A LOCATION ANALYSIS OF EARLY SEVENTEENTH CENTURY NEUTRAL SETTLEMENTS, SOUTHERN ONTARIO

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Abstract

A Location Analysis of Early Seventeenth Century Neutral Settlements

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This is a re-examination of the settlement pattern of seventeenth century Neutral town, village and hamlet sites within the Fairchild-Big Creeks and Spencer-Bronte Creeks drainages. The updated analysis is intended to take into consideration the questions of the relationships of site size, economic factors and socio-political organization, which have been raised in the years subsequent to earlier studies of the Neutral settlement pattern. GIS is used to tabulate the contents of catchments and comparisons of the results by site size and locations are used to examine the relationships between sites and environmental features.

This analysis confirms existing assumptions about the association of Neutral sites with respect to individual environmental variables, namely streams, elevated locations and well-drained light textured soils. This analysis also reveals differences between the Glass Bead Period 2 and Glass Bead Period 3 site locations indicating greater association with larger streams, population concentration southwards in the Fairchild-Big Creeks site cluster, and movement eastwards into the Spencer-Bronte site cluster.

Keywords: Ontario Archaeology, historic Neutral, Iroquoians, GIS and archaeology, site location, Ontario Iroquoian economy

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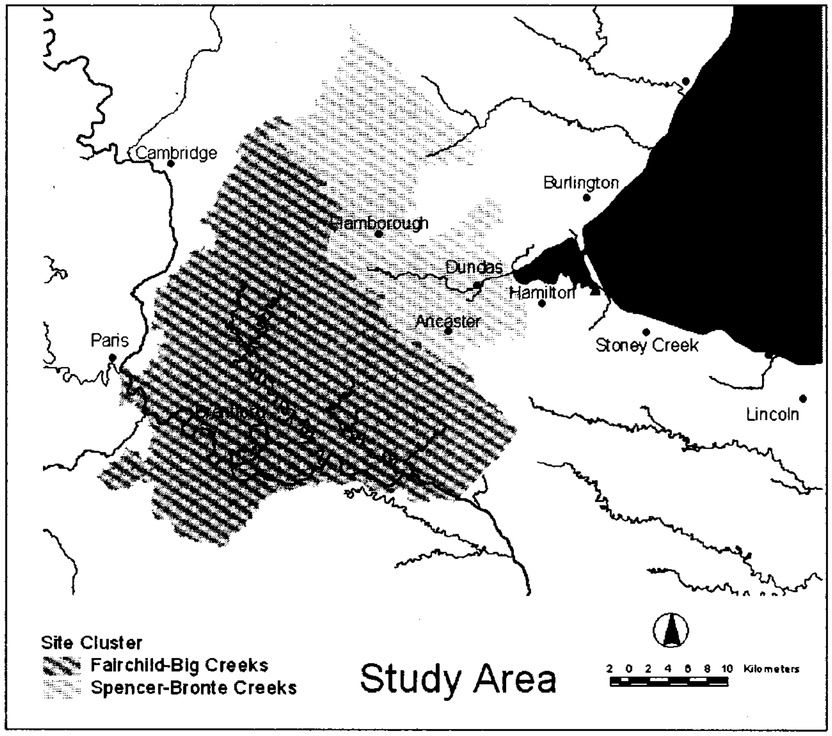
Chapter 1. Introduction

This study is a macro level location analysis of Historic Neutral sites that were occupied ca. A.D. 1600-1650. The Neutral were a native Iroquoian people living in what is now that part of southern Ontario to the north of Lake Erie and to the west of Lake Ontario, clustered into groupings of up to 9 or 10 tribes (Noble 1984:4). This analysis is focused on the two largest Neutral site clusters shown in Figure 1. These clusters are the Fairchild-Big Creeks cluster, located southwest of the present day city of Hamilton, Ontario, and the Spencer-Bronte Creeks cluster located inland at the western tip of Lake Ontario. Using site size estimations taken from Borden form information provided by the Ontario Ministry of Culture, sites are categorized according to size ranges following Noble (1984:13): (1) Hamlets are small sites less than .4 hectares in area; (2) villages range in size from .4 to two hectares; (3) Towns are from two to six hectares in area; and, (4) a possible Capital, which may fall into fourth unique size category of its own.

These sites and their surroundings are assessed in relationship to environmental variables in order to develop a location signature for these sites and discuss the reasons for location preference. Based on the assumption that economic functions of sites and social structure can be reflected in settlement pattern, specific attention is paid to the potential differences in location signature between sites of different size classifications, including the large Walker site,

Figure 1: Study Area



which, based on *the Jesuit Relations*, is presumed to be the chief town of the entire Neutral confederacy (Wright 1981:1).

The study of site location in reference to the surrounding environment is important for two reasons: To begin with, economy, social structure, population size, territoriality, intra-site relationships and cultural differences have influence upon site location (Trigger 1967). A better understanding of settlement patterns is therefore an important tool for expanding our understanding of past societies. Secondly, by expanding our understanding of how elements of settlement pattern are connected to environmental features that can still be identified today, information is provided which may be helpful to those developing criteria for conserving locations of high archaeological potential and for mitigation.

Within Ontario, historic Neutral towns and villages are a suitable class of sites for performing this sort of analysis because of their high visibility, the large number of sites recorded, and the availability of a large body of published literature, including the historical accounts of French missionaries.

The historic period was a time of great social, economic, and demographic change for Iroquoian groups, including the Neutral, due to increased trade (both Native and European), warfare, and disease epidemics. It has been argued that the late historic Neutral differed from other northern Iroquoian groups in that the Neutral chief Tsouharissen exercised greater control over his people than other contemporary Iroquoian leaders. There is evidence that Neutral possessed a high level of craft specialization, social hierarchies or even stratification, engaged in intensive long distance trade, and large-scale warfare. Some archaeologists have proposed that the historic Neutral meet the criteria of a chiefdom level society (Jamieson 1996,1999; Noble 1985). This hypothesis is supported by archaeological evidence based on burial data and settlement patterns, and is described in greater detail in Chapter 2.

It is expected that this analysis may also determine if there are any significant changes in site location preferences over time during the early seventeenth century, or if differences exist between the two largest site clusters which have been inferred to represent two Neutral tribal divisions.

In order to avoid falling into the trap of classifying the landscape into a false dichotomy of sites versus non-sites, this study makes use of a site location analysis composed in part of a modified form of catchment analysis to examine the areas *surrounding* Neutral sites in order to describe site location in reference to the wider regional settlement pattern and Neutral economy.

Catchment analysis is a method originally developed by Vita-Finzi and Higgs (1970) whereby circles of a specified distance are drawn around sites and the resources within these circles are documented and used to infer site economy. The original Site Catchment Analysis method, its criticisms and subsequent improvements, is described in greater detail in Chapter 3.

There have been similar uses of catchment analysis to study the distribution of Iroquoian sites. In New York State, Hunt (1992) examined the soil characteristics of five kilometer catchments for twenty-two sites spanning the Late Woodland period. He was able to show a clear trend over time towards site catchments containing soils with higher productivity ratings for corn. This trend leveled off and decreased during the seventeenth and eighteenth centuries (Hunt 1992:306). Hasenstab (1990) analyzed site distributions in New York State and found evidence to support a core-periphery hypothesis of social interaction. He found that in the core of the Iroquois homeland, sites were oriented towards corn cultivation, whereas on the periphery there was increased utilization and depletion of deer, as well as a shift away from locating sites near navigable waterways. This is believed to have been a result of competition and warfare resulting from population pressures pushing northeast out of the Missisipian core area (Hasenstab 1990:169-172).

In Neutralia, Horne (1987) analyzed the catchments of 10 pre-European Neutral and late Middleport Ontario Iroquois sites in the Waterloo region. Concentric catchment circles around the sites were sized according to the resource being analyzed (Horne 1987:6). The circles were also used to examine site clustering patterns and speculate about village movements. He concluded that village movement patterns result in a pattern of successive sites with overlapping catchments, and that sites are located near smaller streams (Horne 1987:21-22). However, as these sites are older than the ones I am interested in, and are located in a different region, these results differ from my findings.

An often cited but unpublished graduate research paper by Stevens (1974) examined the point locations of 41 Neutral sites in relation to environmental features such as slope, soil, and proximity to water. Stevens' results confirmed the traditional view of sites being located at elevated locations on well-drained sandy soils, close to water sources.

In the intervening years, there has been a growing body of knowledge about the importance of trade to the Neutral economy and a greater focus on social structure and organization of the Neutral during the late sixteenth and early seventeenth centuries. The goal of this analysis is to pick up where Stevens and others left off and attempt to demonstrate linkages between the Neutral economy and settlement pattern with an additional emphasis on observing if there are changes to these patterns relating to the factors mentioned above.

Compared to earlier works, this analysis makes use of more up-to-date computer based Geographic Information Systems (GIS) and database software to analyze an expanded list of newer digital map data products from a variety of government agencies, including water data, digital elevation models, soil survey data, and wildlife potential.

Sites are considered not as point locations, but also in terms of the contents of site catchment areas. A method of 200, 500, 1000, and 5000 meter circular zones centered upon the site are used to determine these catchments. Town, village, and hamlet sites of two clusters are compared based on tabulated environmental variables such as soil suitability, surface curvature, proximity to water and wetlands. Temporal changes to settlement pattern are also considered.

Contents of site catchments are tabulated in a database and compared with background distribution based on random points to determine which variables depart from a random distribution and therefore hold statistical significance. Aggregate differences between site clusters and time periods are discussed in relation to the social and economic changes known to be taking place at that time. Tabulations of catchment overlaps are examined in the same way to determine if there is a consistent pattern of shared space, which may indicate a relationship between sites of different ages. In Chapter 2, I present an overview of what is known about the sixteenth and early seventeenth century Neutral with an emphasis on their settlement pattern, sociopolitical organization and economy. This is followed in Chapter 3 by an introduction to Site Catchment Analysis and a critical review of updated methods which may be relevant to my analysis. Chapter 4 presents the methodology for the analysis used. The results of the analysis are presented in Chapter 5, followed by discussion and interpretation in Chapter 6.

Chapter 2. Background Overview: The Neutral

The Neutral were the native people who the French explorer Champlain first described as occupying the territory between the Hurons and the Iroquois at the western tip of Lake Ontario and North of Lake Erie prior to being dispersed by the League Iroquois in 1651/52 (Lennox and Fitzgerald 1990:437). They were an Iroquoian speaking people whose culture is believed to originate from the 1350 A.D. Middleport Horizon by (Wright 1966:64-65). This horizon is believed to be the source of both the Huron-Petun and Neutral branches of the Ontario Iroquois Tradition that became distinct through processes of regional differentiation (Lennox 1981:214).

The early seventeenth century was a time of rapid social and technological change for Iroquoian people in the Northeast, including the Neutral. The importance of these influences should be taken into consideration when studying the distribution and location of historic Neutral sites.

Overall, Neutral culture, social organization, and economy are said to be very similar to those of other Northeastern Iroquoian groups. They lived in semi-sedentary towns, villages, and semi-sedentary to seasonal hamlets. They were matrilineal and resided in longhouses together with extended family social units (Wright 1981:134; Lennox 1981:214). Like other Iroquoians, they were agriculturalists who cultivated domesticated crops of corn, beans, squash, and sunflower. These were supplemented by fishing, hunting, and gathering (Lennox 1984a:4).

The Neutral occupied a "middle-man" trade position among native groups in the region in between the Huron to the north, and southern trade connections to Ohio and the Atlantic coast (Noble 1978:160; Pendergast 1991:52-68). The time period of 1630-1650 was marked by increasing trade, but was also a time of disease epidemics and harsh winters leading to famine and population decline (Lennox and Fitzgerald 1990:409-410).

Territorial Range and Distribution

The northern boundary of Neutral territory corresponds roughly to the northern boundary of the Carolinean Biotic Zone (Noble 1984:14; Lennox and Fitzgerald 1990: 406).

In the fifteenth and sixteenth centuries, the ancestral people who were to become the Neutral were spread across an area as far to the west as the present day City of Chatham, Ontario; however, it was observed that there are fewer seventeenth century sites west of the Grand River (Lennox 1981:214; Lennox and Fitzgerald, 1990:405). There is a consensus that an eastward migration occurred in the proto-historic period sometime between 1550-1620 (Lennox 1984:3). The first European manufactured goods began to arrive through indirect trade with early European explorers and fisherman along the St Lawrence River after 1540 (Noble 1978:152). It is presently unknown what connection, if any, this may have had to the eastward migration. Whatever the reason, after 1620, the Neutral population was mostly concentrated within 20 miles of the west end of Lake Ontario (Lennox 1984a:3; Lennox 1981:214). This central core of the

Neutral homeland was centered on top of the Niagara Escarpment around what is today the City of Hamilton (Wright 1981:9; Noble 1978:156). At the time, there was sparse population in much of the Niagara peninsula and the New York State Niagara frontier.

It was estimated by Champlain in 1615, as well as by Brébeuf and Lalement in 1641, that there were approximately 40 Neutral communities. These include towns and smaller satellite villages and hamlets associated with the towns (Noble 1978:156; Lennox 1981:214). Archaeologists have observed that these communities are grouped into separate clusters. Some have suggested that these clusters may represent tribal units (Kenyon 1972:7; Noble 1978:156). The Neutral were subdivided into a number of tribes. The actual number of tribal divisions may vary by up to fifty percent, depending upon the source being referenced. At the low end of the spectrum, Wright states that the Neutral had 5-8 tribes (Wright 1981:9). Lennox (1981) gives an estimate of 5-9 tribes. Later, Noble estimates that there were 9 or 10 tribes (1984:4).

The seventeenth century was a time of great change for Iroquoian groups in Ontario. Beyond local subsistence economy, adaptation to large-scale socio-political factors such as European influence, intensification of trade and warfare. The effects of disease epidemics also resulted in a declining population.

Neutral Settlement Patterns

History. The study of settlement patterns of the Neutral Indians, and of Iroquoian sites in general, developed in response to the theoretical trends of settlement study in North America in the past century. Neutral sites have been subjected to archaeological interest since the land clearing activities of British settlers first began disturbing sites. Collection of artefacts on these newly re-discovered sites began as early as 1829. At that time, palisades were still visible at some of these locations and were noted by early observers (Lennox and Fitzgerald 1990:406).

During the late nineteenth century, David Boyle undertook the first systematic archaeological investigations of Neutral sites (Lennox and Fitzgerald 1990:407). These observations were published in the *Annual Archaeological Reports for Ontario* and, while these early reports by Boyle and others are an attempt to make regional inventories, they are primarily limited to descriptions of artefact collections, as was the focus of archaeology in that period. This work continued into the early twentieth century by Wintemberg, Waugh and others (Lennox and Fitzgerald 1990:407). Waugh (1902:75-78) recorded his observations about site locations, noting that sites occupied elevated ground on sandy soils and were usually near creeks and streams. When sites were away from water, he believed it might have been to avoid attack by raiding parties. He also made notes of roads that may have originated from pre-existing Indian trails. Houghton, around 1915, was the first to observe in the archaeological record, the apparent migration of the Neutral to the east of the Grand River at time of European contact (Lennox and Fitzgerald 1990:407). Ridley (1961) published an extensive inventory of Neutral sites and their locations.

Modern settlement studies began with the first excavation of a longhouse at the Christianson site in 1969 (Noble 1984:6). There was growing interest in Iroquoian archaeology in this area in the 1970s and the 1980s with university - based research and salvage digs as some of these sites were threatened by urban development. With the new archaeology came an increased focus on in-depth site analyses, osteological analysis, faunal/floral analysis, and settlement pattern and regional analysis (Lennox and Fitzgerald 1990:407-408).

The trend to processualism the 1970s saw a greater influx of expertise from other academic and scientific disciplines being applied to archaeology. This included contributions of geographers to the study of the relationship between the environment and archaeological settlement patterns. In 1971, geographer Conrad Heidenreich published *Huronia, A History and Geography of the Huron Indians, 1600-1650.* This was a monumental, in-depth examination of the geography, environment, and economy of the Huron with reference to historical and archaeological information. Much of what we believe we know about Iroquoian settlement patterns in general is inferred primarily from localized studies of the Huron, such as Heidenreich's, and therefore may not be universally applicable.

In an attempt to remedy this situation, Manuel Stevens (1974), examined and tabulated the placement of 41 Neutral village sites in relation to a variety of environmental criteria such as soil, slope, and proximity to water in order to calculate an index of preference for each condition. Regional and site cluster variations were also examined.

Subsequently, Horne (1987) applied the concept of catchment analysis to a sample of 10 prehistoric and protohistoric Neutral and Middleport sites in the Waterloo region. Unlike Stevens, who examined the placement and extent of the sites themselves in relation to environmental features, Horne used concentric circles around sites sized according to the type of resource being analyzed (Horne, 1987:6). These circles were also used to examine site clustering patterns and speculate about village movements (Horne 1987:21). While sites such as these, which date from A.D. 1350-1580, are not the time period I am focusing on, inferences about what produced their settlement patterns may still have some application to my research.

From published site reports, studies such as the examples mentioned above and the publications of those who have worked to integrate information about the Neutral such as Noble (1984), and Lennox and Fitzgerald (1990), we now have considerable knowledge about their location preferences in relation to local geography.

Site Location, Agriculture, and Soil Types. It is commonly accepted that Neutral sites are located upon elevated topography. Some have considered the defensive value of an elevated position. However, many Neutral sites are located on only moderately elevated locations. The preference for elevated locations therefore may be more related to site drainage than defensive considerations. This applies to both the settlements as a whole, as well as the selection of sites for individual houses within the settlements (Noble 1984:14). Sandy soils are also considered to be the best base for construction (Wright 1981:47). This should come as no surprise, for in addition to being dry, sandy soils would be easier to dig when erecting posts or creating storage pits. Thus Neutral sites tend to be located on loams and sandy loams (Noble 1984:14). The preference for these soil types is also believed to reflect the fact that heavier soils were unsuitable for the type of agriculture practiced by the Neutral (Lennox and Fitzgerald 1990:440). The ideal soil types described for maize are deep, moisture retaining, well-drained loams and sandy loams (Heidenreich 1971, 181). Additionally, Stevens (1974) observes a Neutral preference for silt loams.

Based on observations by Kalm in the mid eighteenth century, the two major varieties of maize that were described as being cultivated by the Huron are a large variety known as Flour Corn which could take up to six months to mature, and the shorter Flint Corn which was hardier, had a short three month growing season, and produced yields equivalent to the larger variety because it could be planted in greater density. Flint Corn is believed to have been the variety of maize that was most commonly cultivated by the Ontario Iroquois, and this variety had a preference for sandy soils (Heidenreich 1971:172-173).

Native digging-stick agriculture involved the creation of hills, where maize, squash and in some cases, beans could be grown together. Preference is presumed to be for loose textured, stone-free soil on flat or gently sloping land. However, it must be remembered that some of the limitations of modern mechanized agriculture would not have been an issue for the Iroquoians. It is possible to cultivate around obstacles that would inhibit modern agricultural techniques such as large stones or tree stumps. However, they would reduce the amount of land available for crops and require more labour to be expended clearing land (Heidenreich 1971:177). Digging stick cultivation also makes it possible to cultivate steeper slopes than is accessible to machinery, and causes fewer disturbances to the soil that would result in leaching (Heidenreich 1971:185).

Various forms of catchment analysis focused on soil productivity have been used to examine the pattern of Iroquoian site movements and length of settlement, where older sites were abandoned and new villages constructed as part of the process of swidden horticulture. There is good evidence to relate settlement location to arable land and a consistent distance between sites (Bamann et al. 1991:440). Iroquoian sites have been described as being compact – single occupation sites of short duration, making it easy to track them in space and time and look at movements (Bamann et al. 1991: 447).

Village Movements. Early French explorers and missionaries observed that the Huron practiced a pattern of village movements within a distance of one to fifteen kilometers from the old village site every eight to twelve years. Heidenriech (1971:195-200) calculated that the amount of land required to maintain a population would need to double over a period of 5 years of cultivation, as the Huron did not add fertilizer to the fields aside from the nutrients released from burning of vegetation in the initial land clearing operation. Therefore, the loam-sand soils in Huronia are quickly depleted of potassium through maize cultivation. He further described the village movement cycle as a product of population size, pest problems, soil depletion, and diminishing returns for effort expended in land clearing, crop cultivation and firewood gathering

(Heidenreich 1971:213-216). This movement pattern has been a continuing area of interest. In the 1980s, the prehistoric Draper site was studied by Warrick, who not only examined the site itself, but the adjacent lands. From this study, he reconstructed the process of Iroquoian village growth, fusion, and fission. In Warrick's model of the Iroquoian village, change is the result of long-term demographic, social, and environmental factors (Bamann et al. 1991: 439).

Horne (1987:8-9) assumed that soil would be a primary factor in site location, but the results of his catchment analysis showed that while there was a preference for better soils, he had difficulty seeing any trends. Horne (1987:19-20) noted a chain link patterning of site catchments and speculated that they could be interrelated settlements, or sequences of site movements, where overlapping catchments allowed re-growth of young trees in old fields to be utilized. Horne's catchment analysis also helps explain the importance of the observation that original pioneer fence posts on former Neutral sites are predominantly of white pine (Wright 1981:4; Lennox 1984a:11). Based on work by other authors who speculated that white pine stands would represent forest succession on abandoned cornfields, he identified modern stands of white pine and found that much of the white pine noted by early surveyors, and present on vegetation maps, does fall within 3 km of known village sites (Horne 1987:19-22). One of the problems encountered by Horne when using old township survey records was that only survey lines had geographic features and trees noted. This problem exists for old township surveys throughout Ontario and is not limited to the Waterloo region.

Wood Supply and its Importance. The importance of forested areas growing appropriate types and sizes of trees is a factor that has often been overlooked. Trees produce mast crops such as walnuts and hickory nuts that would have been collected seasonally to supplement the diet. Heidenriech (1971:112) notes that for the Huron, oak trees (that tend to grow on sandy soils) provided acorns, but these were considered a starvation food, and therefore may not have been a consideration for settlement location. More important than mast crops, forests would have provided wood and bark. In order to establish and maintain a large village or town, a huge supply of wood is required for construction as well as fuel for heat and cooking. The need for wood may have been the reason villages are located near cedar swamps and old village catchments to make use of re-growth (Bamann et al. 1991: 445).

The Neutral built wooden "bark covered pole structures" both in square "cabin" and in rectangular "long house" configurations (Noble 1984:8-9; Lennox and Fitzgerald 1990:441). The size of these structures varied considerably but some could be immensely large. For example, at the Walker site, the sample of 12 structures that were excavated varied in length from 6-35 meters. Aside from size, postmolds provide us with insights into to the number of timbers used, as well as the sizes and species of wood that were selected for construction. At Walker, there were 540 house wall post molds recorded at 3.8 – 28 cm in diameter, and 141 interior postmolds of 3.8 - 21.6 cm in diameter (Wright 1981:12). There was a mean diameter of 9.9 and 9.1 cm respectively. This preference for small-diameter trees is probably a reflection of the degree of effort that would be required to harvest the larger trees given the available technology (Heidenreich 1971:151-153).

Based on floral analysis at the Hood site, Lennox (1984:16) concluded that there was a preference in using Eastern White Cedar for house construction. Noble (1984:10) stated that analysis of charcoal from burned posts has demonstrated a preference for cedar for large interior supports while maple and oak were used for exterior walls. He believes that exterior posts were harvested from thin, tall saplings found in mature deciduous forests. Elm and cedar trees growing in low-lying, moist, heavy soils provided the bark that was used on the exterior walls of longhouses (Heidenreich 1971:112; Lennox 1981:214; Lennox 1984a, 3). The double layer of bark not only shielded from moisture, but also trapped an insulating air pocket within the wall (Noble 1984:10).

Many Neutral sites show evidence of being surrounded or partially surrounded by a protective palisade. The palisade at the Hamilton site was a double palisade. The exterior posts were 10.1 cm in diameter with a 70 cm spacing while the interior posts were 7.6 cm diameter with 30.5 – 45.7 cm spacing. Interior cordon walls between structures created alleyways and cul-de-sacs providing additional security (Lennox, 1981:218). A much more impressive fortification was found at the Hood site. It had a palisade of up to 5 rows, with 3 outer and 1 inner row of post molds 8 cm wide being spaced at 25 cm while the second inner row was larger, consisting of 30 cm posts spaced at 45 cm. It was estimated that 9,500 White Cedar posts were used to construct the palisade at Hood (Lennox 1984:12). Even the small Bogle II site had a palisade of sorts in place (Lennox 1984b:227).

