (NYSDEC) - Major Ecological Features in Kingston, NY (note 3 "large natural areas")

Figure 6: Hudson River Shoreline Habitat in Kingston, NY

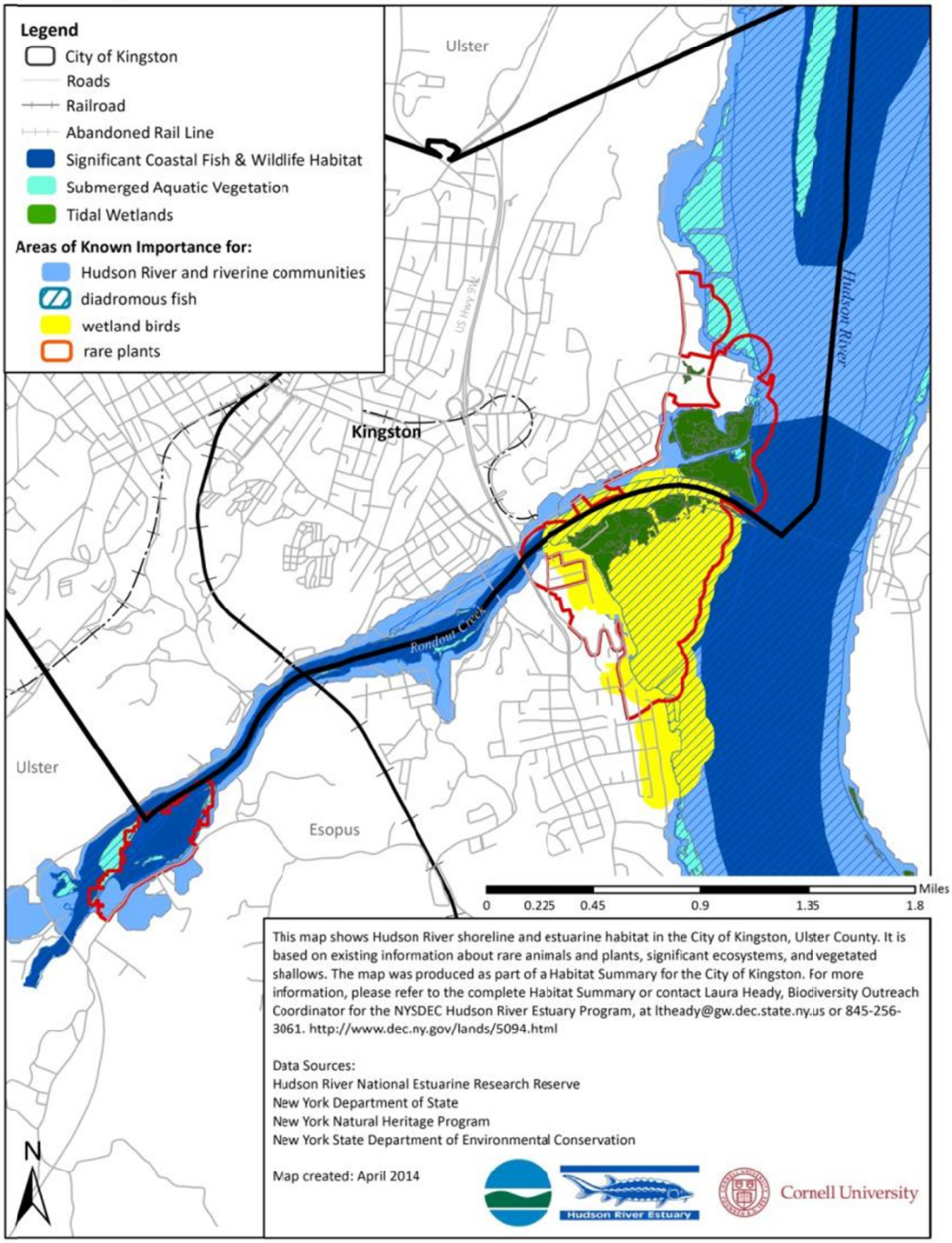


Figure 38. NRI Map - (NYSDEC) Hudson River Shoreline Habitat in Kingston, NY

Figure 7: Hudson River Shoreline Type in Kingston, NY

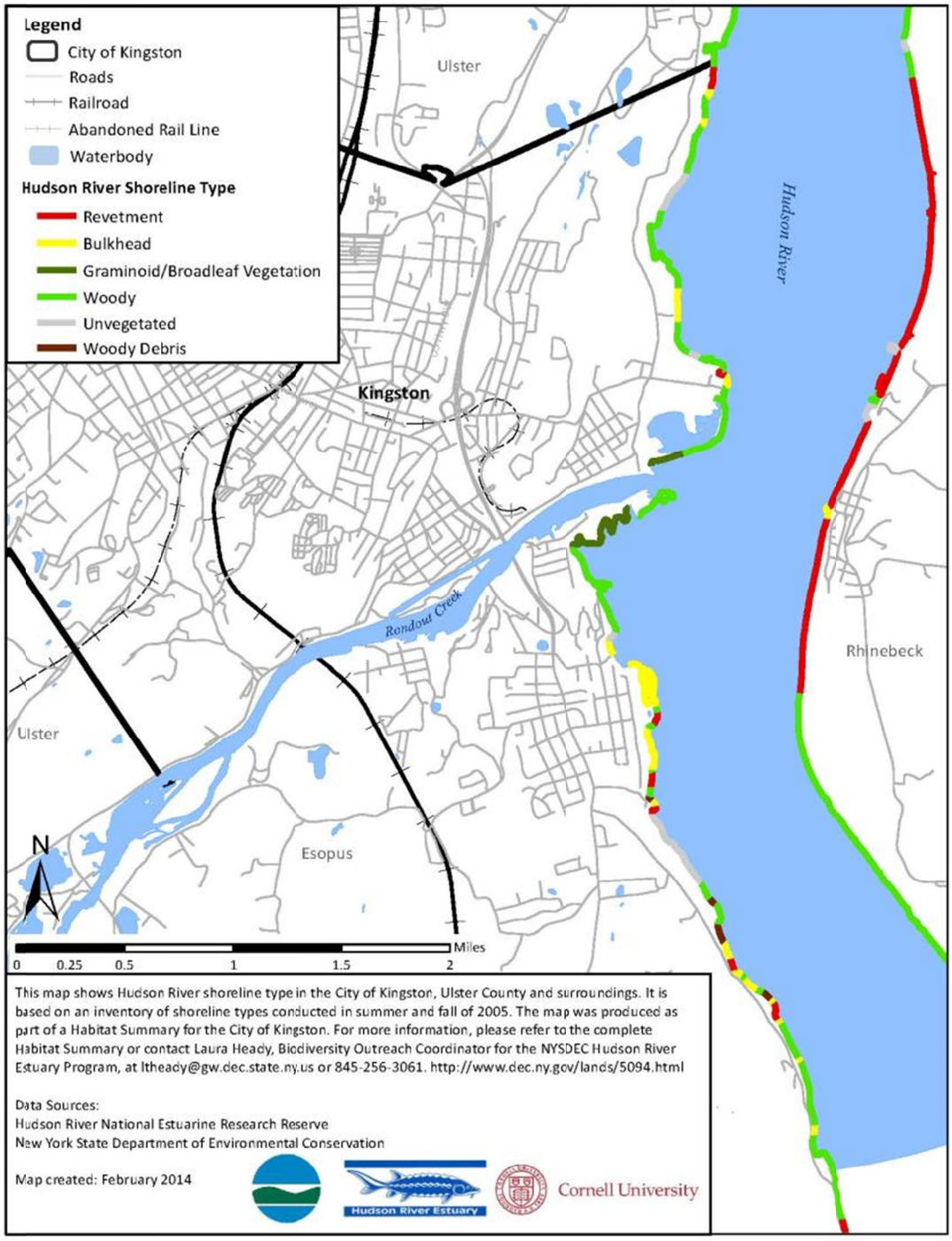


Figure 39. NRI Map - (NYSDEC) Hudson River Shoreline Type in Kingston, NY

Figure 8: Shoreline Habitat at Mouth of Rondout Creek, Kingston, NY

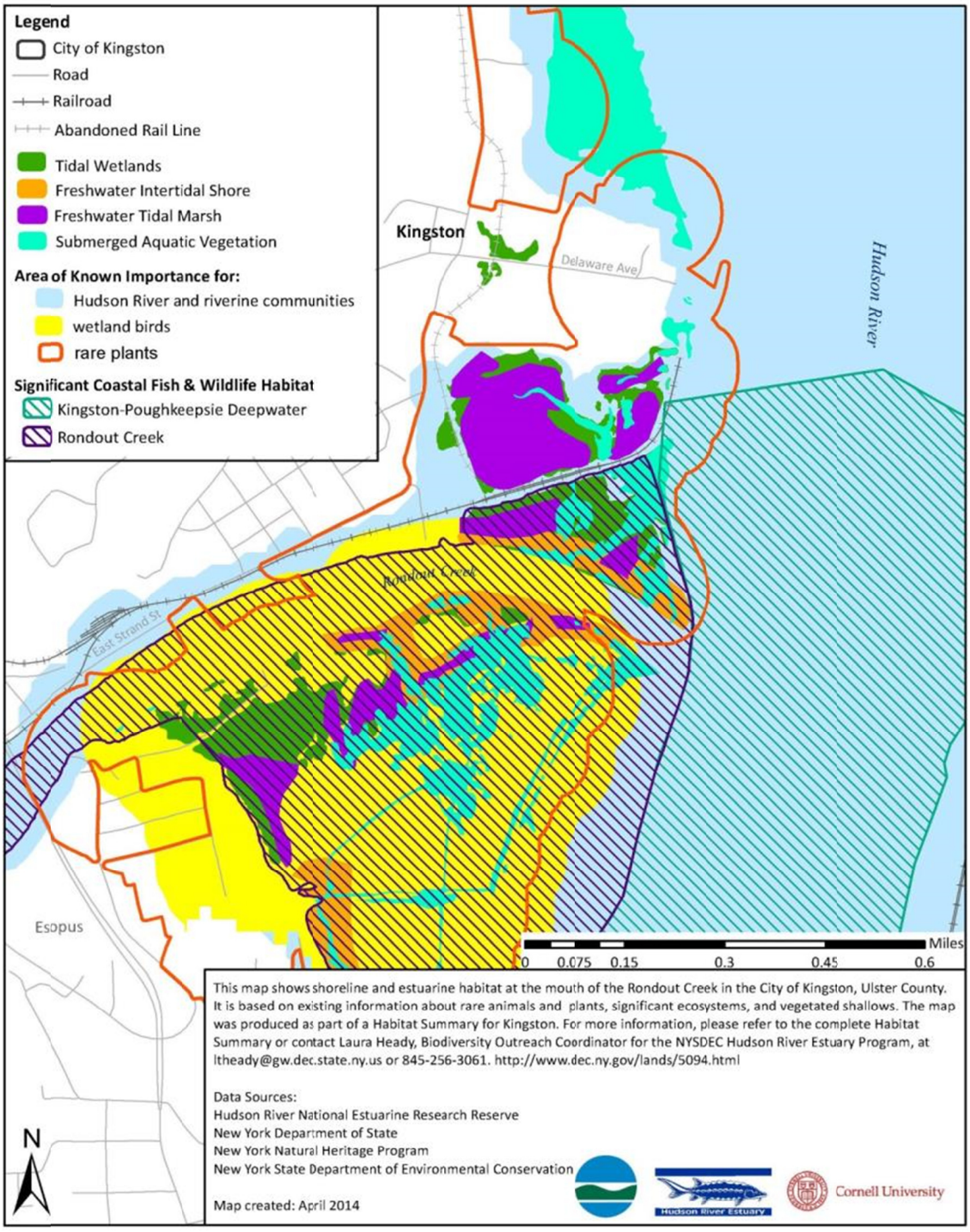


Figure 40. NRI Map - (NYSDEC) Shoreline Habitat at Mouth of the Rondout Creek, Kingston, NY

Appendix E. Open Space Index (OSI) Maps

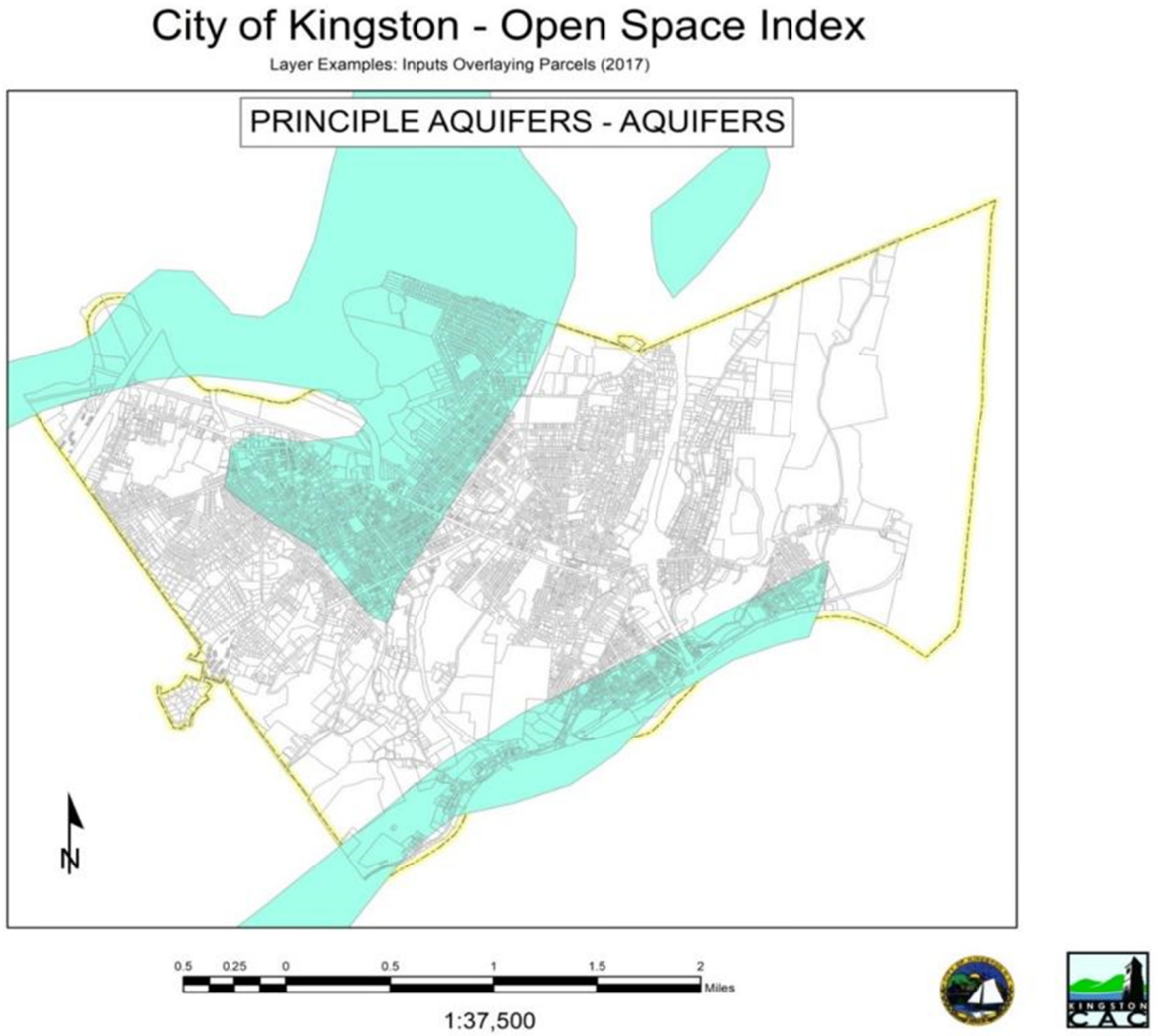


Figure 41. OSI Layer: Aquifers – Among the variables chosen to inform OSI index of important natural resource & open space features in Kingston, using Tax Parcels as analysis unit.

