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## Using GIS to determine the influence of wetlands on Cayuga Iroquois settlement location strategies

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USING GIS TO DETERMINE THE INFLUENCE OF WETLANDS ON  
CAYUGA IROQUOIS SETTLEMENT LOCATION STRATEGIES

by

DAVID J. BIRNBAUM

A thesis submitted in partial fulfillment of the requirements  
for the Honors in the Major Program in Anthropology  
in the College of Sciences  
and in The Burnett Honors College  
at the University of Central Florida  
Orlando, Florida

Fall Term 2011

Thesis Chair: Dr. John H. Walker

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## ABSTRACT

The archaeological record of the Iroquois supports that settlements were regularly relocated during the protohistoric period (1500-1650 A.D.). With the use of Geographic Information Systems (GIS) computer software, archaeologists may analyze variables potentially resulting in or influencing the movement of settlements. Through the use of spatial analysis, I argue that Cayuga Iroquois settlement locations were influenced by the environmental characteristics of their surrounding landscape. Specifically, wetlands are believed to have influenced settlement location choices in central New York state. This study examines the spatial relationships between wetland habitats and protohistoric period Cayuga Iroquois settlements where swidden maize agriculture comprised most of the diet. Considering previous research that has linked the movement of settlements to Iroquois agricultural practices, I hypothesize that wetlands played a significant role in the Iroquoian subsistence system by providing supplementary plant and animal resources to a diet primarily characterized by maize consumption, and thereby influenced the strategy behind settlement relocation.

Nine Cayuga Iroquois settlements dating to the protohistoric period were selected for analysis using GIS. Two control groups, each consisting of nine random points, were generated for comparison. Distance buffers show the amount of wetlands that are situated within 1-, 2.5-, and 5-kilometers from Cayuga settlements and random points. The total number of wetlands within proximity of these distances to the settlements and random points are recorded and analyzed. The results indicate a statistical significance regarding the prominence of wetlands within the landscape which pertains to the Cayuga Iroquois settlement strategy.

## DEDICATIONS

For my family, whose support has encouraged me to aim for and achieve success.

For the Hominids Anonymous Society, which has fostered an environment in which undergraduate anthropologists at the University of Central Florida can thrive and flourish.

For Paige, whose brilliant smile helps me embrace life with a positive outlook each day.

## ACKNOWLEDGEMENTS

I would like to thank each of my committee members for making themselves readily available to me throughout the research and writing process and for providing feedback on various drafts of this paper. My sincerest thanks and appreciation to my Thesis Chair, Dr. John H. Walker, for being a constant source of positive encouragement and direction. Special thanks to my out-of-department committee member, Dr. John F. Weishampel, who secured a student license for ArcGIS on my behalf. Thanks to my anthropology department committee member Dr. Sarah “Stacy” B. Barber for providing feedback regarding the aesthetics and functionality of my maps. Special thanks to Dr. Kenneth E. Sassaman for providing an invaluable critique of an early draft of this paper, and to Dr. Eric E. Jones for providing advice on acquiring locations of Cayuga settlements. Additional thanks to my friend and colleague Kendall McCollough for assisting me with generating statistical results from my data. I would also like to thank the College of Sciences and The Burnett Honors College of the University of Central Florida for awarding me a research scholarship that enabled me to continue my spatial analysis and thus substantially expand the depth of my study.

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## INTRODUCTION

Documenting the settlement patterns of Native American peoples has been established as a staple practice of North American archaeology. Investigating the spatial relationships between the physical landscape and the distribution of settlement locations provides a foundation upon which archaeologists may develop theories regarding the influence of variables on the strategic placement of settlements. Most of the early research in this area of study focused on predictive modeling based on spatial distributions of culture areas and their respective systems of subsistence and settlement patterns. Recently, archaeologists have increasingly utilized Geographic Information Systems (GIS) and spatial analysis to distinguish relationships between the environment and cultural aspects such as settlement locations. Studies have considered the impact of cultural, political, economic, and ideological factors on settlement location (Ingold 1993; Jones 2006; Llobera 2000, 2001; Maschner 1996b), but environmental factors remain the most tangible variables for which empirical data may be easily obtained and thereby examined, analyzed and interpreted through the use of GIS (Allen 1996; Hasenstab 1996a; Jones 2010).

With the present study the correlation between a cultural phenomenon, the regular movement of Cayuga Iroquois settlements in intervals of fifteen to twenty years (Allen 1996, 2009; Hasenstab 1996a), and the prominence of wetlands in the surrounding landscape is analyzed through the use of GIS. This relationship demonstrates that the Cayuga practiced a settlement strategy that exhibits a deliberate positioning of new settlements with the presence of



wetlands as a variable of major consideration in the settlement strategy.

The relative importance of wetland resources has been inferred from the confluence of several lines of evidence, including studies of wetland use in the archaeological record, predictive modeling studies relating wetlands to prehistoric site distributions, and descriptions of Iroquois culture. Funk (1992) conducted a study in which the biological resources of present-day wetlands were compared with those found in the archaeological record of prehistoric sites in upstate New York. Hasenstab (1991) and Sanders (2008) conducted spatial analyses of prehistoric site distributions in New Jersey and coastal New York, respectively, which resulted in predictive models of archaeological site locations in relation to wetlands and waterways. Allen (2009) and Snow (1994) describe an existing sexual division of labor among the Iroquois as being standard across the different cultural groups. The men were responsible for long-distance trade, hunting, and warfare, while the women were responsible for land management and domestic duties including childcare, food preparation, and basket weaving. The Iroquois women would accomplish their daily tasks both inside and nearby the village, though they did not venture beyond reasonable walking distances to gather food and raw materials. The Cayuga were no exception to this system of gender-based labor assignments among the Iroquois. Furthermore, of the major Iroquois culture groups, the Cayuga in particular have been noted to be adept hunters and relied more heavily on hunting and foraging than the other Iroquois tribes (Allen 2009). It is likely that wetlands were pertinent in regards to the hunting and gathering aspect of Cayuga subsistence based on the descriptions of the daily labor tasks present in Iroquois society

as summarized above. I hypothesize that wetlands played a vital role in maintaining a mixed subsistence system of maize agriculture and seasonal foraging, and thus were a major consideration for the Cayuga when periodically relocating their villages.

This study explores the potential ecological benefits that native peoples would have enjoyed by utilizing a settlement strategy that adheres to certain criteria, as well as highlighting the notion of purposeful placement of settlements within a given landscape. The presence of wetland ecosystems within proximity to settlement locations suggests that the Iroquois considered this environmental factor when relocating their settlements every generation, or more specifically, in intervals of fifteen to twenty years (Allen 1996; Hasenstab 1996a). Furthermore, it may be inferred that Iroquois peoples regularly made use of the faunal resources, such as seasonal waterfowl, provided by wetlands as dietary supplements alongside the primary means of subsistence, swidden maize agriculture. It is hypothesized that in order to maintain this mixed subsistence strategy, the Cayuga sought to establish settlements on lands that contained enough agriculturally viable soils to establish swidden plots for fifteen to twenty years while simultaneously situating themselves within reasonable walking distance to wetlands.

The goal of this research is to show that wetland environments were considered by Cayuga Iroquois populations during the protohistoric period as they periodically relocated and established new village settlements. This research also has three generalized goals regarding theory and method in archaeological research. Primarily, this project will potentially augment explanations of how settlement location choices were made in the past in relation to the

environment and the features of the natural landscape. Moreover, this research is intended to further explore the efficacy of utilizing GIS to reconstruct past settlement strategies and social behaviors in archaeological settlement research. Lastly, this study will serve the broader purpose of evaluating the use of spatial analysis research related to settlement patterns and ecology, regarding the degree of proximity to environmental features and their prominence in the landscape as a means of interpreting cultural trends and human behavior.

## LITERATURE REVIEW

The following sub-sections address the popularly known applications of GIS for spatial analysis in archaeology, the definition and utilization of settlement ecology theory, the history and relevance of Iroquois settlement archaeology, a summary of previous research that has investigated environmental variables in relation to settlement locations and/or use of GIS in the Iroquois region, and a summary of the site sample that has been selected for the present study.

### *GIS and Spatial Analysis in Archaeology*

A Geographic Information System (GIS) can create and utilize spatial information. Bolstad (2008:1) defines GIS as “a computer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information.” In contrast to map-generating software, GIS software contains the added capabilities of acquiring, manipulating, visualizing, and storing geographic data. Noting the program's ability to work with various sorts of data, its analytical functions, and its ability to generate new information, GIS may be viewed primarily as a tool for anthropologists and archaeologists alike to use in drawing interpretations about human behavior (Aldenderfer and Maschner 1996). According to Connolly and Lake (2006:11), “GIS should be considered as both an integrated and as an integrating technology that provides a suite of tools” that afford archaeologists an array of vehicles by which to better

understand and interact with spatial data. “Among the most productive avenues of inquiry in GIS-based research are the areas of graphical representation, exploratory data analysis, and spatial statistics” (Maschner 1996a:5). Hodder and Orton (1976) provide a detailed discussion of various statistical applications related to spatial analysis in settlement archaeology and artifact distributions. In the realm of archaeological research, GIS has demonstrated its efficiency in creating easily disseminated visual representations of site distributions and associated geographical data.

### *Settlement Ecology Theory*

“Settlement ecology is the investigation of the relative influences of various natural and cultural factors on the location, size, movement, and distribution of settlements of a given society during a given time period” (Jones 2010:1). Generally included within the examination of cultural factors in settlement ecology are primary characteristics of societal complexity such as subsistence, trade, and political organization. This study will primarily investigate population and settlement movement, a cultural characteristic which can be closely associated to subsistence systems and political organization, or related stresses as in the case of the Iroquois during the historic period. Settlement ecology may explore how the needs and the development of cultural factors such as swidden agriculture or tribal territoriality influence the decisions made by populations as they actively place themselves and strategically arrange their settlements within

the physical landscape. This rests on the assumption that the collective behavior of a population is affected by tangible variables, and that settlement patterns are influenced by certain environmental factors. Thus, within the theoretical approach and geographic region of this study, it seems the environmental characteristics of a location are the primary external stimuli affecting the distribution of the Cayuga and the places in which they live within a given spatial context.

Some theorists also contend that prehistoric peoples behaved according to the principles of utilitarian-functionalism by methodically minimizing energy expenditure and maximizing productive efficiency through proximity to arable soils or occupying defensible locations. This theoretical perspective in turn leads to the observable patterns noted by anthropological archaeology, and henceforth may be quantified and measured objectively (Wheatley and Gillings 2002). “Once measured, this information could be rigorously analyzed and the effects of factors such as distance and the varying potentialities of site locations could be objectively specified” (Wheatley and Gillings 2002:6). Studies including the spatial analysis of archaeological settlement locations have resulted in such observable patterns of behavior and the formation of predictive models for hunting and gathering societies (Tobias 1976). While predictive modeling works well in conjunction with optimal foraging theory, it has been noted to become increasingly more complicated when attempting to apply the same principles to complex societies (Maschner 1996b). In other words, predictive models may remain accurate for societies that adhere to known criteria related to the functionalism of hunting and gathering, but complex societies do not necessarily adhere to these criteria; furthermore, all complex societies do not develop and

thrive in alike environments or with similar cultural manifestations, and should therefore be examined individually and independently of one another. Stone (1996) remarks that within studies of settlement ecology, agrarian societies should not be examined using the same models as hunting and gathering societies. Additionally, it has been recommended that swidden agricultural settlement ecology should not be studied in the same manner as that of foraging societies or of societies that practice intensive agriculture (Jones 2010). Settlement ecology yields a relativistic interpretation based on an individual culture within a specific temporal period. Therefore, the results of this study will be applicable to the Cayuga Iroquois culture and the Finger Lakes region exclusively.

### *Iroquois Settlement Archaeology*

The study of behavioral adaptation to the environment as related to settlement pattern archaeology became an outgrowth of the cultural ecology movement in anthropology in the 1960s (Hasenstab 1996b). During the time period with which this study is concerned, Iroquois settlements were constructed and maintained by the community, and regularly relocated every generation (Hasenstab 1996b), or more specifically, every fifteen to twenty years (Allen 1996, 2009). Because of this regular movement of villages within a specific region, the local landscape serves as a canvas by which settlement archaeologists can investigate certain variables and analyze the collective behavior of native peoples. Based on prior research and spatial analyses, it

has been suggested that environmental features associated with agricultural productivity, such as soil type and annual precipitation, were influential factors in the placement of villages (Allen 1996; Bond 1985; Engelbrecht 2003; Hasenstab 1996a, 1996b). Other naturally occurring determinants of settlement location that have been suggested include proximity to hardwood for building purposes (Engelbrecht 2003; Snow 1997), elevation and natural topography related to hunting and defensive strategies (Engelbrecht 2009), and proximity to stone outcroppings and to major wetlands (Funk 1992; Hasenstab 1991; Sanders 2008). Socio-cultural, economic, and political factors have been considered when investigating this topic, albeit to a lesser extent than factors related to subsistence methods. For example, inter-tribal warfare fought for access to territory and natural resources among the separate nations of the Iroquois and their Algonquian-speaking neighbors is frequently cited (Bond 1985; Hasenstab 1996a; Snow 1994). The relationship of site locations to transportation routes including navigable waterways and overland trails has been only briefly examined (Bell and Lock 2002; Hasenstab 1996a; Llobera 2000). Other factors such as the relationship of the landscape with sites featuring the construction of defensive palisades (Engelbrecht 2009; Hasenstab 1996a) or the presence of anthropogenic landscapes designed for hunting practices (Engelbrecht 2003) have been briefly explored in the available literature. The influence of inter-tribal trading, contact period commerce and the associated movement of native and European commodities remain among other socio-cultural factors that have been largely neglected in research pertaining to Iroquoian settlement archaeology (Jones 2010). GIS and spatial analysis may be used to investigate the connections



between these various environmental factors and aspects of Iroquois culture. By correlating the locations of sites within proximity to wetlands with the Iroquois subsistence system, the degree of influence on settlement strategies can be measured for this specific environmental variable.