While cedar may have been used extensively for construction, Lennox (1984a:132) found that hardwoods such as maple were the wood of choice for burning in the hearths. This is simply common sense since hardwoods burn longer and hotter making them ideal for this purpose. It does show that the ability to harvest wood and the selection of species and sizes for particular purposes should have also been important consideration in site location. Soil depletion may not have been as much of a limiting factor in comparison to warfare, lack of firewood, and even garbage accumulation. The need for large amounts of wood, particularly Eastern White Cedar, helps explain the proximity of Neutral sites to low lying wetlands, such as the Beverly Swamp. Overall, there is very little noted about the vegetation on Neutral sites, or attempts to reconstruct the historic environment surrounding these sites. What little is recorded tends to describe the forest that was present on the sites when the land was cleared and settled.

Hunting. Many Neutral sites are located near wetlands. It has been stated that the proximity to wetlands would also provide ideal habitat for wildlife. Noble (1984:15) suggests that this was to utilize deer and fur-bearing animals that would be plentiful in these areas. Historical accounts state that the Neutral made more extensive use of animal resources than did their Huron neighbors (Wright 1981:130; Noble 1978:159). The Jesuit Lalement commented that they were taller, stronger, and healthier than the Huron, this being attributed to their diet (Wright 1981:131). The large quantities of faunal remains, specifically those of deer, in the archaeological record, as well as a lithic toolkit dominated by projectile points and scrapers, indicates a greater reliance on meat and confirms observations of French missionaries who remarked upon the availability of game and the hunting abilities of these people (Noble 1978:159). In 1626, Daillon was the first to note how plentiful deer were. He observed the Neutral drove the deer into three sided enclosures to herd and corral them (Wright 1981:130; Noble 1985:139).

Noble states that young deer were captured and kept in pens. He also states that populations were "managed" as a resource (1985:139). Descriptions of this activity seem to indicate that large numbers of deer were corralled and captured. Changes to the environment affected by Neutral's agricultural activities would have contributed to the increase of the deer population. Deer would have been drawn to feed on cornfields, perhaps causing some nuisance and crop loss, but also providing hunting opportunities. The clearing of land and proximity to a mixed environment of well-drained uplands near marshes and creeks, and areas of regenerating forest from previous village sites, would have provided plenty of edge effect or a patchiness of vegetation pattern that is known to provide ideal habitat for deer and other wildlife (Horne1987:21).

Aquatic Resources. In addition to terrestrial resources, the Neutral also caught fish and collected snails, bivalves, and crayfish (Noble 1978:159). While deer may have been a seasonally available resource, fish was available year round. Examination of residues found on ceramics indicates that fish was an important part of the diet for Ontario Iroquoians (Morton and Schwarcz 2004:511-514). Neutral settlements are often noted to be near small streams or near springs that produced potable water (Wright 1963; Noble 1984:14).

Stevens (1974:30-31) argues that rivers in Neutral territory were not suitable for trade because of the Niagara Escarpment and that they flowed in the wrong direction to trade with the Huron. When making the argument regarding flow direction Stevens did not take into account that the Neutral were also trading to the South.

Site Size. In 1626, the French missionary Daillon observed different categories of Neutral settlements, dividing them into hamlets, villages, and towns. Alluding to what may have been sites with specialized economic functions, he described hamlets as being small settlements established for the purpose of carrying out fishing, hunting, or farming (Lennox 1981:349). Archaeological evidence has confirmed the observations made by Daillon (Noble 1978:156; 1984:17; Lennox and Fitzgerald 1990:438). To this day, Neutral sites are categorized as towns, villages, hamlets, or camps.

Site size and number of dwellings appear to be the primary consideration used to apply these categories to Neutral archaeological sites. The size of Neutral settlements vary considerably from under .25 hectares for the Bogle hamlets to 6.25 hectares at Walker. Noble defines hamlets as being sites of less than one acre, or .4 hectares (1984:13). Noble interprets the Bogle 1 and Bogle 2 as being examples of the temporary sites that the Jesuits observed being used for hunting, fishing, and agriculture. A sampling problem exists within the database of known sites, resulting from larger sites being more visible and productive archaeologically in comparison to small sites.

The question about the role of small sites in relation to nearby larger sites is what Lennox has referred to as the Capital/Satellite problem (1984:186). Are these smaller sites simply smaller versions of the larger sites or is there a specialized economic role? Are these sites seasonal or year round occupations?

Lennox attempted to answer these questions by examining the settlement pattern within Bogle sites, and comparing them to the larger Hood and Hamilton sites within the same Spencer-Bronte Creeks site cluster. Hood and Bogle I are believed to date to the 1630s and to be contemporary to each other. Hamilton and Bogle II date to the 1640s (Lennox 1984b:264). Lennox compared site artefact types and counts, faunal remains, and house structures. No evidence in faunal remains or refuse accumulation was found at the Bogle sites that would permit inference as to site seasonality or length of occupation. Evidence of repairs to house structures, and the presence of food storage facilities did, however, show convincing evidence for long-term, year round use of these sites (Lennox 1984b:264-266). Artefact frequencies and house sizes indicated that there were socio-economic differences between the large and small settlements.

Lennox found that the hamlets had fewer artefacts that represented status or were the product of trade. This included fewer European artefacts, and less use of imported high quality Onondoga chert relative to the local low-quality Ancaster chert (Lennox 1984:268-269). He concludes that the larger sites were cultural and political centres benefiting from a greater focus on external affairs such as trade, while hamlets were more subsistence oriented subsidiary communities which may have assisted with warfare (Lennox 1984b:272). As this conclusion appears to be based entirely on artefact counts and house structures, it would be productive to examine the catchments of the sites to see if there is a difference in local resources.

Other small sites interpreted as being fishing and hunting camps have been observed as well. These tiny sites, such as Stratford Knoll and Alder, have been referred to as temporary activity loci, not habitations (Lennox and Fitzgerald 1990:439). Lacking habitation features, these sites are clearly of a short-term nature. This matter is further confused by the fact that these camps are small multi-component sites with few diagnostic artefacts. For instance, the late historic Neutral occupation from the Alder site is inferred from only a single red glass bead (Hagerty and Lennox 1990:8).

There has been an increasing attention to variations in site size, site function, and the existence of small special purpose sites. The function of these small sites can vary from horticultural hamlets, to fishing, and hunting camps (Bamann et al. 1991: 441-445).

European Interaction

The French explorer Étienne Brûlé visited the Neutral from 1615-1616 and was the first white man documented to have done so (Noble 1978:152; Lennox 1984a:1). In 1626 Joseph d La Roche Dallion accompanied by Genolle and la Vallé established a Récollect mission to the Neutral (Noble 1978:153; Lennox 1984b:1). They were brought to the capital *Ounotisaston* where they spent three months and were personally adopted by the Neutral Chief Tsouharissen. It has been assumed that the village of *Ounontisaston* correlates with the village known as the Walker site (Noble 1978:153). In order to maintain their middleman trading position, hostilities and rumors were spread by the Huron, leading to Dallion's life being threatened and he left the Neutral in 1627 (Noble 1978:155; Lennox 1984a:1).

Both the Récollects and the Jesuits left Canada in 1629 when Quebec was captured by the English. After 1636, only the Jesuits were permitted to return by the decree of French Cardinal Richelieu (Noble 1978:153). Missionary records are the primary source of historical information, so after Dallion left, there was little contact documented with the Neutral until 1640. In 1640, missionaries briefly returned to the Neutral. Jesuits Jean Brébuf and Joseph Marie Chaumonot, along with two French domestics, stayed over the winter of 1640-1641. They were not well accepted, and this was the last documented visit prior to the Neutral dispersal (Noble 1978:154; Lennox 1984:1).

Jesuit Jerome Lalement mentioned in 1641 that many *courier de bois* were visiting the Neutral prior to 1640 to engage in trade. So while little may have been documented about those visits, the Neutral were not isolated from European influence during those years, and Noble (1978:153) believes that these traders may have introduced the smallpox epidemic.

It has been established that during the 1630s into the 1650s, political and European-induced economic changes caused by the intensification of trade, warfare and disease resulted in population shifts that resulted in changes to the northern Iroquoian settlement pattern. These are visible in the archaeological record. Among the Huron, this involved a shift away from dispersed and agriculturally oriented communities to an aggregation of population into areas with access to game and in proximity to larger water courses (Trigger 1963:92-93; Heidenriech 1971:89,113). Similar trends have been observed among the League Iroquois (Snow and Starna 1989:147; Hasenstab 1990:166-167; Hunt 1992:306).

Trade

Prior to the 1970s, the Neutral nation was viewed by archaeologists and historians a sort of economic backwater. This interpretation is not surprising considering that many researchers at the time relied heavily upon the *Jesuit Relations*, and that the Jesuits were primarily dealing with and getting their information from the Huron, who were economic rivals to the Neutral.

More recent sources supported by the evidence found in the archaeological record stress the importance of trade to the Neutral with exotic materials of both Native and European origin being recovered. European trade goods begin to appear on Neutral sites after ca. A.D. 1580 (Lennox and Fitzgerald 1990:429). While the Récollects and Jesuit missionaries had short stays and were received with hostilities, there was a consistent European influence among the Neutral, which resulted from the fur trade (Wright 1981:2). Depending upon the classification system being followed, the century prior to A.D. 1580 is either known as the Pre-Fur Trade period or the Protohistoric period (Lennox and Fitzgerald 1990:409). The Fur Trade period began after A.D.1580 and this provided an injection of dateable European artefacts into the archaeological record of the Northeast. Most useful of these are glass trade beads. A bracketing system of dating sites based on beads has been developed using historic records of glass bead manufacture, as well as collections from sites. From Lennox and Fitzgerald (1990:410), these periods are listed in Table 1.

Table 1: Glass Bead Periods as Used in this Analysis.

Period	Date range
Glass Bead Period 1 (GBP1)	A.D. 1580 - 1600
Glass Bead Period 2 (GBP2)	A.D. 1600 - 1624/1630
Glass Bead Period 3 (GBP3)	A.D. 1624/1630 – 1650

It should be noted that the dates listed here associated with these periods are not universally accepted, but are used for the purposes of this theses because they originate from the same published source which provides the listing of dates for the majority of sites used in the analysis.

With the onset of Glass Bead Period Two (GBP2) after 1600, the quantity of both native and European trade goods increased. After 1630 (GBP3) there was a large increase in the importation of finished red Manitoulin Island siltstone and catlinite beads which were acquired through the northern trading route and were manufactured on Petun/Odawa winter sites (Lennox and Fitzgerald 1990:435).

There were two other important routes, which brought exotic material into southern Ontario. The most commonly documented of these was the trade network to the North and East along the Great lakes – St Lawrence system which linked the Algonkians, Petuns, Huron, and French. While previous to the 1970's, the St Lawrence trade route was over emphasized in the historical record, it is now accepted that the other large trading network that also was important even prior to European contact was the southern linkage to the Ohio and Mississippi river trade network. This network connected the Neutral, Wenro and Erie people (Noble 1978:60, Jamieson 1981:20). Thus, while there was a large amount of trade with the Huron and the Algonkians, the Neutral were primarily trading to the

South and Southeast (Jamieson 1992:77; 1996:163). The importance of these trade routes are corroborated by others including Bradley (1987) and Pendergast (1999), who argued that the Atlantic Coast (Chesapeake Bay) trading route was also a major connection into the Northeast, including southern Ontario. The southern trade route brought shell, in both raw and finished product form, as well as European goods into Iroquoia up the Susquehanna river, from the Chesapeake Bay on the Atlantic coast (Bradley 1987:39-40; Pendergast 1999). This trade route had already been established to import marine shell prior to the fur trade. Some say that this route was already established up to 50 years before it was used to trade European goods (Bamann et al. 1992:453). Others claim that this route also supplied marine shell to Central New York for over 1000 years (Bradley 1987:41). The trade network for shell continued to expand through the sixteenth century with the presence of marine shell on Neutral sites increasing dramatically in the period from A.D.1600 to 1620 (Pendergast 1989:98). The same trade routes then served as a route for European goods (Bradley 1987:39). Pendergast (1989:102-103) suggests that European activity on the Atlantic coast served to trigger the increased use of these existing trade networks.

The location of Neutral territory at the western tip of Lake Ontario placed them in a geographically advantageous position between the ends of two major trade networks. To the north were the Petuns and Huron with trade connections to the French fur trade. This provided access to European manufactured trade goods such as metal tools, kettles, and glass beads, as well as providing them an additional source of native corn in times of shortages. To the south, the Neutral engaged in trade with the Andaste and Eries, and had access to the Atlantic coast and the Ohio-Mississippi trade networks. These trade routes brought exotic native goods such as steatite stone for pipes, wampum, marine whelk shells, and shell tempered pottery (Wright 1981:135; Lennox 1981:215; Noble 1978:160).

The Neutral had valuable resources of tobacco, skins, and chert to trade in return for imported goods. The Neutral are known for their high-quality flint knapping which surpassed that of other contemporary Iroquoian groups, and they had access to local chert sources (Noble 1984:16). However, the major resources at their disposal were the deer and fur-bearing animals that were hunted and trapped. These provided meat, but also provided less-perishable trading goods like rendered fat, furs, and hides. Furs were traded directly, or through their native neighbors who had direct trade with the French, Dutch, and English. Deer hides were also valuable commodities. Three deer hides would purchase one large conch shell bead from Chesapeake Bay (Noble 1985:139).

Population

Early French explorers commented that the Neutral were numerous (Noble 1984:17) and archaeological survey and excavation confirms a high pre-epidemic population density (Noble 1985:137). Just as estimates about the number of tribes vary, population estimates for the Neutral vary as well, from 35,000 to over 40,000 (Wright 1966:7-8; Lennox and Fitzgerald 1990:410). Thus, in the eastern Woodlands culture area of the early 1600s, the Neutral were the most populous of the Iroquoian speaking groups (Noble 1984:3). For example, similar pre-epidemic estimates are for 18,000-30,000 Hurons, and 25,000-30,000 Five Nations Iroquois during this same period (Noble 1985:137).

It has been found that in Ontario, Iroquoian populations grew rapidly until the sixteenth century when populations leveled off, presumably due to diseases such as tuberculosis, which spread easier in a dense population (Bamann et al. 1992:448). Snow and Starna (1989) report similar patterns of increasing population density and sudden decline in the Mohawk Valley with total mortality rates of up to 95 pecent over the course of the century. They also point out some of the potential sources of error in population estimates, such as the fact that aggregation of population can result in a smaller number of sites represented in the archaeological record, as well as the effects of emigration and immigration.

The Glass Bead Period 3 that coincided with a large increase in trade was also the time when European introduced diseases began to decimate the Neutral as well as other Iroquoian societies. During this time, Neutral longhouse size decreased and there was an increase in burial activity and multiple ossuaries (Lennox and Fitzgerald 1990:432).

The effects of disease were compounded when in the year of 1639 and winter of 1640 brought agricultural famine and unusually heavy snows. The Neutral had to trade away children to the Huron in exchange for corn (Wright 1981:130; Noble 1978:159). By the late 1630s, war, famine, and disease had reduced the population of the Neutral dramatically (Lennox 1984:4). To provide an example of the devastation of the population during this time period, the Neutral army had been estimated at 4,000-6,000 by early French observers. After 1640, it was reduced to 2,000 warriors (Noble 1978:160).

Warfare

Warfare was an important activity held in high esteem by men in Iroquoian society (Fenton 1978:315). In this respect, the Neutral were no exception. If anything, in the late historic period, the Neutral may have been just as, if not more, warlike than some of their neighbors. Normally, in Iroquoian tribal societies wars were led by war chiefs who's authority was temporary. War was such an important part of Neutral life that the Neutral leader Tsouharissen was a war chief who led 17 successful campaigns but did not relinquish control back when returning from them (Noble 1978:161). The Neutral were allied with the Petun, Kakouagoga, Wenros, Eries, Andaste, and Ottawas (Noble 1984:3). They were, however, embroiled in a long-standing war with their "sworn enemies", the Algonkian Mascoutin Fire Nation of Michigan (Noble 1978:161, 1985:137).

Throughout the historic period warfare became an increasingly important factor in Iroquoian life. According to Fenton, more and more resources and time were dedicated to warfare during the fur trade period, to the extent that warfare "became a shattering force in their culture that threatened the very structure of their society" (Fenton 1978:315).

While tribes as cultural entities were defeated by the Iroquois, the people continued to live on through those who were dispersed and adopted by relatives (Jamieson 1992:77). By the mid-seventeenth century, Iroquoian population was being depleted by disease and warfare faster than they could be replenished by the adoption of captives. By the mid 1600s, adopted outsiders tipped the balance of the Iroquois population (Fenton 1978:315).

Scholars dispute whether low-intensity ritualized fighting was the norm, or if warfare was focused on capturing territory and defeating the enemy. The serious nature of warfare during this period is supported by evidence of continued improvements to village defenses and historical accounts of prolonged sieges culminating in the destruction of villages. An example of this was the 10 day long Neutral siege of a Fire-Nation village in 1642, which ended in the destruction of the village, the burning of 70 warriors at the stake and the capture of 800 people (Keener 1999:788).

Ultimately, it was warfare with the Onondoga and the Seneca that destroyed and dispersed the Neutral nation after the collapse of the Huron (Noble 1978:161). The Seneca destroyed the Ahondironon tribe in A.D. 1647 without retaliation (Noble 1978:155). According to the *Jesuit Relations*, the Iroquois captured two Neutral villages in the autumn and spring of 1650 and 1651 following the dispersal of the Huron. The majority of the Neutral are believed to have been dispersed during that time period, although small groups continued on (Wright 1963, White 1978:415; Lennox and Fitzgerald 1990:410; Pendergast 1991:56; Jamieson 1996:162). As a result of population loss and the effects of warfare, the Neutral had been removed as an entity from the political landscape of Ontario by 1653.

Social Organization

There are differing views about the social organization of the Neutral. One view is that the Neutral were a confederacy of tribes similar to their Huron and Iroquois neighbours. The late sixteenth and early seventeenth century Neutral settlement pattern is used as evidence to support this viewpoint. The Neutral were distributed among eight or nine clusters of contemporary sites with distances between clusters indicating separate tribal territories. This is similar to the settlement pattern of the tribes of the Iroquois confederacy in New York (Lennox and Fitzgerald 1990:411).

This view is challenged by those who believe that the Neutral settlement and burial practices are more hierarchical than those of their neighbors, and this is indicative of the development from a tribal society into a chiefdom (Jamieson 1981, 1996; Noble 1985). Thus, while some elements of the Neutral settlement pattern are pointed to as evidence for a tribal model of social organization, other elements of the settlement pattern are also used to support the hypothesis of a Neutral chiefdom. In particular, this hinges upon the existence of the large Walker site and the role of capital attributed to it. The Neutral settlement pattern concentrates into identifiable clusters of villages and towns (Jamieson 1981:26). A pattern of smaller towns focused around a central capital is one of the characteristics of a chiefdom (Noble 1985:132). The Walker site is centrally located, and, unlike other large Huron and Iroquoian villages, does not have a palisade indicating that it was offered some level of protection by the surrounding villages (Jamieson 1996:163).

A “critical mass” of population density is considered to be important for the development of chiefdom societies. The Increased economic productivity of chiefdoms make them denser than tribal level societies, therefore the difference in social organization would have implications regarding settlement, location, and catchment analyses (Jamieson 1981:19). The Neutral were known to have a larger population than the Huron, but the settlements and tribal areas are also smaller and more concentrated, with the largest concentration of population being in the Fairchild-Big Creeks site cluster in which the Walker site is located and the neighboring Spencer-Bronte Creeks site cluster. It is also noted that the structure of the buildings at the Walker site are larger and more sturdy than is normally encountered, and in this respect, shares similarities with sites in the Ohio drainage (Jamieson 1996:163).

Archaeological evidence for increased social stratification consistent with a chiefdom can be provided by changes in mortuary practices, such as ranked burials. An in-depth examination of examples of social hierarchy in Neutral burials, as compared to Huron ossuary burials, is provided by Jackes (1996). Both Noble (1985) and Jamieson (1996) point out that the existence of ranked or hierarchical burials, and the existence of these types of burials in proximity to the Walker site, provide evidence of social stratification consistent with a chiefdom.

Another important factor in the development of chiefdoms are the changes in relations with external groups. Chiefdoms are characterized by larger scale warfare with the taking of captives and trophies, and also by an increase in long-distance trade in exotic goods (Noble 1985:132). As noted above, the Neutral are known to have increasingly engaged in both of these activities during the historic period.

During the period of trade intensification after A.D. 1500, villages grew in size as well as in population density. The establishment of long-distance southern trade route for marine shell is believed to have been an important factor leading to the development of the chiefdom. The Neutral nation may have been subject to a “spread effect” due to proximity and trade with people in the Ohio-Mississippi drainage, and along the Atlantic coast where chiefdoms were already established. Artefacts found in burials with similarities to those found in the Ohio-Mississippi area provide support for the argument that development of a Neutral chiefdom also may have been due in part to the diffusion of ideas and social organization through this association (Jamieson 1981:27).

Both Noble and Jamieson present differing interpretations of the level of control exercised by Tsouharissen over the Neutral. Using Malcom Webb's definition of a chiefdom where “leadership over the entire population is centralized and concentrated in the hands of one individual”, Noble describes a *paramount* chief who is able to maintain control over the other chiefs and councils (Noble 1985:131). As evidence for the paramount status of Tsouharissen, Noble (1985:134) points out that the Jesuit missionaries who wished to live among the Neutral were required to travel to the Neutral capital in order to receive permission, and that their gifts could not be accepted by the council until Tsouharissen had returned. When he did return from war, Tsouharissen did not relinquish power as was customary for war chiefs among other Iroquoian groups (Noble 1985:138). Another argument for Tsouharissen's elevated status was that his status provided both political and religious power (Noble 1985:135). The eventual loss of social stability and centralized control within the chiefdom is attributed to a cyclical pattern (Noble 1985:140).

In contrast, Jamieson (1996:165-166) notes the difficulty of distinguishing between a simple chiefdom and a complex tribal polity. Jamieson describes a chief whose power was less absolute, where the more distant concentrations of Neutral settlement, such as along the Niagara frontier, exercised a greater degree of political autonomy. It was also stated that a level of instability was inherent in any chiefdom at this level of complexity.

Some authors discount the chiefdom hypothesis entirely, saying that it is based on limited historical accounts and is not testable archaeologically (Lennox and Fitzgerald 1990:411). If the chiefdom did exist, it was short lived. It lasted only 37 years or two generations (Noble 1984:5).

Chapter Summary

The Neutral were an Iroquoian people who inhabited a territory in what is today part of southern Ontario at the tip of Lake Ontario, and as far south as the Niagara Peninsula. The density of historic Neutral sites is highest within the area of the Fairchild-Big Creeks and Spencer Bronte Creeks drainages.

Neutral settlement patterns and subsistence strategies are believed to be generally similar to those of other contemporary Iroquoian groups, in that they lived in long houses within semi-sedentary agricultural communities of varying size which, depending on the settlement may or may not have been protected by a palisade. Animal resources such as deer and fish supplemented crops of corn bean and squash. Smaller sites of less than .4 hectares in size existed as temporary extensions of the settlement for the purpose of agricultural or hunting and gathering activities. There is some debate, however, whether some small sites which have been discovered in the archaeological record should be classed as seasonal or year-round settlements.

Soil fertility and supplies of firewood were limiting factors for village and town settlements and after a time, a new village or town would be constructed when resources available within a reasonable distance of the old site became depleted. It is believed that proximity to old settlements resulted from cultural reasons as well as animal and plant resources available in regenerating fields.

Researchers examining the settlement pattern of the Neutral have observed spatial associations of village with elevated sites near sources of water. It has also been observed that villages are often located in areas near swamps, which may have been sources of plant and animal resources, as well as construction materials. The Neutral are commonly believed to have differed from other Iroquoian groups in that they maintained a higher population, were more involved in trade and in the hunting of deer, which were an abundant resource.

During the historic periods defined in Chapter 1 as Glass Bead 2 and Glass Bead 3, the Neutral experienced a great deal of change connected to external influences. As previously mentioned, this period was marked by a major increase in long distance trade and in particular trade southwards through Ohio to the Atlantic coast. This trade route resulted in an influx not only of marine shell but socio-cultural influences as well. While critics dismiss the idea of a

Neutral chiefdom on the basis that this idea was originally derived from historical accounts, evidence for social stratification or hierarchy, and contact with external belief systems in burials, provide archaeological support for the idea that the trade may have contributed to the development of a Neutral chiefdom. Large scale organized warfare, and the concentration of population in the area of the large Walker site, which may have functioned as a capital, provide further evidence.