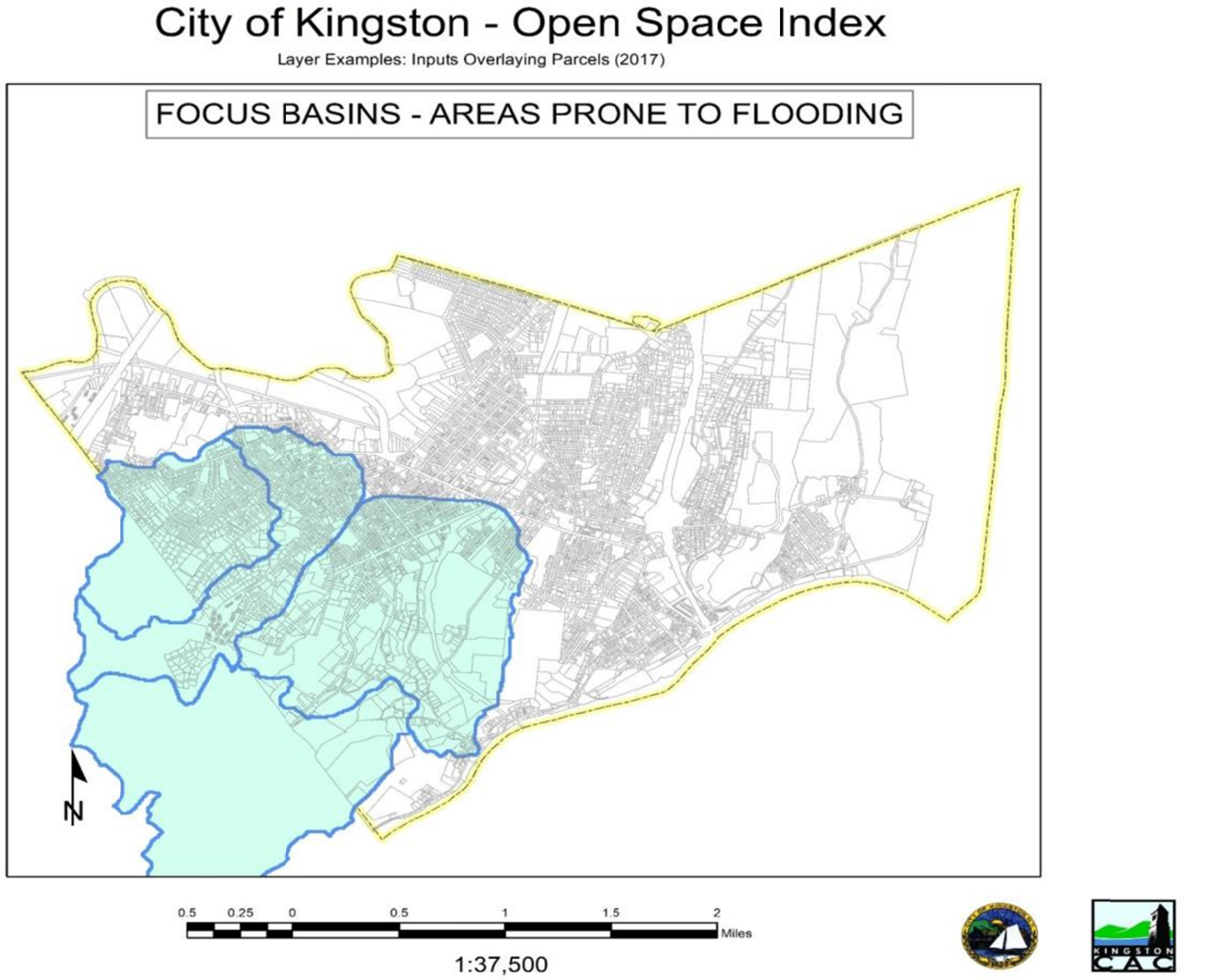


Figure 42. OSI Layer - Drainages containing stream prone to flooding: Main Street Brook, Tannery Brook and Twaalfskill Creek.