This study revolves around the general trend in Iroquois settlement relocation patterns in the protohistoric period (ca. 1500-1650 A.D.). The protohistoric period has been defined by the presence of European trade goods in the New York Iroquois area, and by the introduction of frilled or barbed pottery collars in both Seneca and Cayuga territories (DeOrio 1980; Niemczycki 1984). The early phase of the historic period is referred to as the protohistoric period because it is generally accepted that increased exchange and dependence on European trade goods prevailed in the New York Iroquois area during the sixteenth century, but the timing of direct contact between Europeans and Native American groups varied. European explorers and traders made contact with the easternmost tribes prior to encountering the westernmost tribes. Therefore, the protohistoric of the Mohawk Iroquois, for example, is dated roughly fifty years earlier than that of the Cayuga or Seneca regions. Direct European contact with the westernmost Iroquois tribes, the Seneca and the Cayuga, was not recorded in the historical record until A.D. 1650 (Niemczycki 1984).

The first documents regarding the native peoples of the northeast were written by European explorers and missionaries. Much of the early academic research on the Iroquois occurred centuries later, and was primarily concerned with establishing culture histories and delineating the origins of the various Iroquoian culture groups. Investigations into Cayuga

culture history began in the early twentieth century with the work of Skinner in 1918 (see Niemczycki 1984), who proposed a northward migration by populations from Pennsylvania to the shores of Cayuga Lake. He hypothesized a degree of cultural influence from the Susquehannocks, as evidenced by similar ceramic assemblages found in both regions. In the 1950s, the ceramic typology devised by MacNeish (1980) supported the earlier hypothesis. Subsequent works by Follette in the 1950s, Lenig in the 1960s, White in the 1970s (see Niemczycki 1894), DeOrio (1980), and Niemczycki (1984) focused on ceramic analysis, population migrations and cultural origins of the Cayuga Iroquois.

### *Previous Research*

In New York state, the practice of recording the cultural features within the environment dates back to the mid-nineteenth century with the explorations and research of the pioneering American anthropologist and ethnographer Lewis Henry Morgan. Morgan acquired his data through ethnohistoric research with the Seneca, by using both written documents and the recollections of his informants. Though Morgan may be renowned for his theories of social evolution and ethnographic fieldwork with the Seneca Iroquois (Morgan 1851), his record of overland trails in the Iroquois region maintains relevance for present-day archaeological research. In a recent study, Jones (2010) digitized Morgan's overland trail data into vector files for integration within a GIS, and it was adjusted to account for known topographic and

hydrographic features.

Over the last three decades or so, there have been several settlement ecology studies that have focused on identifying possible environmental influences on Iroquois settlement locations. Spatial analysis has proven effective in allowing archaeologists to explore the relationship between various landscape features and settlement locations. The following studies, presented in chronological order starting with the earlier works, have specifically examined environmental factors that influenced the settlement strategies of the Iroquois.

Bond (1985) analyzed Mohawk Iroquois sites in the protohistoric period, dating from 1450-1525 A.D., to investigate the relationship of settlement locations to soil type. His spatial analysis entailed creating one kilometer radius catchments around a relatively small sample of five sites. The total corn productivity within each radius was measured. His results found that as villages increased in size, the proportion of agricultural productivity decreased. This refuted his hypothesis, and he concluded that acts of warfare stressed the Mohawk populations and altered their settlement strategy. Bond claimed that by the end of the fifteenth century, site defensibility was of the utmost concern when Mohawk communities decided on the placement of a settlement. This conclusion demonstrates a hasty generalization primarily characterized by black and white reasoning, in that Bond jumped to the warfare hypothesis without offering much supporting evidence. He concluded that warfare was the prime mover simply because an agricultural hypothesis did not seem to mesh with his results.

Funk (1992) analyzed prehistoric settlement data in relation to five major wetlands, or

wetlands that are geographically prominent in terms of their areal extent, in upstate New York. He compared the biological resources available in wetland ecosystems to those recorded in the historic past and documented in the archaeological record to find faunal similarities. Funk also investigated potential advantages of wetland environments over other aspects of the habitable landscape, and explored the influential role that wetlands had on regional subsistence and settlement systems. His data suggested that prehistoric peoples in New York had a tendency to cluster their settlements in or adjacent to wetlands “at the expense of other local habitats such as rivers, lakes, creeks, and upland terrain” (Funk 1992:39). Due to the seasonality of plant and animal food resources available in wetlands, Funk concluded that wetlands would have been a prime environment for repeated foraging for months at a time.

Allen (1996) used a raster-based GIS interface to analyze the spatial distributions of Iroquois groups dating between 900-1550 A.D. Her analysis of environmental factors in relation to agriculture examined climatic features rather than physical geography. Allen compared the settlement pattern distribution to the length of the growing season and regional average precipitation. Her study found that the greatest impact on settlement location was imparted by the length of the growing season. Allen entered these results into a raster classification scheme that displayed varying degrees of maize harvest yields in the region based on the previously analyzed variables. Her results revealed a positive correlation between settlement locations and the highest ranked areas, or those areas most suited for maize agriculture. However, she concluded that the Iroquois who occupied sites during the later portion of the contact period had

made the decision to relocate based on defensive need, and would situate their new settlements farther upland where they would be defensible but were less agriculturally viable for maize production.

Hasenstab (1996a) conducted a similar analysis of the spatial and environmental variables influencing settlement locations in the Iroquois area. His hypothesis included the notion of strategic settlement placement in regards to site defensibility and access to natural resources. Hasenstab's research also focused on agricultural data but additionally included an analysis of canoe transportation routes and hunting strategies. He evaluated the environmental characteristics of each site in the GIS, and used discriminant function analysis to compare all known Iroquois sites dating from approximately 1000-1700 A.D. to random points. Hasenstab concluded that the most influential factor on settlement location was their distance from navigable waterways. Summarized, his interpretation was that the farther a site was distanced from all canoe transport corridors, the more removed villages were from traveling warriors, traders and explorers; thus, the significant distance from navigable waterways indicated that defense was the primary influential factor in the strategic selection of settlement location. Slightly less influential on settlement location was the degree of soil productivity in the area, indicating that agricultural needs were secondary to defensive measures. Subsequent studies in this topic indicate that the distance from waterways remained an influential factor in regards to settlement placement through the late historic period in the seventeenth century.

Jones (2006) used viewshed analysis to study the relationship between settlement location

and the physical landscape for the historic period Onondaga Iroquois. His results indicated a trend of inter-visibility among settlement locations which implied that efforts to maintain inter-site communication influenced settlement placement. Jones concluded that maintaining effective lines of sight between communities plotted across the landscape influenced the placement of villages, and correlated this to their overall defensive strategy. In a more recent study, Jones (2010) used GIS to evaluate the environmental characteristics of settlements and to compare these locations to a set of randomly distributed points. His results showed that high elevation and dominant viewshed were less significant for settlement location than criteria that fulfilled agricultural needs, proximity to hardwood, and access to transportation routes. He concluded that issues concerning site defensibility were met through community efforts to establish the construction of palisades and to maintain lines of sight, suggesting that defensive needs could be met independently of environmental causal factors.

The aforementioned studies “analyzed small sets of variables and the results have been useful in identifying influences on settlement locations. However, sociopolitical factors have been insufficiently researched” (Jones 2010:4). It is inherently difficult to discern strictly cultural influences on settlement patterns and the relationships between sociopolitical entities through archaeological research because the archaeological record in this region does not directly account for specific interactions through writing or imagery. Furthermore, each study analyzed a small set of factors, yielding individually relative interpretations of the archaeological record. When comparing the collective results, this creates a complicated narrative due to the variety of factors,

temporal periods, and cultural characteristics examined. “The next step is to directly analyze more environmental and sociopolitical factors in one study in order to achieve results that more accurately model how settlement location decisions were made in the past” (Jones 2010:4). A relatively tangential examination of the multivariate socio-cultural factors has been included in the discussion rather than an in-depth exploration of how they may be related to either environmental aspects or influential on settlement distribution.

This paper draws from the theoretical paradigms of this previous research, and principally expands upon the studies by Funk (1992) and Allen (1996) using settlement ecology theory as applied specifically to agricultural societies as noted by Jones (2010). While other prior wetland research focused on prehistoric hunter-gatherers in the archaeological record (Funk 1992; Hasenstab 1991; Sanders 2008), the present study seeks to discern the influence of wetland habitats on protohistoric Cayuga Iroquois settlement locations where swidden maize agriculture was the primary subsistence method and maize consumption comprised most of the diet. As noted by Jones (2010:3), “swidden agriculture is a well-documented subsistence strategy, but its relationship to the associated settlement system and other cultural features is not necessarily well understood. This strategy in a temperate climate, as practiced by the Haudenosaunee [Iroquois], has been studied even less.” Likewise, prehistoric practitioners of swidden agriculture may have employed varying techniques from agriculturalists in the protohistoric period who had access to European goods and tools.

### *The Site Sample*

In order to place the sample of selected archaeological sites in context, some information about the locations, material culture, and interpretations of the sites is necessary. The Cayuga Iroquois settlement locations included in this study all date approximately to the protohistoric period (1500-1650 A.D.), a temporal phase characterized by the presence of European trade goods prior to direct or historically recorded contact between Europeans and the Cayuga. The information in the following descriptions of the sites are adapted from DeOrio (1980) and Niemczycki (1984), which contained descriptions based on historic accounts, early archaeological investigations, ceramic analyses, and site files from the SUNY Buffalo and Rochester Museum and Science Center site files. Many of the date ranges have been derived from ceramic analyses based on DeOrio's collection and samples from the SUNY Buffalo collection. A map showing the labeled settlement locations was created using ArcMap (Figure 1). Below, the site names are shown in bold typeface, followed by their descriptions. This information is also presented in Table 1.

The **Carmen** site is a village on a ridge above Taughannock Creek. According to Follette (1957, see Niemczycki 1984), the first European material in the archaeological record of the Cayuga culture area is observed here, suggesting an early seventeenth century occupation. **Colgan** is a village site lying above Little Salmon Creek. Eleven ceramic types recovered from this site suggest a multi-component late sixteenth century occupation (DeOrio 1980). **Genoa**



**Fort** is a “fortified village and cemetery on a terraced hill above Big Salmon Creek” (Niemczycki 1984:117). The site was occupied from approximately 1570-1630 A.D., with ceramic analysis favoring a narrower range of 1600-1620 A.D. (DeOrio 1980). **Indian Fort Road** is a fortified village overlooking Taughannock Creek. The site was established and occupied sometime around 1550 A.D. The **Klinko** site is a “palisaded village on a hilltop above Cayuga Lake” (Niemczycki 1984:118), situated 15 miles northwest of Ithaca, New York (DeOrio 1980). Ceramic analysis describes this site as a single-component late prehistoric/protohistoric occupation in the early sixteenth century. **Locke Fort** is a “fortified village on a hilltop above the Owasco Inlet” (Niemczycki 1984:118). Ceramics and trade material date this site to around 1550 A.D. **Mahaney** is a small settlement above Cayuga Lake containing corded and incised rim collars, denoting an Early Iroquois occupation. **Parker Farm** is “a possibly fortified village and cemetery on a low hill above Taughannock Creek” (Niemczycki 1984:118). The presence of Genoa Frilled pottery suggests a date between 1525-1550 A.D. **Weir** is a “village in a defensible promontory above Cayuga Lake” (Niemczycki 1984:118) containing small amounts of incised ceramic rim collars.

According to Allen (2009), the four village sites to the west of Cayuga Lake (Klinko, Indian Fort Road, Parker Farm, and Carmen) represent the continuous relocation of one portion of the Cayuga tribe that occupied the area for about 150 years (Allen 2009; Niemczycki 1984) before relocating and joining the rest of the Cayuga population on “the east side of the lake, probably after the occupation of the Carmen site” (Allen 2009:14). In other words, these four

settlements were not coeval, but rather were successive of one another moving from north to south. Despite the distance from the rest of the Cayuga peoples and the differences in the soil content near the Seneca boundary, the western sites followed a similar pattern of relocating their settlements generation-by-generation, a phenomenon evidenced by the relatively consecutive dates of the four sites (early 1500s at Klinko, 1525-1550 at Parker Farm, ca. 1550 at Indian Fort Road, and early 1600s at Carmen).

## METHODS

In their discussion of the utility of GIS for landscape archaeology, Connolly and Lake (2006:42-43) were keen to highlight a major concern: “The assembly of structures, fields, hydrology, soils, elevation, and extant archaeological evidence into a GIS does not directly lead to an understanding of the all-important social landscape. Meaningful and substantive interpretations of the complex and often unpredictable relationships humans have with their landscapes cannot be arrived at by assembling data alone.” Numerous GIS databases exist on the Internet, and contain geographic information coded into the various file types associated with GIS computer software. However, most publicly available, government-housed information depicts the current sociopolitical realities of the world such as modern political boundaries or the locations of present-day establishments. These are important for applications related to the present world and may be pertinent to other avenues of study, but this sort of geographic information simply does not apply to the realm of archaeological research explored in this study. Archaeologists may be able to assume that lands used for agriculture in the present were indeed agriculturally viable in the past, but hundreds of years of development, industrialization, and modernization prevent the inclusion of this sort of data in this study. This phenomenon is known as the multiple phasing of landscapes, a process executed by environmental change and the development of visual obstructions over time leading to varied and/or relatively limited perceptions and experiences of the landscape (Chapman 2000). As Sanders (2008) noted,

wetland environments are susceptible to this phenomenon, as their extents may either expand or recede over time.