It is believed that during the Glass Bead 2 and 3 periods, the Neutral had achieved their highest levels of population and population density. However population began to level off and decline as a result of large-scale warfare and disease epidemics. The declining power of an aging chief or divisions within the polity may have also contributed to the Neutral decline.

Chapter 3. Modeling and Site Catchment Analysis

Site Catchment Analysis

Site Catchment Analysis is a method of studying those landscape features surrounding an archaeological site which are of economic value, and which may have been directly utilized by the site inhabitants. Site Catchment Analysis became popular in the 1970s. Subsequent researchers have employed such methodological refinements as enhanced statistical tests and GIS programs.

In 1970, Vita-Finzi and Higgs published "Prehistoric Economy in the Mount Carmel Area of Palestine: Site Catchment Analysis." The goal of the authors was to study the economy of prehistoric archaeological sites by examining the environment and resources around the site. Prior to this time, archeologists typically made reference to the environment as the setting or background in which the site was found. However the Vita-Finzi and Higgs noted that these are general statements about the site's environments as components of larger physiographic, vegetation, and climatic zones. These descriptions were environmentally or ecologically centered. Thus, where there was focus on "micro-environments" it may not be relevant to humans. In contrast, Vita-Finzi and Higgs approached their environmental analysis from an economic perspective. They assumed that the most important factors effecting the cultural development of the prehistoric inhabitants were the challenges directly related to survival. The authors were only therefore interested in the environmental resources that may have been of value to the economy of the human inhabitants. This has been described as being a subset of an "Economic Spatial Theory", rather than an ecological approach (Clarke 1977:19; Foley 1977:169).

Site Catchment Analysis and its Implementation. The site catchment area, or the site *exploitation territory*, as it was termed by Vita-Finzi and Higgs, is the area being utilized for subsistence purposes, which is surrounding a permanent or home-base site. The practical catchment area of a site was based upon an assumption of a cost/benefit balance between energy expended and potential energy returns from utilization of a resource. The only variable which appears to have been taken into consideration is travel time. A Euclidean (linear) distance was used in place of actual travel time based on estimates borrowed from other authors. The travel time and distance estimates used by the authors had been drawn from only two sources. Site catchments for agricultural land-use were based on Chisolm's (1968) study of contemporary rural land-use. The maximum travel distance of one kilometer marked the boundary where the "net return is large enough to be significant as a factor adversely affecting the prosperity of the farming population..."(Chisolm 1968: 66; Vita-Finzi and Higgs 1970:7). For the purpose of this analysis the authors used a weighting scale linked to linear distance from the site.

Site catchment distances for hunter-gatherers were determined to be two hours walk. This distance was arrived at based on Lee's (1967) studies of the !Kung Bushman, who have a subsistence activity range extending 10 km from a site (Lee 1967, Vita-Finzi and Higgs 1970:2-7). A distance weighting scale was likely not used for hunter-gathers due to the mobile nature of the resource.

It was noted that the effects of terrain could alter the time taken to traverse a given distance. Site catchment maps produced for the analysis showed both circular catchment areas based on Euclidean distance as well as irregularly shaped polygons representing the catchment perimeter based upon a 2 hour travel time.

General criticisms. A catchment analysis requires that natural resources on the landscape surrounding sites be mapped and inventoried. A significant problem encountered by all archaeologists wishing to study environmental conditions is the fact that the natural environment changes over time. Factors such as erosion, sedimentation, rainfall, temperature, glacial activity, and resource depletion can make drastic changes to the classification or boundaries of features such as shorelines, vegetation, and even landforms. In the original example, Vita-Finzi and Higgs wished to analyze sites spanning the entire 50,000 year span of prehistoric human occupation of Palestine. As a result of this overview, they conclude that aside from slightly warmer temperatures, climatic changes have not had much effect on the environment as have local factors such as drainage and erosion. Consequently, they have produced a descriptive exercise not much different than the practice they initially criticized.

In the original method used by Vita-Finzi and Higgs, the catchment analysis depends upon a map of land use potential based on contemporary conditions. Land is classified into agricultural land use categories such as irrigated land, arable, rough grazing, good grazing/potentially arable, seasonal marsh, sand dunes and irrigated crops. Other features of economic value, such as the point locations of springs, are also marked. The locations of the sites are identified and the site catchment boundaries were super-imposed on the land use potential map. Both circular distance catchments and irregularly shaped travel-time catchments were displayed on the map. However, it was not made clear how travel time boundaries were actually used in the analysis. Land use potential classes within the catchment areas were both tabulated and graphed by area and then a weighting was applied by one kilometer diameter circles.

Uses for Site Catchment Analysis

Defining the site economy. These are two somewhat conflicting presumptions made by Vita-Finzi and Higgs about human adaptation to the environment: First, site locations were chosen where a catchment area encompassed all of the separate so-called micro-environments necessary to support a viable economy; and/or second, the type of economy practiced at a given location would evolve to make the most efficient use of the available resources. In the conclusions drawn from the Site Catchment Analysis, Vita Finzi and Higgs appeared to lean towards the first presumption. That is, Site Catchment Analysis was used as a means of explaining the prehistoric economy of a sites based on the economic possibilities presented by the resources available within the site catchment area.

Along with other criticisms, the assumption that the economy of a site could be determined by the percentages of arable land in a 8,000 ha catchment area is challenged by Flannery (1976). Looking at Mesoamerican villages, Flannery pointed out that the average village consisted of about 70 families totaling 350 persons. Based on studies of maize yield, the villages could support themselves on just one percent of the catchment area. It is highly questionable if this criticism would remain as valid in an Ontario context due to the much shorter growing seasons possible at this latitude. Simulation modelling at the regional scale has shown that the areas inhabited by the Huron and the Neutral in Southern Ontario represent the northern extent of corn cultivation, with areas containing settlements being limited to zones with good edaphic condition and a minimum number of 90 frost-free days, nine years out of ten (Campbell and Campbell 1992:22)

Explanation of Site Locations. Identification of the reasons for site location is another of the primary uses for Site Catchment Analysis. From an economic perspective, the selection of site location will be based on the factors that allow for the optimal utilization of available resources with the available technology. When considering the issue of site location, Vita-Finzi and Higgs (1970) noted that sites often occur at the junction of ecological zones. These rich areas described as "ecotones" should not be looked at as micro-environments in themselves, but rather as places where humans are able to make optimal use of a variety of resources to integrate into a complete economy. In the original article, Vita-Finzi and Higgs aimed at studying a selection of sites spanning the entire 50,00 years of human prehistory of the Mount Carmel area of Palestine. In spite of the potential problems related to landscape change, they were comfortable looking at sites spanning thousands of years over time because they believed that their distribution should be looked at in terms of long-term trends rather than the unusual. Unfortunately, archaeologists are often pre-occupied with atypical situations, which should really be considered adaptive failures (Vita-Finzi and Higgs 1970:6). A cultural evolutionary process of economic selection will select out less productive economies while more productive economies will be better able to cope with the pressures of a growing population. Mobile hunter-gatherers will make use of the remaining areas that cannot support a sedentary population.

There are many obvious problems with attempting such a generalized approach as used by Vita-Finzi and Higgs. The landscape features and environmental resources are subject to change and the relative importance of these resources is also dependent upon an ever-changing set of human technologies and cultural values. It is for these reasons that catchment analysis is best used for sites within a narrowly defined time period, function and cultural affinity.

Webley (1972), noted that the majority of explanations about the growth of *tel* sites in the Near East focus on socio-political factors and fail to acknowledge the influence of economic factors. In his examination of *tel* site location in Palestine, Webley follows a catchment analysis methodology. Unlike Vita-Finzi and Higgs, Webley refined the scope of his analysis to consider a single variable: the relationship between soil productivity attributes and site location, using th site of *Tel Gezer* as a case study.

Webley (1972) argued that before catchments can be analyzed, the soil types in the study area must be classified according to productivity both for crops and grazing pasture for livestock. The agricultural potential of soil is identified as a product of the interaction between soil type and slope, which relates to drainage. Thematic soil mapping of Palestine from 1968 divided the landscape into 15 classes of soil (Webley 1972:170). The concept is applicable to this study and soil maps should be similarly reclassified into suitable soils for Neutral agriculture and soil productivity indexes.

According to Webley, Palaeolithic, Natufian and pre-pottery Neolithic sites are located in areas with a high diversity of soil types. As described earlier, these ecotones would have provided a rich environment for hunting and gathering due to the tendency of game to be more plentiful where different types of environments come together. This same concept can also be applied in Southern Ontario, as deer are animals that are known to have preference for edges of different vegetation types.

Explanation of Relationships Between Sites. Higgs and Vita-Finzi (1972:29) claim to have introduced the concept of territory to archaeology in 1967. They define the archaeological concept of territory as being "an area which is habitually exploited from a single site." (Higgs and Vita-Finzi 1972:30). When studying prehistoric economy, there are distinctions drawn between different types of sites and territories. While Site Catchment Analysis is based on the assumption that resources further from the site are of lower value relative the cost of utilization, some special situations may exist that are the exception to the rule. Beyond the site territory, is the *extended site territory.* The extended territory is described as being an area that is habitually utilized, but outside of the normal distance limitation of the site territory. Examples given include areas where animals can be naturally corralled (Higgs and Vita-Finzi 1972:30). This concept may have been introduced afterwards to account for exceptions to the arbitrary 5 km and 10 km rings, or weighting of zones by distance cited in criticisms of the site catchment methodology. Flannery provides other examples of this. In some contemporary Mesoamerican villages, farming is dispersed to different valley floors and distant mountain fields. This practice helps ensure that even if one crop is affected by a natural disaster, it may be isolated to a physiographic zone and the loss is not complete. Flannery also provides the example of Formative Mezoamerican sites whose occupants hunted deer in the mountains far away from the valley floor. These resources were accessed from what he refers to as "temporary annexes to the village" at certain times in the years (Flannery 1976:94). While expressed as a problem of the site catchment methodology, this is an example of how transit, or *transitory sites* must be taken into consideration. Transit sites are used on a short-term basis, or for special purposes. These sites may be used on migration, or to utilize a specific resource such as a raw materials or food. Examples of transit sites include flintknapping loci or kill sites. Primary habitation sites are termed *home bases* or *preferred sites*. As described earlier, these served as a home base for resource utilization in the surrounding territory. In addition to the home base may be one or more *transit* or *transitory sites*. One can only decide if a site is a preferred site, or a transit site by performing an analysis of the site territory (Vita-Finzi and Higgs 1970: 7; Higgs and Vita-Finzi 1972:30). In Neutralia, this concept of a small site which extends the catchment of larger sites applies to cabins and potentially applies to hamlet sites.

When considering the territories of wildlife, a distinction can be made between the home range -- the area traversed and in which subsistence activities occur, and that of the defended territory (Higgs and Vita-Finzi 1972:30). A similar situation can be considered when studying the catchments of human habitations. The zone surrounding a site may be exclusively used by the inhabitants of the site, while further afield, overlapping zones of territory may be shared with other sites.

A relevant example can be found in Flannery's study of villages in the valley of Oaxaca. A map of six villages on the Atoyac River, with 2.5, 5, and 7.5 km catchments shows that the villages are fairly evenly spaced with approximately 2.5 km between each. This study supports the idea that sites are spaced based upon zones of exclusivity. It is reasonable to assume that while conflict may arise over hunting and gathering territory, it is almost certain when the resources and territory in question has had a great deal of investment of energy in the form of planting and growing of crops. Although it would appear to be an obvious conclusion, Flannery warns that agricultural factors alone can not explain this situation, because the 2.5 km zone can provide more food than what is required for each village (1976:111). He concludes that while Site Catchment Analysis may have bearing on site location, social factors had greater influence over site spacing than the contents of the catchment (Flannery 1976:117).

Population Estimates. When considering the problem of population, Vita-Finzi and Higgs (1970) advocate an assumption that considers human population as a function of available resources much in the way that biologists look at animal populations. They believe that population will continue to rise to the level that can be maintained by the available resources. The difference is that with humans we must also consider the additional variable of technology affecting the ability to utilize resources (Vita-Finzi and Higgs 1970:4).

Vita-Finzi and Higgs warn against drawing parallels with population levels of contemporary hunter-gathering populations and resources:

> Furthermore, existing hunter-gatherer groups are scarcely likely to be typical of the genre. In cultural and economic cul-de-sacs they are engaged in practicing the least productive of known technologies in the least advantageous areas, whereas their prehistoric counterparts were exploiting the most rewarding of the known techniques in the most favorable regions. ...Most present-day hunter-gatherers are under short-term pressures, a few may be enjoying an advantageous respite, others are in the process of being absorbed or eliminated by more successful economies (Vita-Finzi and Higgs 1970:5).

Hirth observes that: "Catchment analysis can never measure the actual amount of a resource used by a prehistoric group, only the relative amount available within a specified radius of the site." (1984:137).

Criticisms of Site Catchment Analysis and Improvements to the Analysis Method

Land Use Mapping and the Problem of Constancy. There are many criticisms of the Site Catchment Analysis method in the form that was initially introduced by Vita-Finzi and Higgs. The most common and obvious problem is that of relevance of contemporary land use mapping (Flannery 1976: 94-95; Foley 1977:185). The entire premise of the analysis is that the land surrounding the site be thematically classified according to the land use potential. In order to do this, we must do one of two things: Attempt to reconstruct the paleo-environment, and/or rely upon existing land cover and landform mapping in the hope that features and available resources have not changed significantly. Vita-Finzi and Higgs's initial analysis is particularly vulnerable to this problem as it spans 50,000 years of prehistory. They discuss the known climate factors that affected the landscape (1970:8-16), but it appears that it is only used in qualitative terms, and they rely on contemporary land use mapping to perform the actual analysis.

Some site applications of Site Catchment Analysis primarily use soils as a measure of productivity (Webley 1972; Tiffany and Abbot 1982; Hunt 1992). The advantage of this method is that soils act as a proxy for vegetation to determine the potential productive capacity of the land. While vegetation may change according to cycles of succession, climate, and human intervention, in many places, the soils themselves may change very little over thousands of years. For example, Tiffany and Abbot (1982:315-316) justify using this method to reconstruct vegetation because in their study area of Iowa and the upper Midwest. The vegetation pattern has remained stable for the past 4,000 years. Soils can be very useful when performing catchment analysis of agricultural sites to determine the potential for growing crops, but it can also be used to consider the available habitat and grazing potential for animals, both wild and domestic.

Soil types and physiographic data were used by Jamieson (1986:28-35) to develop a model of landuse for the catchment area of a Late Middleport Ontario Iroquois hamlet. Resource utilization zones were divided into: (1) marsh, creek, alluvium, and bedrock for utilizing wild animal, plant, and chert resources; (2) light textured loam deposits suitable for native agriculture; (3) heavy-textured clay deposits which are areas where perhaps firewood was gathered; and, (4) the Lake Erie shore and beyond. A similar classification system should prove useful for calculating areas of potential landuse for historic Neutral sites. However, a similar problem exists, as mentioned by Jamieson (1986:29-30), in that much of the study area has been subjected to artificial drainage and other modification in recent history.

There is no easy answer to the problem of constancy, and regardless of the method of analysis being used, it remains a challenge for anyone attempting to consider an archaeological site in relation to its environmental setting. As stated by Flannery, "One has two choices: he can throw up his hands in defeat, or he can reconstruct the prehistoric environment to the best of his ability and plunge ahead"(1976:95).

Other Problems with Land Use Mapping. Another problem with most of the Site Catchment Analysis that have been described is the one-dimensional nature of the thematic land use mapping. The authors seem to be limited by the paradigm of the paper map, where categories are for the most part mutually exclusive. In reality, a given plot of land could be classified differently for different uses. For instance, areas suitable for certain types of wildlife or grazing of livestock may also be suitable for crops. This problem is partly addressed by assigning multiple attributes to a given land class. Webley (1972:170) gives each soil type a numerical rating for arable land and a numerical rating for pasture. The problem remains however, that even in Webley's (1972:175) analysis, the catchment maps show land use as either "arable" or "grazing".

As observed by Hunt (1992), land classifications used in traditional Site Catchment Analyses are over-simplifications that depend upon collapsing available thematic map classes into more generalized landforms (upland/lowland) or relative value categories for a given land use. Such simplifications risk the loss of much of the detail and accuracy of the source maps (Hunt 1992:284-285).

Quantification of Resources in the Site Catchment. Foley (1977) also criticized the simplistic nature of the original method of site cachment analysis. Foley raises the issue of quantification of extractive value of land units. He states that although Vita-Finzi and Higgs use technical terminology, like earlier works they present merely a qualitative description of habitat types which then are correlated to economic forms (Foley 1977:164).

Foley advocates a quantitative approach that considers the amount of energy available within the economic system, and measures the amount of energy being expended by a particular technology to make use of it. This can be expressed in a variety of formulas depending upon the questions being asked. Foley lists a number of questions, which could be examined from this perspective. These include various expressions of efficiency, stability, and unused potential (Foley 1977:167-168). The problem with these sort of equations is when one attempts to find a numerical value for some of the variables, such as expenditure of energy, or available energy within a system, most of these kinds of calculation methods require a knowledge of the number of persons within a prehistoric community at a given time, and is also dependent upon the technology of resource extraction and processing that was used. These values can only be estimated (but at this time cannot be measured) and thus remain highly variable and subjective. The danger exists that when such formulas are used, they may generate the false impression of an exact science, when the results are probably not much more accurate than qualitative analyses. To credit Vita-Finzi and Higgs 1970:8), they did admit that their methodology was merely a starting point and that further development was required. The actual measurement of the energy in the system was one of the future improvements suggested.

To inventory the productivity of the land, the methodology advocated by Foley (1977) expanded upon Site Catchment Analysis by not only mapping the features surrounding the site, but by dividing that area into a grid. Each grid cell is inventoried in terms of its value in plants, animals, and total productivity value. Contours are then added to the map to reflect expenditure of energy required to harvest the resources (Foley 1977:170-181). This results in a spatial attempt to inventory and quantify the value of the landscape, which should be looked at as an early paper-based fore-runner of a raster GIS analysis.

In Hunt's (1992) analysis of the catchments of Iroquoian village sites in Southwestern New York State, a sample of 22 village sites was chosen. This sample satisfied five criteria: all phases of the Late Woodland were represented; all sites of a given phase were selected if the total was less than 5; all sites fell within recent soil mapping areas; the entire catchment of the sites fell within the soil maps, and, finally, all sites of a village movement sequence were included (Hunt 1992:291). Five kilometer catchments for each of these sites were analyzed using US Department of Agriculture soil maps. Total areas and corn-growing productivity indexes of each soil type were tabulated by site catchment boundary. When the statistics for sites of each category were analyzed and graphed, they demonstrated a clear shift over time towards site catchments with higher productivity ratings for growing corn. This trend leveled off and decreased during the contact period (Hunt 1992:306).

Statistics and Catchment Analysis. One of the problems with Site Catchment Analysis is the assumption that relative percentages of land within the catchment can be used to determine what economic factors were important to the inhabitants of the site. The extreme but amusing example is made, that if a village is located in an oasis in the Nubian Desert, and 1% of the surrounding 5 km consists of water and 99% desert, then a traditional Site Catchment Analysis would have concluded that the inhabitants were obviously there because they were more interested in the blowing sand than the water (Zarkey 1976:117). Zarkey suggests that Site Catchment Analysis should consider the relative scarcity of a resource in relationship to the rest of the landscape when determining which resources in the catchment were of primary value. He draws upon the work of Plog (1968) who uses the Chi-Square statistic to compare expected vs. observed frequencies of sites in relation to environmental features. This is a traditional statistical analysis, which is used in inductive predictive modeling, and has also been used by Kvamme (1991), and others. Zarkey's approach is novel in that he proposes a method of applying this statistical method to Site Catchment Analysis. Rather than correlating sites with environmental classes, Zarkey (1976:119-120) considers the factor of area, and he suggests that sites should be considered in terms of people rather than the number of point locations.

Arbitrary Circular Site Catchment Boundaries Based on Linear Distance. Another major problem with Site Catchment Analysis is the arbitrary nature of the catchment area boundary. These circular catchment boundaries of 10 km for hunter-gatherers and 5 km for agriculturalists were justified by only two studies (Vita-Finzi and Higgs 1970:7; Foley 1977:163). While circular distances are used, it is understood that these distances were arrived at by the sources as an estimation of time and energy expended to traverse territory to get to the resources. Again, this is an analysis, which assumes optimization of energy return vs. energy expended. Site catchment boundaries can be delineated in three different ways: 1) euclidean (linear) distance; 2) natural boundaries; and, 3) travel time catchments (Christopherson et al.1999:2). In their original 1970, article as well as their 1972 article, Vita-Finzi and Higgs display both the linear distance circles and the irregularly shaped terrain/travel-time based outline of the territory. It appears that this defined the catchment boundary and that linear distance was used for weightings. Some studies that appeared later cut corners and simply based the catchments on the linear distance circles (Hunt 1992:287; Zarkey 1976:122). Other researchers used natural boundaries, such as contour lines (Rossman 1976:96).

Travel time catchments which are probably the best method and stay true to the original methodology as justified by Vita-Finzi and Higgs, and are also the most difficult to construct. Traditionally, they have required that numerous transects be walked away from the site in different directions. Aside from the time and cost of this method, results vary depending on the day's weather conditions and the walking speed and stride length of the people doing the walking (Christopherson, et al.1999:2). A major limitation of this method is the amount of time and energy expended in the process, thereby making it impractical to perform Site Catchment Analysis on a large number of sites.

Another factor to consider is that the actual shape of site catchments may vary depending on the cultural affinities, age, type of site, and type of resources being utilized by the population. Jamieson's (1986:28-29) catchment analysis of the Slack-Caswell Middleport site is based on an oval catchment area following the drainage system. It is mentioned that in other areas where there may be a higher density of sites along a river, actual catchments may actually extend perpendicular to the drainage system as social packing increases. These patterns are important to keep in mind in relation to other sites and drainage networks. However, as development of an automated method of generating these catchments may prove difficult, use of these catchment shapes would be limited to studies of one or a small number of sites.

Landscape Archaeology

A theoretical perspective that became an increasingly popular area of interest for settlement studies in the 1990's is referred to as Landscape Archaeology. Landscape archaeology attempts to avoid the dichotomy between the cultural and the natural environment or space (Ingold 1993:153). Landscape archaeology focuses on the subjective aspects of interaction between humans and culture with the landscape. Ingold (1993:156,171) describes the landscape as a product of the human mind: it is created as it is experienced.

As opposed to an aerial cartographic represantation of space, Landscape Archaeology places the human within the landscape, what Ingold refers to as a "dwelling perspective". From this perspective, humans are considered to be part of the landscape and the landscape is part of human culture (Ingold 1993:154). Within a culture, the landscape contributes to the sense of identity and is imbued with spiritual significance. In the past, landscape features were attributed with spiritual significance and thereby also served to create in the individual a sense of self and an understanding of his or her place within society and nature (Tilley 1996).

The concept of landscape as used in an examination into the relationship between culture and the environment, can also be used to develop a greater understanding of the nature of social and political changes, over time. Examples of this have been provided by landscape studies of sacred rocks and stone structures in the British Isles (Tilley, 1996; Barrett, 1999; Tilley and Bennet, 2001).

These studies demonstrate the importance of time or temporality and how the role of any given landscape changed over time. Traditional archaeology looks at monuments as a physical record of activies or markers of particular stage in the development of a society (Barrett 1999:256). Ingold (1993:157), stresses that temporality is not the same as chronology, but rather that the temporality of the landscape is experienced through the cycles of activity. The evolving role of the landscape within the culture, and in relation to power structures, are shown by the chronology of monuments, cairns, burials and other archaeological evidence found to be associated in relation to these features (Tilley 1996).

Barrett (1999) observed that Neolithic and Bronze Age settlements are focused on monuments while later Iron Age sites are not. Barrett (1999, 264) concludes that political power was gained through control of places of past significance, and passed on to the future generations. Similar observations and conclusions were made by Tilley and Bennet (2001), in an examination of the significance of stone outcrops, tors, and stone solution basins, dolmens and stone circles in West Penwith, Cornwall. Natural features of stone are attributed with spiritual significance and emulated in burial features. The sacred sites become modified or improved with features constructed by humans. During the Bronze Age and Iron Age, the past significance of these features was utilized and their access was restricted in order to create social power (Tilley and Bennet 2001:360).