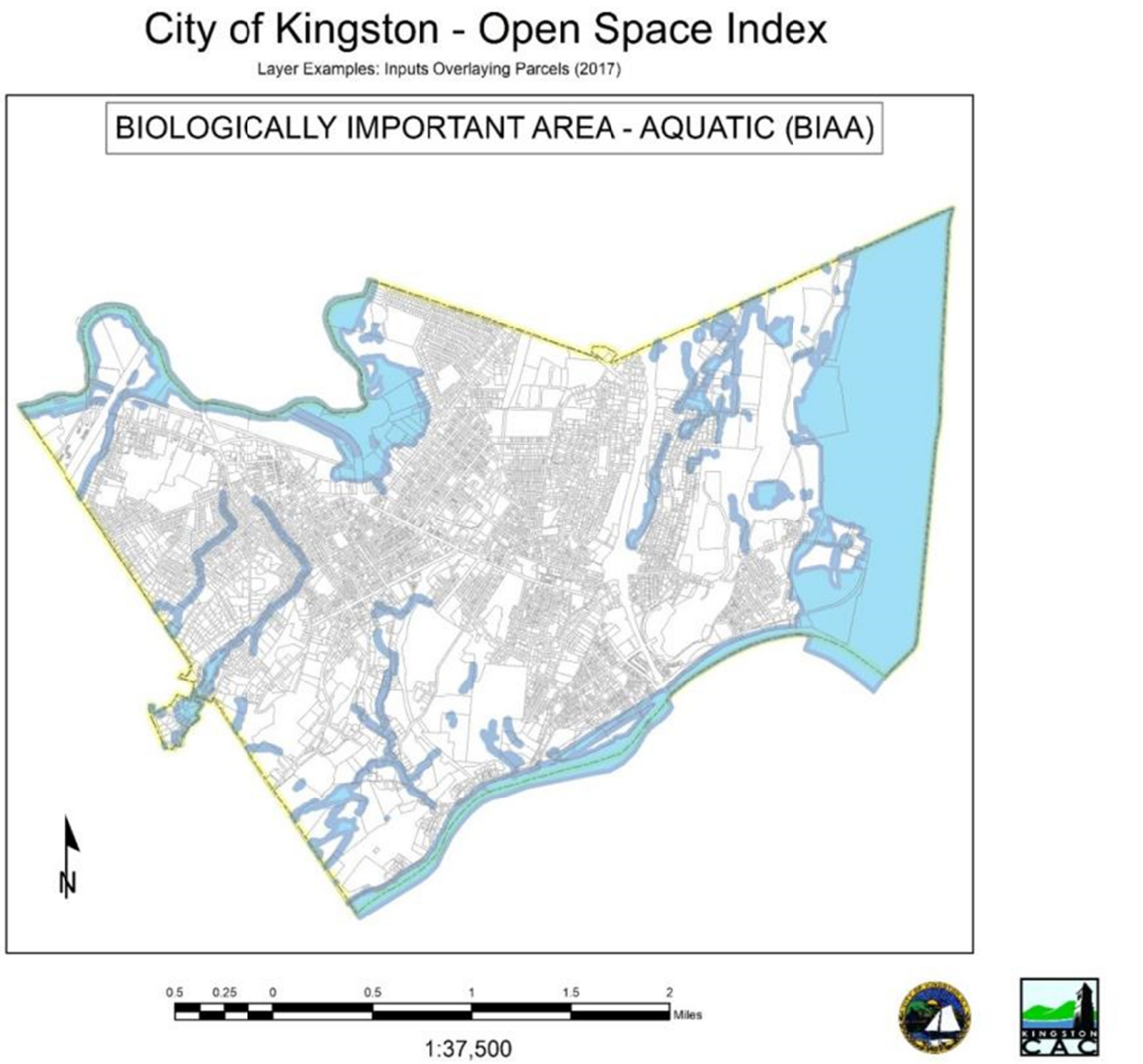


Figure 43. OSI Layer Biologically Important Areas - Aquatic

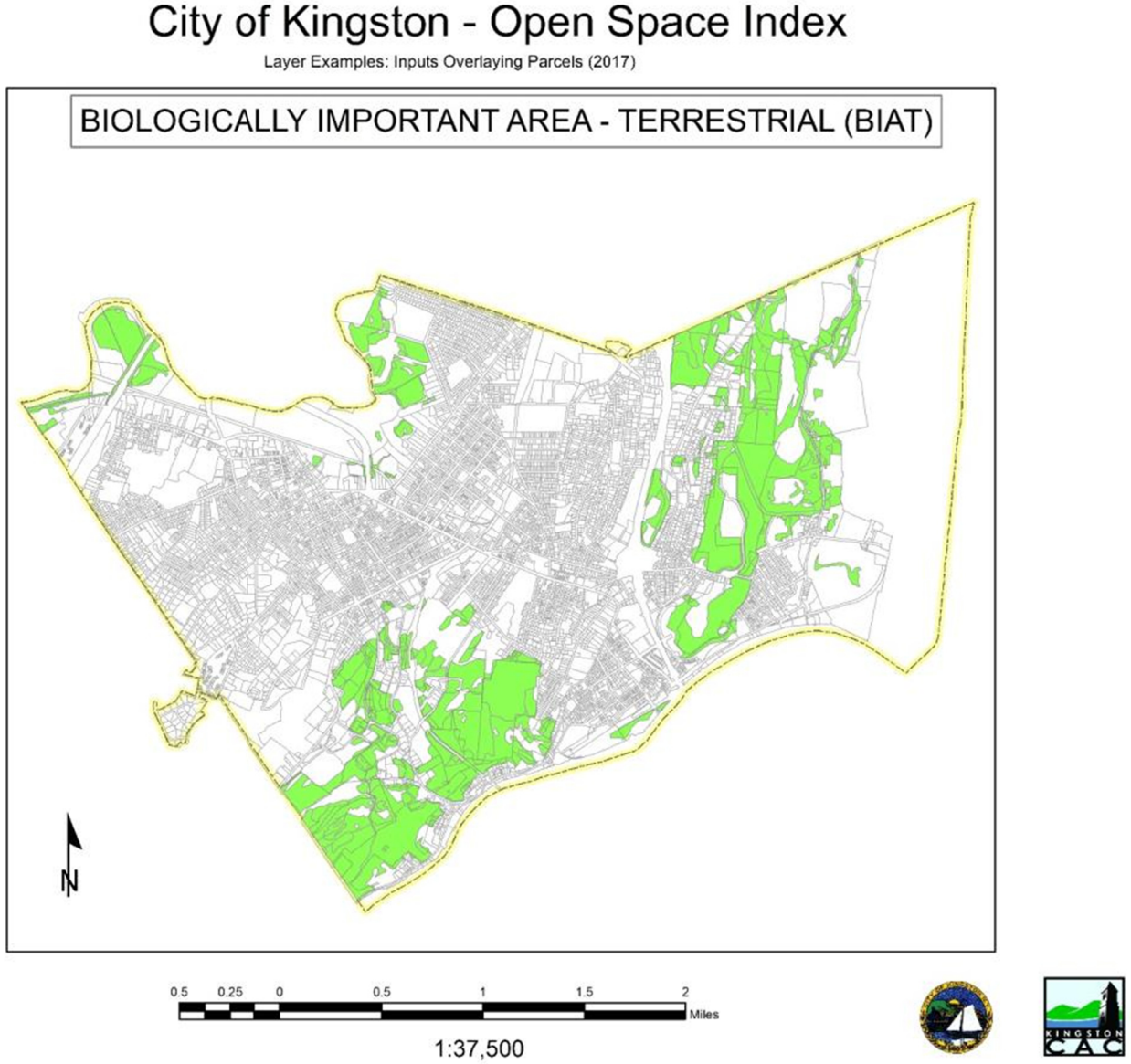


Figure 44. OSI Layer: Biologically Important Areas - Terrestrial

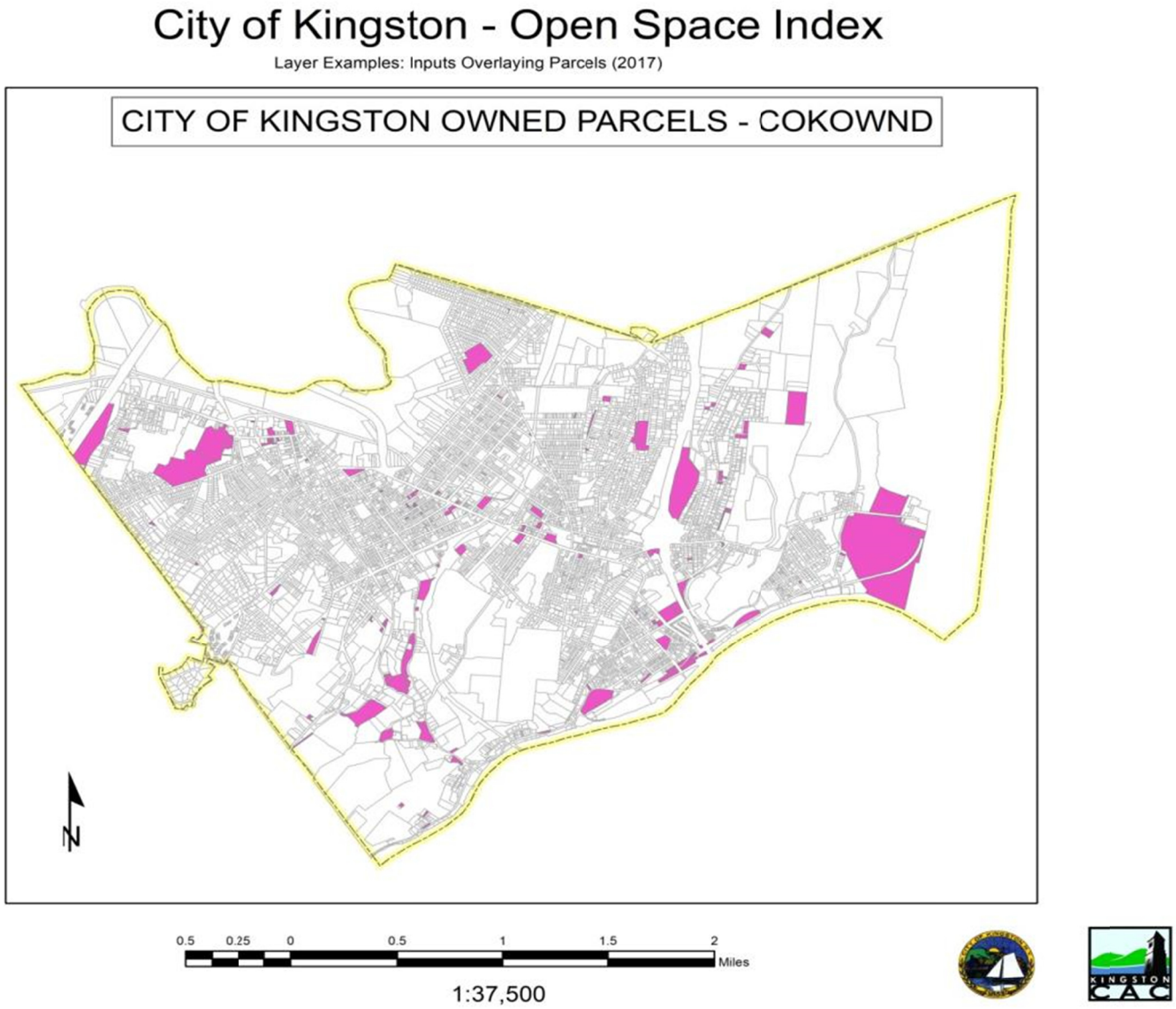


Figure 45. OSI Layer - City Owned Parcels - 2017

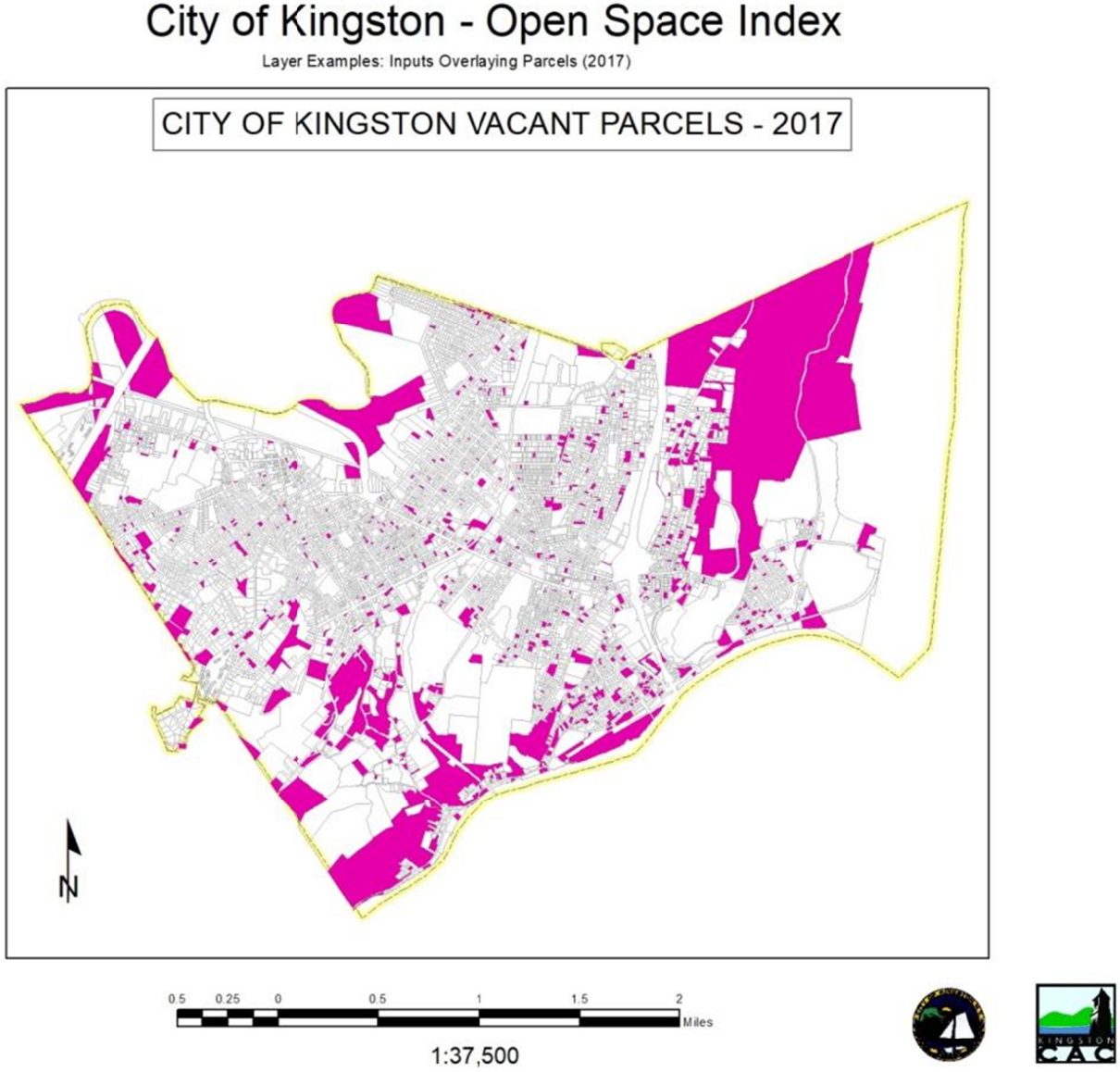


Figure 46. OSI Layer - Vacant Parcels (code 300's) (2017)

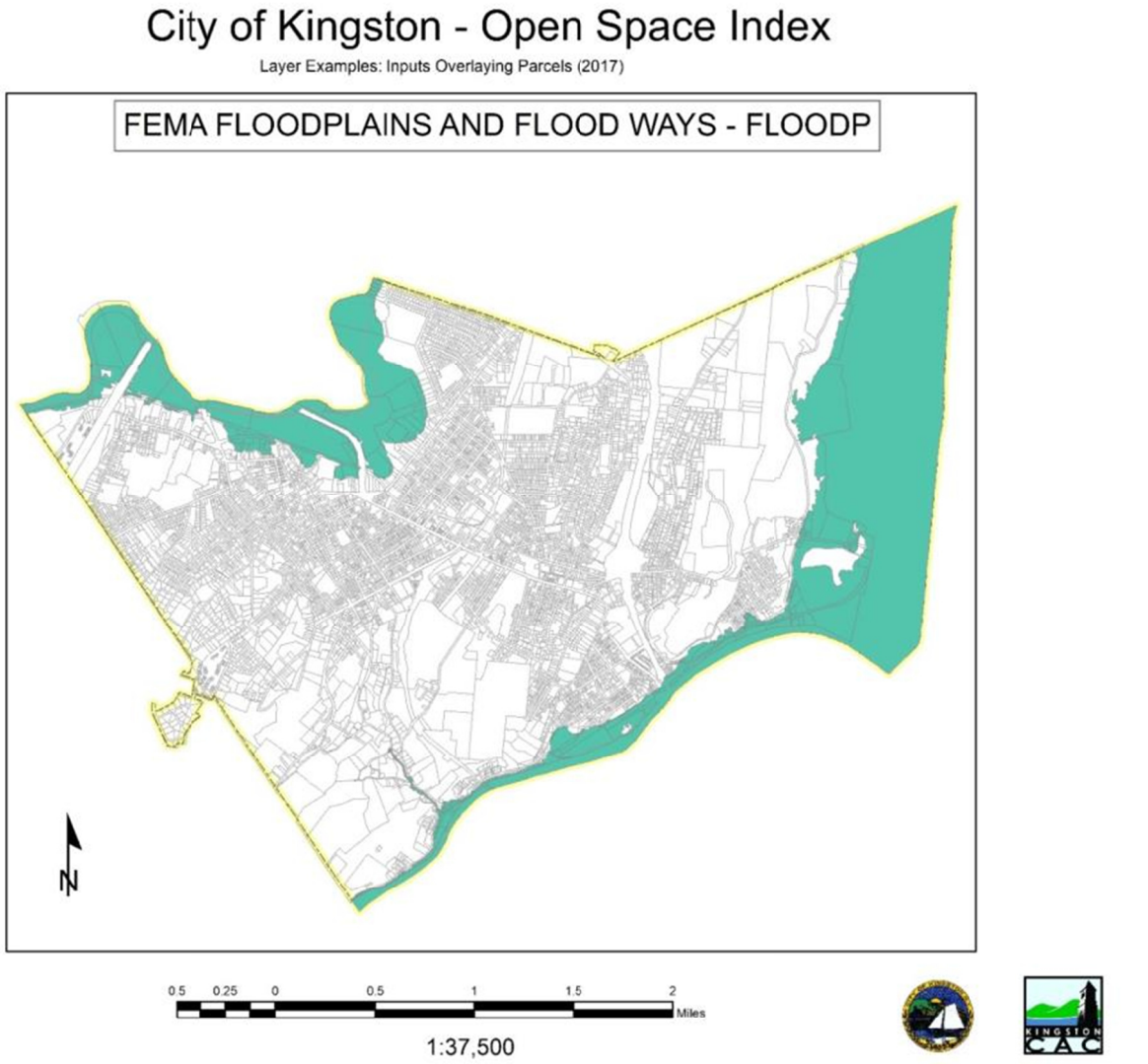


Figure 47. OSI Layer- FEMA Flood Hazard Zones and Floodways (2017)

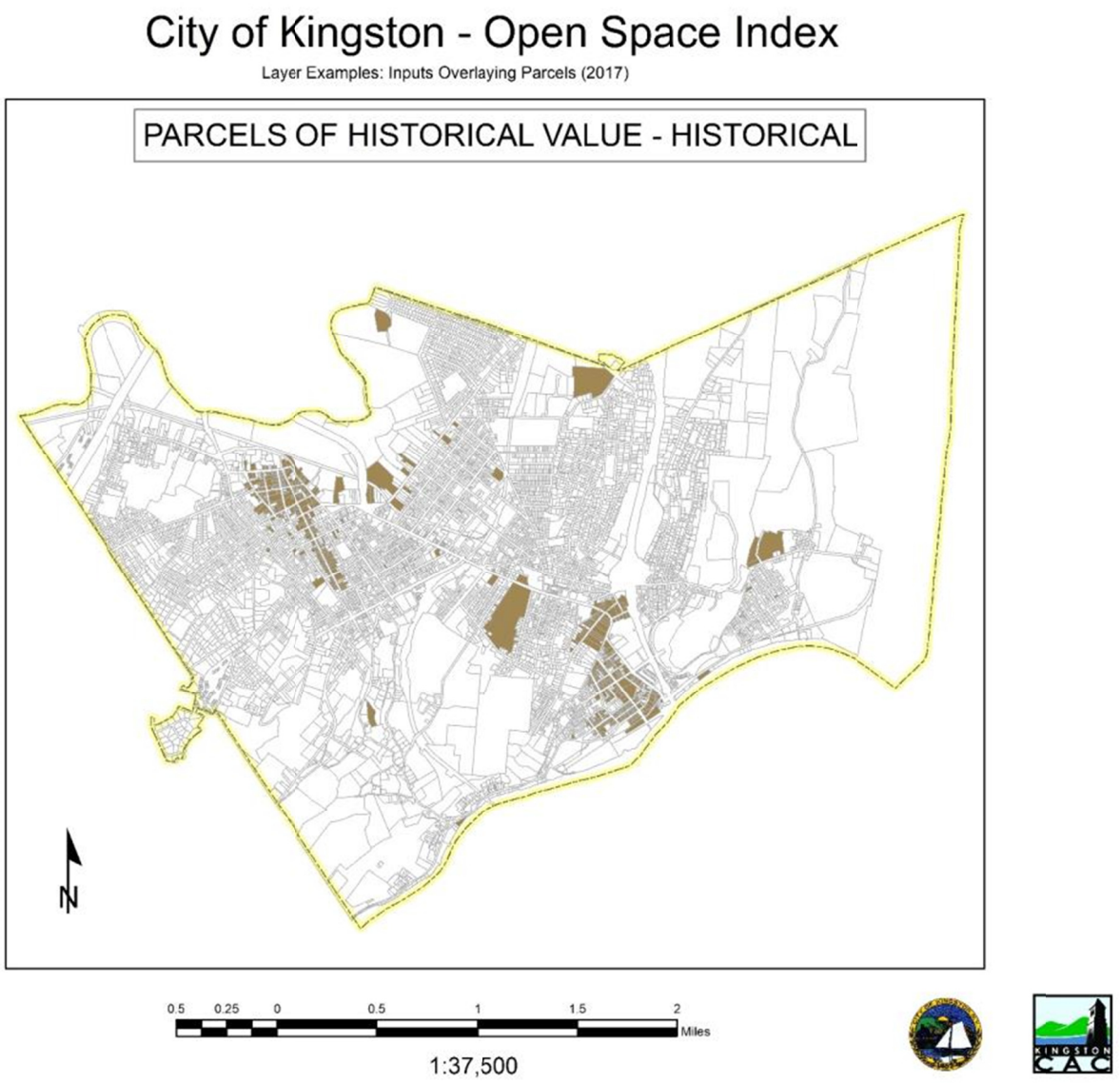


Figure 48. OSI Layer- Historical Resources (2017)