### *Acquiring Data*

GIS data for this study were obtained through the websites of the United States Geological Survey (USGS), the New York State GIS Clearinghouse, and the Cornell University Geospatial Information Repository (CUGIR). These catalogs facilitated the accumulation of geographic and environmental data pertaining to the region of study including Shuttle Radar Topography Mission (SRTM) raster data, vector shapefiles of state ecological zones, and statewide soil surveys. The CUGIR database provided county-specific GIS directories from which the soil survey data were procured and modified to display only wetlands.

With so much geographic data available at one's finger tips via the Internet, there is a tendency to over-integrate data into the GIS, hence the “erroneous belief that can arise in GIS-led landscape surveys: that 'data assembled is data understood'” (Connolly and Lake 2006:42). The area where the Cayuga Iroquois settled overlaps several present-day county lines. The sites included in the sample used for this study are situated across the boundaries of four separate New York state counties: Tompkins, Cayuga, Seneca, and Schuyler counties. As such, county-specific soil survey data from these four counties were selected for this analysis. Additionally, just a single SRTM Digital Elevation Model (DEM) tile was necessary in order to display this area as

opposed to a mosaic of several DEM tiles. The 1-arc-second (30-meter) resolution DEM with coordinates of north 42 degrees and west -76 degrees (N 42°, W -76°) was downloaded from the USGS EarthExplorer database.

Ascertaining data on the locations of Iroquois archaeological sites in this region proved to be the most difficult task in the process of conducting this research. The aforementioned internet resources did not include any data pertaining to the locations of archaeological sites.

Furthermore, the archaeology division of the New York State Historic Preservation Office (SHPO) was unable to provide locational data on the contact period archaeological sites selected for this study. A data request was sent to the SHPO regarding the locations of Iroquois sites in the Cayuga region, and was processed by both the Cayuga County archaeological representative and the resident GIS specialist. Unfortunately no information pertaining to archaeological site locations from either the protohistoric or historic periods was present in their records, perhaps because the collections from these sites are privately housed or curated at university facilities. To overcome this obstacle in obtaining exact site locations, the locations of nine Iroquois settlements as referenced in Herrick (1897), Jones and Jones (1980), DeOrio (1980), and Niemczycki (1984) were approximated for use in the analysis by referencing scaled illustrations and using the measuring and mapping features in ArcMap. Niemczycki (1984) contained a scaled map of a distribution of archaeological sites in the Cayuga territory for the period spanning years 1000-1700 A.D. which proved invaluable in constructing the map in the GIS.

### *Constructing the Map*

All mapping and spatial analysis for this study was performed with ArcGIS 10 (ESRI), using the ArcCatalog and ArcMap interfaces. Before overlaying multiple data sets to create the map, all layers of data were referenced to the same projected coordinate system, thus the finished maps (Figures 1 through 14) are projected in the North American Datum (NAD) 1983, Universal Transverse Mercator (UTM) Zone 18 coordinate system.

A basemap of New York state was ascertained by using a statewide ecological zones shapefile. The SRTM tile was overlaid on the state boundary layer to show the contextual location of the DEM tile within the state. The classified values of elevation within the SRTM layer were edited to display Cayuga Lake in a shade of blue, while the rest remained in grayscale (Figure 2). Using a spatial analyst function in ArcMap, the SRTM raster was hillshaded to show physiography (Figure 3).

Based on the locations of sites as described in the aforementioned publications, a shapefile was created in ArcMap that displays the locations of nine Cayuga Iroquois archaeological sites. Using the scale from the map illustration in Niemczycki (1984) and the measure and snapping functions in ArcMap, the locations of the nine Iroquois settlements were plotted on the map as a separate layer which was overlaid atop the regional map (Figure 4). The Iroquois settlement locations are displayed as bright green triangular points.

The county-specific soil survey layers were modified to display only points characterized

as wetlands. These were identified by the feature symbol “WET” in the attribute tables of these layers of data as opposed to various other soil classifications. These wetland areas are represented by yellow points so as to be distinguished from the settlement locations. The county-wide wetlands were layered over the regional map (Figure 5).

It should be observed that the site distribution occupies a relatively small area compared to the full extent of the SRTM tile, while the soil survey data reaches well beyond the extent of the tile. To focus on the site sample at hand and the relevant soil data, the clip function in ArcMap was used to reduce the extent of the SRTM tile and eliminate the extraneous portions of the soil data. This was accomplished by creating a polygonal vector shapefile which outlined the study area (Figure 6). The study area was established in a way that would accommodate the furthest directional extents of the site distribution and the five-kilometer site catchments generated for the spatial analysis conducted in this study. Using the clip function in this way effectively reduced the total area of study from the full extent of the original SRTM tile, measuring approximately 9,129.5 square kilometers, to a much more manageable study area measuring approximately 1,423 square kilometers, seen inset on top of the regional map to show its relative areal extent (Figure 7). The Iroquois settlement locations and wetland points are shown zoomed in on the study area, centered on Cayuga Lake (Figure 8).

The spatial analysis conducted in this study is comprised of creating site catchments or distance buffer rings around each of the Iroquois sites (Figure 9) as well as two control groups comprised of two sets of nine random points (Figures 10 and 11) generated through the Create

Random Points function in ArcMap, a new data management function in version 10 of the software. The minimum distance between the generated points was set to 3 kilometers to avoid significant overlap of buffer zones. Two control groups were generated to yield results for a sample of points concentrated to the west of Cayuga lake as well as a sample of points concentrated to the east of Cayuga lake. The random points are represented by red and white triangles for control groups one and two, respectively, to differentiate them from the Iroquois site distribution. The buffer rings around each point were displayed transparently in order to keep the image less cluttered and with outlines of differing color in order to facilitate their functionality during analysis.

### *Spatial Analysis*

Using the Proximity Analysis functions in ArcMap, multiple ring distance buffers were created around each settlement location with radii of one (1) kilometer, two and one half (2.5) kilometers, and five (5) kilometers. These distances were chosen to represent varying degrees of energy expenditure in relation to foraging: one (1) kilometer being more or less adjacent to the village location and therefore readily accessible, two and one half (2.5) kilometers representing a reasonable walking distance to and from the village, and five (5) kilometers representing the hypothetical maximum reasonable distance one could travel in a single day to gather resources locally. The same multiple ring distance buffer function was run on the two control groups.



Using the clip function, the wetland points lying outside of the distance buffer zones were eliminated, yielding the “Wetlands Proximal to Iroquois Sites” layer (Figure 12). In the case of the control groups, whose distance buffer rings occasionally reached beyond the extent of the area of investigation, the “Total Wetlands” (county-wide) layers were clipped to only show wetland points within the distance buffers of these random points, yielding the “Wetlands Proximal to Random Points” layers (Figures 13 and 14).

The specific rings for each site were highlighted via the attribute table for the Iroquois site distance buffer layer. With the distance buffer rings highlighted, the total number of wetland points contained within each radial distance bracket were counted for each site. The total number of wetlands within each distance ring are recorded, as well as the average number of proximal wetlands and the standard deviation for each distance bracket in Table 2. The same process was used to attain figures for the control groups. Table 3 contains these figures for the first set of randomly generated points, and Table 4 contains the figures for the second set of randomly generated points. Table 5 shows the percentage of wetlands within five-kilometer proximity to the settlement locations and to the random points out of the total number of wetlands within the study area.

## RESULTS

The spatial analysis resulted in a total of 309 wetland points in five-kilometer proximity to the sample of Cayuga Iroquois settlement locations, yielding an overall average of 34.3 wetlands within five-kilometer proximity to settlement locations with a standard deviation of 19.31. The averages and standard deviations for each distance bracket are accounted for in Table 2. The settlement locations' distance buffers contained nearly 37% of the total number of wetland points located within the study area (Table 5).

The first control group yielded higher numeric results than the settlement locations. The total number of wetlands within five-kilometer proximity to nine randomly generated points amounted to 447, with an overall average of 49.67 wetlands within five-kilometer proximity and a standard deviation of 28.04 for the total number of wetland points within distance buffers around these random points. The averages and standard deviations for each distance bracket are accounted for in Table 3. The distance buffers of the first control group contained 53.4% of the total number of wetlands within the study area (Table 5). The first set of random points demonstrated wetland presence within five-kilometer proximity measuring 16.5% greater than the actual Cayuga settlement locations, as well as greater averages and standard deviations than those of the settlement locations in each distance bracket.

The second control group yielded similarly robust results. The total number of wetlands within five-kilometer proximity amounted to 472, with an average of 52.44 wetlands within five-

kilometer proximity and a standard deviation of 31.69 for the total number of wetland points within distance buffers around these random points. The averages and standard deviations for each distance bracket are accounted for in Table 4. The distance buffers of the second control group contained 56.39% of the total wetlands within the study area (Table 5). The second set of random points demonstrated wetland presence within five-kilometer proximity that is 19.5% greater than the actual Cayuga site distribution, as well as greater averages and standard deviations than those of the settlement locations in all distance brackets.

Compared to the two control groups that were randomly generated in the spatial analysis, the numerical results of the settlement locations are not greater, but do appear to be statistically significant in regards to the standard deviations for each distance bracket. The greater total wetland counts of the two control groups illustrate that these points were generated in locations where wetlands are more prominent in the landscape compared to the locations of Cayuga settlements. The greater range of standard deviations of the control groups indicates that the actual settlement locations are relatively nonrandom, and demonstrates that Cayuga populations were selecting for areas with notably less wetlands than any given random point on the landscape.

## DISCUSSION

Two interpretations can be made of the results of this spatial analysis. The first, a more cursory interpretation, would be to acknowledge that all of the points in question, the settlement locations and the control groups, contained wetland points within their distance buffers. The greater numerical figures of the sets of random points may imply that the presence of wetlands was not as important to the Cayuga settlement pattern as hypothesized because the randomly assigned locations were situated in areas with higher prominence of wetlands. Thus, the original hypothesis should be rejected on the grounds that a greater presence of wetlands does not seem to have a significant impact on the selection of new locations for settlements during the protohistoric period. Within five-kilometer proximity, the sets of randomly generated points demonstrated greater totals of wetlands within each distance bracket of the spatial analysis, and yielded higher averages and greater percentages of wetlands out of the total number of wetlands in the study area. This demonstrates that wetlands did not need to be a highly prominent environmental characteristic of the surrounding landscape of a potential settlement location in order for the Cayuga to select it for settlement.

Although the numbers appear to speak for themselves, it is still entirely plausible that the results do in fact support the original hypothesis, although necessitating an adjustment to the wetland presence criterion. Since all of the random points were within reasonable distance to a greater amount of wetlands than the settlement locations, the hypothesis should not aim to

determine the influence of wetlands on settlement locations from the mere presence of wetlands in the landscape. Rather, the wetland proximity requirement could be augmented to reflect the prominence of wetlands in the landscape as an influential factor rather than presence alone. The Cayuga settlements are consistently established in areas with lower densities of wetlands. Areas with too much wetland soil would not contain sufficient agricultural soils to sustain swidden agriculture for an entire generation. The need for a village to be adjacent to sufficient area for clearing swidden plots and maintaining agricultural fields for fifteen to twenty years would weigh heavily in the settlement location strategy. The fact that the random points yielded wetland percentages greater than 50% and had wider ranging standard deviations shows that the Cayuga settlement locations were relatively nonrandom by comparison, and supports the adjusted hypothesis. The randomly selected areas may be interpreted as areas which the Cayuga ruled out as settlement locations because they were not agriculturally viable due to the high density of wetlands. Instead, they favored areas characterized by the presence of sufficient agricultural soils complimented by a low-to-moderate density of wetlands within proximity to the village.

Comparing the averages and the standard deviations of the data sets in Tables 2 through 4 shows that the Cayuga selected for areas with notably less wetlands than the randomly generated points, and is especially evident in the 2.5-kilometer distance bracket. This clearly demonstrates that the Cayuga exhibited a conscientious effort to select areas adhering to consistent environmental criteria when relocating their settlements. Therefore, the results of the spatial analysis show that the overall prominence of wetlands, or geographical density of wetlands

within a given landscape, was more influential on Cayuga settlement locations than the mere presence of wetlands. Furthermore, the results demonstrate that the Cayuga employed a strategic approach to the placement of village settlements rather than randomly or arbitrarily distributing their settlement locations.

Settlement location can be correlated to subsistence needs within the context of this study. Allen (1996) concluded that Iroquois settlement choices were influenced by the length of the growing season and the presence of soils deemed viable for maize agriculture. Assuming that villages were in need of resources during the seasons when maize was not processed and readily available for consumption, it is likely that people turned to hunting and foraging for a partial supplement to their diet. Allen (2009) outlines the daily and seasonal activities of Iroquois men and women, noting a significant difference in labor tasks based on Iroquois gender roles. She explains that the men would travel further distances to hunt and trade, but highlights that the daily work in and around the site was mostly done by women and consisted of food preparation, childcare, and basket weaving. Within the context of this study, the fact that the daily tasks of women in the village included “movements in and out of the village in search of needed subsistence and technological resources” (Allen 2009:11) lends itself to a favorable argument for the importance of wetlands in regards to settlement location. Knowing that the Iroquois practiced a mixed subsistence strategy and maintained a diet consisting of up to 65% maize (Jones 2010), it can be assumed that certain plant and animal resources were procured from the local ecosystem and nearby wetland habitats to be used as dietary supplements. Funk (1992) claimed

that wetland habitats provided suitable environments that could sustain subsistence foraging for months at a time. Close proximity to wetlands indicates that the locals took advantage of these environmental benefits and considered the potential energy expenditure of distance traveled.