While Neutral spirituality and burials are not considered in this analysis, the previous examples show that a landscape-centred examination of the chronology of Neutral sites in relation to past sites and places of spiritual significance as well as other culturally based landscape factors may help provide context to observed changes in the Neutral settlement pattern. Although the examples cited above take a more subjective, narrative approach to describing the landscape, there are examples where landscape variables such as visibility and travel routes can be quantitatively analyzed using cartographic data.

Sites and Visibility. A landscape factor, which can affect site placement, and perhaps the shape of the site catchment, is visibility from the ground. Depending on the nature of the site, visibility can be an important feature that relates to communication, security of control of territory or important resources, and observation of game. In many ways, the area that can be viewed from the site is a form of site catchment, and analysis of this area can provide useful insights.

Llobera (2003), builds upon the dated concept of Isovists, and explores the use of visualscapes. Rather than simple measures of intervisibility, a visualscape is concerned with the spatial configuration of the visual field (Llobera 2003:31). Visual fields take into account additional variables such as contiguity of areas within view (Llobera 2003:32). Llobera (2003) also describes other measures such as visual prominence, visual exposure and curvature and cumulative viewsheds.

Traditionally, it has been a difficult and time consuming task to delineate viewsheds by graphing cross-sections of contours from topographic maps, however today many GIS software packages today allow for automated calculation of viewsheds by examining the location of a site or sites in relation to a Digital Elevation Model of the surrounding landscape.

Christopherson and Guertin (1996) demonstrate the usefulness of viewshed analysis by examining the viewshed of a number of sites in the Umayr region of Jordan. They find that most sites have a view of a large percentage of the land surrounding the site. One site, Tall Umayri, which did not have such a view was found to have smaller neighboring "watchtower" sites on ridges within shouting distance of the main site (Christopherson and Guertin 1996:4). The authors also believe that visual communication between sites was a consideration in site location. To test intervisibility between sites, the authors developed a cumulative viewshed to determine how many sites were in view of each other. It was determined that intervisibility was a statistically significant factor for site location in the Early Bronze age (Christopherson and Guertin 1996:6).

The concept of complementary site intervisibility zones reminds one of Flannery's observations about the complementary catchments of sites. Jones (2006) applied viewsheds and site intervisibility to Onondaga Iroquois sites. The viewshed was hypothesized to be a measure of defensibility, but it was found that sites often had significant blind spots allowing routes of approach for potential attackers, and that a few were in view of older villages (Jones 2006:536).

For viewsheds, (or any other measures of visibility) to be accurate representations of the area that can be viewed from a given point, the location and height of vegetation must be reconstructed. Jones admits that vegetation height was not taken into account. The argument that the land would have been cleared (Jones 2006:536) is questionable because not all land would have been cleared for cultivation, and based on the observations made by the Jesuits, the Huron (and presumably other northern Iroquoians) are not believed to have been able to fell larger living trees when clearing new fields (Heidenreich 1971:175).

Travel Routes. Access to travel routes by land or water are both important cultural factors relating to settlement patterns.

Zubrow (1990) demonstrated an example of a simulation model for travel by water. He hypothesized that, as rivers were the primary routes for transportation, these features would have defined the pattern of European migration and settlement in New York State. Zubrow (1990), simulated the process of settlement by using a hydrological network of New York State and tested his model by adding known settlements in chronological order and determining which routes along the hydrological network would have been used based on "draw" of population and by resistance, or cost (Zubrow 1990:309). Different alternative models were tested based on different points of entry into the network from the St. Lawrence, Hudson, Susquehanna, and Delaware rivers, as well as routes from Lake Ontario (Zubrow 1990:310-314). Results of the analysis indicated that population spread up the Hudson to the Susquehanna rivers as opposed to the traditional assumption that it spread from the Hudson to the Mohawk (Zubrow 1990:317).

Chapter Summary

Site Catchment Analysis provides a method for quantifying the resources available within distance of a site. Catchments are generally represented as circular, but actual catchments are based on travel times, topography, and a concept of territory. Reasonably accurate travel times are normally based upon walking transects from the site. This method is not suitable for conducting catchment analysis on a large number of sites, or sites that are otherwise inaccessible. Attempts have been made to use cost surfaces to model travel time. However, these methods rely upon highly subjective determinations of cost values for terrain types. Standard circular catchments remain the most tested and reliable to generate. Standardized sizes are also most useful for statistical comparisons based upon area.

Catchment analyses are complicated by the existence of temporary camps for resource utilization. It is known that Iroquoians utilized temporary camps and small cabin sites for agricultural activities, hunting, and collection of other resources, such as chert. Ideally, the surroundings of these sites and the proximity of these sites to permanent villages must also be taken into consideration.

Early implementations of catchment analysis failed to consider that the mere presence of variables at a site location do not necessarily mean that they were important. Analysis of site location must consider the relative scarcity of resources when attributing them with importance. Statistical analysis provides a method for quantifying and proving this association between sites and landscape features.

It is known that soil fertility and firewood supplies were limiting factors for the lifespan of Iroquoian villages, and that these villages were relocated regularly in part because firewood supplies and soil fertility were depleted. The catchment's sizes and variables analyzed should attempt to take this into consideration. Attempts have been made to quantify the resources in the catchments, determine the actual amount of energy that could be extracted, and the level of population that can be supported. The problems with these assumptions were demonstrated by Flannery (1976). The fact that not all available plots of land would have been cultivated at any given time, and that soil fertility would not remain constant, means that even if it was possible to calculate the actual total yield of native crops, using native cultivation methods for a catchment, it would still have no more use than an index of relative soil productivity.

Some researchers have developed viewsheds and intervisibility studies of sites. While this may be valid in some areas where there is little vegetation, it is impossible at this point to determine what areas within the catchment remained wooded, and what height these trees may have been. The one published example of where viewshed analysis was applied to Iroquoian sites fails to take tree heights into consideration. For these reasons, viewshed analysis does not appear to be useable for anything other than producing a result based upon the relative height of the land where the site is located, and there are simpler methods of doing this.

In summary, detractors cited the problems of representation of the environmental data. They have criticized the assumption that economy can be determined by the catchment contents, and provided examples of exceptions that provide contradictory evidence. Site Catchment Analysis has been described as overly simplistic and descriptive in nature. As with any model, it is a limited representation of the real world and can be used to produce misleading results. In spite of its criticisms, Site Catchment Analysis in a modified forms offer the promise of providing a method to analyze an archaeological site in the context of its surrounding environment based on economic factors, and provides way of studying the relationship of factors such as site economy, site location, population, and relationships between sites.

Various authors have adapted new methods and technologies to the Site Catchment Analysis process. Implementation of some of these improvements deemed feasible for this study serve to provide solutions to some of the criticisms that have been raised.

Chapter 4. Methodology

Methodology Overview

In this thesis, I perform a spatial analysis of late sixteenth and early seventeenth century Neutral sites in reference to geographical variables that may have been factors in shaping the settlement patterns and influencing distribution of these sites. The method of analysis used is a hybrid of predictive modeling methods and the revised Vita-Finzi and Higgs (1970) Site Catchment Analysis method, with some of the more recent improvements to this method, introduced in Chapter 3.

The goal of this thesis is to demonstrate the ability to produce information about the historic Neutral through the analysis of settlement patterns using existing databases of sites and geospatial data. Therefore, this analysis must be performed within the context of a model, which I use to organize data.

Clarke (1972:1) in part defines a model as "Pieces of machinery that relate observations to theoretical ideas". Furthermore, a model is an ordered representation of reality created by simplifying and eliminating observed details that do not contribute to its purpose. By doing so one seeks to identify the set of variables and interrelationships which explain the phenomenon being studied (Clarke 1972:2).

Models are divided into two major categories, those being the controlling model (or paradigm), and the operational model. Based on Clarke (1972), this thesis may be described as an operational, physical model – that is, it is an attempt to build a virtual representation of the environment around the sites and explain site location in reference to these representational features.

To avoid some of the pitfalls of environmentally deterministic approaches, this study compares the settlement pattern for 22 Neutral Glass Bead Period 2 and Glass Bead Period 3 sites in the Fairchild-Big Creeks and Spencer-Bronte Creeks clusters and interprets the results in reference to the established body of knowledge about historic Neutral historical economic and social factors such as trade, social structure, warfare, and population.

While previous analyses of Neutral site locations employed manual methods of spatial pattern recognition (for example, Stevens [1974] relied solely on paper-based maps and mylar overlays), this analysis uses Geographic Information System (GIS) software.

The problems associated with simplification of data classes and the mutually exclusive nature of paper-based catchment maps can be greatly reduced today through the use of GIS technology, as explained by Hunt (1992). Digital maps in GIS allow the researcher to overlay various themes and perform various intersection computations while still maintaining the cartographic integrity, shape, and area values of the input data layers. The database capabilities of GIS can accommodate the large number of landform attributes that can be queried and analyzed without the requirement to collapse data classes (Hunt 1992:285-286).

A textbook definition of GIS is:

> An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically reference information (ESRI1997:1-2).

GIS has become the standard method of performing spatial analysis in most fields, including archaeology. Due to the large number of sites being examined and the coarse cartographic scale of the landscape data, analysis at the level of the individual structure, or even the organization and structure of the site occupation areas, if available, would be very complex to digitize, manipulate, and analyse and thus are beyond the scope of this study. Consequently the levels of analysis for this investigation of settlement patterns are limited to potential catchment areas surrounding individual settlements and to the regional distribution of settlements within the study area.

At the individual site catchment, I examine environmental variables based upon topography soil and proximity to water. As documented in Chapter 2, there is overlap between themes for many of the geographic variables being considered. For instance, site catchments are analyzed based on capacity for food procurement, including both horticultural potential as well as wild game. Proximity to water bodies relates to trade, as well as to fishing and defence of the site. Proximity to wetlands is a factor related to both procurement of animal and plant resources for food and medicinal purposes, as well as a supply of firewood and building materials used for certain aspects of village construction.

Catchment Boundary Definition

Shape and size for site catchment zones are based upon available established practice and relevant literature. In the introduction to their Site Catchment Analysis, Vita-Finzi and Higgs (1970:7) determined that a maximum distance of 5 km for horticulturalists and 10 km for hunter/gatherers were adequate to delineate the most intensively utilised area. They also demonstrated the use of simple circular catchments as well as boundaries modified according to travel time.

Christopherson, et al. (1999) offer a method that potentially could establish a catchment boundary based on travel-time without the time and cost of actually walking transects for each site. They suggest the use of the PathDistance command available in the GRID extension of ESRI's Arc/Info GIS software. Using this method they delineate and analyze the catchments for Old World Iron Age sites (Christopherson, et al. 1999:4-8).

The PathDistance command uses the Digital Elevation Model (DEM), to calculate actual on-ground distance factoring in the effect of walking up and down hill. A cost surface is produced to add impedance values depending on how difficult different terrain types may be to traverse. When run, the command produces an output grid classifying the landscape according to accumulated cost as one travels away from the source points (Christopherson, et al. 1999:3). Properly calibrated, cost can be used to represent travel time.

Bell, et al. (2002) demonstrated an improved method for the use of cost surfaces to model Samnite overland communication routes within the Sangro

Valley in Italy. Cost is assigned, not based on a linear relationship with slope, but based on the tangent of the slope (Bell, et al. 2002:175). The fact that uphill slopes are also more difficult to traverse than downhill slopes is modeled by calculating the cost of a grid cell based the direction of travel across it (Bell, et al. 2002:176). This directional cost surface was calculated for each site and combined to generate an optimal path where overlapping paths were rated based on the number of sites potentially using that route (Bell, et al. 2002:177). The alignment of these routes with modern agricultural travel routes provided support for the validity of the model (Bell, et al. 2002:185).

Cost surfaces could offer an ideal tool for delineating the catchments of potentially many sites at a time without even needing to leave one's desk. However, the problem with attempting to generate these cost surfaces lies in the calibration of the costs of travel. Aside from hills and slopes, other landscape features, such as drainage and vegetation, should have an effect. Attempting to calibrate the cost surface requires some knowledge of how long it actually takes to traverse different terrain types. Even if this is performed using an extensive program of experimental walking tests, different levels of physical fitness, clothing, and equipment must also be taken into account. All of these factors make it much more complicated, and the results just as difficult to defend as the simple circles. I use circular catchments in this study.

Two previous applications of Site Catchment Analysis to Iroquoian sites examined soils for horticultural productivity and have also used simple circular catchments limited to two kilometers or less. Horne (1987:8) used one and two kilometer circular catchments. Hunt (1992:292) used 1.5 km circular catchments, but admitted that GIS allows for better definition of actual catchment boundaries (Hunt 1992:285-286). Horne (1987:19-21) observed a chain link patterning of sites and concluded that this was confirmation of a pattern of utilizing resources particularly abundant in re-generating abandoned fields. Both Hunt (1992:291) and Horne (1987:5) state that Iroquoian sites would move from two to five kilometers when resources were depleted. I believe their results support the use of Vita-Finzi's and Higgs' five kilometer catchment size. Catchment boundaries used here are therefore circular in shape, extending to a maximum of five kilometers for all variables.

Site Clusters

Similar to the method used by Hasenstab (1990:76) and Stevens (1974:4), the study area is subdivided by site cluster boundaries and each cluster is analyzed separately to determine if differences in settlement pattern between these inferred tribal divisions can be detected. Boundaries used for defining the cluster are the quaternary watersheds in which the site clusters are located.

The aggregates of the results of the analysis performed in the individual site catchments for the Fairchild-Big Creeks cluster are compared with the results of the Spencer-Bronte Creeks cluster. Furthermore, I explore the possibility that observed differences may relate to distance from the centre of the cluster. The potential relationship between sites and the catchments of older sites is also examined.

Before conclusions can be drawn based upon the tabulated results of the analysis, it must first be determined whether or not the results of each variable considered in the Site Catchment Analysis reveal anything about Neutral settlement patterns and land use, or if they are simply a random sample which is representative of the landscape features in the Neutral cluster area. To this end, the observed distributions of features within catchments are compared to the background distribution of these same landscape variables within the cluster areas as a whole.

Study Area

The study area for this analysis comprises the territory surrounding the two largest of the Neutral site clusters, namely the Spencer-Bronte Creek cluster and the Fairchild-Big Creek cluster. The territorial boundaries used by archaeologists to define these clusters approximate the watershed boundaries of the creeks for which they are named. For the purpose of this analysis, site cluster boundaries are spatially defined using the Tertiary and Quaternary watershed boundaries generated by the Ontario Ministry of Natural Resources (MNR) Water Resource Information Project (WRIP). These watersheds were delineated by WRIP staff using an automated process which used a hydrologically corrected Digital Elevation Model together with streams which had been assigned orders using the Strahler stream ordering method as the input data. The process assigned "Top-Down" coded watershed names based upon the Water Resource Index Filing System developed by the Department of the Interior-Canada (WRIP 2002:14).

The Spencer-Bronte Creek site cluster is positioned to the Northwest of the western-most tip of Lake Ontario, and the present-day city of Hamilton. For the purpose of this analysis, the 2HB-07 and 2HB-04 Quaternary watersheds as they are identified from the Water Resource Index Filing System, define the boundaries of this cluster.

The Fairchild-Big Creeks cluster is located West of Hamilton to the Grand River. This is by far the largest cluster of Neutral sites and contains the large Walker site, which has been interpreted as having been the Neutral capital of *Ounotisaston* documented by the Jesuits prior to the dispersion of the Neutral nation. For the purposes of this analysis, the 2GB-01, 2GB-03 and 2GB-04 Quaternary watersheds define the cluster boundaries.

Neutral Site Sample

The sample of Neutral sites analyzed herein is selected from the Ontario Ministry of Culture archaeological database. One of the common criticisms of using government databases of known sites to study settlement patterns is that these are a sample as opposed to a population. This sample is comprised of whatever sites have been reported by a number of individuals using a variety of different survey techniques. In some cases, members of the public may have reported sites in the database after accidental discovery.

Another commonly raised concern about the use of known site location data is that archaeologists search for sites with pre-conceptions about where they can be found, hence any resulting settlement analysis will be biased towards areas that were more likely to be surveyed, or in which sites have a higher visibility and are more easily found (Dalla Bona 1994b:3; Hamilton 2000:45). This is somewhat less of a problem when dealing with Neutral towns and villages because this class of sites is large, and can cover several hectares. The region where these sites are located has also been cleared and tilled for agriculture since the mid 1800s, and in recent times been subject to extensive urbanization and development. Surveys to locate sites were conducted in the 1960s by Bill Noble and in the 1970s by his students, e.g., Noble (1970); Wright (1981); Lennox (1981,1984a, 1984b). Amateur archaeologists such as Frank Ridley (1961) and Rutherford Smith had documented many Neutral sites prior to this (Susan Jamieson, personal communication 2007). These factors all contribute to high visibility and increase the likelihood that a large proportion of these types of sites will have been discovered and represented in the database.

Sites were initially selected out of the database by a spatial search for all sites in the study area, and then narrowed down by examining the site type and cultural affinities fields associated with these records. Due to the fact that this database does not presently appear to use lookup tables to standardize the definitions of cultural affinities and site types, as a wide variety of terms (or even spelling of terms) were used to describe sites which could be assigned to the historic Neutral. Site records were selected which contained the terms that included "Neutral" or which indicated Late Woodland, late Iroquoian, or historic

Native sites. This selection was then further refined to those site types listed in this database as villages or hamlets. A total sample of 71 village or hamlet sites of probable Neutral origin was selected for the GIS analysis. After the contents of the catchments of these sites were calculated, the sample was further categorized by age based on Lennox and Fitzgerald (1990:412-414) and Ridley (1961). The site size attribute was taken from the site Borden form information also provided by the Ministry of Culture. When site sizes were examined, there were some inconsistencies in the data, so the sites were re-classified into categories of towns (2-6 ha), villages (.4-2 ha), and hamlets (0-.4 ha) using Noble's (1984:13) size criteria. Existing classifications were maintained for those sites where numerical size attributes could not be obtained. The sample of sites was then reduced to 22, so that only seventeenth century sites were included. The sample used in this study is listed in Table 2.

The site data locations provided by the Ministry of Culture consists of geographic coordinates representing a point where each site is located. Many archaeologists have conducted spatial analysis based on sites represented as simple point coordinates on the landscape. In reality, sites are not point coordinate locations, but rather areas of varying size, which were inhabited and surrounded by much larger resource utilization areas. For the purpose of statistical comparison, the site area variable was populated using the information found on the site's Borden form.

Because of the scale of the datasets being used as environmental variables and the quantity of site locations being analyzed, it is not practical to attempt to determine or analyze the actual habitation boundary of each site.

Table 2: Seventeenth Century Neutral Sites as Used in this Analysis.

Site Cluster	Site Type	Borden Number	Site Area (Ha)	Name	GLass Bead Period
Fairchild-Big Creeks	Town	AgHa-9	6.25	Walker	GBP3
		AhHa-5	5.00	Smith-Haley	GBP2
		AgHa-4	2.83	Sealey	GBP3
		AhGx-12	2.50	Daniels	GBP2
	Village	AhHa-9	1.60	Misener	GBP2
		AhHa-25	1.25	Stratford	GBP2
		AhGx-15	1.00	C. Smith	GBP2
		AhGx-22	1.00	Donovan	GBP2
		AhHb-10	1.13	Wood	GBP2
		AgHa-7	0.50	Bundy-Bodwell	N/A
		AgHb-18	N/A	Cooper	GBP3
		AgHa-6	0.56	Westbrook	N/A
	Hamlet	AhHa-58	N/A	Haley's Pond	N/A
Spencer-Bronte Creeks	Town	AiHa-12	3.00	Robertson	GBP3
		AiHa-7	2.70	Hood	GBP3
		AiHa-5	2.00	Hamilton	GBP2
	Village	AiHa-2	1.60	Christianson	GBP2
		AiHa-14	1.01	Freelton	GBP3
		AiHa-8	1.13	Mills	GBP3
		AiHa-18	0.75	Kralt	N/A
	Hamlet	AiHa-10	0.38	Bogle 1	GBP3
		AiHa-11	0.25	Bogle 2	GBP3

It is not known where the coordinate was taken within the site, or the accuracy of the coordinate record. Therefore, a buffer of the actual recorded site size may produce spurious results for the smaller sites. To avoid this problem, a 100 meter circle is drawn around each site regardless of size, and this boundary is used as a substitute for the village footprint to analyze the geographic variables that characterize the landscape of the site habitation area.

Site Location Variables

The variables used for this analysis can be grouped into three categories: site location variables, land use classification of catchments, and relative food procurement potential. These variables are listed in Table 3.

Habitation variables refer to those criteria that directly affect the specific location of the village itself. The land use classification provides a breakdown by area for resource utilization within the catchment of the village, which is loosely based upon the classifications used by Jamieson (1986:28-35). Food procurement potential refers to the attempt to quantify the relative productivity of the site catchments using Canada Land Inventory (CLI) and Ontario Land Inventory (OLI) values for agricultural and deer potential.

Topography: Curvature. Topography is usually considered an important variable for several reasons. It is commonly accepted that Iroquoian sites are located upon elevated topography.

The defensive value of an elevated site is often mentioned; however, in many cases the low rises on which historic Neutral sites are located may not have provided such protection. The Hamilton, Hood and Walker sites were noted to have inadequate topography to have provided any defensive value, and in the case of the Hood site, the site boundaries appear to have extended beyond those features (Wright: 1981; Lennox 1984a:12; 1981:349). Noble notes that site drainage was probably the primary selection criteria being used. He observed that houses are oriented along the elevated knolls and drainages, which were more important than considerations related to wind exposure (Noble 1984:12).

Table 3: Site Location Variables

<table>
<tr><th>Variable Class</th><th>Variable</th><th>Catchment Distances Calculated (Meters)</th></tr>
<tr><td rowspan="2">Site variables</td><td>Surface Curvature</td><td rowspan="2">0-200</td></tr>
<tr><td>Proximity to water – by stream order</td></tr>
<tr><td rowspan="4">Land use variables</td><td>Wetlands (area)</td><td rowspan="6">100-1000, 1000-5000</td></tr>
<tr><td>Water (area)</td></tr>
<tr><td>Suitable agricultural soils by type (area)</td></tr>
<tr><td>Unsuitable agricultural soils (area)</td></tr>
<tr><td rowspan="2">Food procurement potential scores</td><td>Soil Productivity score of suitable agricultural soils of by soil type</td></tr>
<tr><td>Wildlife Potential – Deer (Ontario Land Inventory)</td></tr>
</table>

Topography of site catchments is assessed using the digital elevation model (DEM) developed by the Water Resource Information Program (WRIP).

A DEM is a digital representation of the earth's surface using the raster data model. A raster data model is a geographically referenced continuous surface divided into a grid of cells. Information is recorded by a value assigned to each cell. In the case of a DEM, each cell is assigned a numerical value representing an estimate of elevation for the area covered by the cell. Since it is not possible or economical to collect elevation values for each cell, DEMs are created by software that uses an interpolation algorithm to calculate cell values based on the values of adjacent cells.

The WRIP DEM was created using ANUDEM software and was designed for hydrological modeling, therefore it is a drainage-enforced DEM. Spurious sinkholes were eliminated and mapped stream data is used as part of the interpolation process to ensure that slopes and elevations are consistent with known flow directions. The raster cell size of the DEM is 10 meters and it is derived from contours mapped at 5 meter intervals with a vertical accuracy rated at 2.5 meters. The curvature calculations used here are based upon this DEM.

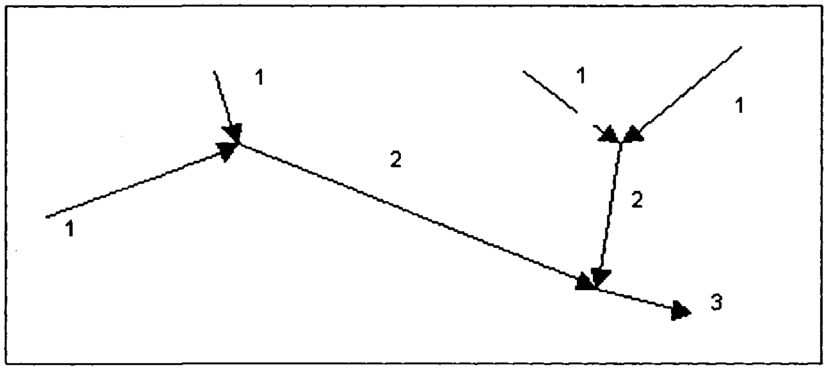
Curvature is calculated from the DEM using the Curvature function included with ESRI ArcMap software. The Curvature function is used to produce a raster with values indicating if the surface of the landscape at any given cell is concave or convex. Positive values indicate a convex surface while negative values indicate a concave surface. The average curvature for the one hundred meter catchment is compared with the average curvature for the surrounding catchment circles to determine if the site is located on elevated topography or in a depression.