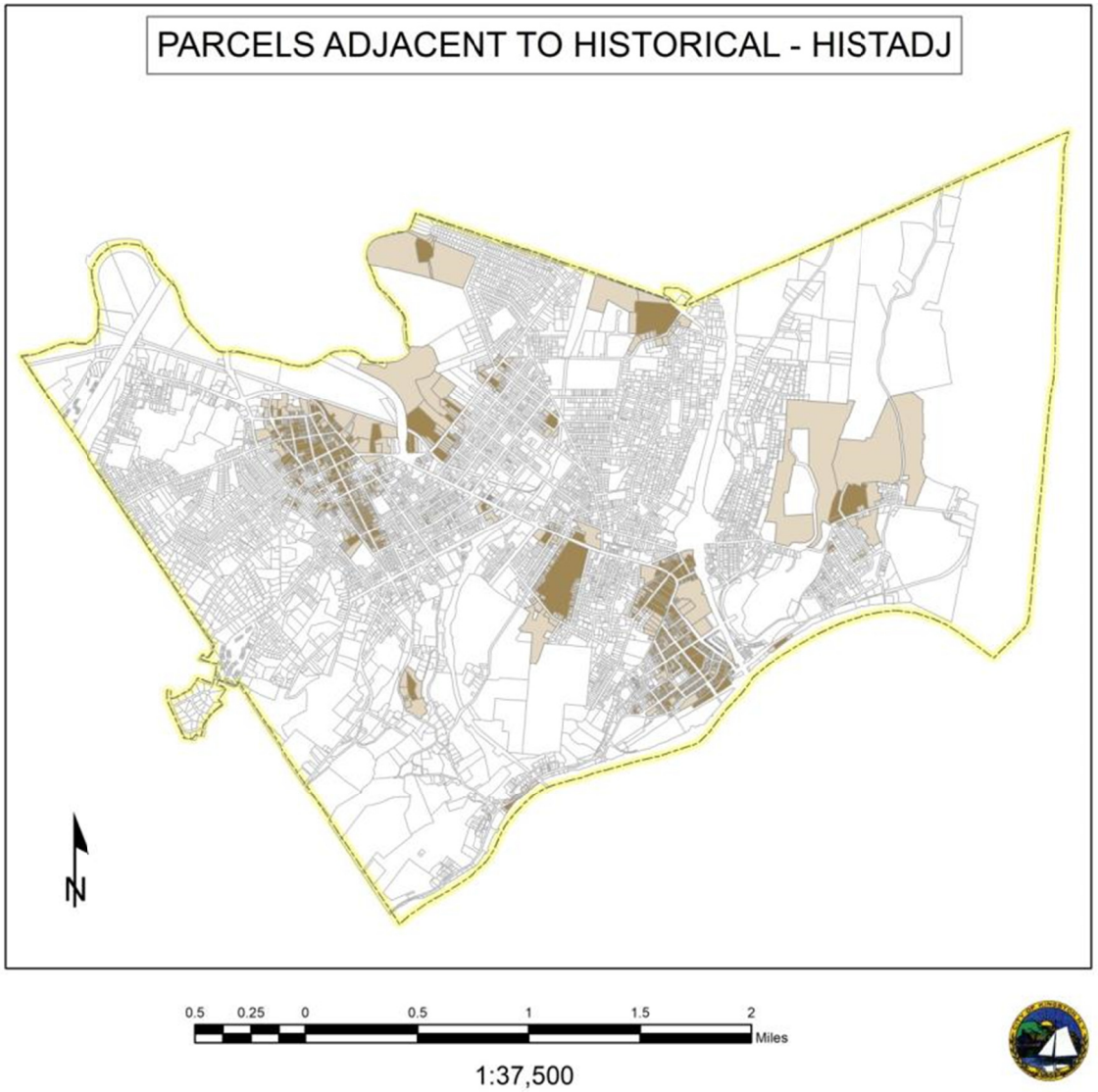


Figure 49. OSI Layer- Parcels Adjacent to Historical

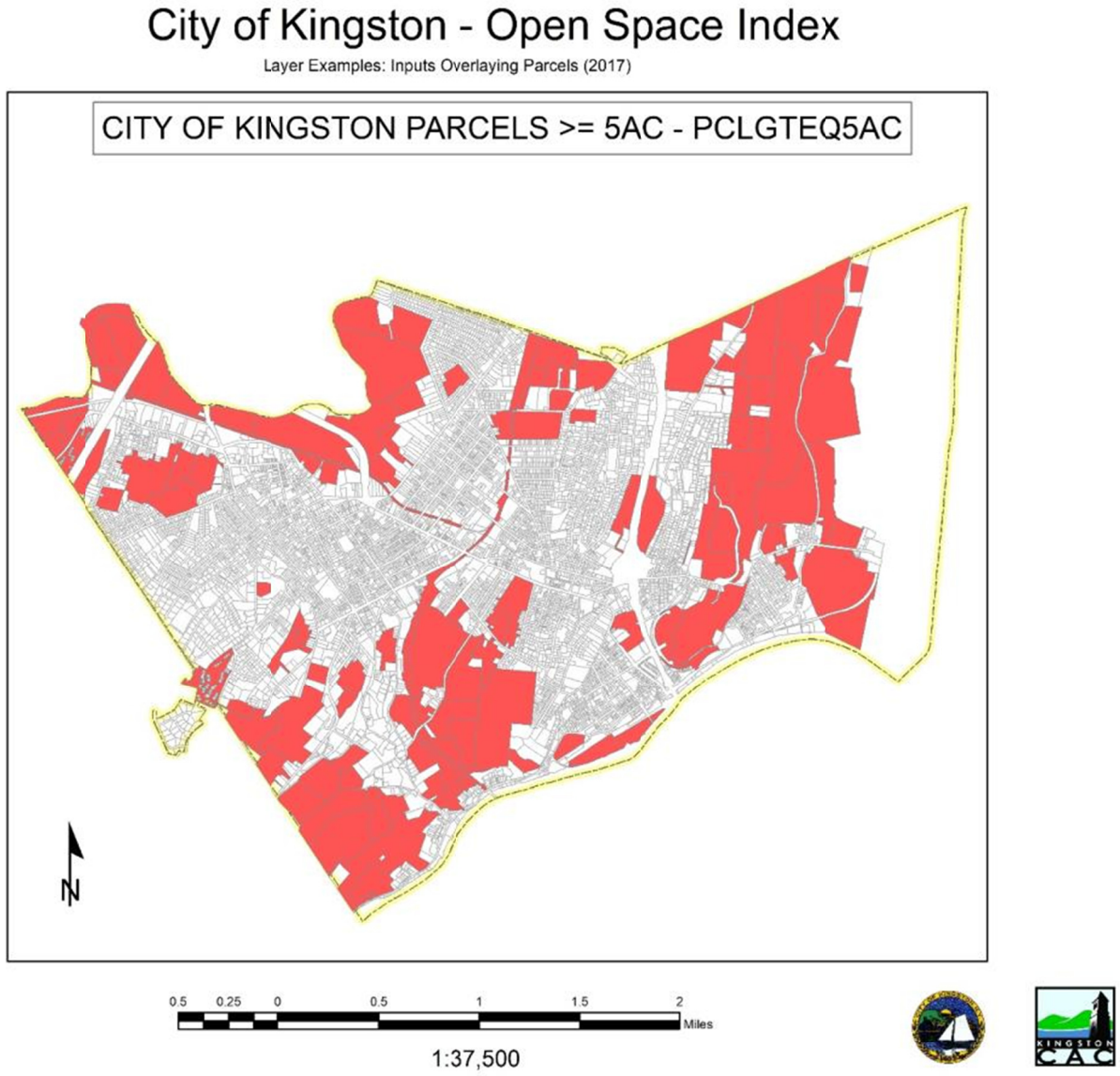


Figure 50. OSI Layer- Parcels Greater Than or Equal To 5 acres. (2017)

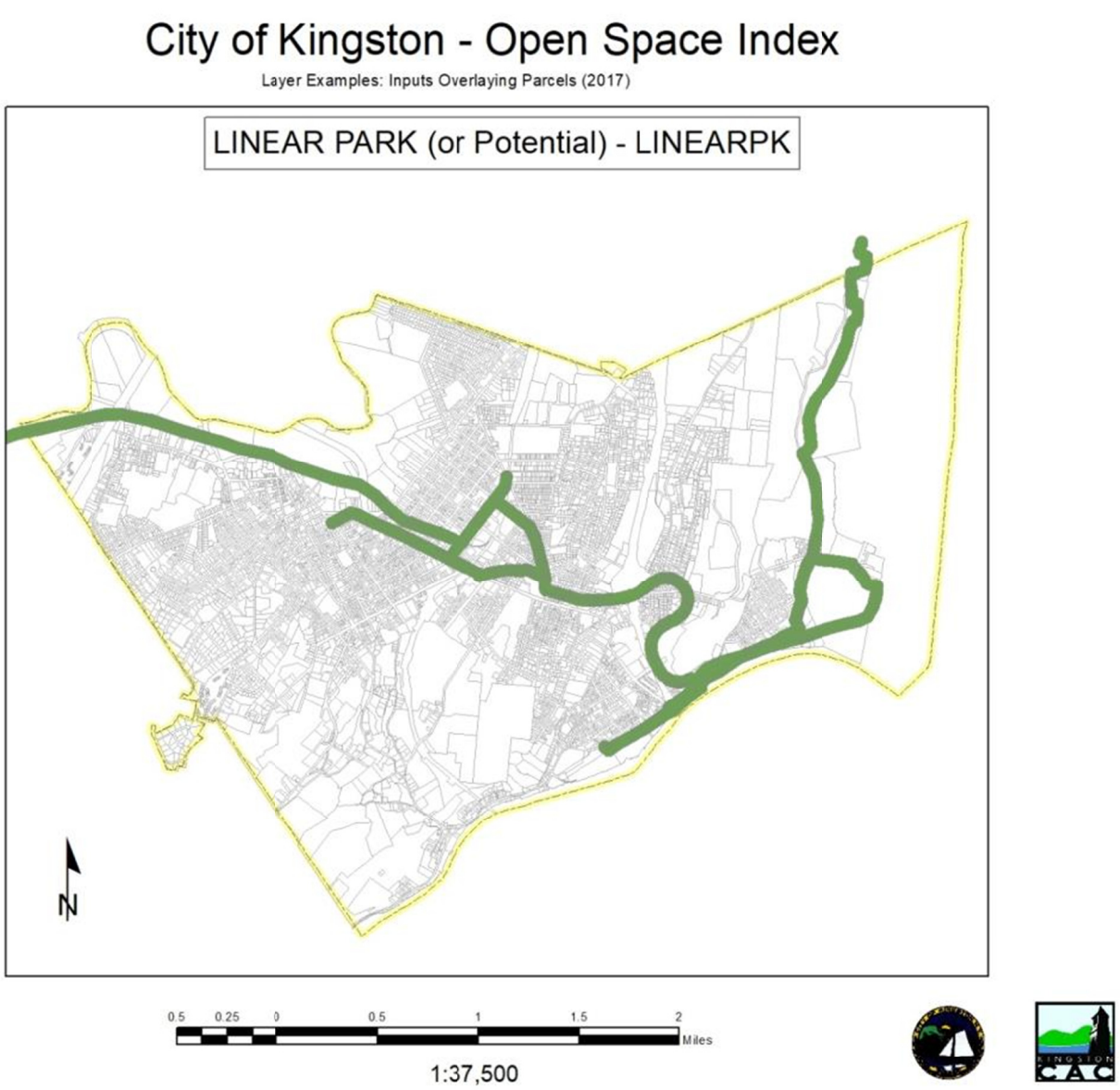


Figure 51. OSI Layer- Falls within Linear Parks (Greenline)