Although prior studies have suggested that inter-tribal warfare impacted the movement of Iroquois peoples and that the distribution of their settlements was influenced by environmental factors related to their overall defensive strategy (Hasenstab 1996a), these connections do not coalesce within the context of the present study. It has been demonstrated that defensive needs were met by situating settlements further away from canoe navigable waterways and overland trails (Hasenstab 1996a), by maintaining lines of sight between villages (Jones 2006), and through community efforts independent of environmental constraints such as the construction of palisades (Jones 2010). This study does not provide evidence to support any notion that the location of settlements adjacent to wetlands was directly influenced by warfare or was a requisite in achieving site defensibility. Furthermore, there seems to be little evidence that connects warfare with the specific fifteen to twenty year interval of settlement relocation.

The movement of villages every fifteen to twenty years seems to correlate with agricultural needs (Allen 1996, 2009) rather than defensive strategies. The regular interval of settlement relocation can be more readily correlated with the use time of swidden agriculture plots than sporadic acts of warfare. Swidden agriculture requires fallow periods after so many harvests in order for the land to rejuvenate, regrow vegetation, and regain potential for swidden productivity. Harris notes, “swidden cultivation necessitates at least a semi-nomadic lifestyle on

the part of the cultivators” (1973:2) and that some groups “prefer to cut new swiddens out of primary rather than secondary forest... and move their settlements frequently in order to do so” (1973:5). This implies that vegetation, soil content and fertility influenced the decision to relocate settlements based on agricultural need. Due to the temperate climate and pronounced seasonality of the region, local resources were necessary to sustain the population while maize was not in season. Because the average wetland habitat in New York is rich in biological resources both faunal and floral (Funk 1992), we can presume the prehistoric inhabitants took advantage of the environment that afforded them these many nutritional benefits.

This paper did not investigate the political relationships among the five nations of the Iroquois League or with neighboring Algonquins, so warfare or other territorial disputes as cultural influences on movement of villages have not been considered. This study did not reconsider elevation or viewshed data as variables affecting movement, although a possible future direction of this research would include investigating the presence of wetlands within the viewsheds of settlement locations. This paper assumed that the biological resources used to supplement the diet were procured from wetland habitats, and did not include an investigation of broader Iroquois hunting methods. Furthermore, this study did not investigate ceremonialism in Iroquois warfare or hunting practices. An examination of ritualistic practices is necessary to rule out defensive strategies and hunting methods as primary factors influencing settlement locations.

There are over 23,000 documented wetland locations interspersed throughout the geographical landscape of New York state (Funk 1992). During the protohistoric period this



figure may have been higher, as centuries of development and industrialization have effectively modernized the landscapes of the northeast. This rapid degree of phasing of the landscape makes it difficult for anyone in the present to perfectly evaluate the environment of the past. The Iroquois who lived in this region during the pre-contact period almost certainly experienced, perceived, and utilized a different landscape from the current reality that our present-day GIS data illustrates.

It must be acknowledged that the numerical figures, percentages, and interpretations of the significance of variables will fluctuate based on the potential arbitrariness involved in the spatial definition of the study area. As stated above, in this analysis the study area boundary was determined by the extent of the site catchments for the Cayuga settlement location sample. Arbitrarily shrinking this area will yield higher percentages all around, while broadening the scope of this area will increase the total number of points outside of site catchments. Defining such an area was important for the study for two reasons: first, without defining the study area boundaries, the number of wetlands within five-kilometer proximity would have to be compared exclusively to the total wetlands from county-wide soil surveys. The results of such an analysis would appear less significant simply due to the fact that the site distribution is located in a smaller area relative to the extent of the four present-day counties. Second, and more importantly, present-day county boundaries themselves are irrelevant to this or any study of Iroquois settlement patterns as they were nonexistent during the temporal period on which this analysis focused. Therefore, a defined study area allows the analyst of focus on the culture area

instead of comparing prehistoric settlement patterns with present-day boundaries.

## CONCLUSION

Based on the spatial analysis and the statistical information generated by this study, it appears that the prominence of wetland habitats in the landscape was influential on decisions regarding the locations of Cayuga settlements. An augmentation of the original hypothesis of this study yields a plausible interpretation of the results of the spatial analysis. During the protohistoric period, Cayuga Iroquois populations actively sought areas to relocate settlements that simultaneously fulfilled two major criteria. First, the potential settlement area required sufficient productive soil in order to sustain swidden maize agriculture. Second, the village location had to be situated within close proximity to wetland environments to facilitate the gathering of natural resources to be utilized as supplements to a diet characterized by maize consumption; however, the prominence of wetland habitats in the surrounding landscape could not overshadow the availability of areas suitable for swidden agriculture. These criteria outline the Cayuga settlement location strategy; a conscientious effort based on the subsistence needs of the population.

Creating an addition to previous research, this study showed that settlement choices were predicated on maintaining a successful subsistence system that relied on swidden maize agriculture for the majority of the diet, but necessitated the procurement of natural faunal and floral supplements from nearby ecosystems including wetland habitats. The Cayuga chose lands on which to establish new settlements based on the availability of agriculturally viable soils that

simultaneously lay within proximity to wetland habitats, but were not eclipsed by the presence of wetlands.

In this study, GIS provided the invaluable platform for spatial analysis, generated new spatial information and visual representations of these data, and helped yield statistical values. All of this builds a case for the interpretation of wetlands as an influential variable on the decisions people made in the past. For research objectives of this sort, it appears GIS is extremely effective and when used properly can be very accurate. In general, evaluating environmental variables based on their degree of proximity suggests the presence of a spatial relationship between the landscape and cultural variables such as settlement locations; however, all spatial relationships should always be considered within an individual context and interpreted with the possibility of interaction with other cultural variables in mind.

As noted above, this study is one of many which have analyzed a small set of variables. The next step for research on this topic within this region is to compile more spatial data and analyze more variables in relation to settlement locations. Historical occurrences and cultural phenomena should not be overlooked, as the narratives of the past may in fact supplement the interpretations of data derived from spatial analysis. For this research in particular, plausible future considerations for integration in the analysis include the physical extent of wetlands, soil data pertaining to maize agriculture, land use/land cover vegetation data, topographic data allowing the identification of anthropogenic clearings related to hunting strategies, and elevation data allowing for the addition of viewshed analysis in relation to specific landscape features or

environmental variables. The inclusion of such data could provide a more complete set of variables to supplement an evaluation of the degree of proximity to environmental landscape characteristics.

This study provided information on the settlement strategies and human ecology of a Native American culture during the period predating initial European contact. As Stone (1996) wisely remarked, settlement ecology should be viewed as an analytical system and not a universal set of rules. Research of this sort is highly relativistic and should remain so on a case-by-case basis in regards to both cultural groups and temporal periods. This approach will maintain the integrity of the research on this topic, and provide the most accurate representations of past cultures and human ecology.

## APPENDIX A: TABLES

**Table 1.** Settlement Locations and site descriptions.

Settlement Location	Date (A.D.)	Site Characteristics	Other Notes
Carmen	ca. 1600-1620	Situated on a ridge above Taughannock Creek	Earliest European material found here
Colgan	ca. 1570-1600	Situated above Little Salmon Creek	Eleven ceramic types represented
Genoa Fort	ca.1570-1630; ca.1600-1620	Fortification and cemetery, situated on a terrace above Big Salmon Creek	Ceramic typology favors narrower range of dates
Indian Fort Road	ca. 1550	Fortified village situated above Taughannock Creek	Situated near a modern road
Klinko	ca. 1500-1525	Village with palisade situated on a hilltop above Cayuga Lake	Ceramic analysis suggests a single-component occupation
Locke Fort	ca. 1550	Fortified village situated above the Owasco Inlet	Ceramics and trade material present
Mahaney	ca. 1500	Small village settlement situated above Cayuga Lake	Corded and incised rim collars indicate an early occupation
Parker Farm	ca. 1525-1550	Village and cemetery situated on a hill above Taughannock Creek, possible palisade	Genoa Frilled pottery present
Weir	ca. 1525	Small village situated on a promontory above Cayuga Lake	Incised ceramic rim collars present

**Table 2.** Wetlands in Proximity to Cayuga Iroquois Settlements.

Settlement Location Site Name	# of Wetlands within 1 km	# of Wetlands within 1-2.5 km	# of Wetlands within 2.5-5 km	Total Proximal Wetlands
Locke Fort	0	4	21	25
Genoa Fort	1	7	32	40
Colgan	0	3	14	17
Weir	0	1	14	15
Mahaney	0	3	5	8
Indian Fort Road	0	3	32	35
Parker	0	10	41	51
Carmen	1	12	45	58
Klinko	3	16	41	60
TOTAL	5	59	245	309
AVERAGE	0.56	6.56	27.22	34.33
STANDARD DEVIATION	1.01	5.08	14.25	19.31



**Table 3.** Wetlands in Proximity to Control Group 1.

Random Point #	# of Wetlands within 1 km	# of Wetlands within 1-2.5 km	# of Wetlands within 2.5-5 km	Total Proximal Wetlands
1	0	2	17	19
2	2	19	35	56
3	3	6	13	22
4	2	11	32	45
5	3	22	40	65
6	0	6	20	26
7	2	4	27	33
8	1	9	73	83
9	4	35	59	98
TOTAL	17	114	316	447
AVERAGE	1.89	12.67	35.11	49.67
STANDARD DEVIATION	1.36	10.72	19.85	28.04

**Table 4.** Wetlands in Proximity to Control Group 2.

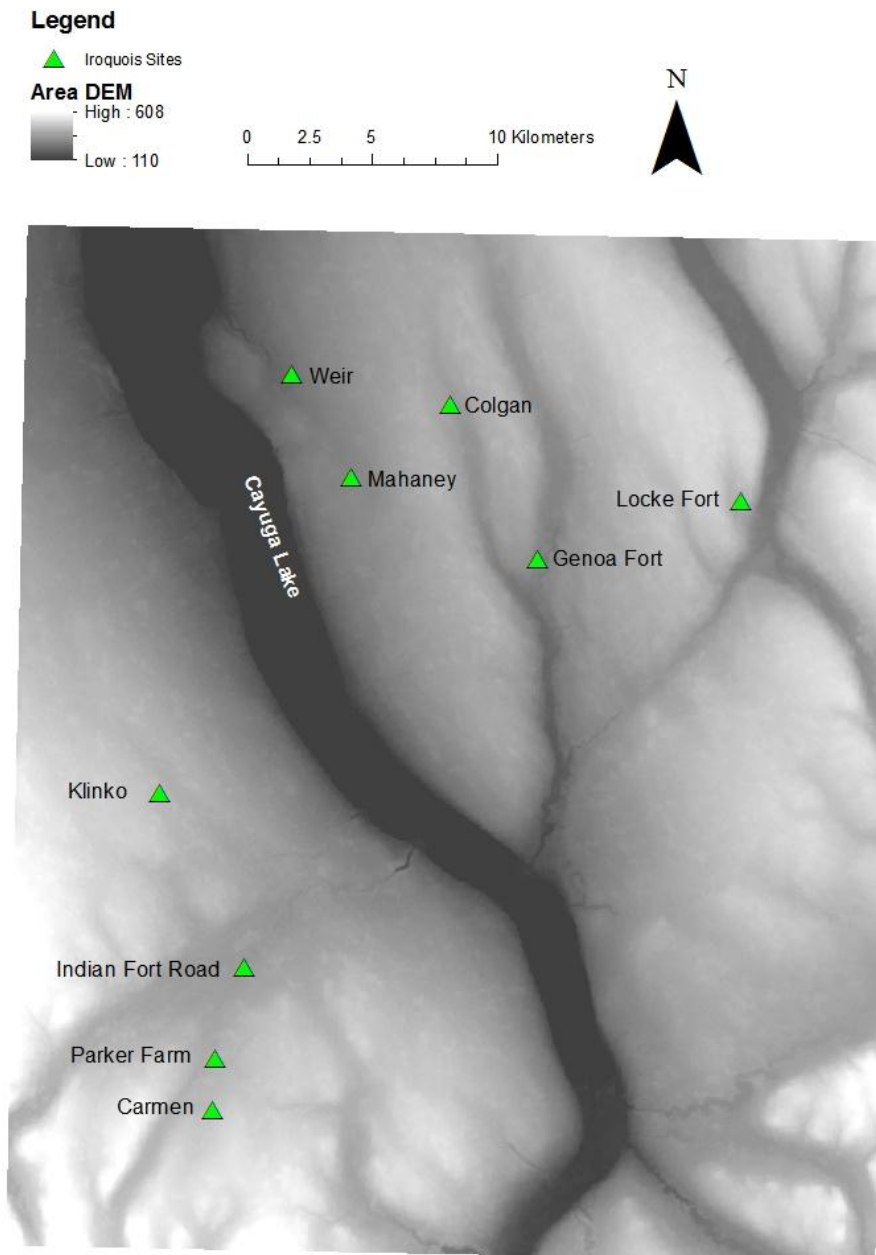
Random Point #	# of Wetlands within 1 km	# of Wetlands within 1-2.5 km	# of Wetlands within 2.5-5 km	Total Proximal Wetlands
1	2	3	17	22
2	0	8	41	49
3	15	29	54	98
4	1	10	51	62
5	3	8	79	90
6	0	0	18	18
7	1	14	12	27
8	0	5	19	24
9	0	22	60	82
TOTAL	22	99	351	472
AVERAGE	2.44	11	39	52.44
STANDARD DEVIATION	4.82	9.31	23.63	31.69