Proximity to Water: Streams and Lakes. Models of archaeological site location are usually heavily weighted towards proximity to water. Iroquoian sites are also usually located near water sources. However, it has been found that village sites are usually close to smaller streams. Proximity of Iroquoian sites to water is usually described in reference to a water supply, such as a spring, as opposed to locations for fishing or navigation. While a nearby water source was obviously important for day-to-day requirements of the site inhabitants, it has been stated that large sites during the seventeenth century were not close to major rivers and lakeshores. Only small hunting and fishing camps were located there (Lennox and Fitzgerald 1990:440). In fact, it has long been assumed that towns and villages were sited to avoid direct access to navigable waterways in order to protect against enemy raiding parties (Waugh 1902:70).

The water body data that is used is acquired through OGDE from the Ministry of Natural Resources base data. This data is digitized at 1:10,000 scale and includes lakes, ponds, large rivers, wetlands, and seasonally flooded land. The water line (streams) data is a modified version of the waterline data that has been edited by WRIP for hydrological modeling purposes, which among other things includes virtual waterline segments providing connectivity through lakes and large river polygons. This connectivity allowed for creation of Strahler and Shreve stream ordering attributes that were provided with the data.

Stream order is a method of classifying stream segments according to their location in a stream flow network based on the number of branches feeding into the segment. Stream segments with a lower value are located higher within the watershed and stream order values increase, as they get farther downstream toward what is known as the network *pour point*, where the water exits the watershed (Figure 2). According to the Strahler method of stream ordering, the smallest streams with no tributaries are coded as a first order stream. A stream segment fed by two or more first order streams is classed as a second order stream. Two or more second order streams feed third order streams, and this pattern in continued down the network (Strahler 1957:913-920).

Figure 2: Strahler Stream Ordering



Stream order is not a true measure of stream size or navigability, but streams that have more tributaries do tend to be larger than those with fewer tributaries. It is for that reason that it has been used as a proxy for stream size and navigability for the purpose of archaeological predictive modelling when other data is not available (Dalla Bona:1994a:37). The study area does not contain a large number of lakes, thus lakes do not play an important role in site location; however, where lakes intersect site catchments they are classified according to Strahler stream order in the same method as the streams. Both the waterbody polygon data and the stream data are merged into a single dataset and intersected with the site catchment boundaries.

Water. The water component of the land use classification defines the surface area of land taken up by water within the catchment boundary. The water layer used is comprised of lakes, ponds, and those rivers and streams which are wide enough to have been represented as polygon features on the 1:10,000 scale base mapping.

Soil Types and Soil Poductivity by Type. Soils, and drainage are important considerations for village location, not only because they provide a suitable dry and comfortable location to erect longhouses and dig storage pits, but also because they affect the inherent potential for the surrounding landscape to produce plant resources of economic importance. The Neutral, similar to the Huron and other Iroquoian peoples in the Northeast, grew domesticated red-kernelled maize, beans, squash, sunflower, and tobacco (Wright 1981:130; Noble 1985:140). As documented in Chapter 2, it is known from historical and archaeological evidence that maize was a major source of food for the Neutral. Based on site catchment modelling, a village would therefore most likely be located so that its catchment area contained large enough zones of the soil types most suitable to reliably produce the yields of crops needed to support a growing population given available technology (Vita-Finzi and Higgs 1970:4).

Sites are assessed based upon soil data, site moisture, and curvature. Results for these classes are tabulated within each site catchment boundary and examined in reference to conditions deemed to be suitable for crops of the type that were known to have been cultivated by Iroquoian people, namely sandy loams, loams, and silt loams as described in Chapter 2.

Digital soil survey data was acquired from the Ontario Ministry of Agriculture and AgriFood for the counties of Hamilton Wentworth, Brant, and Wellington. This data is digitized at a scale of 1:63,360 and each soil polygon is coded with attributes to identify soil type, as well as slope, stoniness, drainage, and texture in addition to the Canada Land Inventory agricultural limitations classes. The descriptions of each soil code are provided in a metadata document that accompanied the data. Three sets of data fields exist for each soil polygon. These exist to indicate up to three different types of soil per polygon and the relative percentage of each. To make this information useable, a considerable amount of preparation was required. The area of well drained sandy loams, loams and silt loams with no other major agricultural limitations, were calculated into a single field for each polygon based on the area of the polygon and the percentage for these soil types. These formed the suitable agricultural soils, with the remainder being classified into the unsuitable or potential wetlands categories.

Proximity to Wetlands. While wetlands would likely not have been preferred locations for siting the village itself, *proximity* to wetlands and flooded land may have been important for the resources available in those areas. Wetlands and the edges of wetlands provide habitat to a variety of animal and plant resources as well as providing a source of cedar suitable for construction and dead hardwoods on flooded lands, which are accessible in the winter and suitable for firewood. Wetlands are tabulated by area within each catchment circle. Wetlands and flooded land from the 10,000 MNR/NRVIS data are used to identify existing wetlands. The extent of modern agricultural land use and urbanization in the study area is likely to have resulted in a great deal of environmental modification and loss of wetlands in particular. The base map wetlands are supplemented with some areas identified in the soils mapping as being poorly drained peat or muck and organic soils. Agricultural tile drainage mapping acquired from OMAF provides some additional information about where other wetlands may have once existed. The area of wetlands, flooded land, and tile drainage is tabulated individually for each site catchment, and also summed for a total wetland area per catchment statistic.

Unsuitable Agricultural Soils. Even while some areas surrounding a site may not have ideal agricultural soils, or have other conditions that restrict agricultural activity such as stones or steep slopes, these areas would still have provided many other important resources such as firewood or mast crops. Uncleared areas in the proximity to native crops would also provide shelter for animals drawn to feed on the crops, only to become part of the harvest themselves. These areas are calculated as being the remainder of the catchment that is not classified as water, wetland, or agricultural.

Wildlife Potential. Wildlife potential of catchment areas is assessed by making use of the Ontario Land Inventory (OLI). The OLI is a 1:250,000 scale dataset that was digitized by the Canadian Forestry Service from older paper maps and which assesses the landscape according to a wide variety of variables. Two of these variables are Deer Capability and Beaver Capability. However, modern wildlife surveys may not have relevance due to changes in land use and removal of predators. The OLI wildlife capability values on the other hand, were classified based on the potential carrying capacity of the landscape.

Regional Level Analysis

The results of the individual site level catchment analysis are used for regional analysis. Tabulation and graphing the aggregate values for each cluster may reveal whether differences exist over time, between clusters, or even between the center and periphery of clusters.

Overlapping site catchments

Areas where the catchments of two or more sites overlap are of particular interest. If these sites are of different age, the area of overlap may contain features or resources of continuing value to which the community wished to remain close. As described in Chapter 2, areas with regenerating fields would also be of economic value.

Analysis Process

Reference map data layers such as soils, physiography, etc. are acquired, converted into a common projection, and clipped down to the study area boundary. The Ministry of Culture sites are provided as a table of X and Y coordinates which require sorting and conversion into point locations. Circular catchments are created around these points and the catchments are segmented to reflect overlaps between sites catchments. The tabular attributes of all layers were then modified into a useable format for the analysis. Some of the input layers required further processing in a raster-based analysis in order to produce meaningful data representing the variables listed. Each variable layer are then unioned with, or summarized by the catchment boundaries and the results imported into a relational database which is used to query the data and produce tables formatted for statistical analysis.

The mutually exclusive categories of catchment data are tabulated into expected and observed frequencies and the percent different of each, as was demonstrated by Zarkey (1976:126). The significance of all landscape variables are tested individually for sites by category against the background distribution that is represented by catchments of randomly generated points using the Kolmogorov-Smirnov two sample test. This is a test that is used to determine if the cumulative distributions of two samples are drawn from the same population. The Kolmogorov-Smirnov test is a non-parametric test that is well suited for smaller sample sizes.

The Spearman's Rank Correlation Coefficient is a non-parametric statistical test that measures the relationship between two ordered list of values. Sites are ordered according to size and distance from the mean centre of each cluster and tested to determine if site size relates to the location being near the core or the periphery. A more detailed description of data preparation, processing and discussion of statistical tests used here is found in Appendix C.

Chapter Summary

This analysis makes use of a modified form of catchment analysis to examine 22 Neutral sites. Site locations are examined relation to environmental variables including soils, proximity to water by stream order, proximity to wetlands, and site curvature using circular catchment boundaries of varying distances. Results are statistically compared to the background distribution of variables using randomly generated sample locations.

Chapter 5: Results

Description and Physiography of the Site Cluster Areas

The Fairchild-Big Creeks cluster drains from North to South into Lake Erie and contains four main physiographic zones creating East to West bands across the watershed (Figure 3). Illustrated in Figure 4, the uplands to the North of the watershed are limestone plains. The middle of the watershed is a sand plain, with the lowlands to the south being a clay plain.

The high ground to the east of the sand plain, which in part divides this watershed from the Spencer-Bronte drainage, is a moraine. All seventeenth century sites in Fairchild-Big Creeks are distributed between the southern half of the sand plain and throughout the clay plain and the breakdown of land classifications reflects this landscape. Overall, with minor exceptions, the sample of site catchments does not differ greatly from the catchments of random point locations in this cluster.

The Spencer-Bronte Creeks cluster is located in a much more diverse environment. As illustrated in Figure 5, the watersheds drain in two different directions into Lake Ontario, to the southeast and northeast, with the sites clustered around the high ground between these two drainages.

In terms of physiography, it contains a continuation of the same three bands of limestone, sand, and clay plains, but these are broken by large, narrow bands of till moraines and swamps (Figure 6). The sample of seventeenth

Figure 3: Topology and Drainage of the Fairchild-Big Creeks Watershed in Relation to Sites

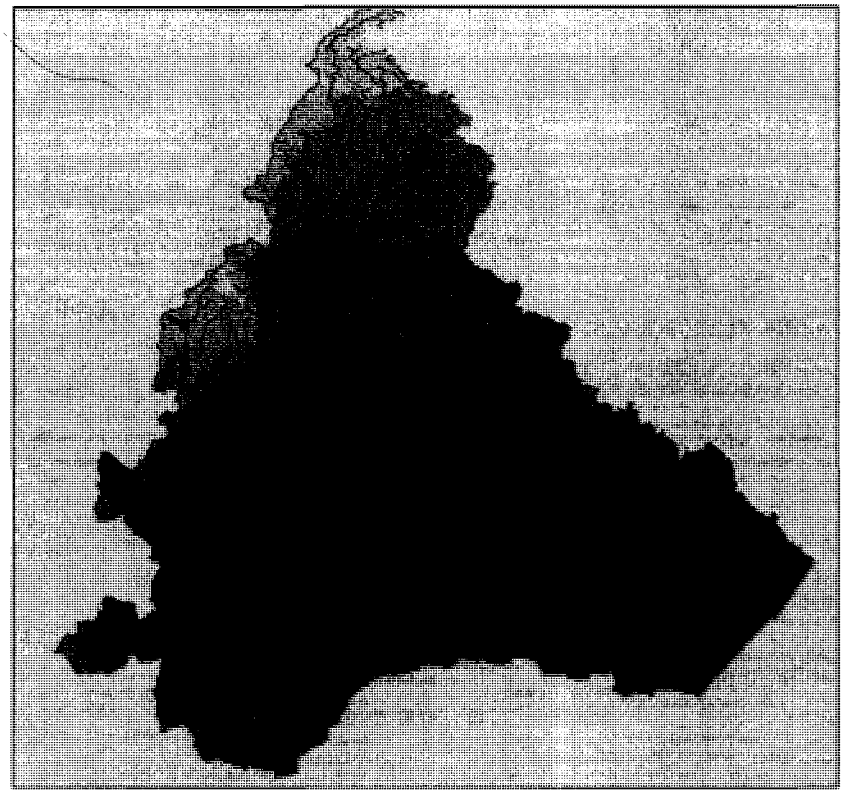


Figure 4: Physiography of the Fairchild-Big Creeks Watershed

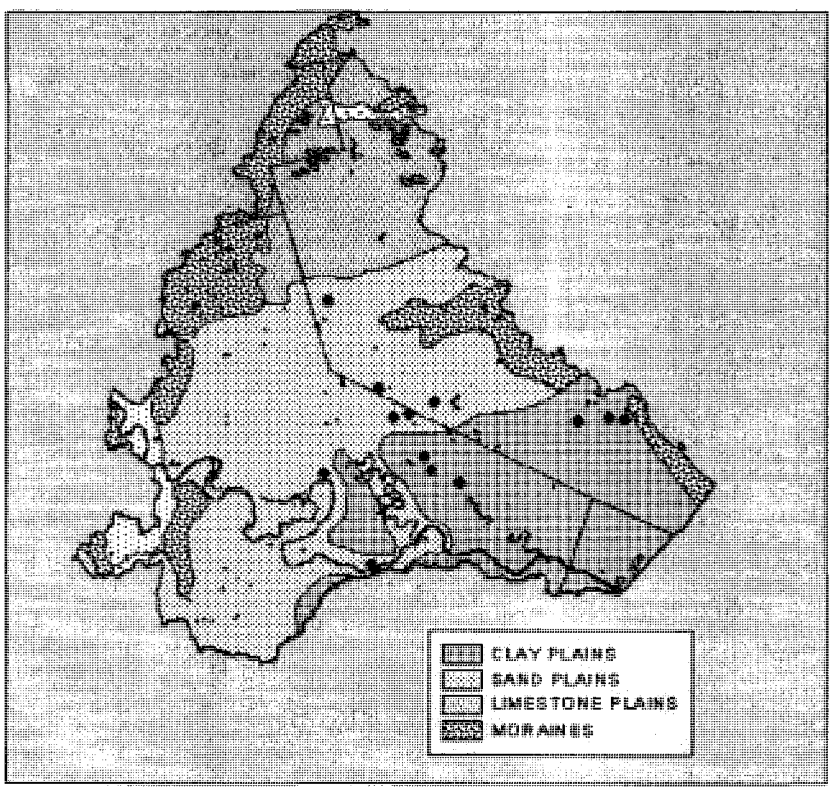
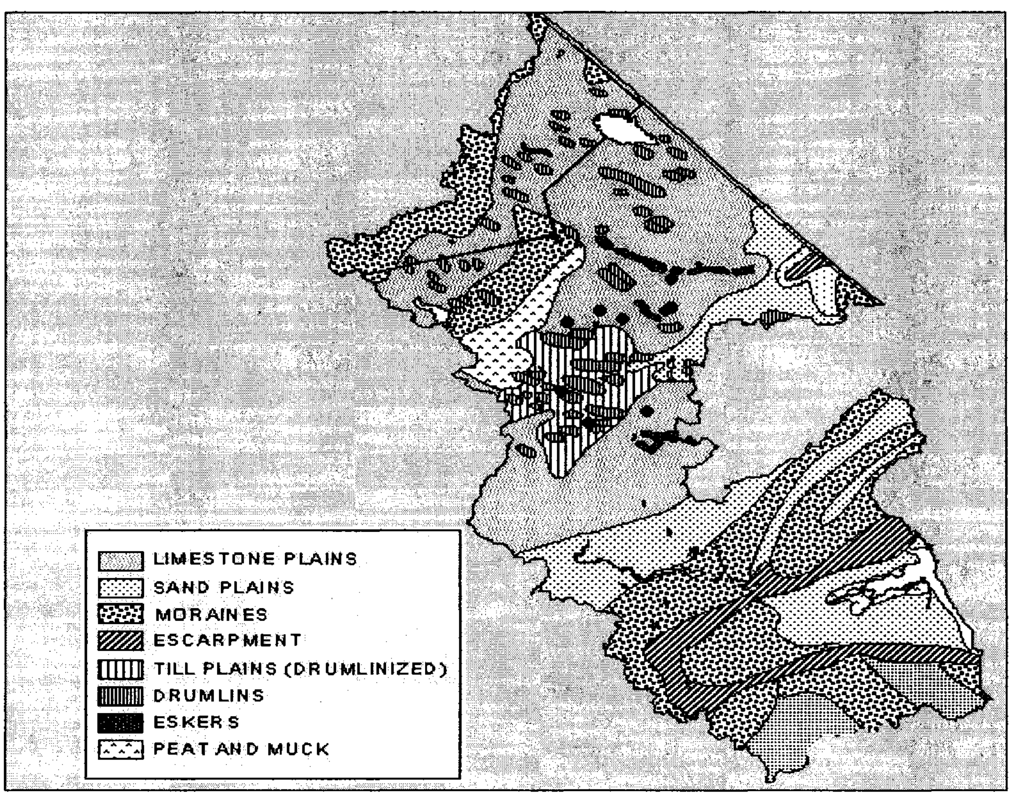


Figure 5: Drainage and Topography of the Spencer-Bronte Watershed

Figure 6: Physiography of the Spencer-Bronte Watershed



century sites in this cluster are located in a drumlin field mixed with small till moraines within the centre of the northern limestone plain.

Site Catchment Characteristics

As described in Chapter 4, the site location variables used for this study are divided into site location variables and catchment variables.
Site catchments were generated in 100, 200, 500, 1000 and 5000 meter radii from each of the site locations and the area of each land use variable are calculated and combined into catchments of 100-1000 m and 1000-5000 m as defined by Table 3, in Chapter 4. By reviewing the raw results, it was observed that many smaller sites (villages or hamlet) may have been selected based on potential landuse for smaller catchment sizes, therefore the results for the 100-1000 m catchments were further subdivided into 100-500 m and 500-1000 m catchment areas. The results of all land use potential variables by catchment distance are tabulated in Tables 7-10, Appendix A. These values are also calculated for the areas where the sample sites overlap with Pre-Fur Trade Neutral sites (Table 11, Appendix A), and prehistoric Neutral sites (Table 12, Appendix A). In addition to the mutually-exclusive categories of potential land use, scored food procurment capability based on CLI agricultural capability scores and OLI deer capability scores, are tabulated for each catchment in Table 13, Appendix A.

The results of all variables are summarized in this chapter separately according to site cluster. In both clusters, the ratios of 1000-5000 m variables that form the traditional site catchment component of this study using mutually exclusive land use analysis are similar for all classes of sites within their respective cluster.

These classification variables are compared to the expected background distribution of these variables using the same method tested by Zarkey (1976:121-126). As explained in Chapter 3, the purpose of comparing site catchment variables to the background distribution is to determine if the observed patterns can be attributed to human land use and site selection behaviour, or are simply reflecting the natural patterning of the environment as a whole. These results using Zarkey's method are presented in Tables 16-19, Appendix B.

Unfortunately, identical to the problem encountered by Zarkey, the very small sample size of this data means that the frequency tables contain expected values in some categories falling below the value of 1. As a result, Chi-Square cannot be used to test if the combination of values for sites is different than that of the background distribution. Unlike Zarkey (1976: 127-128) who used a binomial test to determine the significance of individual categories, I use the Kolmogorov-Smirnov two sample test to compare the difference between sites and the randomly generated sample of locations for each category. The results of the Kolmogorov-Smirnov tests for each variable within each catchment distance are listed in tables 21-27, Appendix B.

As a whole, the physiographic differences in the landscape of the two watersheds in the study area as described above are also reflected in the site catchments of the site clusters, which are defined by these watersheds. The combined distributions of landuse categories for sites in all of the three size categories are listed in Table 4.

When these catchment variables of the entire sample of sites in the two clusters are compared to each other using the two-sample Kolmogorov Smirnov test, it is demonstrated that statistically significant differences exist between sites of the two clusters in most of the categories being measured, including soil types, soil CLI scores, wetland areas, and OLI Deer capability scores (Table 19, Appendix B). Because of these significant differences, the sites from the two clusters are analysed separately.

Fairchild-Big Creeks Cluster Results

The results of the Fairchild-Big Creeks potential land use classifications are displayed in the stack-bar charts in Figure 7.

Wetlands. The Fairchild-Big Creeks cluster is relatively devoid of modern-day wetlands. It is also the cluster with the most modern development, which may have eliminated wetlands through artificial drainage and filling. In this study, areas identified as containing modern tile drainage systems are used as a substitute for these potentially missing wetlands. With these additions, 93% of wetlands areas used for this study area are based on tile drainage mapping and only 7% are based on available modern wetlands mapping. As a whole, there is a slight but statistically insignificant association between sites and wetlands. The Wood site is the only site that has any significant modern wetlands within the one kilometer catchment. When tile drainage is considered, the Walker, Daniels, C.

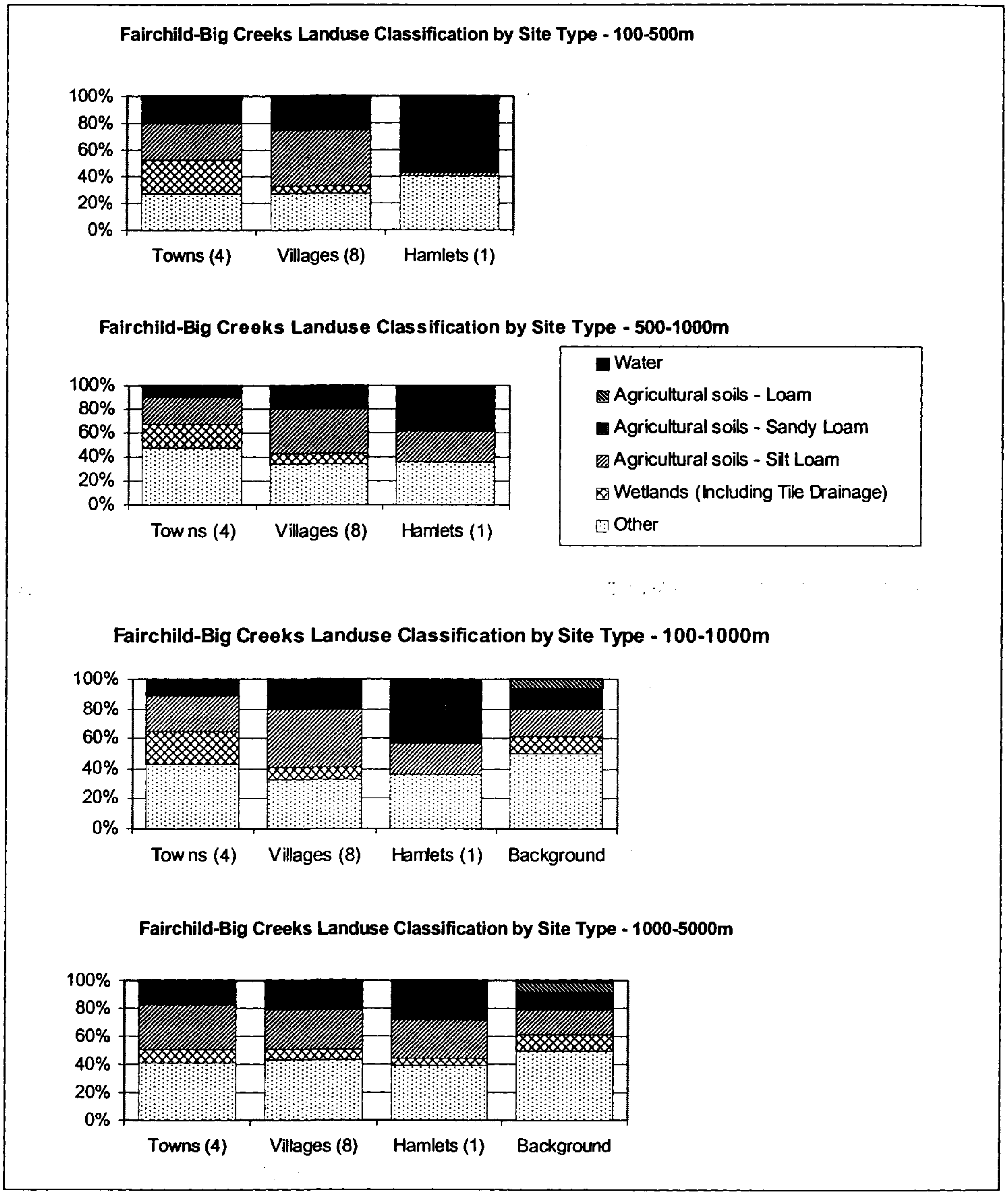
Table 4: Catchment Land Use Classifications by Percent Area

Cluster	Site Sample	Random percentages are displayed in brackets					
		Well-Drained Agricultural Soils			Other Land Use		
		Silt Loam	Sandy Loam	Loam	Wetlands	Steep, heavy textured, other unsuitable soils	Water
Fairchild-Big Creeks	100-1000m	32 (27) %	19 (17) %	0 (3) %	11 (9) %	37 (43) %	1 (1) %
	100-5000m	31 (27) %	19 (17) %	1 (2) %	8 (8) %	40 (45) %	1 (1) %
Spencer-Bronte	100-1000	0 (10) %	4 (14) %	30 (11) %	25 (22) %	41 (42) %	0 (1) %
	100-5000	1 (7) %	6 (14) %	21 (13) %	28 (19) %	43 (46) %	1 (1) %

Smith, and Donovan sites also have a large area of wetlands in proximity. This pattern also pertains to the five kilometer catchment.