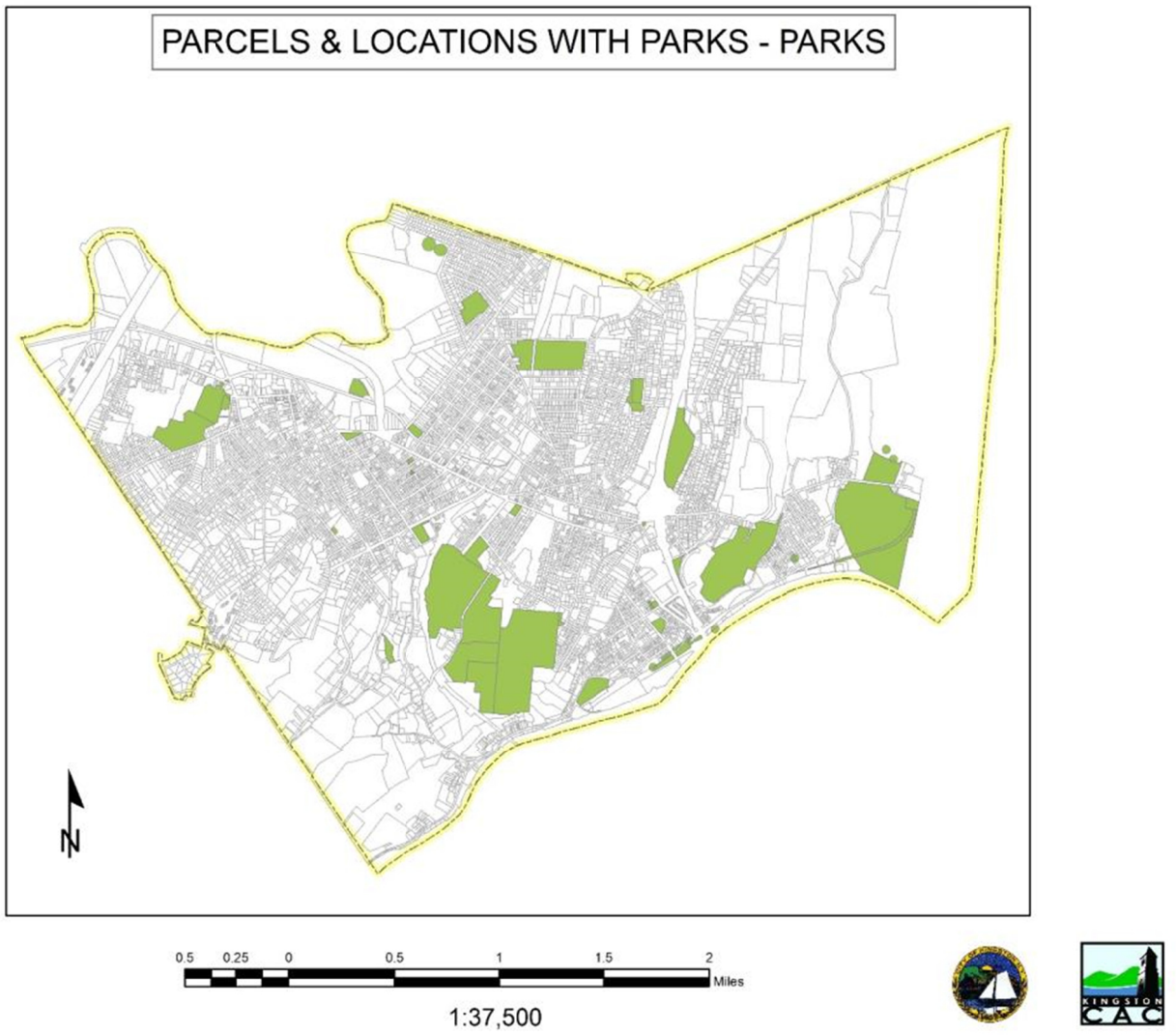


Figure 52. OSI Layer- Contains Park

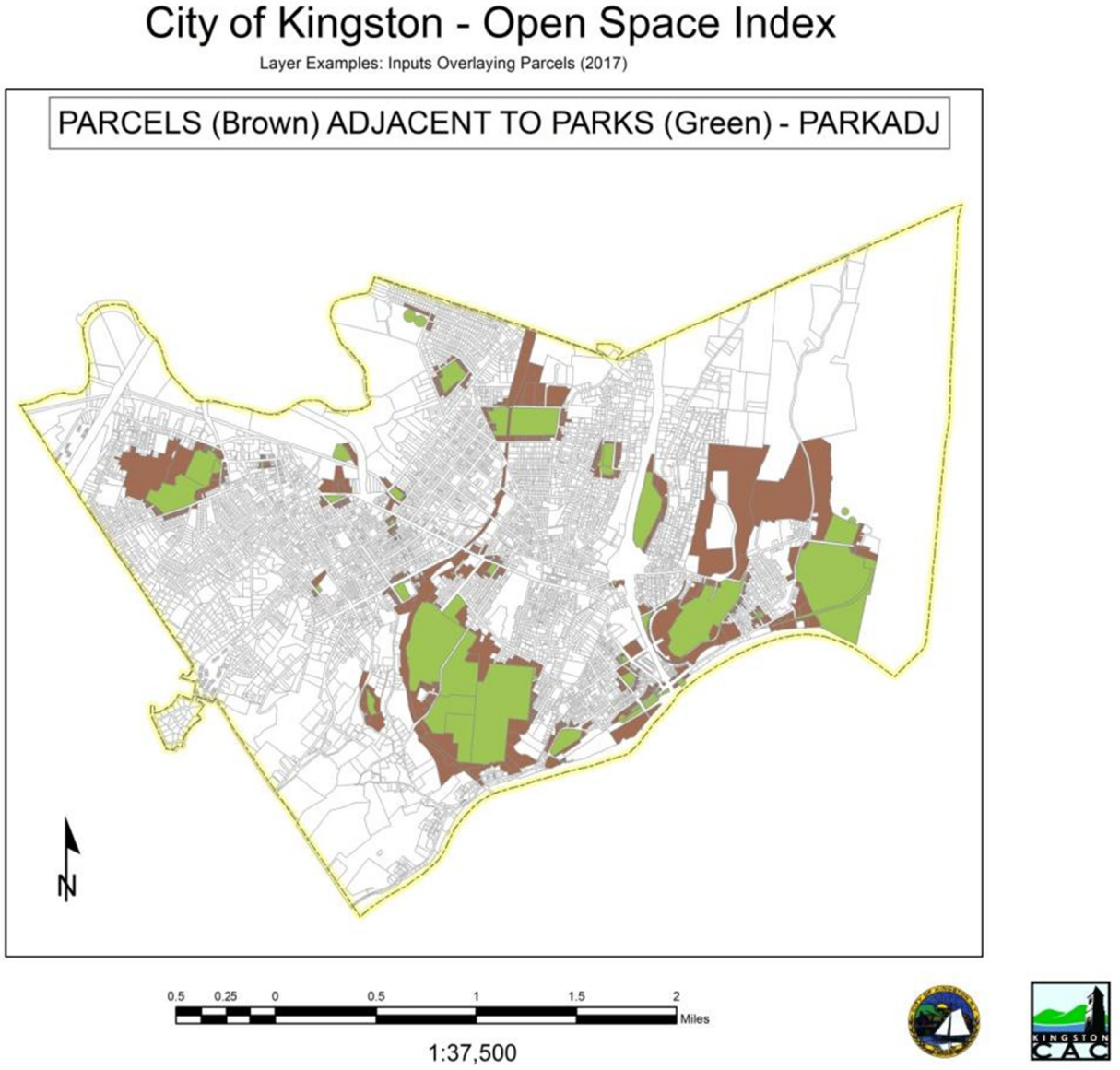


Figure 53. OSI Layer- Is Adjacent to Park

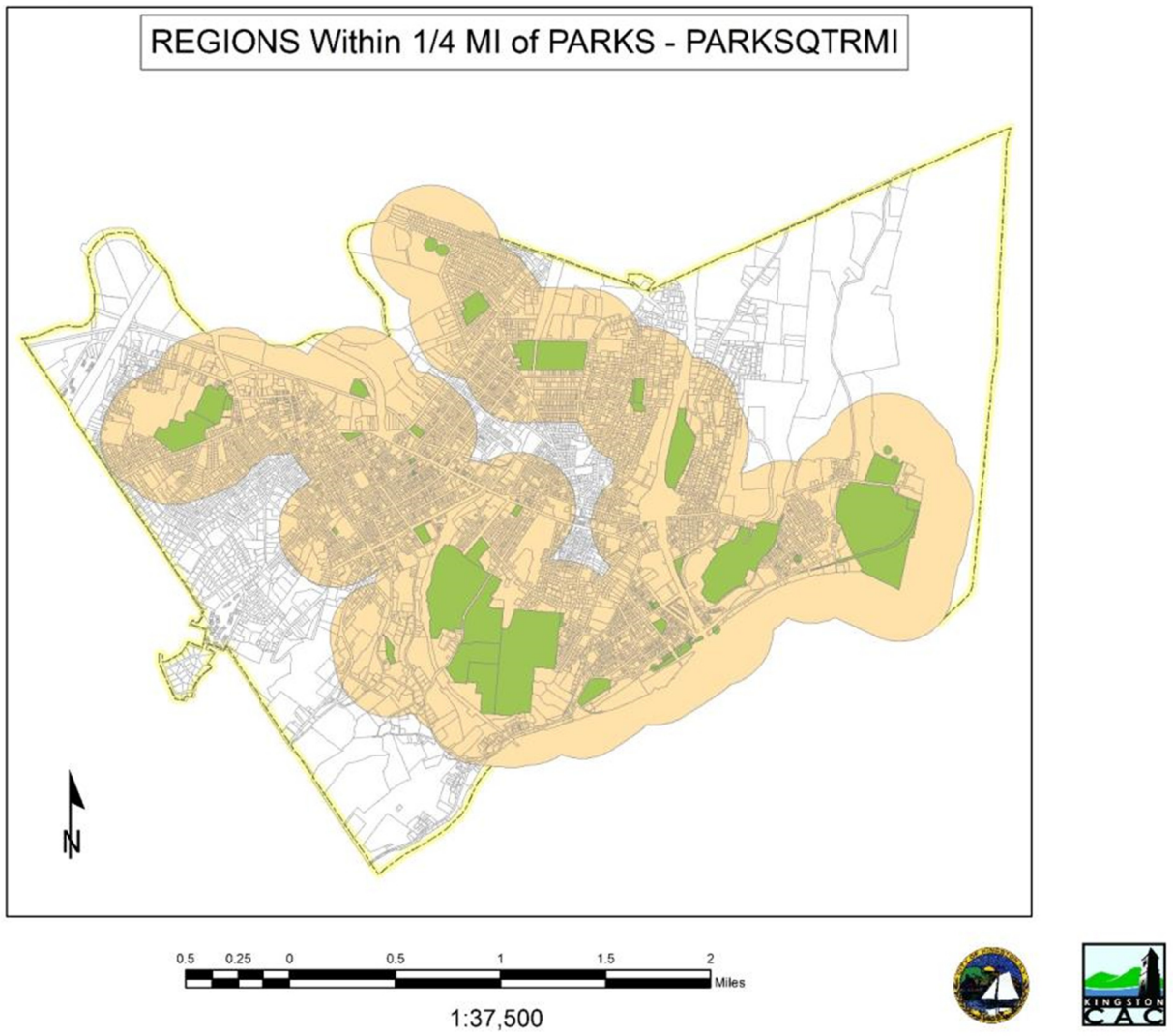


Figure 54. OSI Layer- Falls Within 1/4 mi radius. of Park

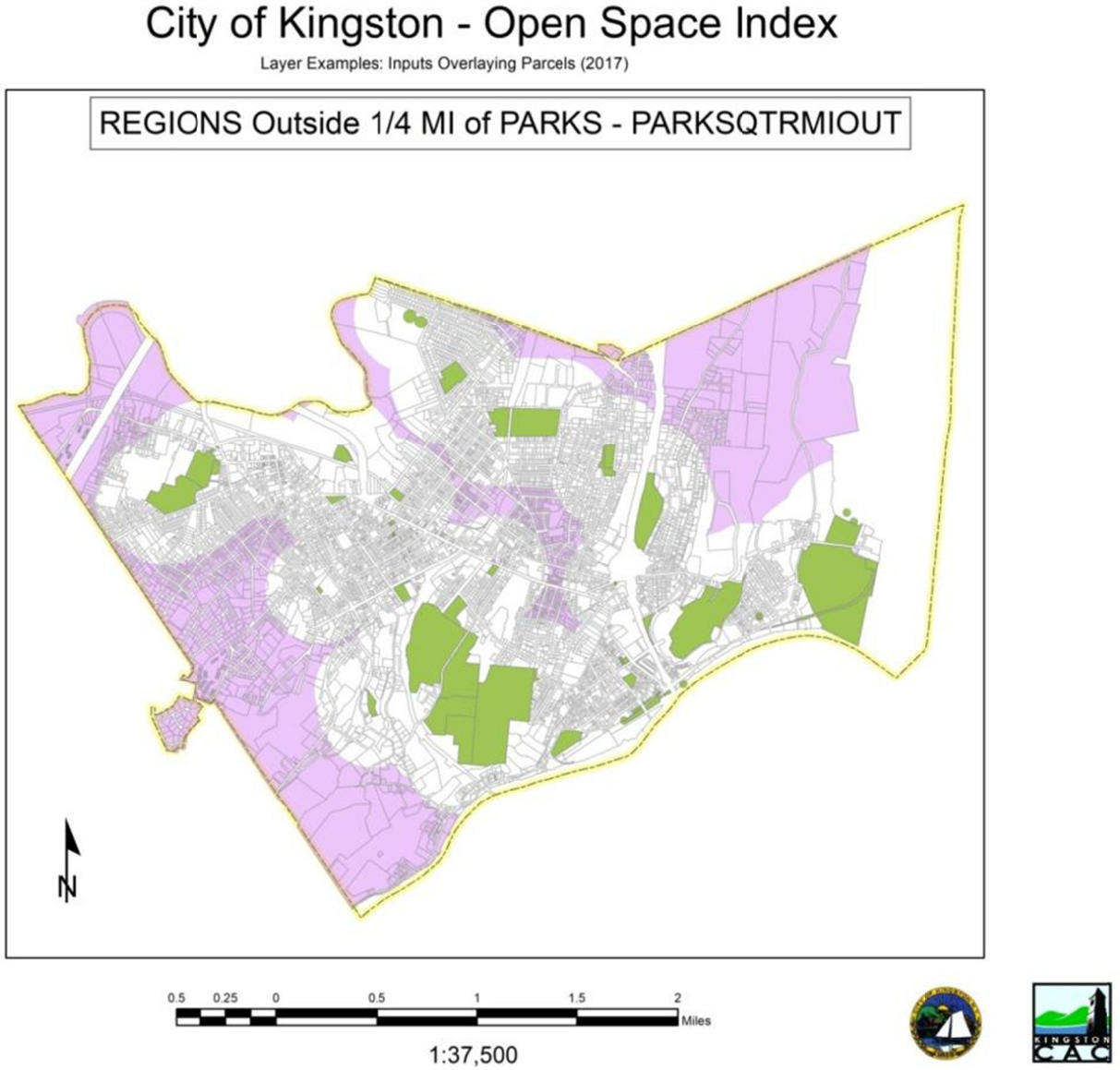


Figure 55. OSI Layer- Falls Outside of 1/4 mi. Radius of Park

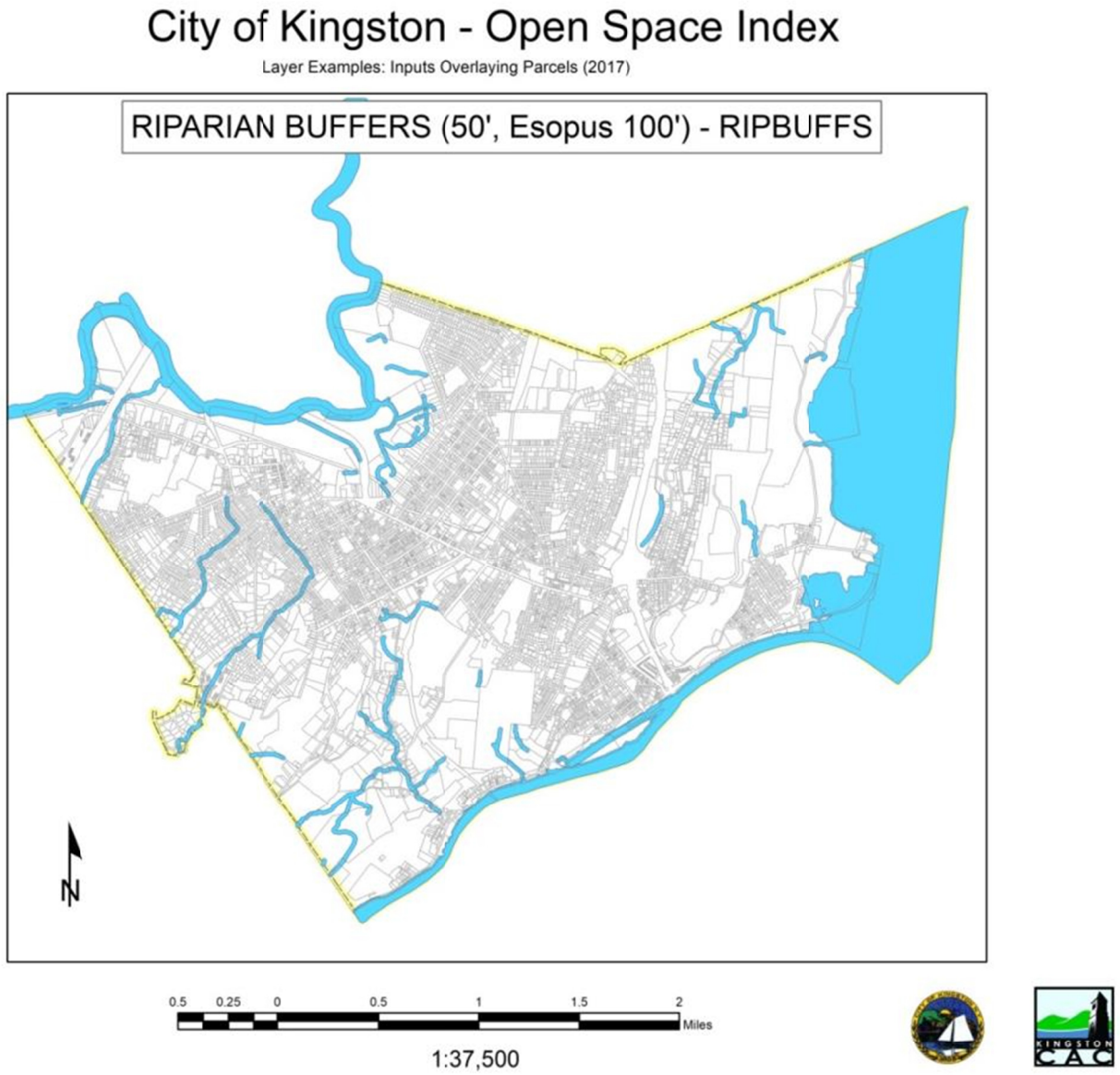


Figure 56. OSI Layer- Contains Riparian Buffers

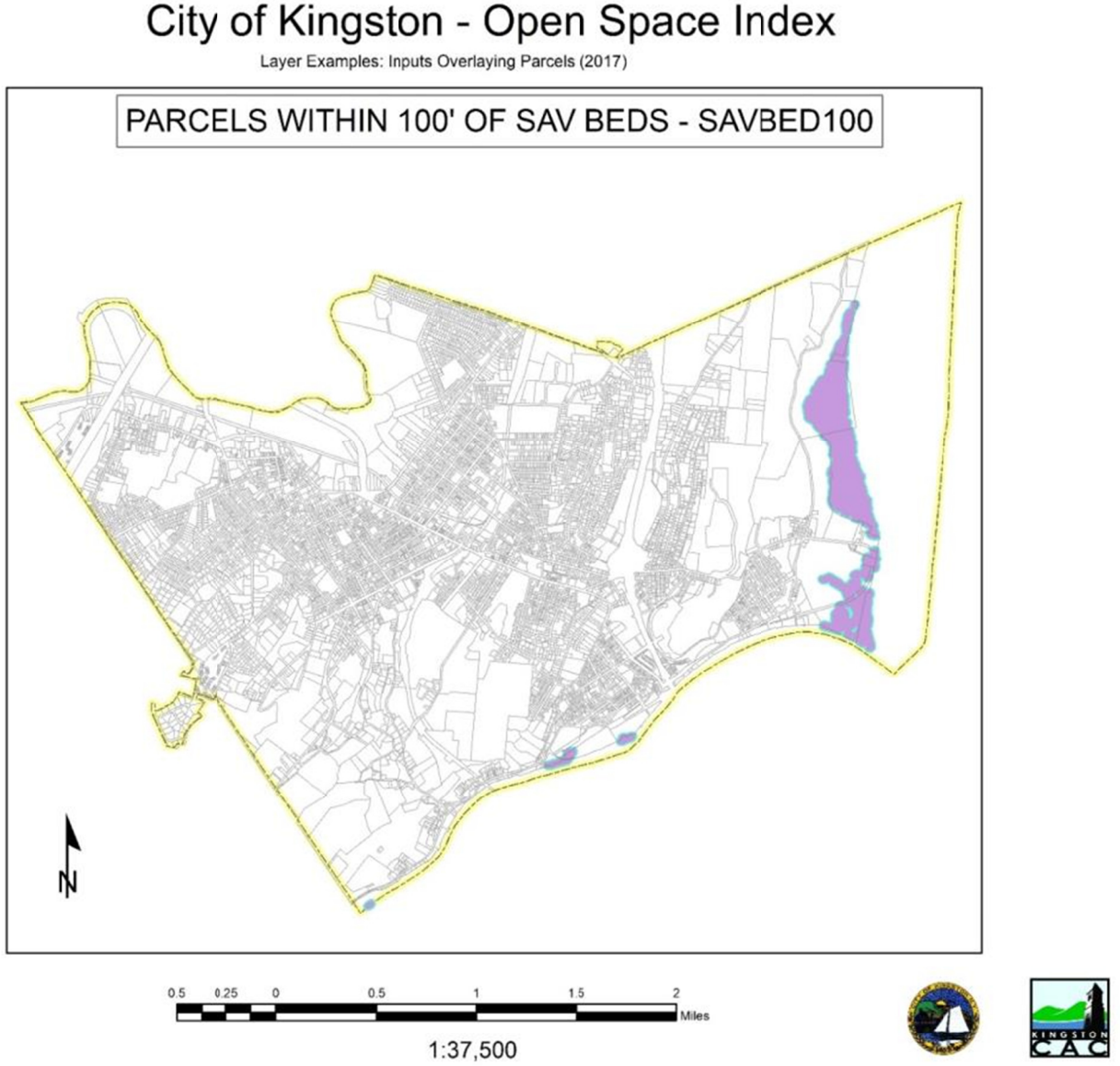


Figure 57. OSI Layer- Falls within 100' of Submerged Aquatic Vegetation bed (Hudson or Rondout)