**Table 5.** Percentages of Proximal Wetlands out of Total # Wetlands Within Area of Investigation

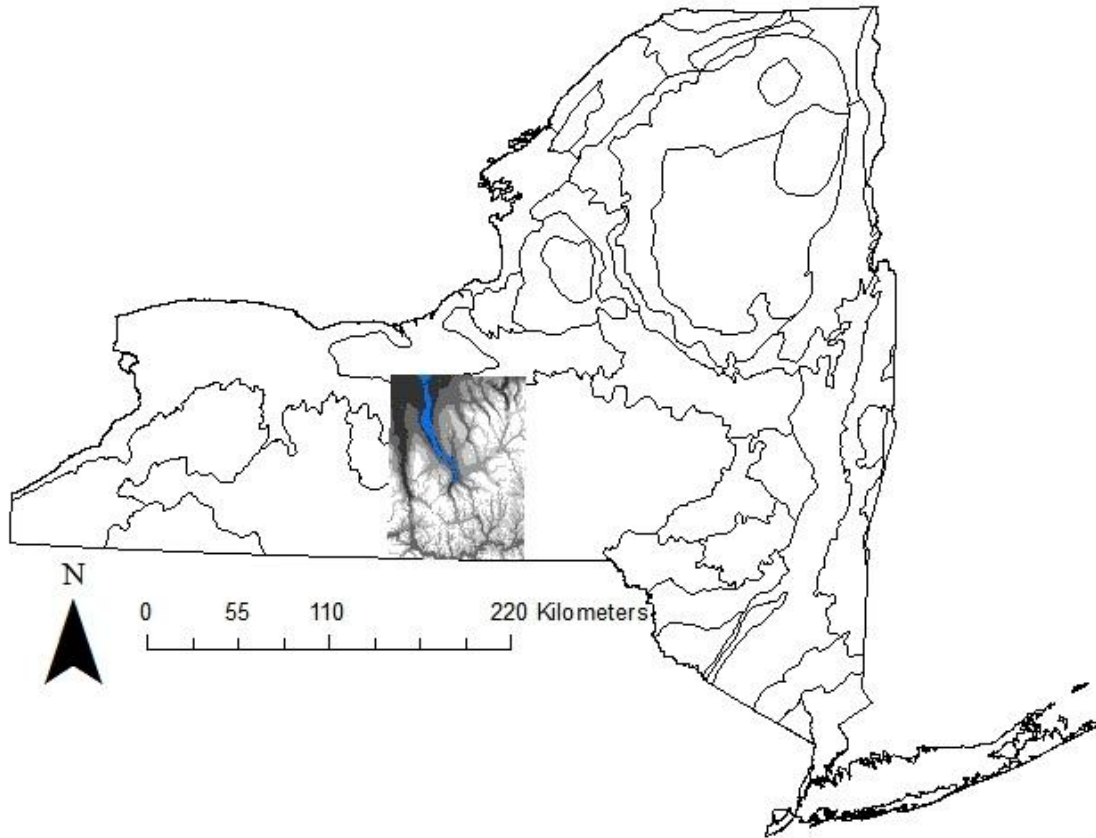
	# Proximal Wetlands	# in Area of Investigation	Percentage
Iroquois Sites	309	837	36.91%
Control Group 1	447	837	53.40%
Control Group 2	472	837	56.39%

## APPENDIX B: FIGURES

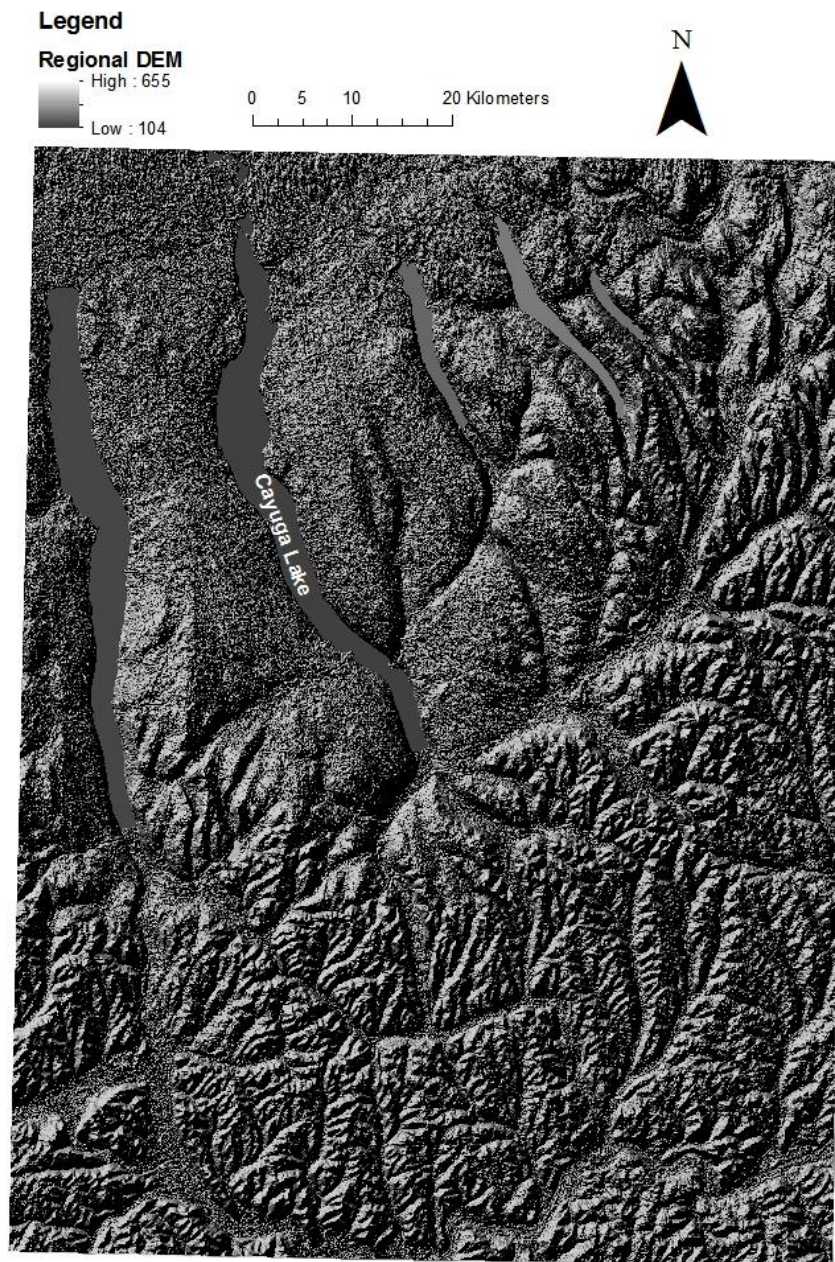
**Figure 1.** The Cayuga Iroquois settlement location sample.