Soils. The initial examination of this variable appeared to be promising. When all Historic Neutral sites (including sixteenth century sites) in the Fairchild-Big Creeks cluster were compared with random catchments there was a statistically significant association with suitable soils and sites in the 5 km catchment. Unfortunately, this statistical significance disappeared when the sample was reduced to seventeenth century sites. Nevertheless, the seventeenth century site catchments in this cluster still do have a higher percentage of suitable soils by area than random, and this fact is reflected when charted in a probability distribution as well as the average of all clusters.

Figure 7: Fairchild-Big Creeks Site Cluster Potential Land Use Classifications



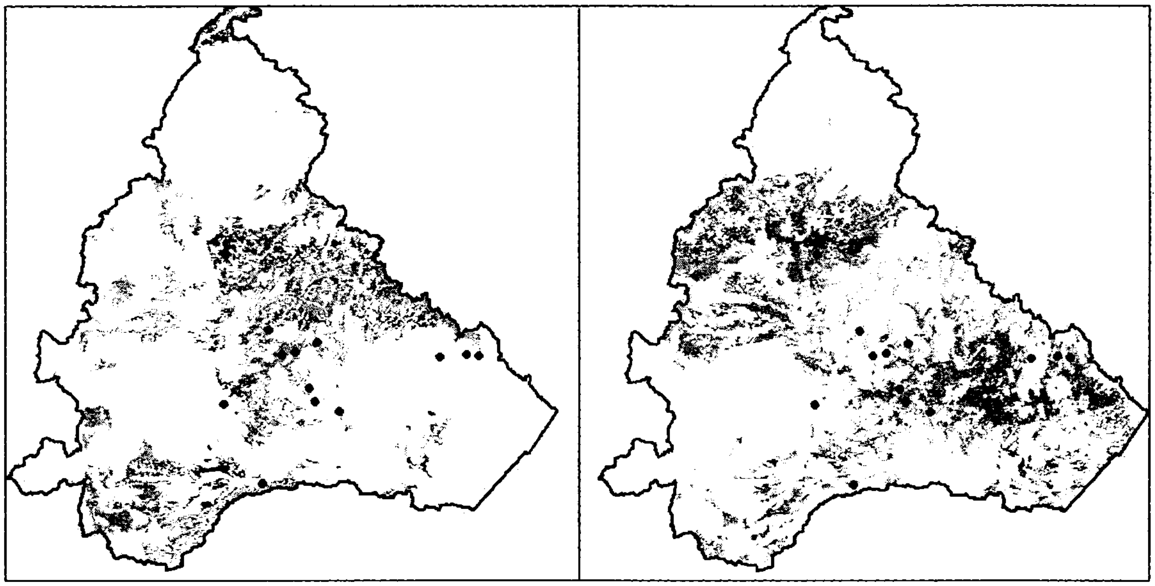
Stevens (1974:25) found that Neutral sites were associated with loam and silt loam soils. The results of this study appear to confirm that this observation also holds true for the site catchments, at least within the Fairchild-Big Creeks cluster. However, a major difference exists between the Glass Bead 2 Period sites and the Glass Bead 3 Period sites.

The Glass Bead 2 period sites are located along the southern portion of the sand plain, along the edge of a large area of suitable sandy-loam soils. In contrast, the Glass Bead 3 period sites are located in the clay plain, although always along the edges of the area of sandy loams. When broken down by period, the Glass Bead 2 sites are located adjacent to areas with higher percentages of productive soils than the later sites. It should also be noted that the Walker site is also located in immediate proximity to an isolated patch of sandy-loam soil deemed suitable for agriculture.

Overall it appears that the site cluster is located at the intersection of the distribution of both suitable sandy and silt-loam soils in the watershed (Figure 8). There are practically no areas of pure loam within distance of sites in this cluster.

When the site sample is broken down by settlement size, the catchments of town sites show no statistically significant differences in comparison to the background distribution of variables. There is a slightly greater tendency for these sites to be associated with water and wetlands, particularly in the 100 – 500 m catchment. Important differences do exist when towns are compared to village sites. Village sites are located in areas with the largest areas of suitable sandy loam and silt loam soils within 100 – 1000 m of the sites. When the catchments are further broken down into 100 – 500 m and 500 – 1000 m radii, it is found that there are slightly more wetlands between 500 – 1000 m.

Figure 8: Distribution of Well-Drained Sandy Loams (left) and Well-Drained Silt Loams (right) in Relation to Sites of the Fairchild-Big Creeks Cluster



Only one hamlet site exists within the sample of Fairchild Big Creeks sites. This, the Haley's Pond site, is strongly associated with agricultural soils, with over sixty percent being sandy loam soils within 100 – 500 m of the site. This carries on to the 500 – 1000 m catchment, but with a larger proportion of silt loam soil. Between 1000 – 5000 m from the sites, the distribution of variables is consistent between site size categories.

Curvature. The curvature results for all of the individual sites within each cluster are presented in Table 15, Appendix A. As a whole, the sample of sites from both clusters combined show positive curvature values in the 100 m catchment in contrast with negative values in the 200 m catchment. When the values are subtracted in order to show the difference between these two catchment zones, and compared to the same calculated values for catchments of random point locations, sites show values which are statistically different from random locations at the .05 level of significance.

In Fairchild-Big Creeks cluster sites follow this pattern. While no grouping of site sizes shows results that achieve statistical significance, on average both towns and villages are located in locations with positive curvature values at one hundred meters and negative values at two hundred meters (Table 5).

Towns are a divided sample. Both the Daniels and Walker sites follow the pattern while Smith-Haley and Sealey do not. The values in catchments for village sites are slightly more consistent.

Proximity to Streams. There is a distinct pattern of sites being located within proximity to larger streams while the majority of random point locations have only very small streams, if any located within close proximity. The largest correlation between sites and larger streams streams within less than 100 m. Beyond 200 m, the differences between large sites and random points become less obvious.

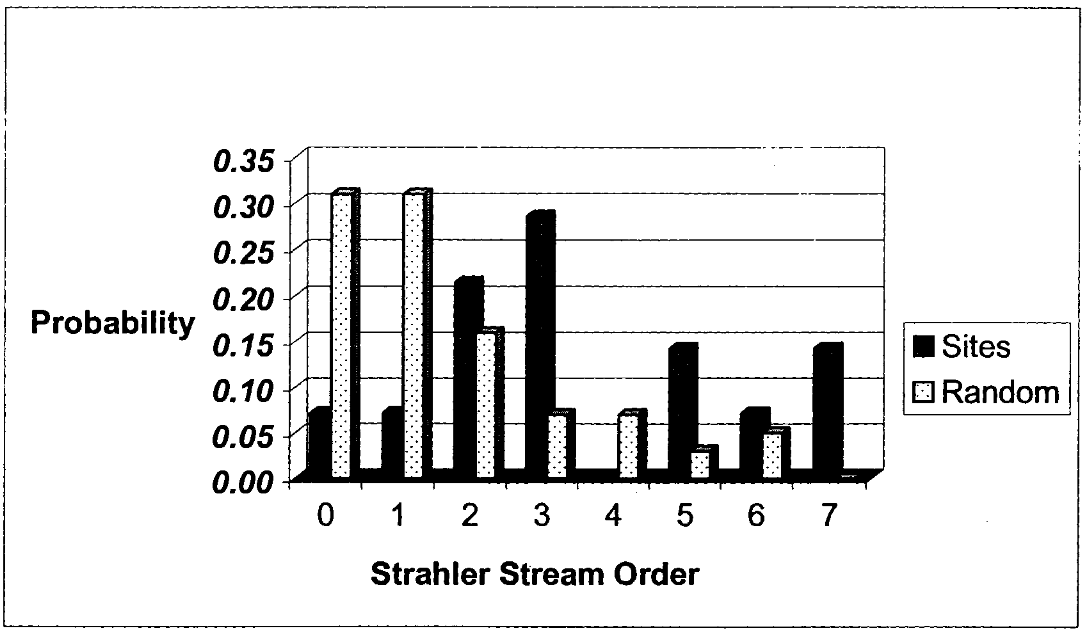
In the Fairchild Big Creeks cluster, just over 80% of random point locations are near streams but half of these are only first order streams. In contrast, the majority of sites in this cluster are associated with streams second order or higher (Figure 8).

It is noted that all three GBP3 period sites in the Fairchild-Big Creeks sample were all at the extreme high end of this spectrum. The Walker site is located within distance of a sixth order segment near the junction with another fifth order stream. The Cooper and Sealey sites were both within proximity of

Table 5: Fairchild-Big Creeks Site Surface Curvature

Fairchild-Big Creeks Sample	Average Curvature by distance				
	100 m	200 m	Difference	500 m	Difference
All Sites (13)......	0.0226	-0.0037	0.0263	-0.0016	-0.0022
Towns (4)..........	0.0167	-0.0086	0.0253	-0.0045	-0.0041
Villages (8)........	0.0277	-0.0016	0.0293	-0.0004	-0.0012
Hamlet (1).........	0.0050	-0.0015	0.0066	0.0009	-0.0024
Random (58)......	0.0056	0.0050	0.0006	0.0000	0.0051

Figure 8: Fairchild-Big Creeks Sites – Presence of Water by Strahler Stream Order within 200 m



seventh order streams – the largest stream order that can found within the cluster boundary.

Spencer-Bronte Cluster Results

Wetlands. In contrast to Fairchild-Big Creeks, an entirely different situation regarding wetlands exists in the Spencer-Bronte cluster. There are no areas of agricultural tile drainage identified by the Ontario Ministry of Agriculture, Food and Rural Affairs. However, there are many areas of large contiguous wetlands and swamps in this watershed surrounding this site cluster (Figure 9).

With the exception of the Hood site, all sites in this cluster have from 15-41% of the area within the one kilometer catchment identified as wetland, with the Kralt, Freelton, and Mills sites at the upper end of this spectrum. While all sites are located in proximity to wetlands, this is not surprising considering the large area of wetlands found in the watershed as a whole. When probabilities are graphed in Figure 10, there is a tendency of sites have a higher probability of having more than 10% wetlands in the one kilometer catchment. However, due to the small sample size, statistically significant differences in the background distribution can only be identified for villages within the 500-1000 m portion of the catchment (see Table 26, Appendix B). Overall, there is a tendency for village sites in this cluster to be located within 1000 m of large wetland areas, and these sites have a considerably higher percentage of wetlands in their catchments than can be expected from the background distribution within the watershed.

Figure 9: Wetlands in and Surrounding the Spencer-Bronte Site Cluster

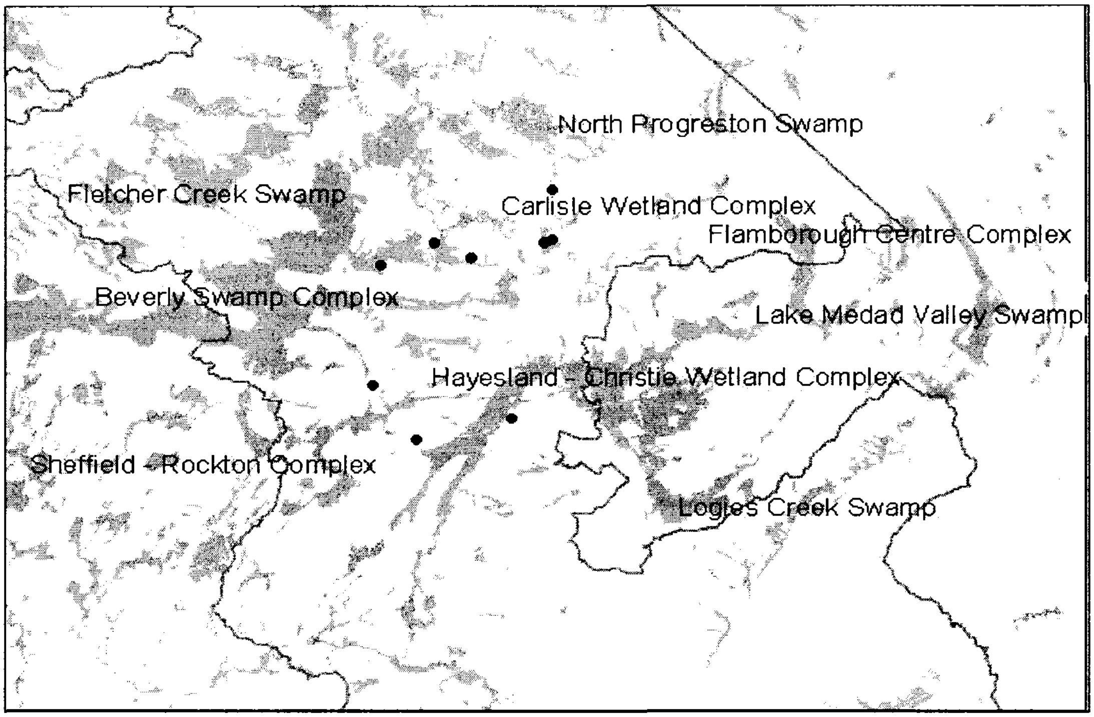
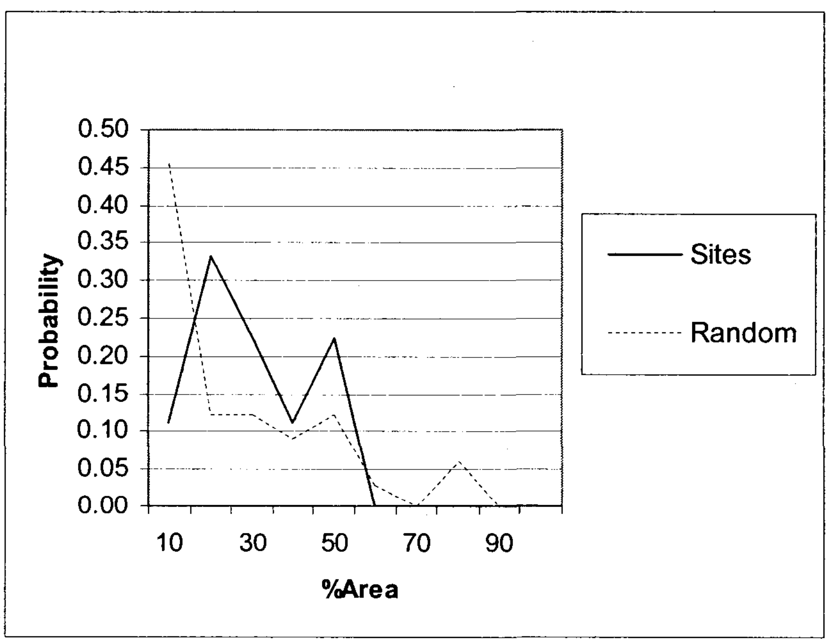


Figure 10: Area of Wetlands for 100-1000 m Catchments within the Spencer-Bronte Site Cluster



The association with wetlands increases for all sites when the five-kilometer catchment is examined. Within five kilometers, no site has less than 20% wetlands while random catchments often have 20% or less. The Kolmogorov Smirnov test statistic of .485 exceeds the critical value of .432 at the .05 level of significance with 9 degrees of freedom; therefore a statistically significant difference exists between the probability of wetlands in the random and site catchments in this cluster.

Spencer-Bronte Soils. When graphed, there appears to be an association with Spencer-Bronte sites and larger areas of soils suitable for agriculture within the 1000 m catchment, but not within 5000 m where areas all fall from 13-25% in contrast with random sites, which have a wider distribution of values. With a Kolmogorov Smirnov test statistic of .485, soil productivity calculations based on the Canada Land Inventory capability score indicate a statistically significant association between Spencer-Bronte sites and higher agricultural productivity scores within the 1000 m catchment.

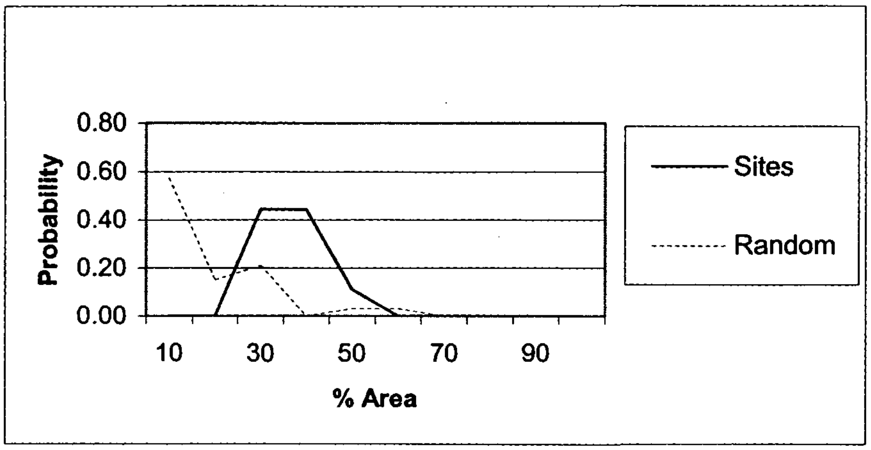
Loam soils are rare within the Fairchild-Big Creeks cluster and are virtually non-existent within the catchments of sites. The opposite is true within the Spencer-Bronte cluster. Approximately 13% of random 5000 m catchments are suitable well-drained loams in Spencer-Bronte. In contrast, 21% of the area within 5000 m of actual sites within this cluster, is classed as well-drained loam (Table 4). With Kolmogorov Smirnov test statistics of .727 for the 1000 m catchment and .455 for the 5000 m catchment, there is a statistically significant difference between the distribution of loam soils within site catchments and the random sample. The large differences between sites and the random sample at the 100-1000 m catchment can be seen in Figure 11. This pattern of association with loam increases closer to the sites. Suitable loam soil accounts for 30% of soil within the 1000 m catchment surrounding sites. When the Canada Land Inventory soil productivity scores are taken into consideration, loam soils account for an average of 88% of the total soil productivity of the 1000 m catchment. Aside from the availability of loam soils, the Spencer Bronte cluster differs from the Fairchild-Big creeks cluster in that settlements of different sizes do not appear to have large differences in the quantity of productive agricultural soils found in their catchments.

As can be seen in Table 5, the highest concentration in the1000 m catchment appears to be the large Hood site with over 43% loam by area. The two other large sites, Hamilton and Christianson, also are at the high end of the spectrum with over 38% and 37% loam, respectively. Dividing the 1000 m catchment further, it can be seen that the association with loam soils primarily occurs in the 500 m catchment (Tables 23 and 24, Appendix A).

As Spencer-Bronte sites appear to be associated with loam soils, these sites appear to be located in an area disproportionately free of sandy soils in comparison to the rest of the watershed. With respect to random catchments, 14% is classed as sandy-loam.

Within 5000 m of Spencer-Bronte sites only 6% is sandy-loam and this number decreases to 6% within the 1000 m catchment. The lack of sandy soils appears for both catchments when compared with random catchments, but only the 5000 m catchment displays a statistically significant difference, with the Kolmogorov

Figure 11: Spencer-Bronte 17th Century Loam Soil Area: 100-1,000 m Catchment

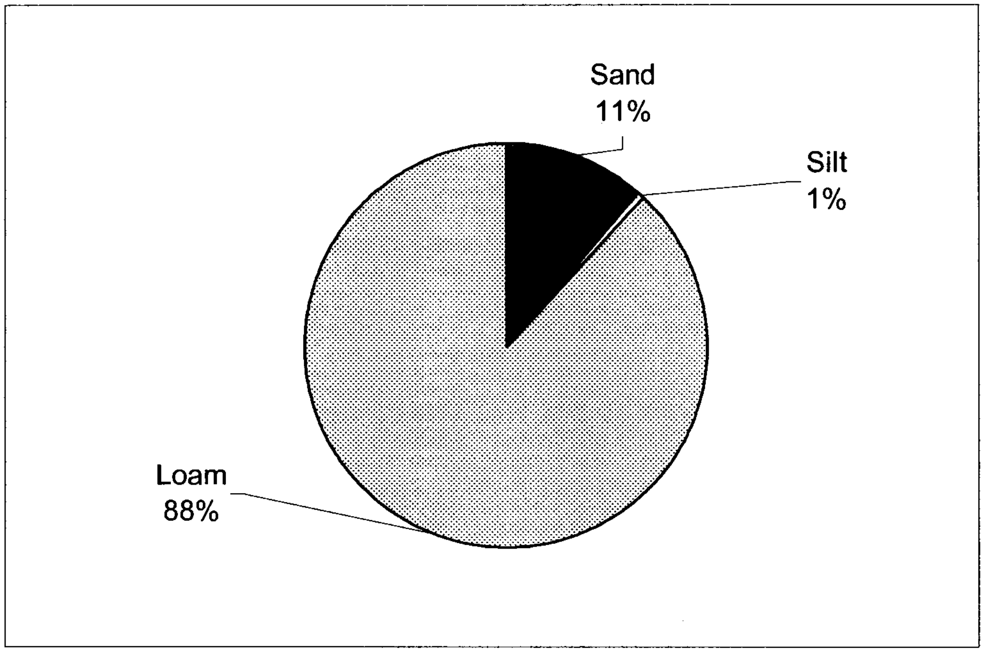


Smirnov test statistic of .606. Sandy soils appear to have slightly higher CLI scores in comparison to their area (Figure 12).

It can be observed that in the 100-1000 m catchment, there are differences in the composition of suitable agricultural soils between the catchments of the Fairchild Big Creeks sites, and those of the Spencer-Bronte Creeks sites. However, it can be seen in Figure 7 and Figure 13, that the ratios of suitable soils, wetlands, and other land use are somewhat similar for towns in both clusters. In contrast, neither villages nor hamlets displayed a similar sort of pattern. It is also interesting to note that when the Walker site is separated from this sample (Figure 6) it appears to have higher proportions of suitable soils.

Curvature. Table 6 shows that, as in Fairchild-Big creeks, the Spencer-Bronte creeks most sites are at locations with positive curvature in the 100 m catchment as compared to the 200 m catchment. Again, village locations have a tendency to show higher average positive curvature values than town locations. For town locations, the difference between values in the 100 m and 200 m catchments is

Figure 12: Spencer-Bronte 17th Century Sites Soil CLI Scores 100-1000 m



statistically significant at the .05 level of significance. The two hamlets locations also have positive curvature values in comparison to the surroundings. However the difference is very slight.

Proximity to Water. Spencer Bronte sites show a strong association with larger order streams (Figure 15). The Spencer Bronte cluster has fewer and smaller streams with the majority of random points having no streams within 200 m. However all but two sites in this cluster are located near streams third order or higher (Table 12, Appendix A). When both clusters are viewed as a whole it appears that Glass Bead Period 3 sites are associated with higher order streams than earlier sites.