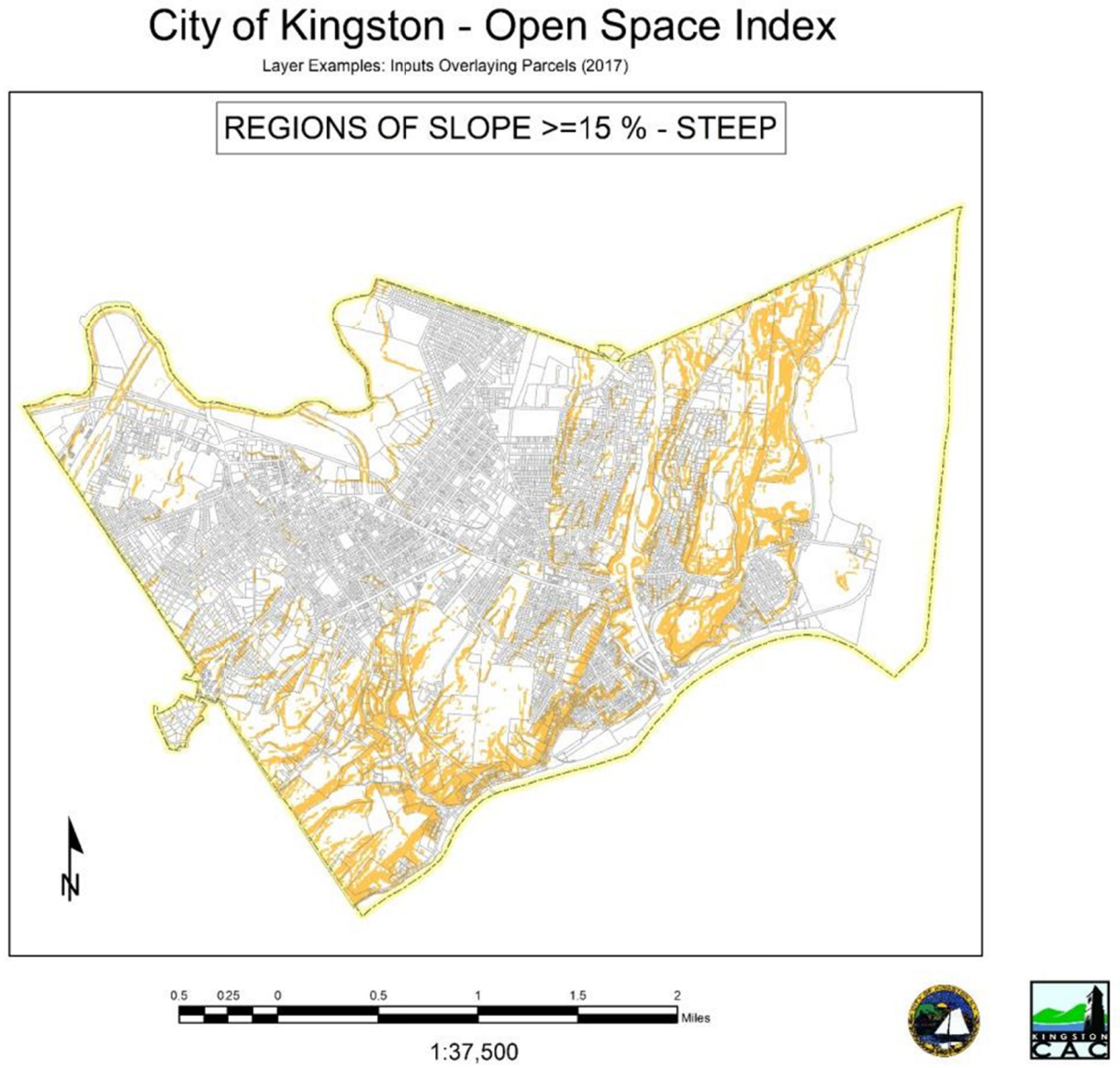


Figure 58. OSI Layer- Contains Steep Slope >= 15%

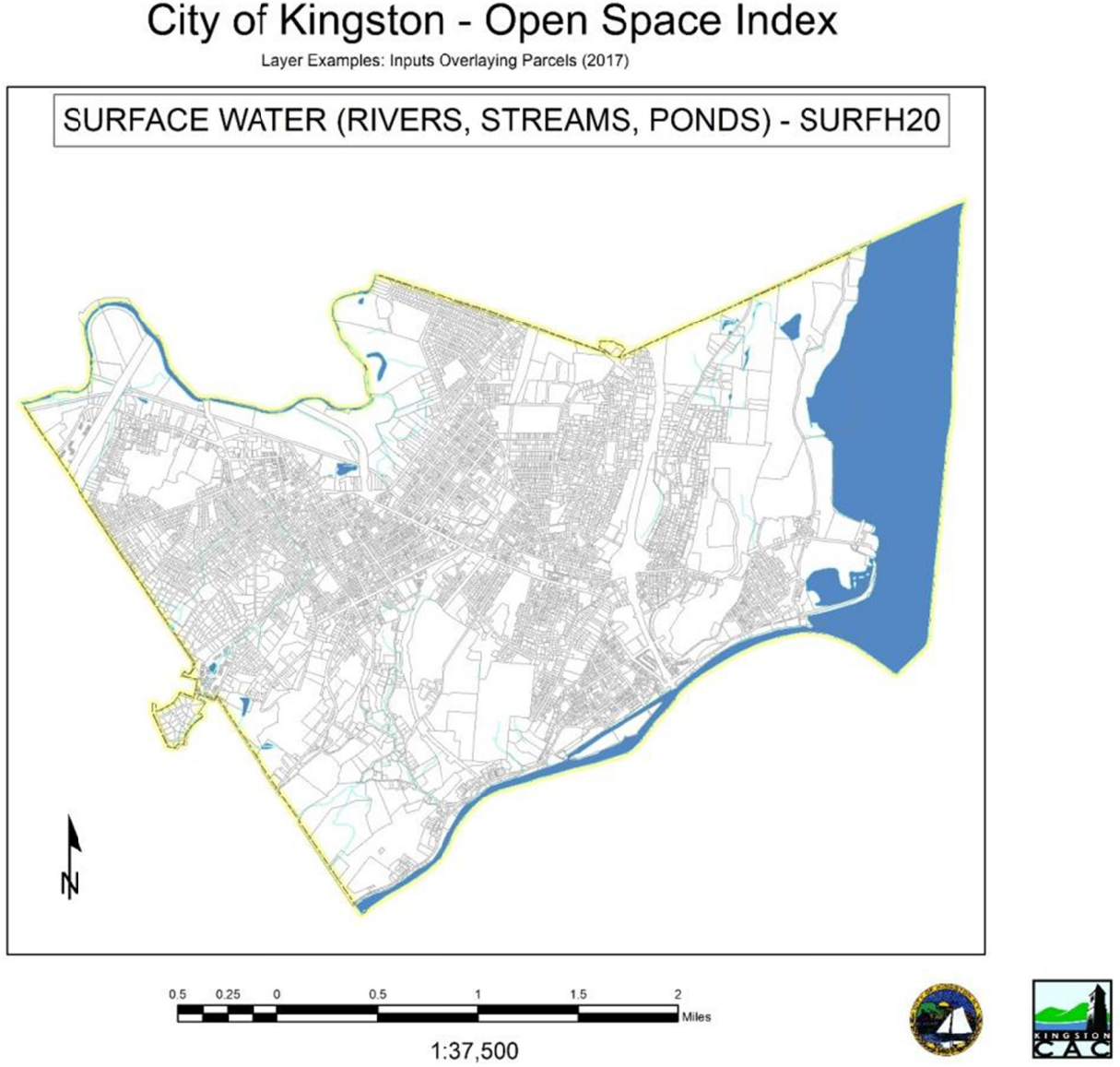


Figure 59. OSI Layer- Contains Surface Water (river, stream, pond)

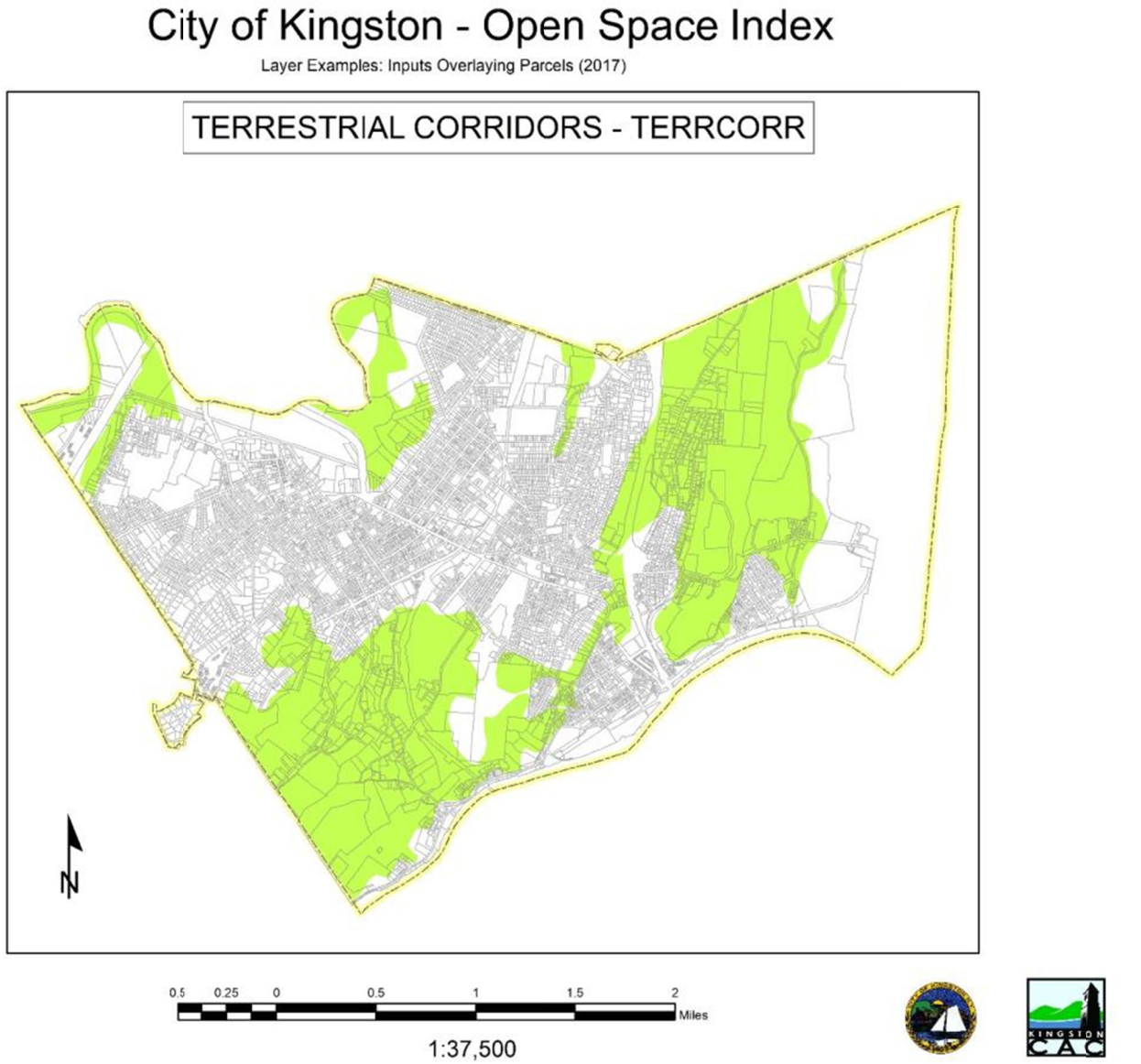


Figure 60. OSI Layer- Part of Terrestrial Corridor (regional\city)

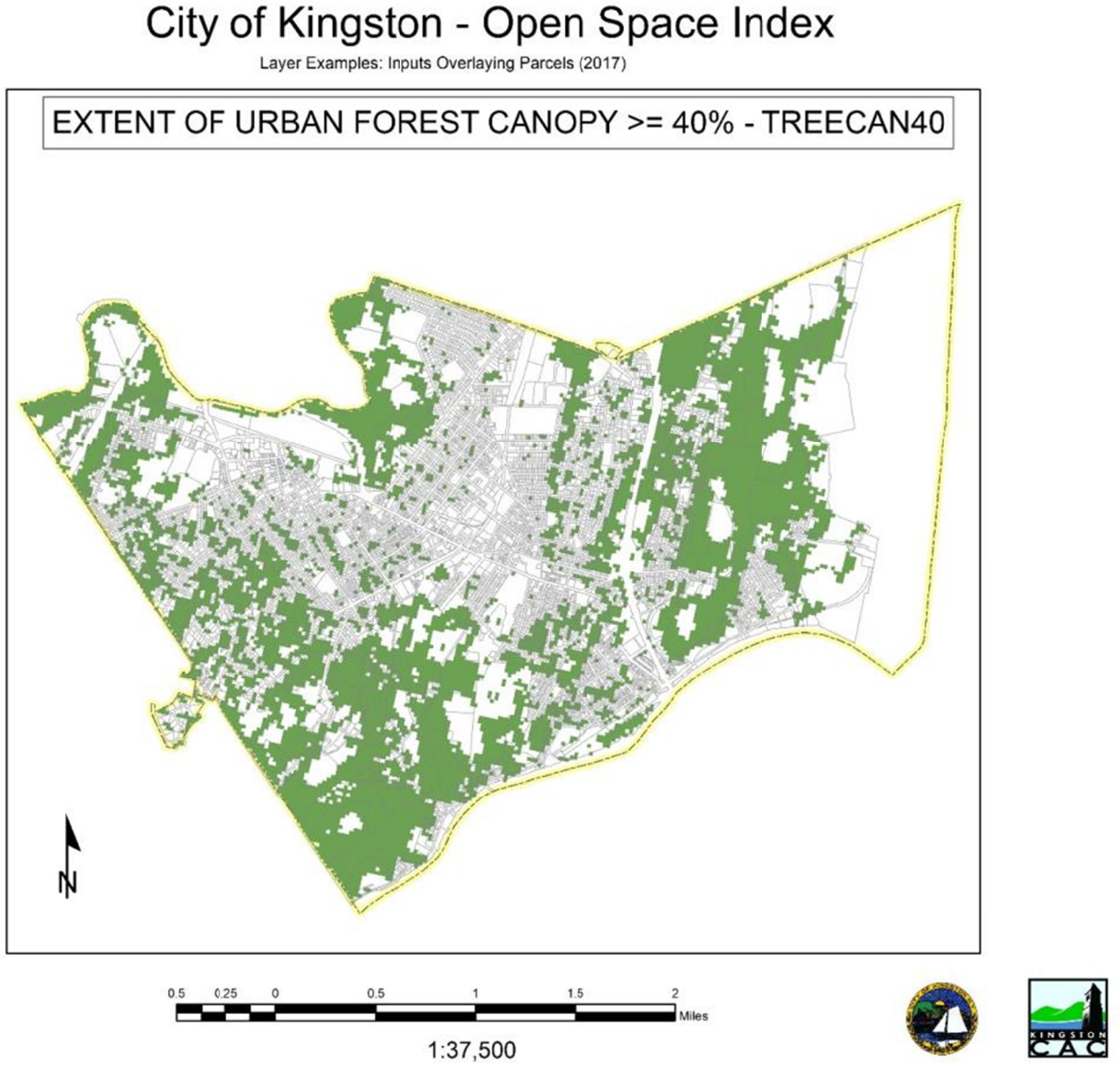


Figure 61. OSI Layer- Contains Forest Canopy >= 40%

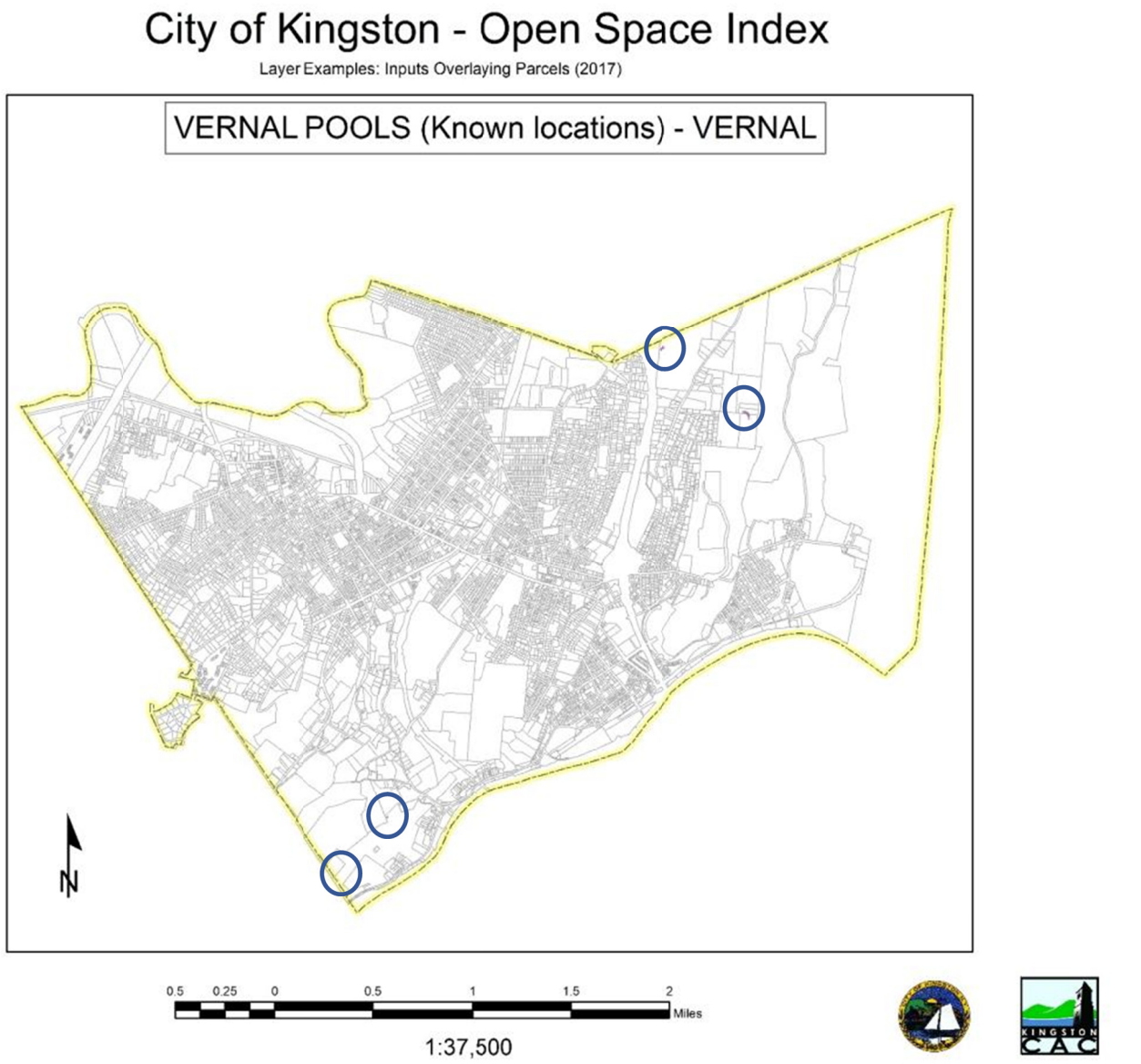


Figure 62. OSI Layer- Contains Known Vernal Pool (features are small)