**Figure 2.** Basemap of New York State, with the SRTM tile for reference.

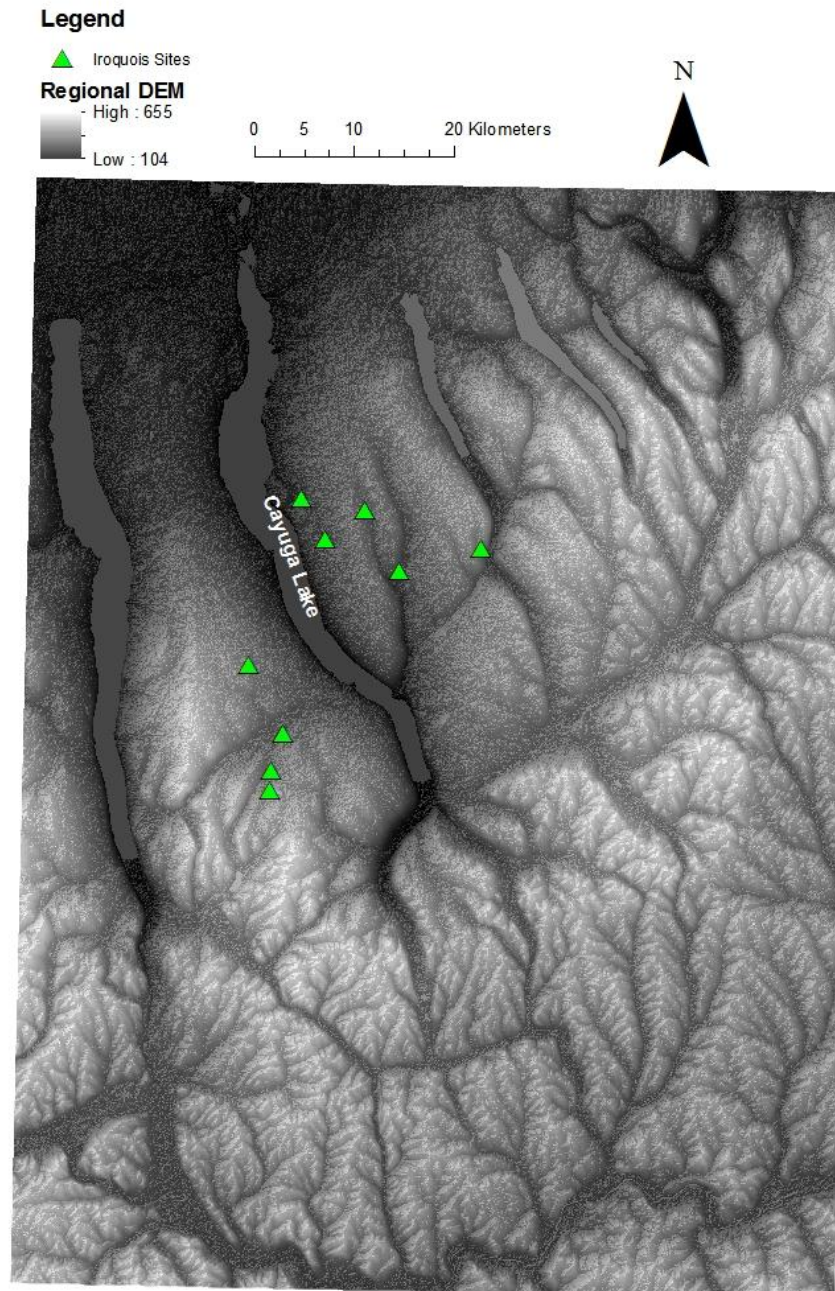


**Figure 3.** Hillshaded map of the region of study.



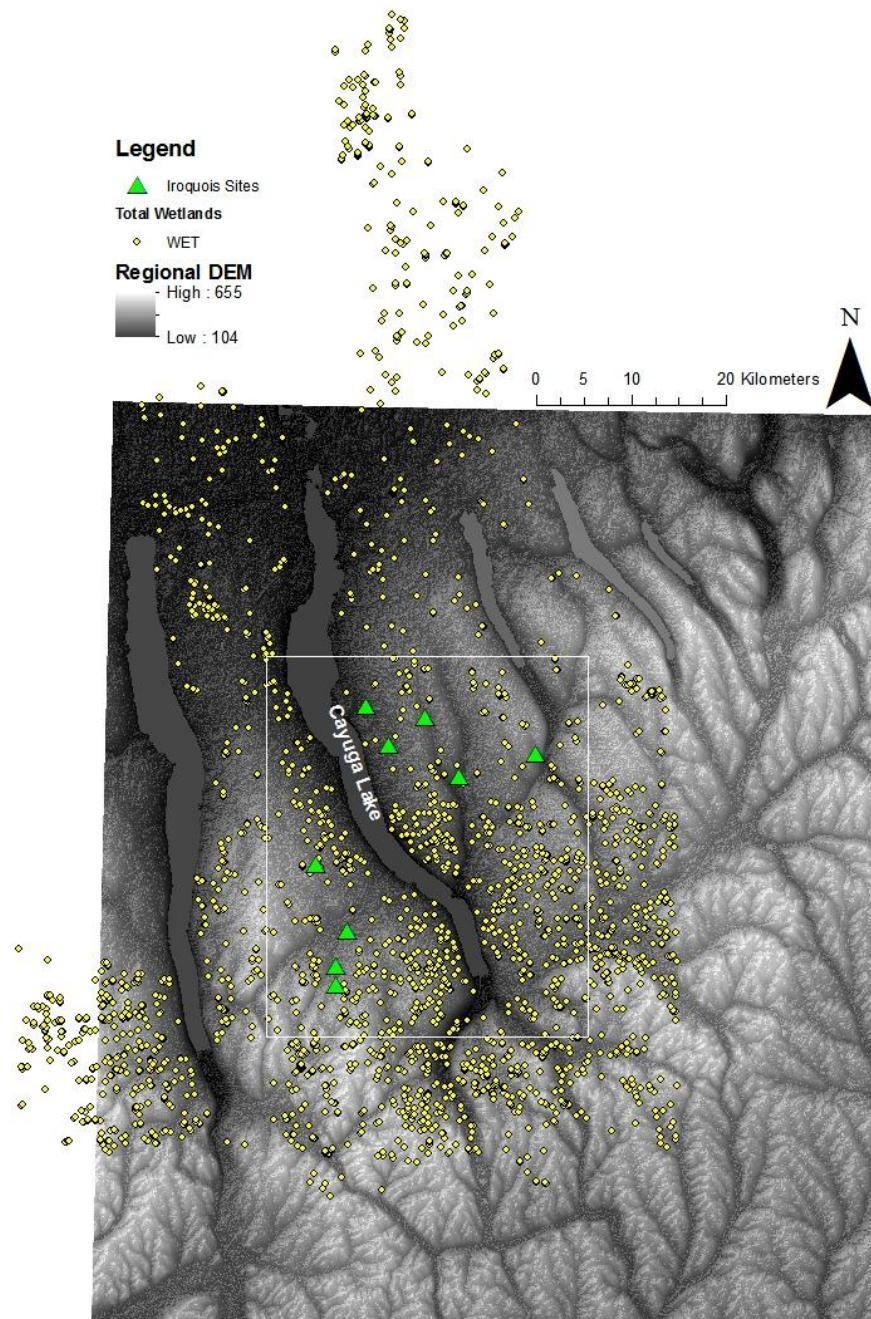


**Figure 4.** Regional map showing the Cayuga settlement location distribution.

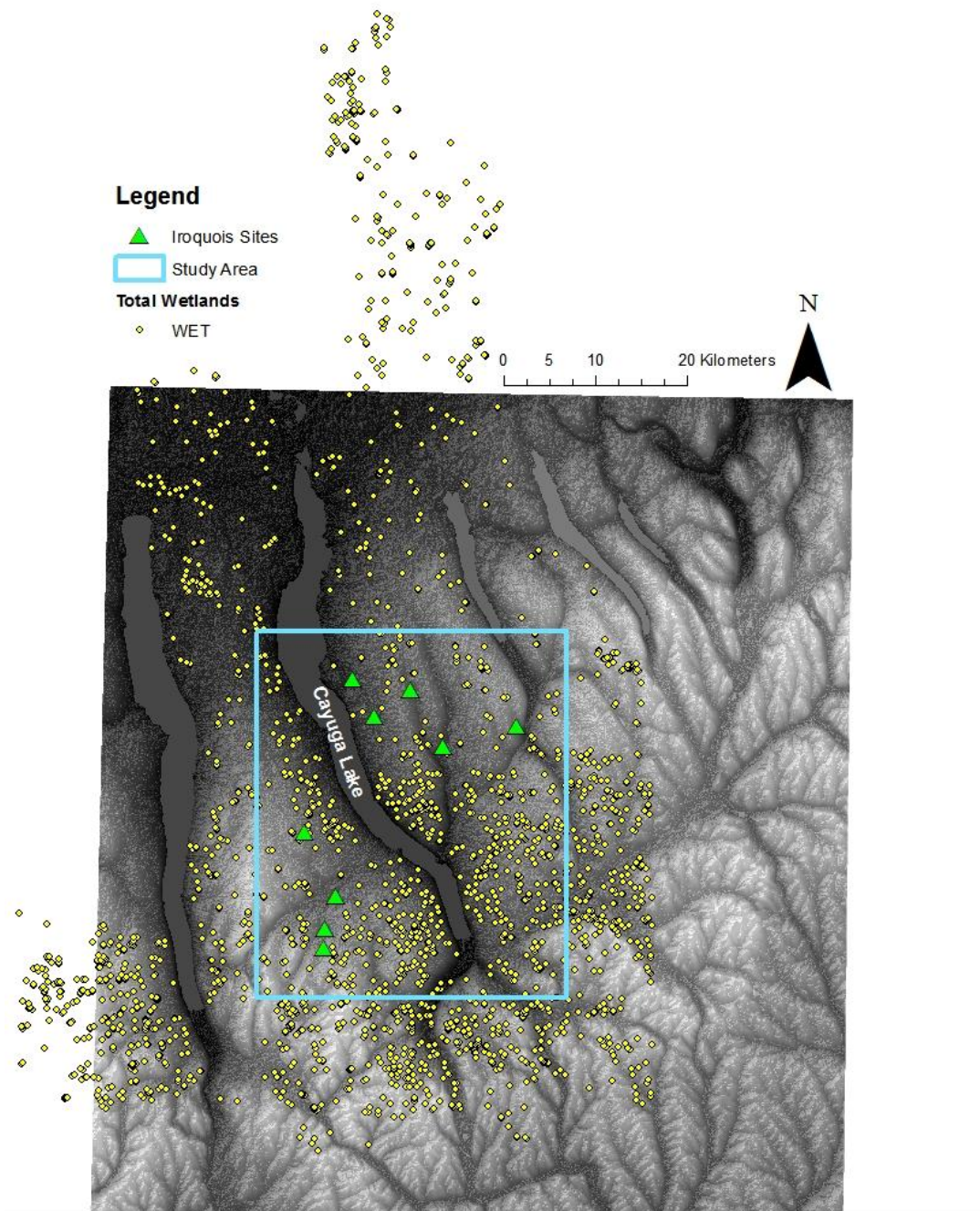




**Figure 5.** Regional map showing the extent of the county-wide wetland soil data compared with the extent of the Cayuga settlement locations.