Figure 13: Spencer-Bronte Potential Land Use

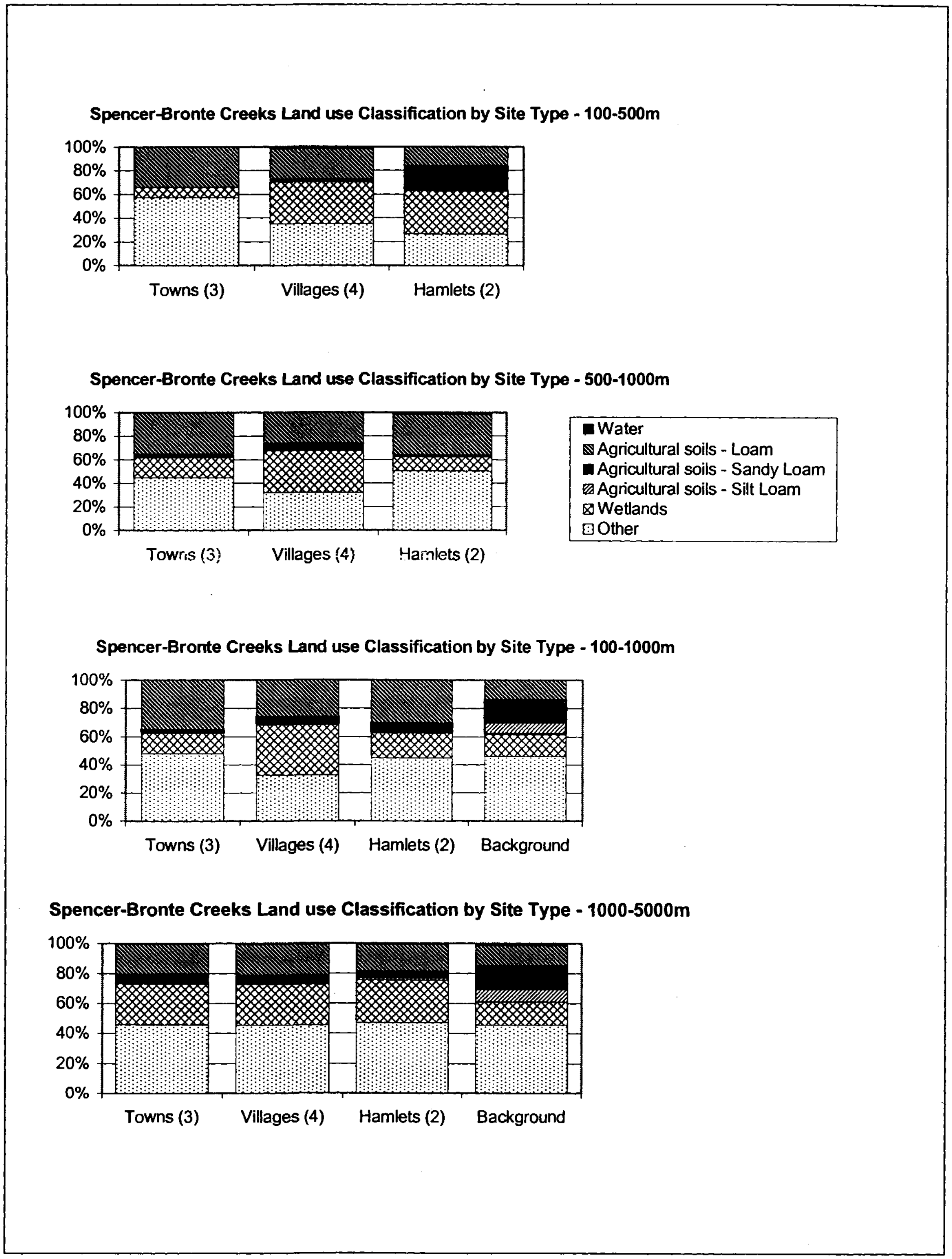


Figure 14: Comparison of Potential Land Use Classifications for Town Sites

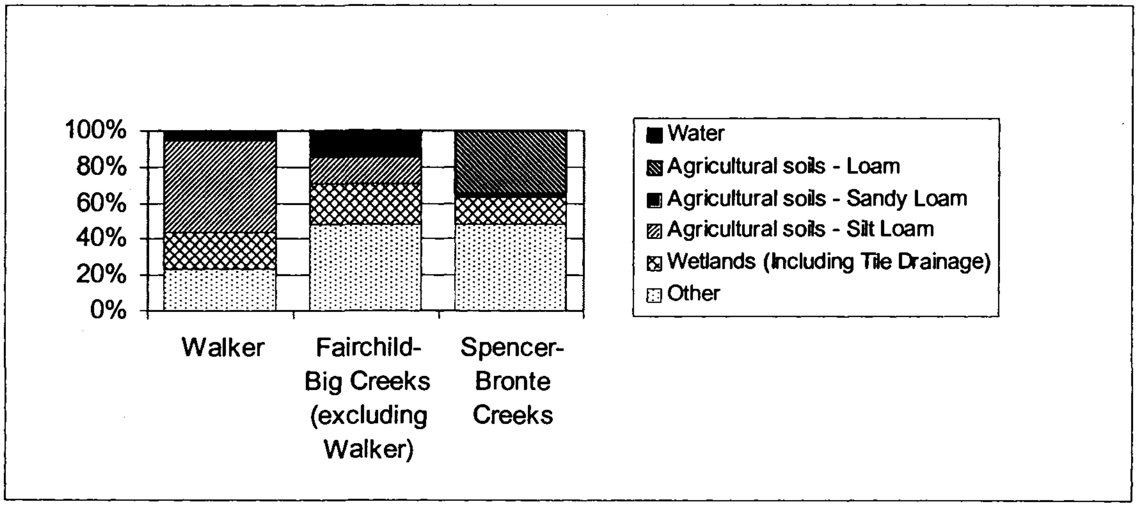
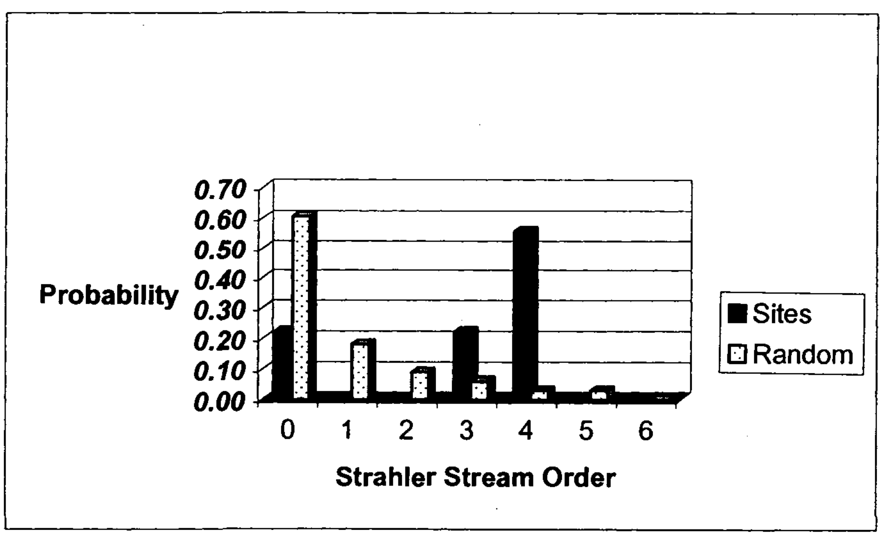


Table 6: Spencer-Bronte Sites Surface Curvature

Spencer-Bronte Sample	Average Curvature by distance				
	100m	200m	Difference	500m	Difference
All Sites (9)	0.0313	-0.0186	0.0499	0.0021	-0.0207
Towns (3)	0.0243	-0.0127	0.0370	0.0021	-0.0148
Villages (4)	0.0438	-0.0259	0.0697	0.0010	-0.0269
Hamlet (2)	0.0167	-0.0129	0.0296	0.0040	-0.0170
Random (32)	0.0020	0.0047	-0.0028	-0.0014	0.0061

Figure 15: Spencer-Bronte Sites – Presence of Water by Strahler Stream Order within 200m



Hunting Potential by Ontario Land Inventory Deer Capability Score

As a whole the Fairchild-Big Creeks cluster contains much higher deer capability scores than the Spencer-Bronte cluster, however, neither the Fairchild-Big Creeks cluster nor the Spencer-Bronte cluster show major differences between Ontario Land Inventory deer capability scores for site catchments and random points in either the 1000 or 5000 meter catchments. Values are consistently high throughout each watershed, confirming Kenyon's (1972:8) observations about this data. His comment that this dataset is only a very coarse measure also appears to be true, and for this reason, I believe that dataset does not warrant further investigation. In order to avoid the problem of constancy with the OLI dataset, an attempt was also made to determine potential for historic vegetation edges using the physiographic data. This initially appeared promising, when physiographic polygon boundaries appeared to match vegetation patterns visible in aerial photography. However this approach was also abandoned as it became apparent that the physiographic regions themselves were probably derived from air photo interpretation. A suitable method for measuring historic wildlife capability does not yet appear to be available.

Regional Site Distribution Patterns

Site proximity to Mean Centre of Cluster. The mean centre of sites was calculated for both site clusters by averaging the X and Y coordinates. A distance from this point was then calculated for each site. When the Spearman's

Rank Correlation test was applied there was no statistical association observed between site size and location within the Fairchild-Big Creeks cluster. However, by simply examining the values it was observed that the Walker site is the village that is closest to the centre point (Table 28, Appendix B). Smith-Haley, the largest among the GBP2 period sites is also very close to the centre.

The Spencer-Bronte cluster also did not display any significant relationship between site size and location within the cluster (Table 29, Appendix B). Hamilton, the largest of the two GBP2 sites, was the closest of all sites within the cluster to the centre. However, the largest GBP3 site, Robertson, was actually furthest from the centre and is the closest site to the boundary with the Fairchild-Big Creeks drainage.

Suitable Agricultural Soils Found Within Overlaps with Catchments of Older Sites. Both the 1000 m and 5000 m catchments of seventeenth century Neutral sites were examined for overlaps with the corresponding distance catchments of sixteenth century Neutral sites and Prehistoric Neutral sites. Only two of the Fairchild-Big Creeks sites are within 1000 m of either sixteenth century or prehistoric Neutral sites, and even those sites have minimal overlap. Overlaps with the 5000 m catchments produced more results. Close to half of the productive soils are found in the overlap area with sixteenth century sites, and while there is a tendency for overlaps with sixteenth century sites to contain more productive soils, this association is not as significant as that found in overlaps with prehistoric Neutral sites. The Kolmogorov Smirnov test statistic of .591 for overlaps with prehistoric Neutral sites exceeds the critical value of .361 for 13 degrees of freedom at the .05 level of significance; therefore a significant difference exists between the catchments of sites and random points for this variable.

The sample of Spencer-Bronte sites have no sixteenth century or prehistoric Neutral sites identified in the area of the seventeenth century cluster. The 5000 m catchment does contain overlaps for some sites; however, these contain significantly less suitable soils than random sample.

Chapter Summary

Significant differences exist between the landscape of the Fairchild-Big Creeks cluster and that of the Spencer Bronte Creeks cluster, as well as in the locations of sites and the contents of their catchment areas.

In Fairchild-Big Creeks, there are noticeable differences between sites based on both size and time period. Village sites are located in proximity to significantly larger areas of suitable agricultural soils composed of silt loams and sandy loams in comparison to town sites, as well as compared to the background distribution of these soil types. While there is proportionately more silt loam soil in the area, the interface between silt and sandy loam soils appears to be a feature with which sites are associated.

The Walker site is located lower in the watershed on a large stream and in an area that is predominantly silt loam, in proximity to a band of sandy loam soils. Walker deviates from other town sites in the potential land-use variable ratios, in that it has more agricultural soils than the other towns, but also more wetlands than the villages.

Haley's Pond, the only hamlet in the Fairchild Big Creeks sample, is located in an area with exceptionally high percentage of suitable soils, which is exclusively sandy-loam within 500 m and then mixes with silt loams beyond 500 m.

Modern wetlands are uncommon in the area. However, sites have a larger than average proportion of low-lying areas that have been subjected to recent agricultural drainage activities.

It was observed that for the 100-1000 m catchment, the average percentages of land use categories is similar for town-sized sites in both the Fairchild-Big Creeks and Spencer Bronte clusters, despite the fact that they are located in very different environments. Individually, the Walker site appears to follow a similar pattern.

The catchments of Spencer-Bronte sites are differentiated from those of the Fairchild-Big creeks sites in that suitable agricultural soils are almost entirely composed of loam, which is virtually absent in watershed of the former cluster. Village and hamlet sites in the Spencer-Bronte Clusteroverall have smaller areas of agricultural soils than those in the Fairchild-Big Creeks Cluster, and are located in more diverse environments. As a whole, the Spencer-Bronte cluster is centred on drumlin features and is encircled by a number of large wetland complexes.

Streams and rivers in the two clusters drain in different directions. The Fairchild-Big Creeks watershed drains into the Grand River and onwards to Lake Erie. Spencer-Bronte drains into Lake Ontario. Virtually all sites in the sample are associated with higher order streams than expected from a random distribution. Bronte sites have a closer association to larger streams; however, this may be a function of age. In both clusters, GBP3 sites appear to be associated with larger streams than the earlier GBP2 sites. Fairchild Big Creeks are predominantly GBP2 with only three sites identified as being GBP3, while the Spencer-Bronte sample is mostly populated with later GBP3 sites.

Fairchild-Big Creeks cluster sites tend to overlap the potential catchments of Pre-Fur Trade and even older Prehistoric Neutral sites at the five kilometer distance, while in the Spencer-Bronte Cluster, virtually no territory is shared with sites dated prior to GBP1.

Chapter 6: Discussion

While it is not possible to identify the definite boundaries of subsistence activities on the map with this data, it should also be considered that the locations and size of areas used for particular purposes would have changed over time as soil nutrients or firewood supplies were depleted.

It is important to remember that mutually-exclusive categories of agricultural land, wetlands, water and other are only used to represent in theory the most likely potential uses of the land to support local site substances activities based on the available mapped resource information.

The small site sample also contributes to the haze, which makes it very difficult to discern patterns. As was experienced by Zarkey (1976), the small site sample made it impossible to apply Chi-Square. Using the Kolmogorov-Smirnov test, statistically significant results compared to background distribution are achieved for some individual environmental variables which indicate a very strong likelihood that the association between sites and these variables are not random, but are related in some way to site location, and it is necessary that these relationships be explained. On the other hand, the lack of statistically significant relationships between sites and some features are deserving of further investigation because of the importance of these variables established through archaeological evidence and historical accounts, as described in Chapter 2.

Wetlands

It is documented that the Neutral relied heavily on hunting and on deer in particular. One of the landscape features that have been interpreted as being significant for Neutral deer hunting areas is the presence of wetlands. Wetlands and low-lying areas would also have been habitat for fur-bearing animals, which were a valuable trading commodity. As explained in Chapter 2, wetlands are also important sources for cedar wood as well as other plant and animal resources.

In spite of the lack of modern sources of wetland data, the drained areas inferred as potential locations of wetlands in the past do show a slightly higher than background association with sites in the Fairchild-Big Creeks cluster. Spencer-Bronte villages also exhibit the association with wetlands, but to a higher degree. The fact that wetlands are more likely to occur from 500 to 1,000 m from the site appears self-evident, in that while it may have been desirable to have the resources of a wetland close at hand, actually locating the settlement itself within a damp and mosquito infested swamp is not desirable.

Another advantage of wetland areas located at this distance may have been a natural obstruction to travel they provide, which, although generally not impassable, they may have contributed to defence or at least contributed to the definition of the defended territory. This defensive or territorial aspect may be particularly important in the case of the Spencer-Bronte cluster, which is virtually encircled by wetlands (see Figure 13).

Agricultural Soils

It is known that while the Neutral utilized animal resources more intensively that other Iroquoian groups, crops remained an important staple in the diet. It is also likely that deer and other wildlife would also be drawn to the edges of fields, making agriculture and hunting complementary activities. Site location was likely more influenced by the agricultural activity and firewood collection because of the reliability of the resource, the amount of work required in relation to yield, and to the division of labour in Iroquoian society. Firewood collection and agricultural tasks such as cultivation, seeding, weeding, pest control, and harvesting are time consuming and labour intensive activities on the land, which were primarily performed by women (Noble 1968:49; Heidenriech 1971:214-215). Deer on the other hand, could be harvested at the edges of fields where they were drawn to feed, or hunted at certain times of the year by parties of men, travelling away from the site to productive hunting areas as far as or beyond the distance that has been defined as the "extended catchment area". Other important resources could have existed in sufficient quantities in the surrounding areas as well as in the extended catchment at specific times in the year, which, in general is too large an area to identify specific resource locations and their relationship to a site.

The results for the Fairchild-Big Creeks cluster show that the largest areas of soils deemed suitable for agricultural use are the silt loams. This would appear to confirm the observations made by Stevens (1974). Stevens did not list the sites that were used in his analysis, so it is not known if similarity of these results can be explained by the possibility that some of the same sites may have been used in both analyses. Stevens based his analysis on soil samples taken at the site locations themselves. In my analysis, it was observed that while the sites in the Fairchild Big Creeks cluster were located on silt loam, confirming Stevens' observations, I also noted that large portions of the catchments' suitable soils were composed of sand loams, and that sites appeared to be situated in a belt-like pattern just past the southern edge of the sand plain at the interface between the sandy and silty loams. For the Spencer-Bronte cluster, Stevens' conclusion that a preference existed for silt loam soils does not apply. While there are some silt loams in this watershed, the sites in this cluster are not located in areas containing silt loams in any significant quantities, and all of the suitable areas for agriculture are loam.

While differences between in the two clusters would indicate that a specific category of soils as represented on the soil maps should not be considered a determinant of Neutral site location, the statistically significant association of sites with well-drained sandy loam, loam, or silt loam soils indicates that agricultural considerations were an important factor in site location decision-making process of the Neutral. The different properties of those soils in relation to native agricultural practices may have had some impact on the economy of those settlements in terms of the amount of land that need to be cleared, the amount of labour required to grow crops, the potential for harvest surpluses or shortfalls, and the lifespan of the settlement.

The suitable soils for this study were narrowed down to those areas classed as well drained, but aside from this factor, other practical differences exist between these soil types. The archaeological record shows that there were different varieties of maize being cultivated by the Ontario Iroquois and that these varieties may have been optimally suited to different growing conditions as discussed in Chapter 2.

There are other practical considerations regardless of the crop type. Sandy soils are the easiest to work using native digging stick technology. However, as indicated by Heidenriech (1971:181-183), they are depleted of nutrients faster, which can only be temporarily boosted by burning of vegetation. Sandy loam soil crops would have initially required less effort to cultivate and plant, but soon would have been depleted and required clearing of new areas. The silt loam soils hold more moisture and nutrients. However, the fine particle size could also have made it more difficult to work and required more effort using digging sticks for building the corn mounds. The granule size for loam is in the middle of these two extremes, and is considered to be the ideal soil for corn. Therefore soil texture may also provide an explanation for the location of Fairchild-Big Creeks sites in relation to the horizon between the sand and clay plain. It is possible that the transition between or the mixture of soils in these areas provided locations where similar optimal conditions for native agriculture, as the loam soils could have provided in Spencer Bronte.

Another explanation for the apparent incidence of sites in Fairchild-Big Creeks with the interface between sandy and silty soils is the idea suggested by Flannery (1976:94) in a Mesoamerican example: that crops grown in more than one different location type and/or of multiple varieties may have helped ensure continuity of the food supply, in spite of unexpected weather conditions.

Other Land Use

The areas defined as "Other Land Use" are those areas that do not fall into the categories of water, wetlands, or suitable agricultural areas. Following Jamieson (1986), it is assumed that these would have remained wooded areas and were primarily used for firewood collection and also for specific forest resources such as mast crops. Similar practical explanations as were offered for agricultural activities could be applied to these resources. Iroquoian division of labour as well as the volume and relatively low value of firewood as a commodity that was continuously needed for heat, the firing of pottery and for cooking would dictate that adequate supplies of this needed to be located close at hand to the settlement for it to be worth the effort expended for its collection.

Water

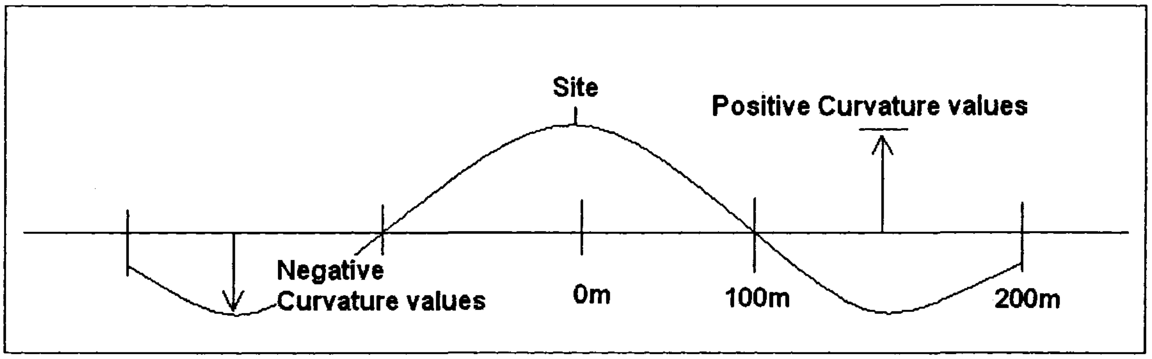
While it is known that aquatic resources were an important part of the Neutral diet, the area-based analysis of landscape features is not suited to demonstrating this. Water on the landscape in this part of the province is mostly rivers, streams, and ponds. Some small lakes exist, but as a whole lakes are not a major feature of the landscape. When water is examined at distances beyond 200 m from the site, it is such a small part of the landscape and of the site catchments that it cannot be considered an important variable based on this method of analysis. To some extent this is the product of a disconnect between the design of the spatial source data and the way it is being used. The source data represents most streams as lines without an area value. This originates from the original purpose of the spatial data, which was to produce a cartographic representation of the landscape suitable for printing paper topographic maps, as opposed to creating an inventory that can be used for GIS analysis. The result is that while fish may have provided a major source of protein during many months of the year, the importance of streams where the fish are caught cannot be seen in an area-based calculation of catchments, because cartographically, they have no area.

Closer to the site itself, proximity to water has a much more detectable influence on site location, and as described in Chapter 5, sites in both clusters are associated with larger streams than can be expected from the background distribution represented by the randomly generated points. It would appear that the later sites in both clusters are associated with larger water bodies, similar to the pattern described for the Huron and the Iroquois during this same time period.

Curvature

Most sites, including Walker, Hamilton, Hood, and Christianson display positive average curvature values within the one hundred meter catchment, and negative curvature values within the two hundred meter catchment. As described in Chapter 4, positive curvature values indicate a convex shape, while negative values indicate concave shape. Figure 16 shows a profile diagram of how these results may be interpreted.

Figure 16: Curvature Diagram



From the consistent difference in curvature values between the 100 and 200 m catchments it can be inferred that Neutral sites have a tendency to be located on elevated ground. The difference of scores between sites by cluster most likely reflects the different physiography of the two cluster areas as a whole. It is not surprising that curvature values are higher for Spencer-Bronte sites, which are in an area of drumlins, as opposed to those of the Fairchild-Big Creeks cluster, which is characterized by more gentle topography.

Stevens (1974) made the observation that larger sites are located near steeper slopes for defensive reasons. His observations were based on site visits. The fact that my sample of village sites demonstrate higher overall differences in curvature values between the 100 m and 200 m catchments, while having lower positive curvature values in the 100 m catchments when compared to town sites, may be a reflection of the difference in the steepness of slopes upon which they are located. The sites such as Smith-Haley, which appear from this data to be located in valleys, are interesting exceptions. Some of these sites are located on the periphery of the cluster, while others are not. There is no detectable pattern differentiating these sites from the others, with the exception of the fact that three of the four sites are dated to the GBP2, and Glass Bead Period of the fourth is unknown. As a group, it appears that GBP2 sites tend to have lower curvature values than GBP3 sites. In the Fairchild-Big Creeks cluster, the GBP3 sites also tend to be located near larger waterways, therefore increased curvature relative to the surroundings at these locations is likely a product of proximity to river banks, which have previously been described as defensive features. Hamlets also have a tendency to be located in areas with less elevation. These sites may have been too small or temporary for independent defence to be a viable consideration, and may have depended upon the proximity of larger population centres for protection.

Catchment Distances

Sites within the study area have a tendency to be spaced from one and a half to three kilometers apart. This would support the use of the standard one kilometer distance as an approximation of the territory for that site. However, it may have been useful to produce one and one half kilometer catchments. Subdividing the 100-1000 m catchment into two parts (five hundred and one thousand) was worthwhile in that it did result in some noteable observations, particularly for wetlands and for the hamlets. The fact that more significant differences between random locations and sites occur in these closer catchment circles, indicates that catchment delineation could use more focused work on developing further refinements to limit the size by taking terrain barriers such as streams into account, and/or adjusting the size of the catchment to match the settlement size. Looking at these subdivided results for the sites of different size categories, the consistency of results for towns, and the different results for villages, and even more so for the hamlets, could reflect that the size of the site is determined by the amount of the landscape which can be intensively used according to the needs of such a site. However, a more systematic approach than that used here would be required to determine if this is in fact true, and what if any actual size limits apply to sites of a given size. The high level of variability between individual site catchments and the small sample size would make any such determination difficult to prove. For instance, individually, the catchment of the Walker site has much larger proportions of agricultural soil and wetlands in comparison to other towns within the same cluster.