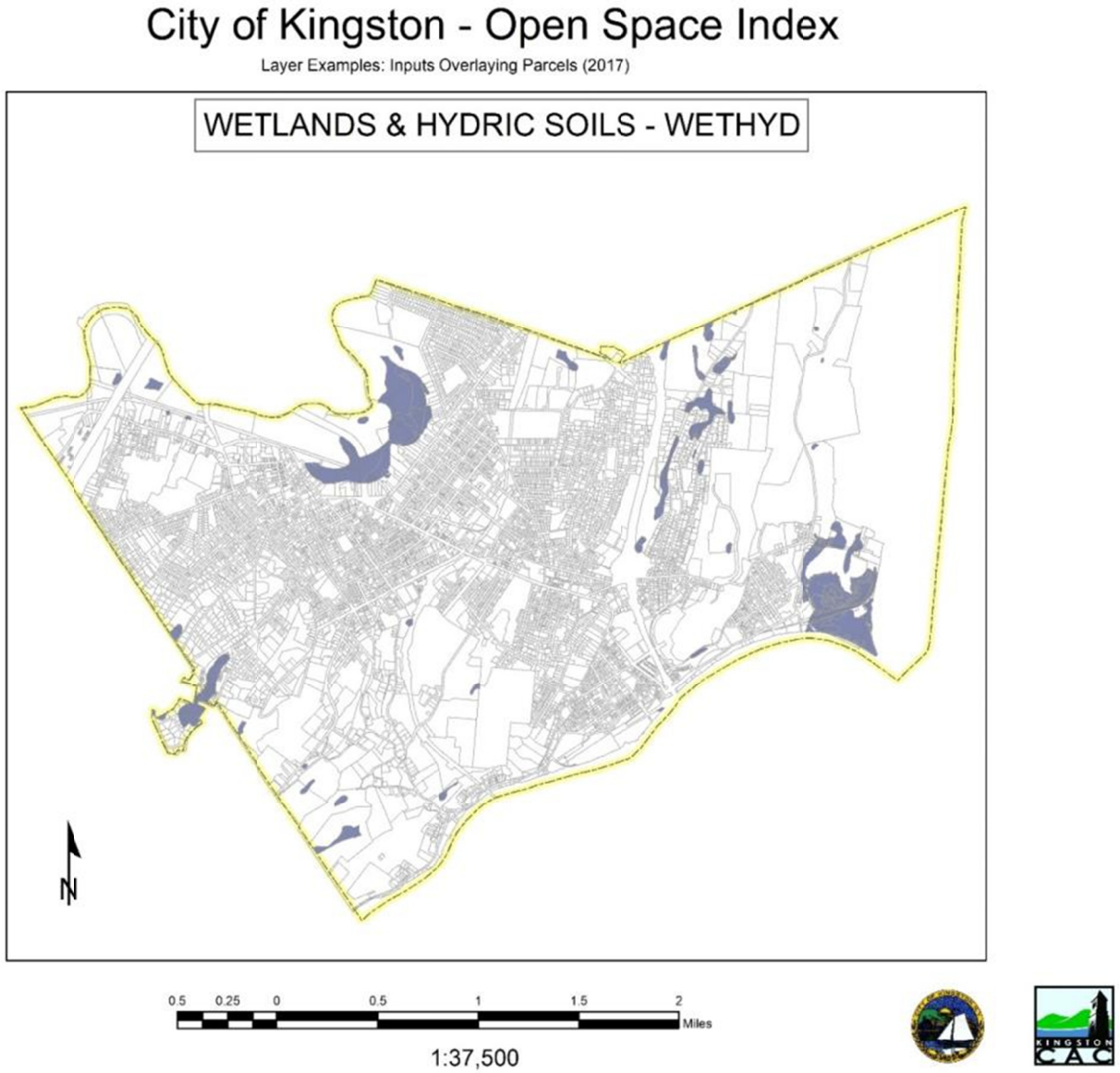


Figure 63. OSI Layer- Contains Wetland or Hydric Soils

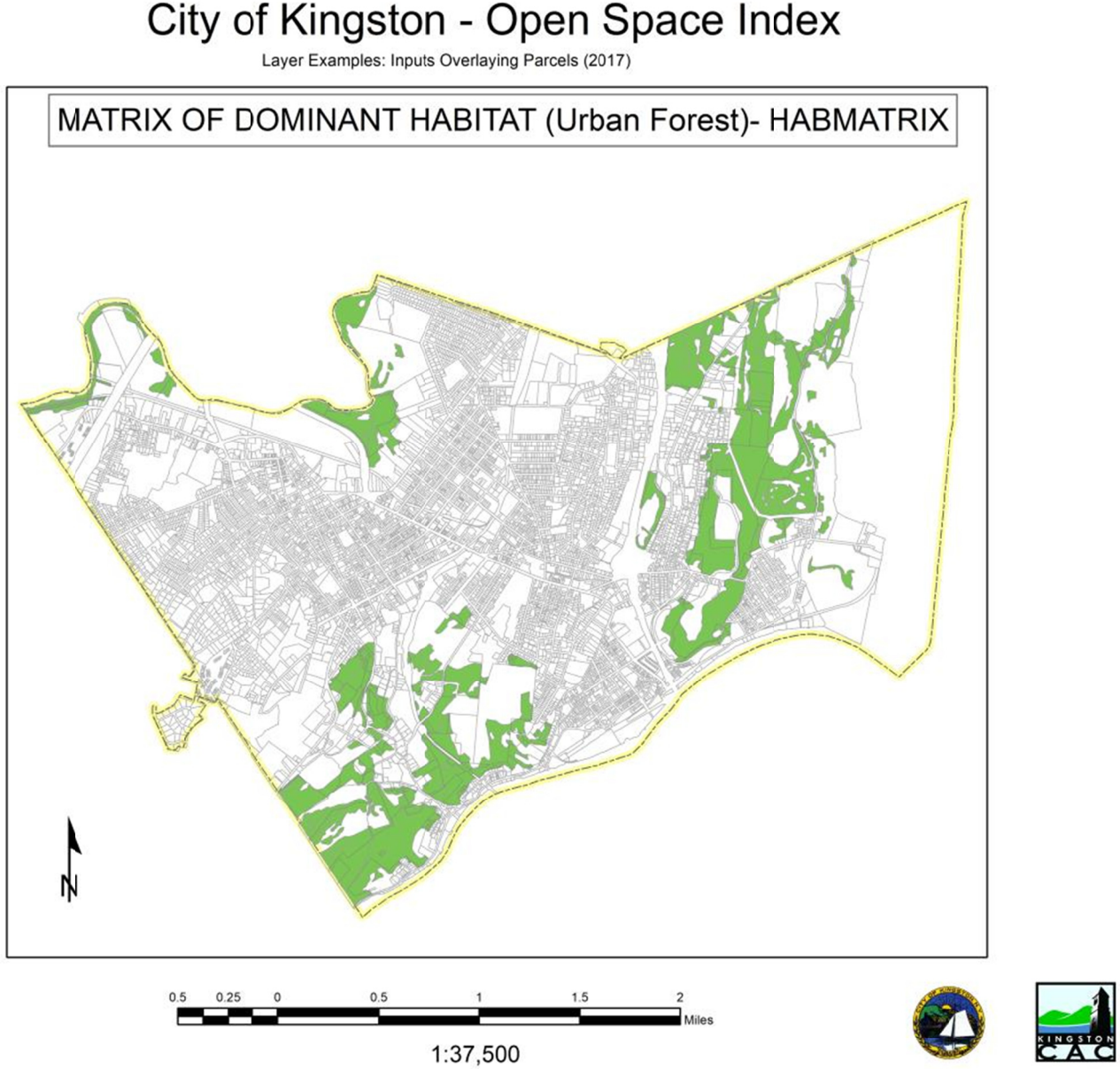


Figure 64. OSI Layer - Contains or dominated by Habitat Matrix (urban forest)

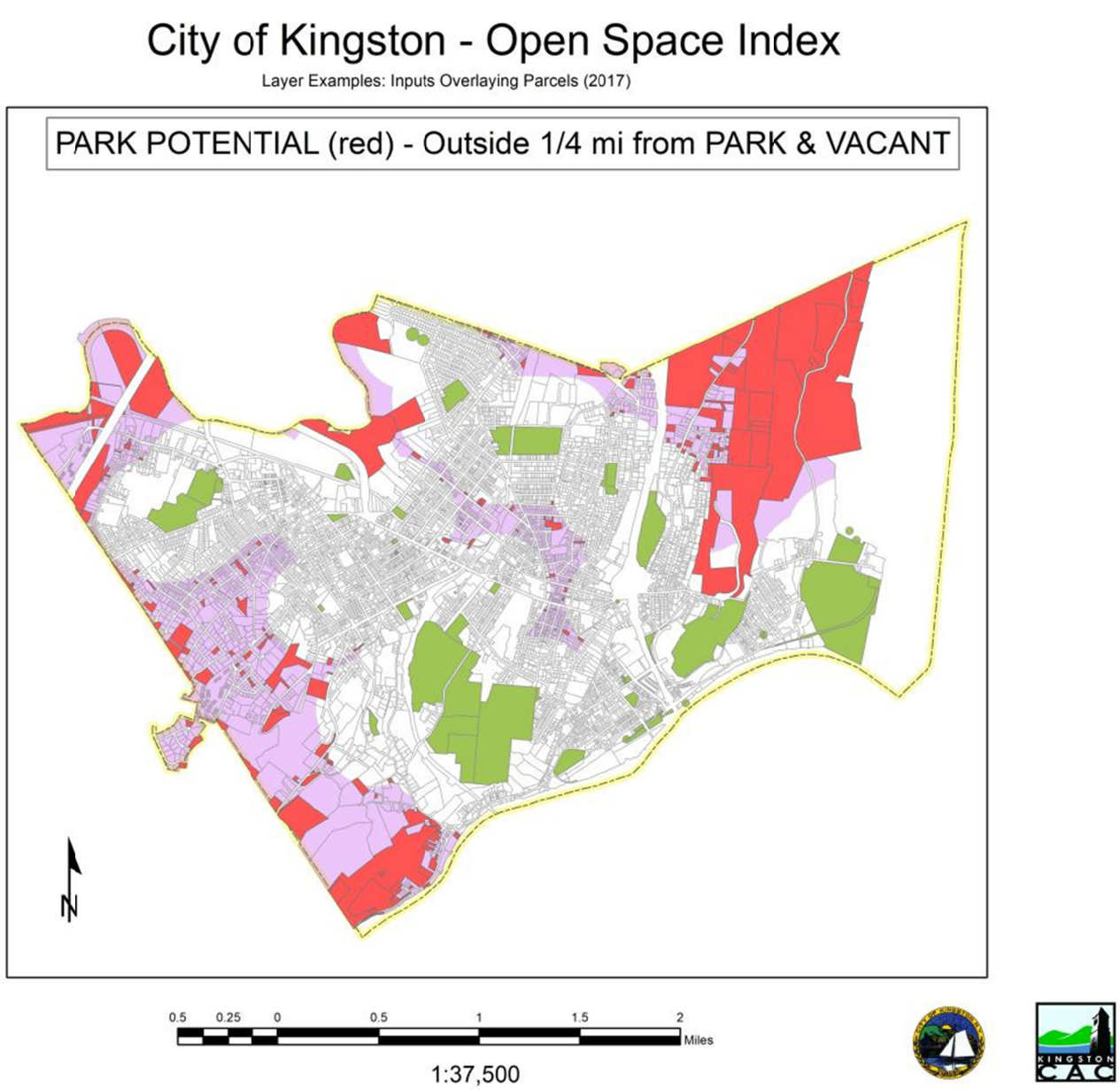


Figure 65. OSI Layer - Contains parcels outside of ¼ mi radius from existing Parklands and is Vacant (parcel code)

Appendix F. Species Tables and Lists (flora & fauna)

Section 1: Species Tables from: : 2014 Natural Areas and Wildlife in Your Community: A Habitat Summary Prepared for the City of Kingston – May 2014. NYSDEC L. Heady.

Species and Ecosystems of Conservation Concern in Kingston

The species and ecosystems of conservation concern that have been recorded in Kingston are listed in Tables 1 and 2. Table 1 lists state rare species and ecosystems and Table 2 lists bird species of conservation concern; both are referenced throughout the Habitat Summary text. In Tables 1 and 2, species are included if they are on the State or Federal Endangered and Threatened Species list, listed as a Species of Greatest Conservation Need in New York's Comprehensive Wildlife Conservation Strategy Plan, recognized as a Hudson River Valley Priority Bird by Audubon New York, or are other indicators of high quality habitat. All species and ecosystems in the lists are linked to a habitat described in the summary.

Note: There may be additional rare species and habitats in Kingston not yet documented.

Table 1. State Rare Animals and Ecosystems in Kingston

The following information comes from the New York Natural Heritage Program (NYNHP) biodiversity databases and the NY Amphibian and Reptile Atlas (NYARA). Data from NYNHP is available on-line from the New York Nature Explorer and information on rare animals, plants, and ecological communities can be found at http://guides.nynhp.org. The NYARA documented more reptile and amphibian species in Kingston than listed below; the table only includes those that are of conservation concern or are indicators of high quality habitat. For wildlife species, the "Description" column is largely based on the species groups in the NYS Comprehensive Wildlife Conservation Strategy (2005).