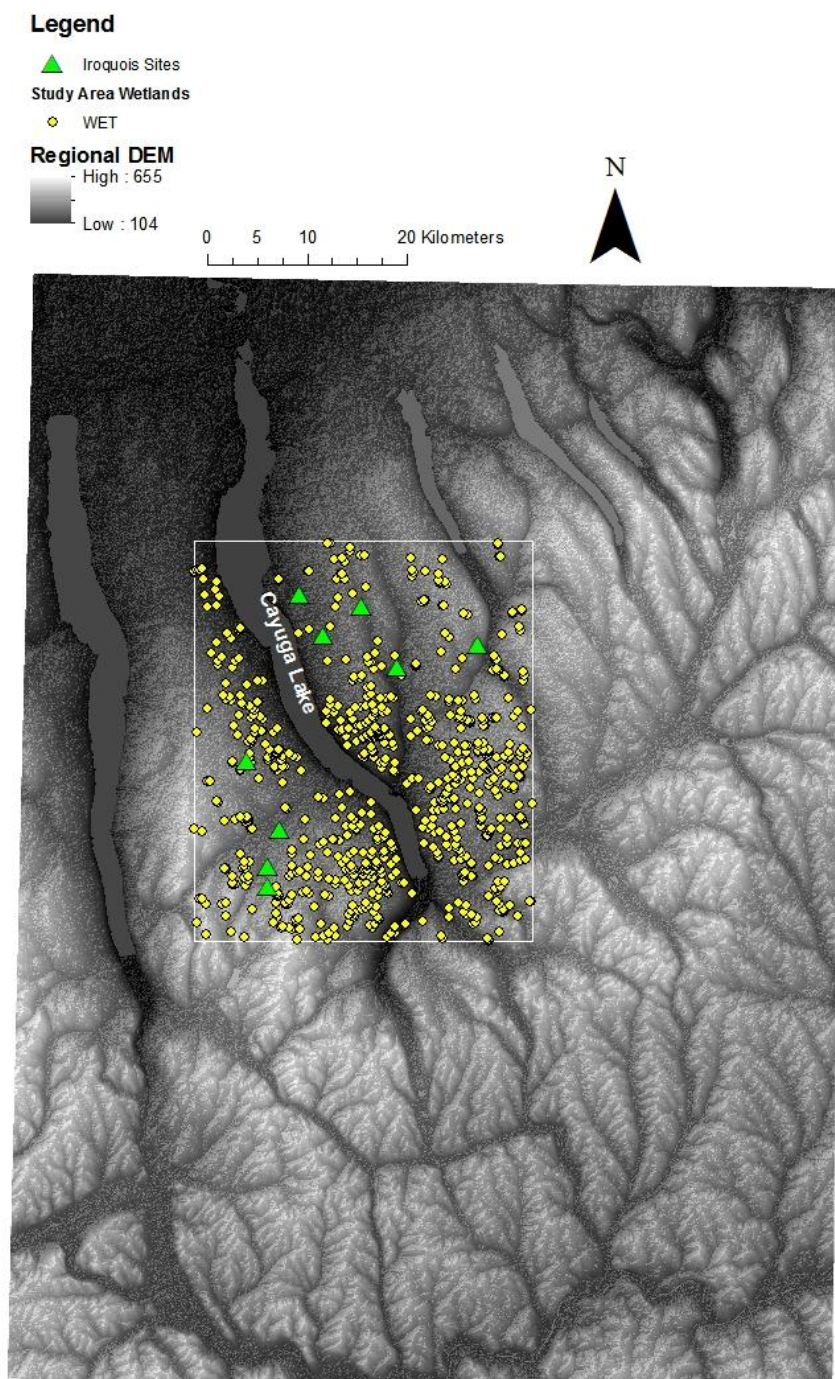


**Figure 6.** Regional map with the study area highlighted.

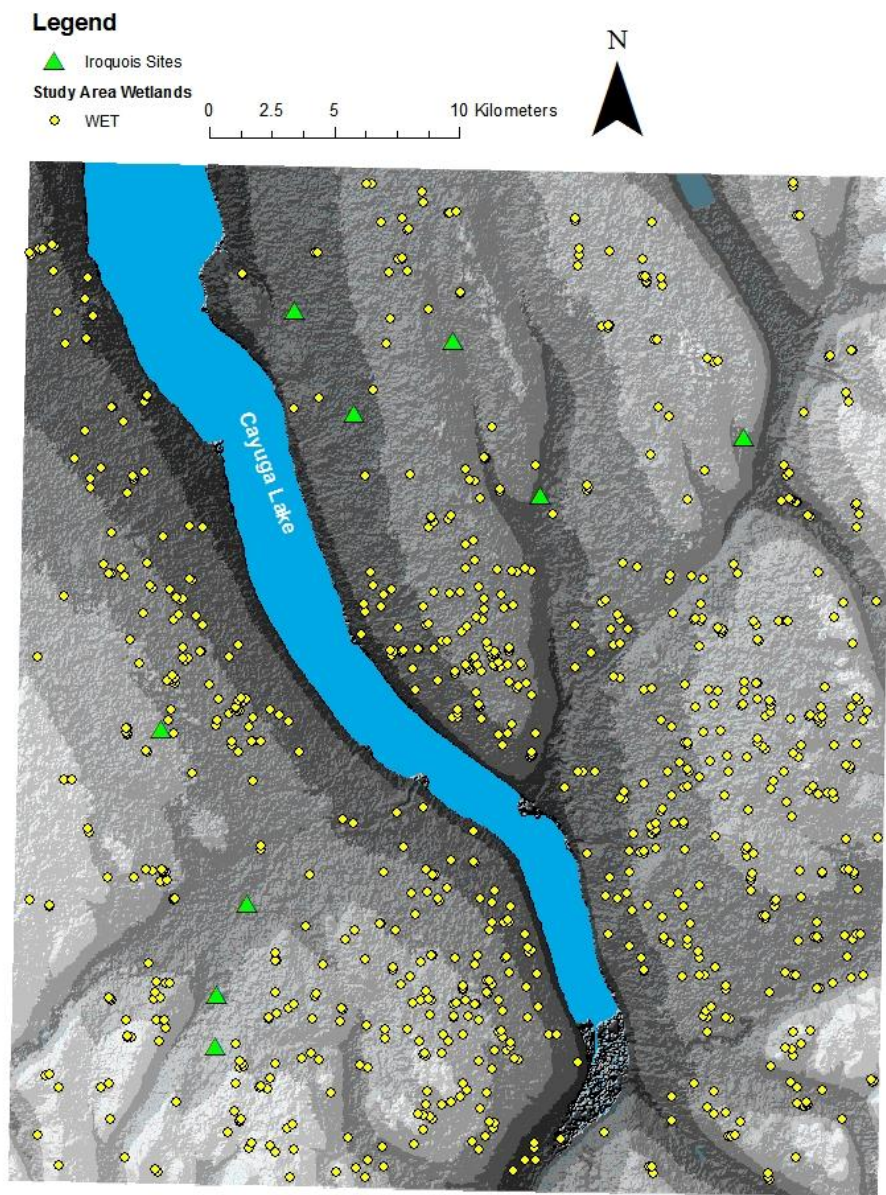




**Figure 7.** Regional map with spatial data restricted to the study area.

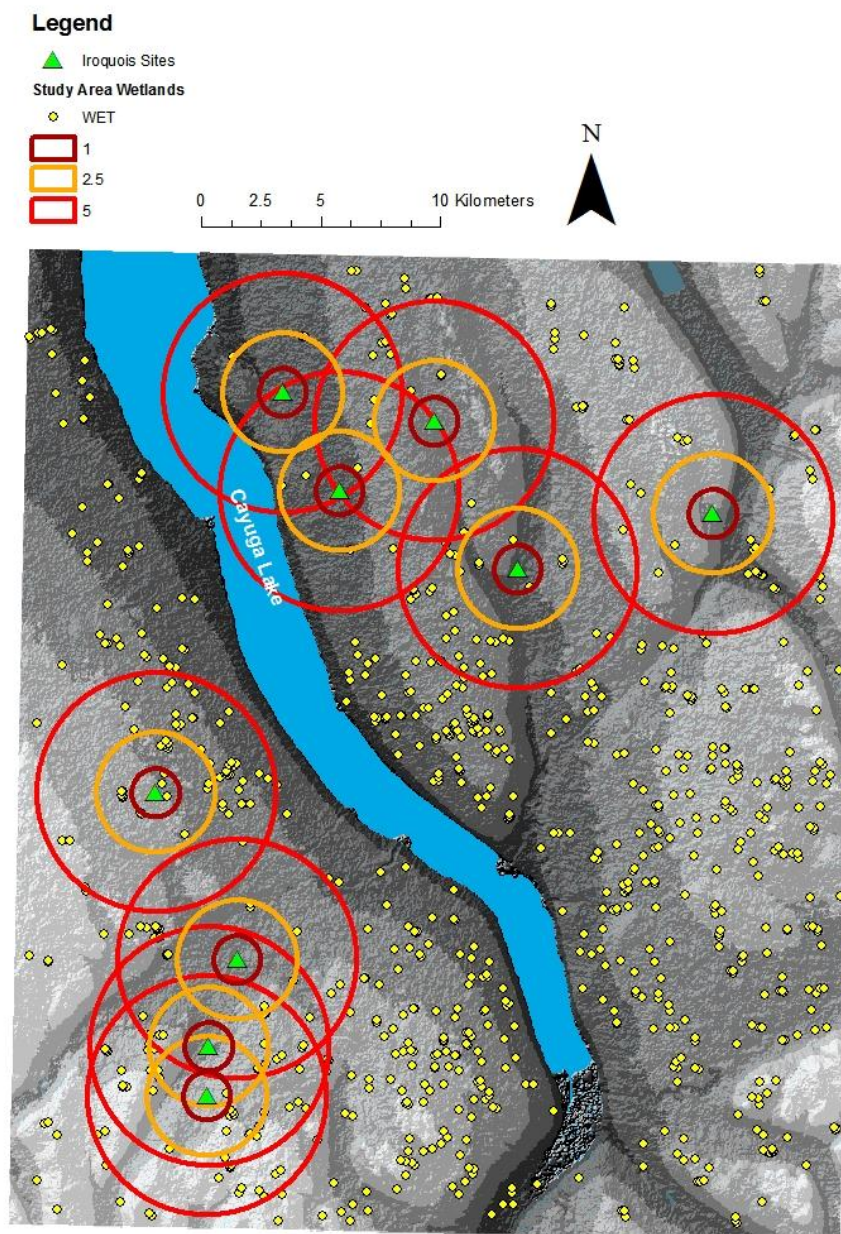


**Figure 8.** Map of the study area with Cayuga settlements and wetland points.

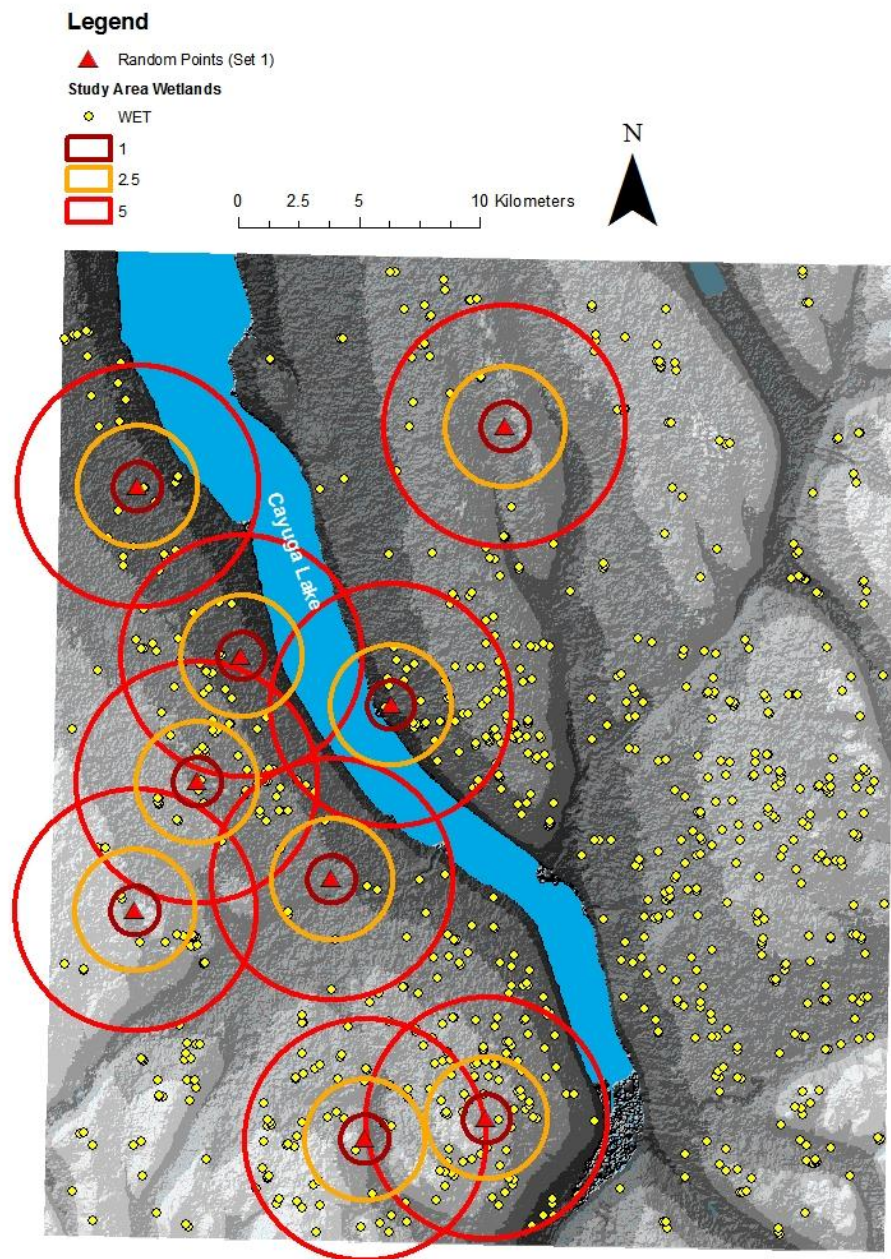




**Figure 9.** Map of the study area with distance buffers at intervals of 1, 2.5, and 5 km around the Cayuga settlement locations.

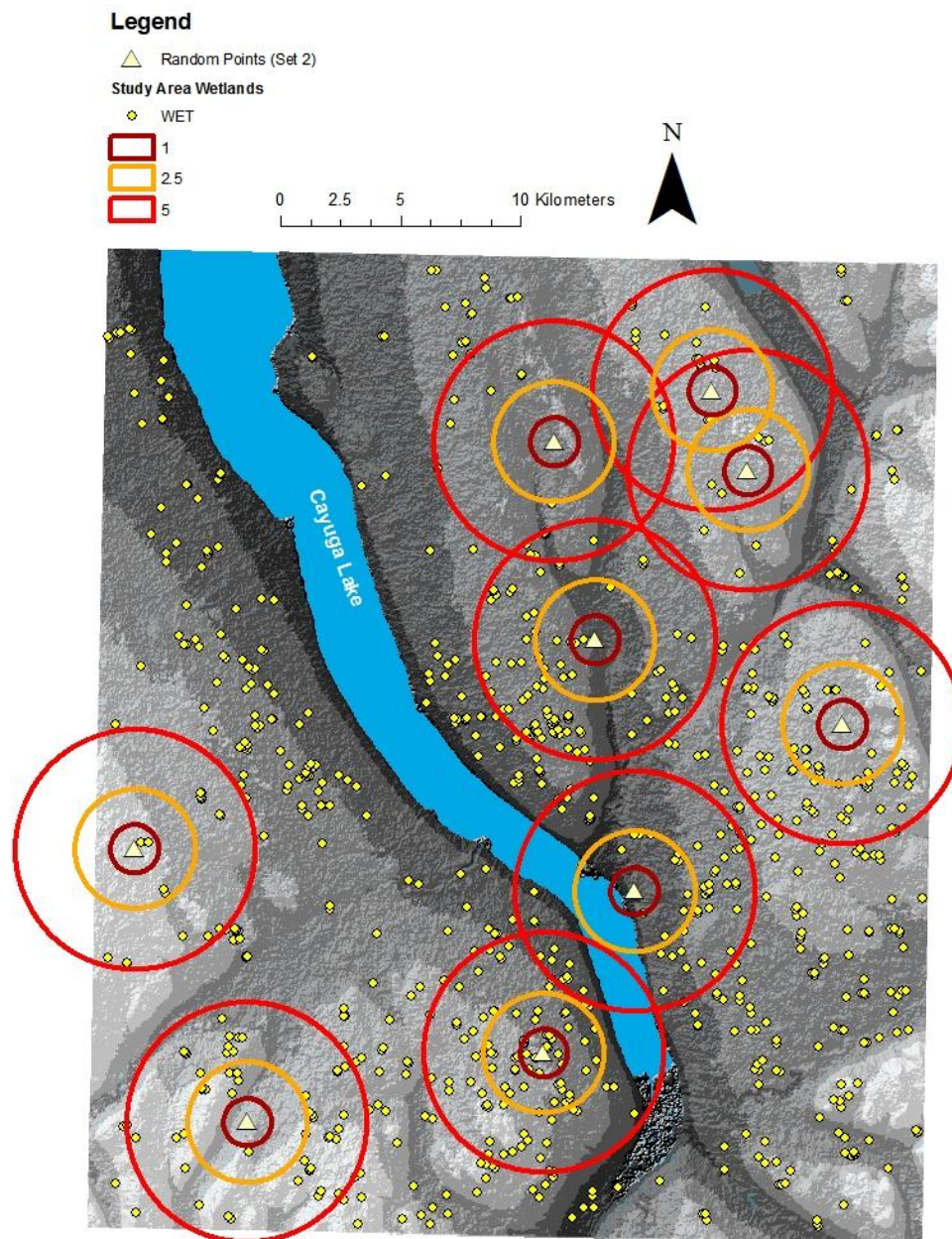


**Figure 10.** Map of the study area with distance buffers at intervals of 1, 2.5, and 5 km around the first control group, a set of nine random points concentrated to the west of Cayuga Lake.

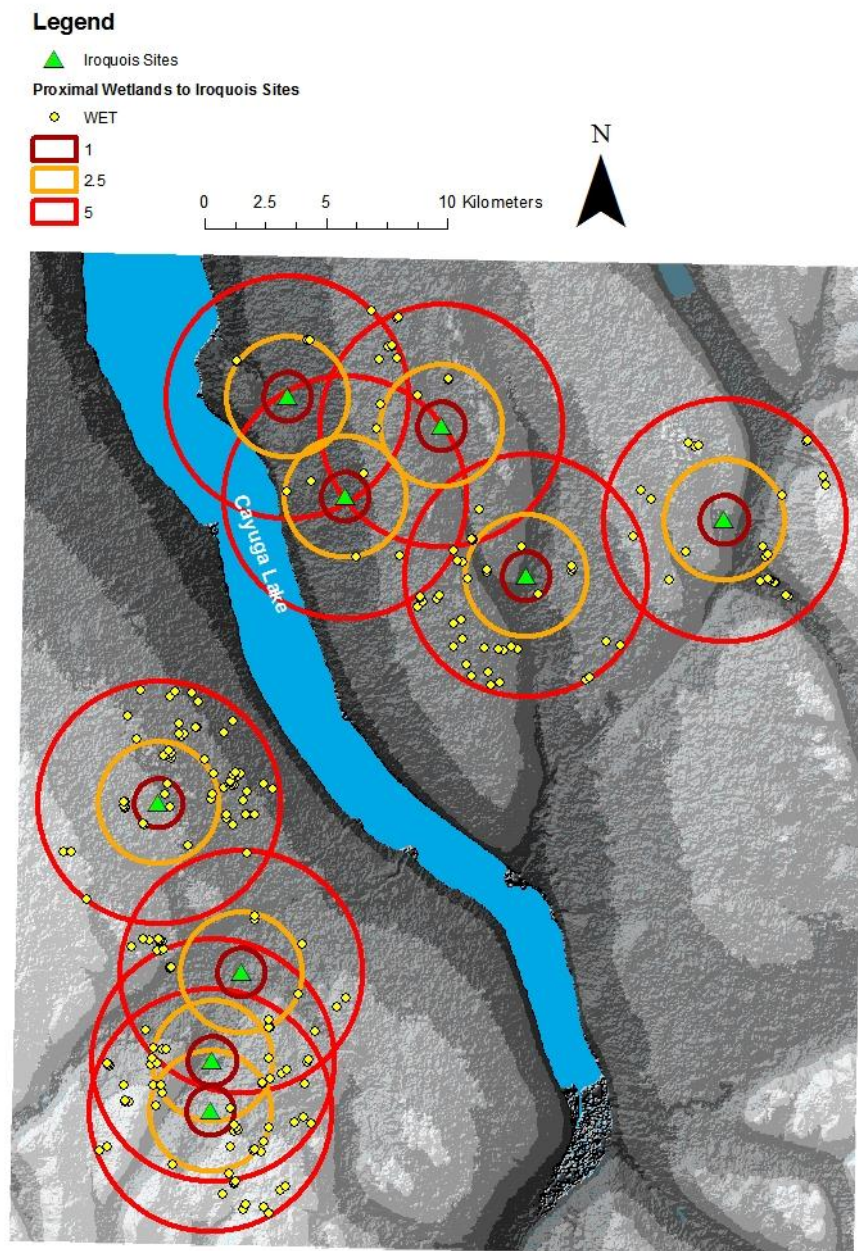




**Figure 11.** Map of the study area with distance buffers at intervals of 1, 2.5, and 5 km around the second control group, a set of nine random points concentrated to the east of Cayuga Lake.

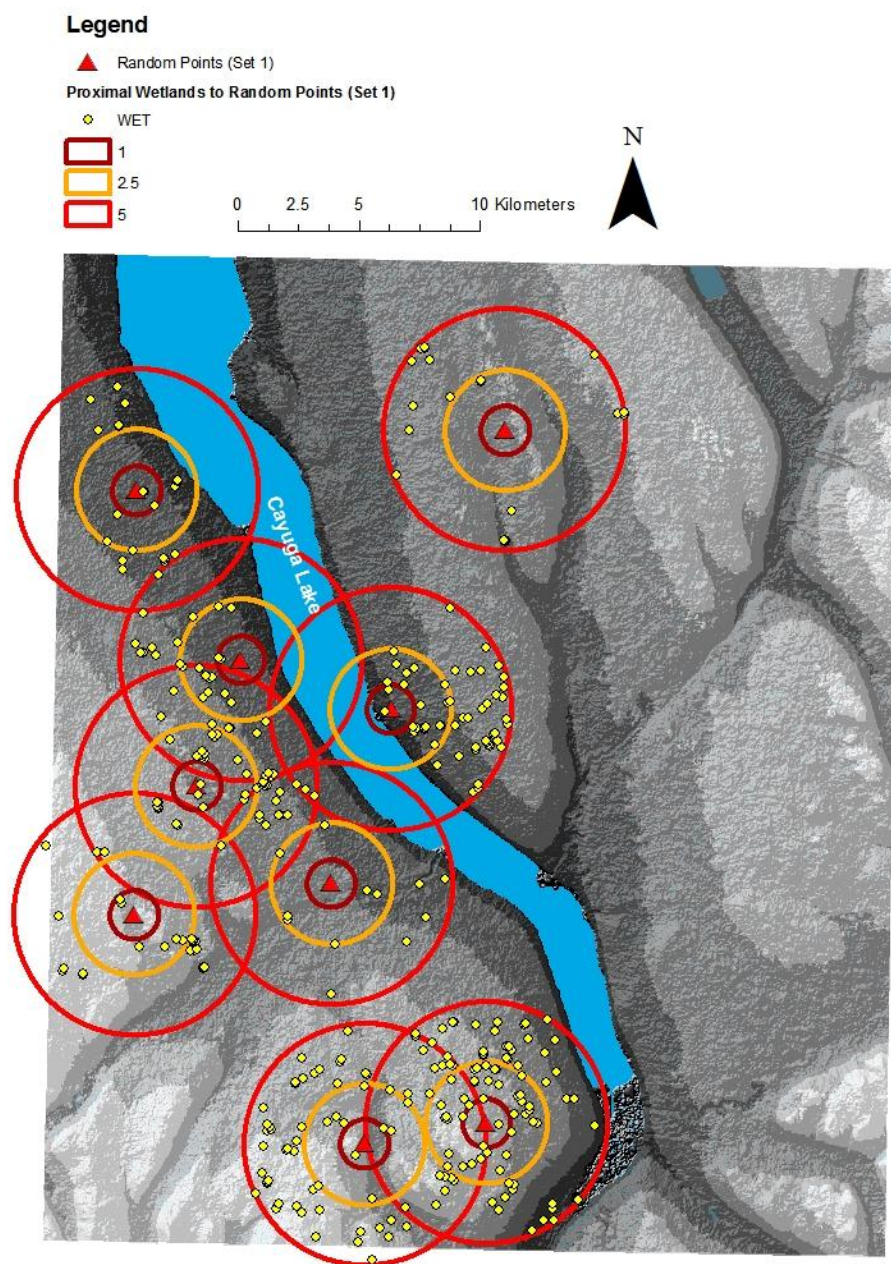


**Figure 12.** Map of the study area showing the Cayuga Iroquois settlement locations and wetland points within 1-, 2.5-, and five-kilometer distance buffers.

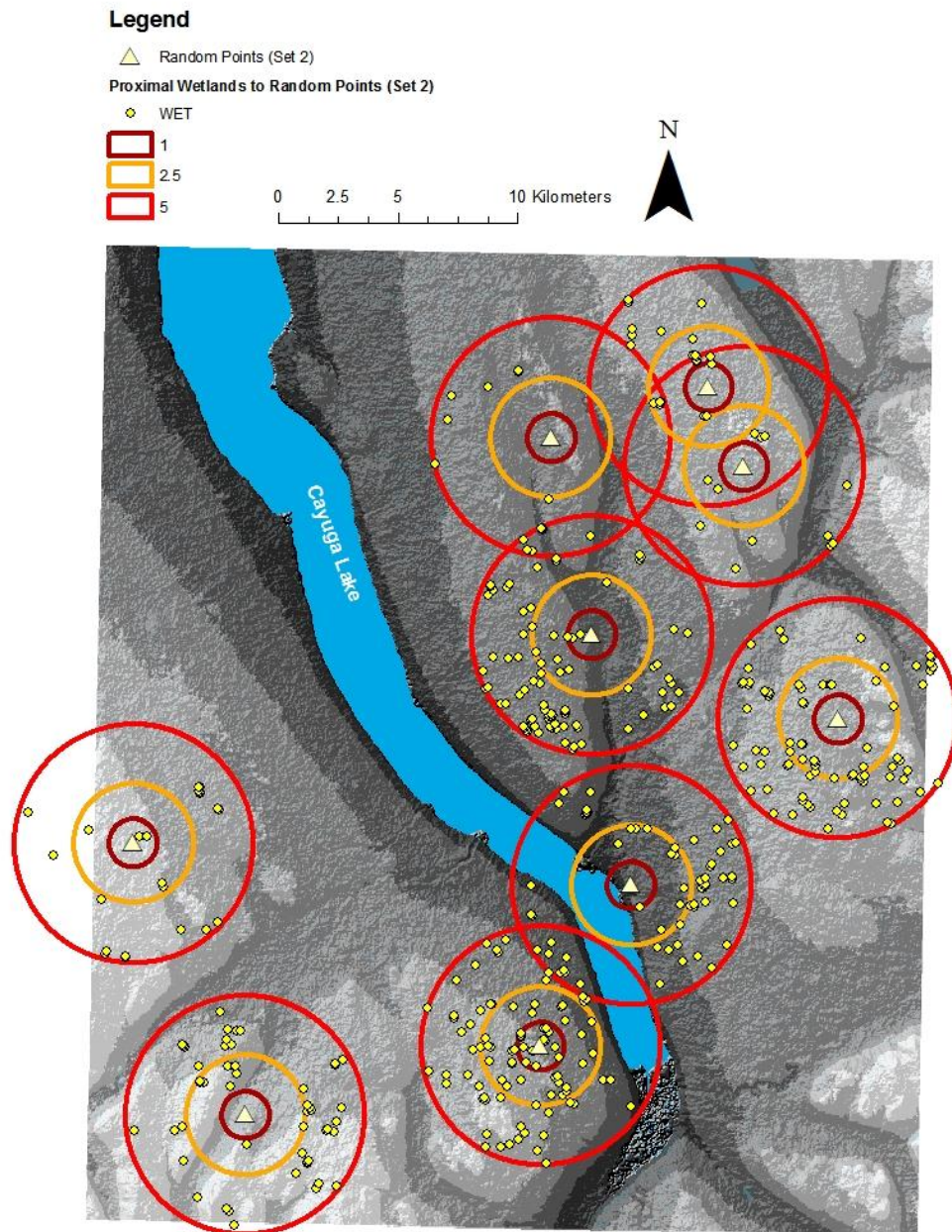




**Figure 13.** Map of the study area showing the first control group and wetland points within 1-, 2.5-, and five-kilometer distance buffers.



**Figure 14.** Map of the study area showing the second control group with wetland points within 1-, 2.5-, and five-kilometer distance buffers.



## REFERENCES

- Aldenderfer, Mark and Herbert D.G. Maschner (editors)  
1996 Anthropology, Space, and Geographic Information Systems. Oxford University Press, New York.
- Allen, Kathleen M.S.  
1996 Iroquoian landscapes: people, environments, and the GIS context. In *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*, edited by H.G. Maschner, pp. 198-222. Center for Archaeological Investigations, Southern Illinois University, Carbondale.  
  
2009 Temporal and Spatial Scales of Activity among the Iroquois. In *Iroquoian Archaeology and Analytic Scale*, edited by L. E. Miroff and T. D. Knapp, pp. 153-178. University of Tennessee Press, Knoxville.
- Bell, Tyler and Gary R. Lock  
2002 Topographic and cultural influences on walking the Ridgeway in later prehistoric times. In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G.R. Lock, pp. 85-100. IOS Press, Amsterdam.
- Bolstad, Paul  
2008 GIS Fundamentals, a First Text on Geographic Information Systems, Eider Press, White Bear Lake, Minnesota.
- Bond, S.C.  
1985 The relationship between soils and settlement patterns in the Mohawk Valley. In *The Mohawk Valley Project: 1982 Field Season Report*, edited by D.R. Snow, pp. 17-40. The Institute for Northeast Anthropology, State University of New York at Albany, Albany.
- Chapman, H.  
2000 Understanding wetland archaeological landscapes: GIS, environmental analysis and landscape reconstruction; pathways and narratives. In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G.R. Lock, pp. 49-60. IOS Press, Amsterdam.

Connolly, James and Mark Lake

2006 Geographical Information Systems in Archaeology, Cambridge, London.

DeOrio, R.D.

1980 Perspectives on the prehistoric Cayuga, post Owasco tradition, through the correlation of ceramic types with area development. In *Proceedings of the 1979 Iroquois Pottery Conference Research Records 13*, edited by C.F. Hayes III, pp. 65-85. Rochester Museum and Science Center, Rochester.

Engelbrecht, W.

2003 Iroquoia: The Development of a Native World, Syracuse University, Syracuse.

2009 Defense in an Iroquois Village. In *Iroquoian Archaeology and Analytic Scale*, edited by L. E. Miroff and T. D. Knapp, pp. 179-188. University of Tennessee Press, Knoxville.

Funk, R.E.

1992 Some major wetlands in New York state: a preliminary assessment of their biological and cultural potential, *Man in the Northeast* 43:25-41.

Harris, David R.

1972 Swidden Systems and Settlement. In *Ecology and Agricultural Settlements: An Ethnographic and Archaeological Perspective*, edited by Ruth Tringham, pp. 59-78. Warner Modular Publications, Inc.

Hasenstab, Robert J.

1991 Wetlands as a critical variable in predictive modeling of prehistoric site locations: a case study from the Passaic River Basin, *Man in the Northeast* 42:39-61

1996a Settlement as adaptation: variability in Iroquois village site selection as inferred through GIS. In *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*, edited by H.G. Maschner, pp. 223-241. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

1996b Aboriginal settlement patterns in late woodland upper New York State, *Journal of Middle Atlantic Archaeology* 12:17-26.

Herrick, F.E.

1897 An ancient fortification in Tompkins County, New York, *The Antiquarian* 1(4):85-

87.

Hodder, Ian R. and Clive Orton

1976 *Spatial Analysis in Archaeology*. Cambridge University Press.

Ingold, Tim

1993 The temporality of the landscape, *World Archaeology* 25:152–174.

Jones, David M. and Anne Jones

1980 The defenses at Indian Fort Road, Tompkins County, New York (An ancient fortification in Tompkins County, N.Y.–revisited), *Pennsylvania Archaeologist* 50:61–71.

Jones, Eric E.

2006 Using viewshed analysis to explore settlement choice: a case study of the Onondaga Iroquois, *American Antiquity* 71(3):523–538.

2010 An analysis of factors influencing sixteenth and seventeenth century Haudenosaunee (Iroquois) settlement locations, *Journal of Anthropological Archaeology* 29(1):1-14

Llobera, Marcos

2000 Understanding movement: a pilot model towards the sociology of movement. In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G.R. Lock, pp. 65–84. IOS Press, Amsterdam.

2001 Building past landscape perception with GIS; understanding topographic prominence, *Journal of Archaeological Science* 28:1005–1114.

MacNeish, Richard S.

1980 Iroquois pottery types 32 years later. In *Proceedings of the 1979 Iroquois Pottery Conference. Research Records 13*, edited by C.F. Hayes III, pp. 1-6. Rochester Museum and Science Center, Rochester.

Maschner, Herbert D.G.

1996a Geographic information systems in archaeology. In *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*, edited by H.G. Maschner, pp. 1-24. Center for Archaeological Investigations, Southern Illinois University, Carbondale.



- 1996b The politics of settlement choice on the northwest coast: cognition, GIS, and coastal landscapes. In *Anthropology, Space, and Geographic Information Systems*, edited by M. Aldenderfer and H. Maschner, pp. 175-189. Oxford University Press, New York.
- Morgan, Lewis H.  
1851 Map of the Ho-De-No-Sau-Nee-Ga or the Territories of the People of the Longhouse in 1720, R.H. Pease, Albany.
- Niemczycki, M.A.P.  
1984 The Origin and Development of the Seneca and Cayuga Tribes of New York State. Rochester Museum and Science Center, Research Records No. 17.
- Sanders, Michael J.  
2008 Poorly drained soils and aboriginal archaeological sites in eastern New York, *The Bulletin: Journal of the New York State Archaeological Association* 124:78-82.
- Snow, Dean R.  
1994 The Iroquois, Blackwell, New York.  
  
1997 The Architecture of Iroquois Longhouses, *Northeast Anthropology* 53:61-84.
- Stone, G.D.  
1996 Settlement Ecology: The Social and Spatial Organization of Kofyar Agriculture, University of Arizona, Tucson.
- Tobias, Phillip V.  
1976 Bushman hunter-gatherers: a study in human ecology. In *Human Ecology: An Environmental Approach*, edited by P.J. Richerson and J. McEvoy, pp. 271-283. Duxbury Press, Massachusetts.
- Wheatley, David and Mark Gillings  
2002 Spatial Technology and Archaeology, Taylor and Francis, London.