Common Name	Description	Scientific Name	Source
tidal river	Hudson River estuary	n/a	NYNHP
freshwater intertidal shore	Hudson River coastal habitat	n/a	NYNHP
freshwater tidal marsh	Hudson River coastal habitat	n/a	NYNHP
waterfowl winter concentration area	Hudson River coastal habitat	n/a	NYNHP
anadromous fish concentration area	Hudson River coastal habitat	n/a	NYNHP
shortnose sturgeon[4]	Hudson River fish	*Acipenser brevirostrum*	NYNHP
bald eagle[3]	open water/forest bird	*Haliaeetus leucocephalus*	NYNHP
Indiana bat[4]	forest mammal	*Myotis sodalis*	NYNHP

eastern small-footed myotis[2]	forest mammal	*Myotis leibii*	NYNHP
northern long-eared bat	forest mammal	*Myotis septentrionalis*	NYNHP
wood frog	vernal pool/forest amphibian	*Rana sylvatica*	NYARA
heartleaf plantain*	vascular plant of Hudson River coastal habitat	*Plantago cordata*	NYNHP
delmarva beggar-ticks*	vascular plant of Hudson River coastal habitat	*Bidens bidentoides*	NYNHP
Davis' sedge[3]	vascular plant of Hudson River coastal habitat	*Carex davisii*	NYNHP
smooth bur-marigold[3]	vascular plant of Hudson River coastal habitat	*Bidens laevis*	NYNHP
American waterwort[4]**	vascular plant of Hudson River coastal habitat	*Elatine americana*	NYNHP
riverbank quillwort[4]**	vascular plant of Hudson River coastal habitat	*Isoetes riparia*	NYNHP
Hudson River water-nymph[4]**	vascular plant of Hudson River coastal habitat	*Najas guadalupensis ssp. muenscheri*	NYNHP
estuary hatpins***	vascular plant of Hudson River coastal habitat	*Eriocaulon parkeri*	NYNHP

[1] NYS Species of Greatest Conservation Need (SGCN)

[2] NYS Special Concern [3] NYS Threatened Species [4] NYS Endangered Species

*State rare

**historical record

***historical record, extirpated from NY

Table 2. Significant Birds in Kingston

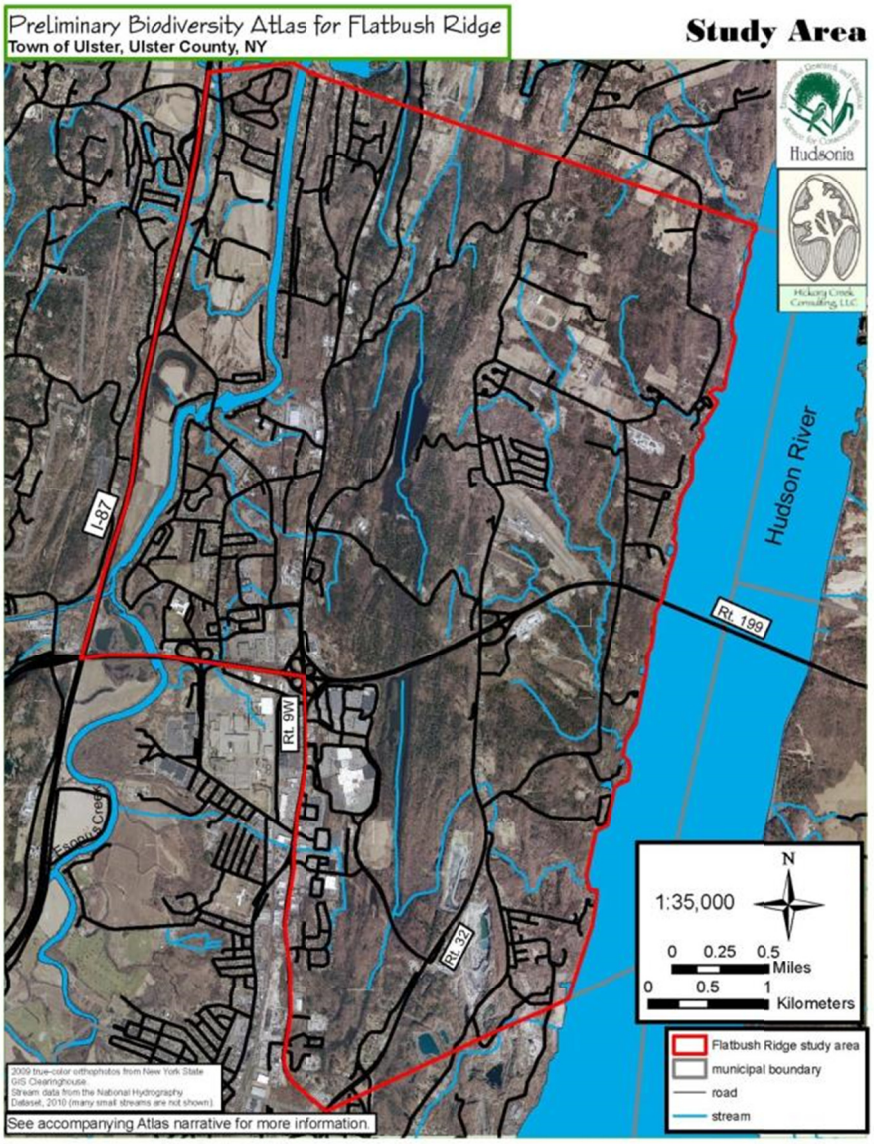
The following table lists bird species of conservation concern that were observed in Kingston during the 2000-2005 New York State Breeding Bird Atlas (BBA). Species are included in the table if 1) they were documented in Atlas blocks that are more than 50% in Kingston and 2) they have been identified as Hudson River Valley Priority Birds by Audubon NY (2009). Associated habitat information and links to species profiles, when available, are also from Audubon NY (2009); young forest and shrubland habitat designations are from DEC Biologist Paul Novak.

		NYS Conservation Status			
Common Name	**Scientific Name**	Species of Greatest Conservation Need	Special Concern	Threatened	Endangered
Forest Birds					
American Redstart	*Setophaga ruticilla*				
Baltimore Oriole	*Icterus galbula*				
Black-and-white Warbler	*Mniotilta varia*				
Black-throated Green Warbler	*Dendroica virens*				
Broad-winged Hawk	*Buteo platypterus*				
Downy Woodpecker	*Picoides pubescens*				
Eastern Wood-Pewee	*Contopus virens*				
Louisiana Waterthrush	*Seiurus motacilla*	**x**			
Northern Flicker	*Colaptes auratus*				
Purple Finch	*Carpodacus purpureus*				
Rose-breasted Grosbeak	*Pheucticus ludovicianus*				
Scarlet Tanager	*Piranga olivacea*	**x**			
Veery	*Catharus fuscescens*				
Wood Thrush	*Hylocichla mustelina*	**x**			
Yellow-throated Vireo	*Vireo flavifrons*				
Young Forest and Shrubland Birds					
American Woodcock	*Scolopax minor*	**x**			
Black-billed Cuckoo	*Coccyzus erythropthalmus*	**x**			
Blue-Winged Warbler	*Vermivora pinus*	**x**			
Brown Thrasher	*Toxostoma rufum*	**x**			
Eastern Kingbird	*Tyrannus tyrannus*				
Eastern Towhee	*Pipilo erythrophthalmus*				
Indigo Bunting	*Passerina cyanea*				
Prairie Warbler	*Dendroica discolor*	**x**			
Willow Flycatcher	*Empidonax trailli*	**x**			

Common Name	Scientific Name	NYS Conservation Status			
		Species of Greatest Conservation Need	Special Concern	Threatened	Endangered
Wetland Birds					
s	*Ixobrychus exilis*	**x**		**x**	
Marsh Wren	*Cistothorus palustris*				
Birds of Other Habitats					
Chimney Swift (urban)	*Chaetura pelagica*				

Section 2. Species Lists from the Flatbush Ridge Project (2010).

Potential species tables from *A Preliminary Biodiversity Atlas for Flatbush Ridge*, (2010) conducted by Hudsonia Ltd. and Hickory Creek Consulting, LLC, for the Lower Esopus Watershed Partnership (http://www.loweresopus.org/). Species distributions were taken from the general Ulster County region, for the project. Field verification was not undertaken and would need to be conducted to verify the actual occurrence within the City of Kingston or the immediate region.



Plants of Conservation Concern, Ulster County, NY

Preliminary Biodiversity Atlas for Flatbush Ridge, 2010

The plants listed below appear on statewide rarity lists, and are also known to occur in Ulster County. A habitat assessment would be needed to ascertain which plants are likely to occur in the Flatbush Ridge study area. The Wetland Indicator Status is given here to indicate the likelihood of occurrence in wetlands. See footnotes for explanations of the abbreviations.

Scientific Name	Common Name	NYS Rarity Rank	NY Natural Heritage Program	USFWS Wetland Indicator Status
Agastache nepetoides	yellow giant hyssop	T	Active inventory	FACU
Agrimonia parviflora	swamp agrimony		Watch list	FAC
Agrimonia rostellata	woodland agrimony	T	Active inventory	FACU
Aplectrum hyemale	puttyroot	E	Active inventory	FACU
Arabis missouriensis	green rock-cress	T		
Arethusa bulbosa	dragon's mouth orchid	T	Active inventory	OBL
Aristolochia serpentaria	Virginia snakeroot	E	Active inventory	UPL
Asclepias viridiflora	green milkweed	T	Active inventory	
Bidens bidentoides	Delmarva beggar-ticks	R	Active inventory	FACW
Bidens laevis	smooth bur-marigold	T	Active inventory	OBL
Blephilia ciliata	downy wood-mint	E		
Boecheria missouriensis	green rock-cress	T	Active inventory	
Botrychium oneidense	blunt-lobe grape fern	E	Active inventory	
Carex albicans var. *emmonsii*	Emmons' sedge		Watch list	
Carex amphibola	narrow-leaved sedge	E	Active inventory	FAC
Carex backii	rocky mountain sedge	T		
Carex bushii	Bush's sedge		Watch list	FACW
Carex cryptolepis	northeastern sedge		Watch list	OBL
Carex cumulata	clustered sedge	T	Watch list	FACU
Carex davisii	Davis's sedge	T	Watch list	FAC
Carex frankii	Frank's sedge	E	Watch list	OBL
Carex glaucodea	glaucous sedge	E	Watch list	
Carex haydenii	cloud sedge	E		

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Carex lupuliformis	false hop sedge	R	Watch list	FACW+
Carex merritt-fernaldi	Fernald's sedge	T	Watch list	
Carex molesta	troublesome sedge	T	Watch list	
Carex retroflexa	reflexed sedge	E	Watch list	
Carex seorsa	weak stellate sedge	T	Watch list	FACW
Carex straminea	straw sedge	E	Watch list	OBL
Castilleja coccinea	scarlet Indian paintbrush	E	Watch list	FAC
Celastrus scandens	American bittersweet		Watch list	
Ceratophyllum echinatum	prickly hornwort	T	Watch list	OBL
Chamaelirium luteum	fairy wand	T	Watch list	FAC
Cheilanthes lanosa	wooly lip-fern	E	Watch list	
Corydalis aurea	golden corydalis	T	Watch list	
Crassula aquatica	water pigmyweed	E	Watch list	OBL
Crotalaria sagittalis	rattlebox	E	Watch list	
Cuscuta cephalanthi	buttonbush dodder	E	Watch list	
Cynoglossum virginianum var. *boreale*	northern wild comfrey	E	Watch list	
Cyperus erythrorhizos	red-root sedge		Watch list	FACW
Cypripedium arietinum	ram's head lady's slipper	T		
Cypripedium parviflorum var. *parviflorum*	small yellow lady's slipper	E	Watch list	
Desmodium laevigatum	smooth tick-clover	E		
Dichanthelium oligosanthes var. *oligosanthes*	rough panic grass	E	Watch list	FACU
Digitaria filiformis	slender crabgrass	T	Watch list	
Diphasiastrum complanatum	northern running-pine	E	Watch list	
Eclipta prostrata	false-daisy	E	Watch list	
Elatine americana	American waterwort	E	Watch list	OBL
Eleocharis fallax	creeping spikerush	E	Watch list	OBL
Eleocharis obtusa var. *ovata*	blunt spikerush	E	Watch list	OBL
Eleocharis quandrangulata	angled spikerush	E	Watch list	OBL

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Mimulus alatus	winged monkeyflower	R	Watch list	OBL
Minuartia glabra	Appalachian sandwort	T		UPL
Minuartia groenlandica	mountain sandwort		Watch list	
Myriophyllum farwellii	farwell watermilfoil	T		OBL
Oenothera laciniata	cut-leaved evening-primrose	E	Active inventory	FACU-
Orontium aquaticum	golden club	T	Active inventory	OBL
Oxalis violacea	violet wood sorrel	T	Active inventory	
Pellaea glabella	smooth cliff-brake	T		
Pedicularis lanceolata	swamp lousewort	T	Active inventory	FACW
Persicaria careyi	Carey's smartweed	E	Active inventory	FACW
Persicaria setacea	swamp smartweed	E	Active inventory	OBL
Petasites frigidus var. *palmatus*	sweet coltsfoot	E		
Plantago cordata	heartleaf plantain		Active inventory	OBL
Platanthera hookeri	Hooker's orchid	E	Active inventory	FAC
Podostemum ceratophyllum	riverweed	T	Active inventory	OBL
Polemonium vanbruntiae	Jacob's ladder	R	Active inventory	FACW
Polygonum erectum	erect knotweed	E	Watch list	FACU
Polygonum tenue	slender knotweed	R	Watch list	
Populus heterophylla	swamp cottonwood	T	Active inventory	FACW+
Potamogeton pulcher	spotted pondweed	T	Active inventory	OBL
Prunus pumila var. *pumila*	low sand cherry	E		
Ranunculus hispidus var. *nitidus*	swamp buttercup	E	Active inventory	FAC
Ranunculus micranthus	small-flowered crowfoot	T	Watch list	FACU
Rotala ramosior	tooth-cup	T	Active inventory	OBL
Sagittaria montevidensis var. *spongiosa*	spongy arrowhead	T	Active inventory	OBL
Sagittaria subulata	strap-leaf arrowhead		Watch list	OBL
Salvia lyrata	lyre-leaf sage	E	Active inventory	UPL
Scirpus georgianus	Georgia bulrush	E	Active inventory	OBL

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Scutellaria integrifolia	hyssop skullcap	E	Active inventory	FACW
Solidago rigida	stiff-leaf goldenrod	T		
Sphenopholis obtusata	prairie wedgegrass	E	Active inventory	FAC-
Sphenopholis pensylvanica	swamp oats	E	Active inventory	OBL
Symphyotrichum laeve var. *concinnum*	smooth blue aster	E	Active inventory	
Thaspium trifoliatum var. *flavum*	purple meadow-parsnip		Active inventory	
Trichomanes intricatum	Appalachian trichomanes	E	Active inventory	
Trichostema brachiatum	false-pennyroyal		Watch list	
Triphora trianthophora	nodding pogonia	E	Active inventory	UPL
Trollius laxus	spreading globeflower	R	Active inventory	OBL
Utricularia juncea	rush bladderwort	T	Active inventory	OBL
Valeriana uliginosa	marsh valerian	E	Active inventory	OBL
Verbesina alternifolia	wingstem	T		FAC
Vernonia gigantea ssp. *gigantea*	tall ironweed	E	Active inventory	
Veronicastrum virginicum	culver's root	T	Active inventory	FACU
Viola hirsutula	southern wood violet	E	Active inventory	
Viola primulifolia	primrose-leaf violet	T	Active inventory	FAC+
Vittaria appalachiana	Appalachian shoestring fern	E	Active inventory	

Explanation of Data

New York State Rarity Rank as listed in the NYS Environmental Conservation Law:
Endangered, E; Threatened, T; Rare, R. The NYS Environmental Conservation Law considers the following groups to be 'vulnerable':

--All native clubmosses
--All native ferns except bracken (*Pteridium aquilinum*), hay-scented (*Dennstaedtia punctilobula*), and sensitive (*Onoclea sensibilis*)
--All native orchids

New York Natural Heritage Program-
Listed here are those species whose presence in Ulster County is confirmed or probable.

Wetland Indicator Status
Wetland Indicator Status is assigned by the U.S. Fish and Wildlife Service (Reed 1988).
Indicator Categories:

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OBL (Obligate Wetland) Plants that occur almost always under natural conditions in wetlands (estimated probability greater than 99%)

FACW (Facultative Wetland) Plants that usually occur in wetlands (estimated probability 67-99%) but occasionally found in nonwetlands

FAC (Facultative) Plants that are equally likely to occur in nonwetlands or wetlands (estimated probability 34-66%)

FACU (Facultative Upland) Plants that usually occur in nonwetlands (estimated probability 67-99%) but occasionally found in wetlands (estimated probability 1-33%)

UPL (Obligate Upland) Plants that occur in wetlands in another region, but occur almost always (estimated probability greater than 99%) under natural conditions in nonwetlands in the region specified (the Northeast in this case) If a plant species does not occur in wetlands in any region, it is not included on the National List. However, changes in plant names (synonomy) may warrant additional investigation regarding potential wetland indicator status.