In both Fairchild-Big Creeks, and in the Spencer-Bronte site cluster, the five kilometer catchments were remarkably similar for all site categories within each respective cluster. This is a product of the fact that many of these values are overlapping areas duplicated in the results and added together. Therefore, the results for the five kilometer catchments could be described as a representation of the most common ratio of landscape values representative of the core area of the cluster. It may be useful for the comparison of one cluster against another, but is not useful for comparing differences between sites within the cluster.

Site Catchment Overlaps and Site Spacing

Much effort was expended in this project to design a data model that would allow the overlaps of site catchments to be identified and calculated separately, and to tabulate this data. Initial results appeared quite promising, showing overlaps of sites at the five-kilometer distance to have statistically significant associations with agricultural soils. This result was soon dismissed as spurious due the consideration explained above, that five kilometers is probably too large of a catchment to be useful and that site overlaps at this extended distance only tell us about the availability of resources within the cluster as a whole, and probably do not tell anything about the site itself. When it was assumed that the one kilometer catchment was the most intensively utilized area for a specific site, overlaps between seventeenth century sites and earlier sites are small and uncommon in the Fairchild Big Creeks cluster, and virtually non-existent in Spencer-Bronte. While it has been observed in other areas that Iroquoian sites exist in chain link patterns and it has been hypothesized that these overlaps represent re-use of regenerating fields. This may be true of the Fairchild-Big Creeks cluster, but not of the Spencer-Bronte cluster.

Within the Fairchild-Big Creeks watershed, prehistoric Neutral sites are found both along the north and to the south of the cluster of GBP2 sites. The distances and small areas of overlap with older sites in this cluster make it unlikely that these old fields were being re-used for agricultural purposes. However, they would have remained within walking distance.

It is a possibility that regenerating areas of former sites further afield were popular locations for harvesting deer, which were drawn to the larger quantities of browse that may have been available; but again, the problem of associating distant features with sites as opposed the landscape as a whole becomes an issue. In the future, a more detailed examination of specific site catchment overlaps within this data may reveal that they contain unique features, or the presence of special purpose sites such as camps or cabins.

Hamlets

The results for hamlet sites vary greatly. This could support the hypothesis that these sites are seasonal or are special purpose sites which function to help provide for larger sites, based on the idea that they were situated to make use of different resources. The extremely high ratio of suitable agricultural soils with sandy loam soils, in particular within the 500 m catchment, and absence of wetlands surrounding the Haley's Pond site, would indicate that this particular site would have been an ideal location as seasonal satellite camp for the tending of crops. The fact that the Bogle sites have comparatively less of their catchment classified as agricultural may simply be a reflection of the cluster as a whole. The Bogle sites also have agriculturally suitable sandy loams within 500 m, which is unusual compared to the other sites. The largest proportion of wetlands are also within this 500m zone. The observation by Lennox (1984b:227-234) of poorer quality soil at Bogle II, combined with unusually large quantities of lithics, could indicate that hunting was a more important activity at this site. Hamlets being in such a small subset of the sample, large variations can be expected, and even in the strongest of associations, landscape features alone would not have achieved statistical significance. Therefore, conclusions about the meaning of this data must be viewed with scepticism.

Villages

One of the most important observations within this data is the significant association that between village-sized sites and large areas suitable agricultural soil in the Fairchild-Big Creeks cluster, whereas towns were not particularly oriented towards these features. The statistically significant association of Spencer Bronte villages with loam soils in the 500 m catchment, and wetlands in the 500-1,000 m catchment, may reflect a similar pattern. Based on these observations, it is reasonable to conclude that the location of village sites in particular could have been more heavily influenced by an orientation toward local crop cultivation and hunting/trapping activities.

Towns

As noted in Chapter 5, similarities exist between the average distribution of potential landuse values within the one kilometer catchment for towns in the Fairchild-Big Creeks cluster are similar to those of the Spencer-Bronte cluster. Lennox's (1984) observed that a capital-satellite relationship existed in the Spencer-Bronte cluster between the Hood and Hamilton towns and the Bogle hamlets based upon anaysis of archaeological evidence recovered from these sites. While the catchment analysis in that cluster does provide strong supporting evidence, the results in the Fairchild Big Creeks sample tend to indicate that villages are more agriculturally oriented than the contemporary towns, and could support the idea that the larger sites were being supplied with food from the neighbouring villages and/or from sites such as the Haley's Pond hamlet. Individually, the Walker site does not fallow this pattern. The Walker site is at an ideal location within the cluster. Its catchment contains large areas of both agricultural soils and wetlands with potential to support a large population. Its location at the mean centre of the cluster and low in the watershed near the junction with highest order stream, also provides support for idea that this site was the capital of the cluster.

It was customary in Iroquoian culture that those who discovered and controlled a trade route benefited from the trade along that route and would also be able extract "tolls" from any other parties permitted to use it. The large stream that the Walker site is located on flows directly into the Grand River and into Lake Erie. This, along with its central location, could have allowed it to become established as a central hub for trade and communication within the cluster. In this role, population would have been drawn to this central site to benefit from trade into the watershed. It is documented that overland trails were extensively used throughout the Neutral territory, but this information was not available for use here. The distribution of sites throughout the watershed on many different tributaries may be a reflection of overland trails used for movement between sites, while long distance trade may have taken place by water from the sites on the larger river tributaries.

According to the capital satellite model as applied to Neutral sites (Kenyon 1972:7; Lennox 1984b:266-267), hamlets such as Haley's pond may have had the economic role of contributing to the towns through exchange in the case of year-round settlements or may to be established specifically for the purpose of harvesting resources further afield, in the case of seasonal special purpose sites. While there are documented accounts of food being a commodity of exchange (Noble 1978:159), it is not likely that firewood or building supplies would be transported very far from their point of origin. Therefore these resources would continue to be an important factor in site location.

Temporal change

There are some important differences in the settlement pattern, which appear to coincide with the transition from GBP2 to GBP3. Proximity to water becomes a more important variable for site location in GBP3. The GBP3 sites tend to be lower in the watershed and associated with high order streams. In the Fairchild-Big Creeks site cluster, the Walker site is located on a sixth order stream, and the Sealy and Cooper sites are located on seventh order streams. In contrast, of the many GBP2 sites in this cluster, only the Wood site is located on a stream with an order higher than three. In the Spencer Bronte site cluster, which has smaller streams overall; the Freelton site is the only GBP3 site with a stream order of three, the remainder being at an order of four. These observations run contrary to the statements by Lennox and Fitzgerald (1990:440) that Neutral settlements were not associated with larger watercourses.

In the Fairchild Big Creeks cluster, there are fewer sites in GBP3. Two of these, Sealy and Walker, are large town sites based upon area. The third, Cooper, did not have an area attribute but was described as a village by Warrick (1984). Lennox and Fitzgerald (1990: 413) describe it as a cemetery. This site is exceptional in that it is indicated to be in an area devoid of the suitable agricultural soils. It is also the only multi-component site within the sample. The only other multi-component historic Neutral sites within the study area are special purpose campsites, the locations of which were not available for use. In spite of its classification as a village, the significance of this site is unclear.

The Spencer Bronte cluster has more of a mixture of site sizes, but unlike the other cluster, it only has two known GBP2 sites and six or more GBP3 sites, indicating that while the population in the Fairchild-Big Creeks cluster may have been declining, or centralizing into larger sites, there could have been growth or influx of population into this area.

Recalling Snow and Starna's (1989) caution about using sites frequencies as an indicator of population size, it could be speculated that the reduction of the number of sites in Fairchild-Big Creeks may represent population concentration and the increase in Spencer-Bronte may well have been the result of fracturing of communities within these clusters. However, the fact that almost none of the seventeenth century sites in this cluster have overlapping catchments with prefurtrade or earlier sites, it would seem that there actually was a continuing process of population migration towards the east.

Based on the listing of site dates from Lennox and Fitzgerald (1990:412:414), only the Onondaga Escarpment cluster at the southern tip of the Niagara Peninsula displays a similar concentration of GBP3 sites. These observations open the question of what factors may be contributing to the increase in the number of sites in the Spencer-Bronte cluster during the GBP3 period. There are a number of the historically documented factors affecting the Neutral, which could have been contributing to these settlement pattern changes being observed.

It is known that the Neutral were experiencing famine during the Glass Bead Period 3 due the effects of disease reducing the number of individuals fit for work, and because of the effects of unfavourable weather (Noble 1978:159; Wright 1981:130). Like their Huron neighbours, the Neutral are believed to have grown 8- and 10- row Northern Flint corn (Noble 1978:159), which is presumed to have preferred sandy soils. Sandy soils are known to be rapidly depleted when used for corn crops, and also are vulnerable to loss of nutrients by leaching.

In the Fairchild-Big Creeks site cluster, GBP2 sites tend to be smaller and to occupy an east-west band near large areas of sandy soils suitable for native agriculture. GBP3 sites are larger and lower in the watershed, following the southern extension of the interface between the clay plain and the sand plain near the Grand River (Figures 4 and 8, Chapter 5). The Walker site is located at an ideal location in this area, with unusually large areas of agriculturally suitable silt loam soils, and adjacent to an isolated patch of suitable sandy loam soils. The process of soil depletion of the sandy-loam soils in proximity to GBP2 sites may have been a contributing factor in the aggregation of population at the

Walker site. These same pressures may have resulted in some of the population moving eastwards into the Spencer-Bronte cluster.

Loam soils are considered more productive for growing crops in general, in contrast to the poorer and more rapidly depleted sandy soils found in proximity to GBP2 Fairchild-Big creeks sites. However, It is also possible that a shift in population into a new area with smaller cleared areas of unfamiliar soil types, less suited for the standard crop varieties previously in use and in combination with the other factors described above, may have contributed to some instability of the food supply.

A potential problem with this explanation is that the sites used for this study are simply grouped by general age brackets and not specific dates for individual sites. The process of site abandonment and re-establishment in new areas would have occurred within in a cycle of more than ten years for each site, therefore many of the sites identified as being GBP3 could have already been established prior to when the famines were reported.

The tendency towards aggregation into larger sites, and a reduction in the agricultural orientation of sites during this time period, has also been noted for the Huron, and among the Five Nations Iroquois. These results presented here show that the Neutral followed a similar pattern of change.

Another factor which contributed to the decline in population, and ultimate destruction of the Neutral during this time period, was the intensification of warfare. The landscape of the Spencer-Bronte cluster may have provided some degree of a separate defined territory, and protection for its residents, but this does not preclude the inference by Jamieson (1996:163-164) that site clusters on the periphery of Neutral territory offered protection for the capital. The presence of these settlements may have been protecting the eastern axis of approach into the centre of Neutral territory occupied by the Walker site. Regardless of which, the idea of a defensive orientation for the cluster is supported by the location of this cluster within a drumlin field with steeper topography and in an area that is encircled by swamps.

The Neutral involvement in large-scale warfare during this period has been believed to be the result of the desire to establish or maintain control over trade. The strong association of GBP3 sites in both clusters with larger streams runs contrary to the old assumption originating from Waugh (1902:70) that sites would be located away from navigable waterways in order to avoid attack. While sites may have been located to defend these approaches, it is also possible that the increasing orientation toward these features is a reflection of the known increase of the importance of long-distance trade to the Neutral economy. A tendency among the Neutral towards larger sites and a corresponding expansion of trade in GBP3, has been documented by Jamieson (1981:24). Differences in the location preferences between GBP2 and GBP3 sites may also be inter-related with the expansion of trade.

The Fairchild-Big Creeks cluster would have had more direct access southwards to Lake Erie and the Ohio-Mississippi, and Susquehanna-Chesapeake Bay trade routes while Spencer-Bronte would (geographically) have had had direct access into the western tip of Lake Ontario and the route northward to Georgian Bay. This could also suggest that the two clusters might have been benefiting from trade along different networks. The location of

Spencer-Bronte cluster sites, and the increase in the number of these sites in GBP3, is likely related to the increasing importance of trade with the Odawa, Petun, and Huron, and the influx of larger quantities of European trade goods.

One of these European trade goods, which may have been procured from the Huron, may also have contributed to the apparent deviation of seventeenth century Spencer-Bronte sites from the traditional Iroquoian pattern of placing sites within proximity to older sites in order to benefit from smaller second growth trees found in regenerating fields. Heidenreich (1971:152) indicates that the French trade axe was distributed in great numbers among the Huron, and although made of poor quality iron, would have reduced the work involved in felling trees by half when compared with traditional stone axes.

The increase in the number of Spencer-Bronte sites, and the location of the GBP3 Fairchild Big Creeks sites near the Grand River, may also have been influenced by the trade with the Petun and Odawa, which is marked by the appearance of red catlinite beads, while the Onandoga cluster to the South may have had access to the southern trade route. It would also be useful to perform a similar analysis of the Onondaga Escarpment cluster to determine if these sites are part of the same trends in terms of location criteria in GBP3.

As described by Noble (1978:160), the Neutral benefited from the "middle-man" position between these trade networks. Similarly, the Fairchild-Big Creeks site cluster is positioned such that it may have been able to exercise a "middle-man" position of its own between the other Neutral tribal groups at either end of the trading network. The apparently immense Smith-Halley GBP2 site is located at a place that may have been located near a suitable crossing between the two watersheds in the study area; however with little information available about this site, I am cautious to draw any conclusions about its function. In GBP3, the Walker site is positioned such that it could either have been in the middle of the trade network, or have bypassed the other clusters, having direct access to both to the South and to the Northwest.

The orientation of these sites towards involvement in trade is also is in line with Noble's (1984:15) observation that the Beverly Swamp which may have been a source for the deer and fur-bearing mammals, and provided the hides and even meat to the Neutral, which were traded through these networks in exchange for the marine shell and European goods.

The changing importance of certain activities reflected in the change in site location patterns, namely trade, warfare and hunting to support the fur trade are also interrelated with the social and political changes which are believed to be occurring in Neutral society during this time period. Increased social complexity and centralization of social control within Neutral society are associated with increased trade and positioning to maintain control of the distribution of exotic goods, as argued by Jamieson (1981:26). The increased spatial association of sites with these activities, which are the domain of men according to the division of labour in Iroquoian society also provides a link to the observation by Jackes (1996:136) that older men were ascribed higher status in the GBP3 Grimsby burials.

Chapter 7: Conclusion

This is an analysis of the settlement pattern of a sample of seventeenth century Neutral town, village, and hamlet sites in the Fairchild-Big Creeks and Spencer-Bronte Creeks drainages. This thesis is based upon the premise that a society's economy and social structure can be reflected in the settlement pattern. While the majority of settlement pattern studies on Iroquoian sites have focused on the sites themselves, the settlement pattern also extends beyond the immediate boundaries of the habitation area of sites as a product of subsistence activities, trade and other intra-site relationships. This analysis focuses on these extra-site factors. The analysis utilizes revived and updated methods based upon Site Catchment Analysis in order to examine the relationship between sites and those relevant environmental variables, which can still be spatially identified today.

This analysis is intended to build upon the knowledge base of Neutral settlement patterns established by Kenyon (1972), Stevens (1974), Noble (1984) and others, and where possible, attempts to reconcile observations with some of the larger political and economic factors known to be affecting the Neutral during the seventeenth century.

Some of the variables, which are examined here, such as OLI deer capability, proximity to the cluster center, and catchment overlaps with older sites, prove to be inconclusive. Other variables revealed moderately significant associations that provide insights into the Neutral settlement pattern, albeit at a coarse scale.

Within their individual feature categories, many of the results presented here for the catchment areas 1000 m or closer help to confirm the existing body of knowledge about Neutral settlement patterns, but the results for some variables contradict the assumptions made by some researchers. For example, the demonstrated association between sites and larger streams runs contrary to the statement by Lennox and Fitzgerald (1990:440), but confirms the observations made by Stevens (1974).

Noble (1984:13) identifies three or possibly four levels of settlement sizes, those being towns of two to six hectares in area, villages of .4 to two hectares and hamlets of less than .4 hectares. A possible fourth category is that of a capital. The distribution of values for some of the geographic variables analyzed here appear to support the argument that important differences do exist between sites of these size classes.

In the Fairchild-Big Creeks cluster, villages and the one identified hamlet show a strong association with areas defined by the Ministry of Agriculture Food and Rural affairs as having well-drained silty and sandy loam soils that have no major constraints to agriculture. With the exception of Walker, the Fairchild Big-Creek towns do not follow this pattern and have less suitable soils, but the towns do exhibit a pattern of potential land use values that is more similar to towns of the adjacent cluster. Not only does this observation support the size classifications used by Noble, but in combination with the confirmation of Stevens' (1974) observation that larger sites are associated with larger streams, and it also supports the idea that smaller sites were more agriculturally oriented than larger sites, which were focused on factors such as trade, suggesting specialization and the presence of social hierarchy.

An interesting observation about the site clusters as a whole is that for both the Fairchild-Big Creeks cluster, and the Spencer-Bronte Creeks cluster, the clusters of sites appear to be centered upon particular combinations of landscape features within their respective watersheds. In the Fairchild-Big Creeks watershed, the site cluster is located where large areas of agriculturally suitable sand loam soils meet with large areas of silt loam soils. In the Spencer-Bronte watershed, the sites are clustered in an area of drumlins surrounded by large wetland complexes.

In my opinion, the most important set of observations from this analysis are the differences for the combination of feature associations between GBP2 sites and GBP3 sites. Between these two periods, the number of sites in the Fairchild-Big Creeks cluster appears to decrease, with the later sites being larger and more heavily oriented towards locations with access to larger streams and, with the exception of Walker, proximity to reduced areas of agriculturally suitable soils. The population may have also become more concentrated into the centrally located Walker site, in part due to the decline of suitable agricultural soils in other areas.

During the same time period, there is an increase in the number of sites in the Spencer-Bronte cluster, in an area where there have been no large permanent settlements recorded in the database that are earlier than the fur-trade. The sites of the Spencer-Bronte cluster are similarly less oriented towards large areas of suitable agricultural soils, but are associated with wetlands and larger streams. These results appear to point to a shift in site location between GBP2 and GBP3 and movements of population, which might be attributed to major social or political changes. The site location characteristics could be interpreted to support a few different explanations that relate to factors believed to have been affecting the Neutral and other Iroquoian groups during this time period, including defensive considerations resulting from warfare, internal politics, and an increase in the importance of long-distance trade.

In terms of methodology, the ability of the analysis to find some statistically significant relationships between sites and spatially identifiable features using criteria from a deductive process based on native land use considerations shows that a catchment-based approach remains a useful tool for understanding the relationships between people and the landscape. Aside from the use of updated information, this analysis attempts to differentiate itself from previous works on the subject in that more effort was made to detail the methods, assumptions, and source data in such a way that others can duplicate it. Expansion of this analysis to incorporate the other Neutral site clusters would be the first step to confirm or reject the observations made here. However, the full potential of this method will not be realized without implementing further improvements. Refinements to catchment sizes and catchment shapes are the primary area where methodological improvements may be of benefit.

Many researchers have suggested that overlaps between contemporary or older sites are of importance. While this analysis did not find results to confirm this, the method of segmenting catchments and linking them to multiple sites within a relational database offers a powerful analysis tool to benefit future research, which is specifically centered on the question of site spacing. The Upper Twenty-Mile Creek cluster in particular would be an ideal candidate for that type of analysis, because of its linear orientation.

While it is believed that agricultural societies may utilize resources up to five kilometers from sites, the results of this analysis show that five-kilometer catchments are virtually meaningless. The traditional Site Catchment Analysis method assumes that the most intensively utilized area falls within one kilometer of the site. However, further subdividing this zone shows that even one kilometer circular catchments may include areas that are not relevant to the analysis. Improvements should focus on developing an automated, yet theoretically defensible approach to creating catchments in a GIS which take site size and natural boundaries, such as the nearest large river or water body into account, as well as the proximity of neighboring sites, and which are specifically tailored to Neutral, or at least Iroquoian land use.

With better source data, additional landscape based analysis processes could be performed to build upon and perhaps further clarify some of the results found here. Reconstructed historical land cover (vegetation) data would allow for inter-visibility analysis, and in addition to historical trails data it could be used to create cost surfaces to model overland travel routes. Portages and optimal canoe travel routes between sites can also be modeled. Additionally, further examination of the spiritual and political significance of the historic landscape may shed light on the movement into a previously unsettled portion of the Spencer-Bronte cluster in GBP3.

Another area of improvement in the source data is the quality of the site sample and the categories they are assigned to. The categorization of the sites within the Ministry of Culture database appeared inconsistent and not necessarily based upon a common set of guidelines. The site location and size attributes also left some doubt, as these too appeared to vary in format and completeness. Much of this likely results from the use of old records in the database and variations in the collection requirement over time. Greater standardization of data collection and dissemination, standardization of legacy data, as well as educating some archaeologists that providing this information is more than just a government paperwork requirement, can only serve to improve the usefulness of this spatial database as a research tool.

Whatever improvements are done to the GIS analysis, it still is best used as a coarse filter, which indicates general spatial associations and observations, and which opens the door to further archaeological research in the more traditional sense. More definitive confirmation of, or explanations resulting from the observed changes in site location in relation to agriculture, or location over time could benefit from analysis of historical accounts, fieldwork, and analysis of existing artefact collections by individuals specialized in those areas of expertise.

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Appendix A: Site Results Tables

Table 7: Land Use Potential Variables 100-1000m

Site	Area in Hectares by category					
	Silt Loam	Sand Loam	Loam	Wetlands (all types)	Water	Other
Walker.................	156.55	16.61	0.00	61.25	0.485	74.549
Smith-Haley...........	50.70	42.42	0.00	9.95	0.769	205.599
Daniels.................	46.08	0.00	0.00	190.46	0.632	72.266
Sealey..................	42.57	70.66	5.78	0.00	16.049	174.388
Westbrook............	206.81	8.46	0.00	3.47	0.790	89.910
Bundy-Bodwell.......	239.19	24.53	0.00	1.37	0.463	43.892
Cooper..................	5.57	7.83	0.05	0.00	9.751	286.240
C. Smith...............	135.94	5.32	0.00	66.48	2.191	99.507
Donovan...............	156.49	8.33	0.00	99.43	4.389	40.799
Stratford...............	16.08	198.54	0.00	0.12	0.383	94.321
Wood...................	160.75	95.28	0.00	29.02	0.000	24.390
Misener................	27.37	148.68	0.00	0.00	1.456	131.942
Haley's Pond.........	62.62	132.58	0.00	0.00	1.090	113.150
Hamilton..............	0.00	0.00	118.54	73.07	0.441	117.398
Hood....................	0.00	21.48	134.71	16.52	0.000	136.727
Robertson.............	0.00	0.00	68.63	49.36	1.193	190.249
Freelton...............	0.00	0.00	67.45	118.95	3.390	119.652
Christianson..........	8.11	1.11	114.74	65.49	0.000	119.989
Mills....................	0.00	0.00	70.45	129.17	0.000	109.825
Kralt....................	0.00	56.20	67.36	128.64	0.249	56.989
Bogle 1................	0.00	14.28	93.82	59.95	3.134	138.262
Bogle 2................	0.00	25.35	92.96	50.04	3.134	137.954
Fairchild-Big Creeks Cluster Summary						
sum sites..............	1306.71	759.24	5.83	461.55	38.448	1450.954
sum towns............	295.89	129.69	5.78	261.67	17.935	526.803
sum villages...........	948.19	496.98	0.05	199.88	19.423	811.001
Hamlet.................	62.62	132.58	0.00	0.00	1.090	113.150
Spencer-Bronte Cluster Summary						
sum sites..............	8.11	118.43	828.65	691.19	11.541	1127.046
sum towns............	0.00	21.48	321.88	138.95	1.634	444.374
sum villages..........	8.11	57.32	319.99	442.25	3.640	406.456
sum hamlets..........	0.00	39.63	186.78	109.99	6.267	276.216
All Sites Summary						
sum all sites..........	1314.82	877.67	834.48	1152.74	49.989	2578.001
sum all towns.........	295.89	151.17	327.66	400.62	19.569	971.177
sum all villages......	956.30	554.29	320.04	642.14	23.062	1217.457
sum all hamlets.......	62.62	172.21	186.78	109.99	7.358	389.367

Table 8: Land Use Potential Variables 100-500m

Site	Area in Hectares by category					
	Silt Loam	Sand Loam	Loam	Wetlands (all types)	Water	Other
Walker................	44.51	14.50	0.00	11.35	0.09	4.56
Smith-Haley...........	23.80	16.33	0.00	0.44	0.34	34.12
Daniels................	3.66	0.00	0.00	63.61	0.00	7.75
Sealey.................	10.03	21.22	0.63	0.00	8.01	35.13
Westbrook...........	64.00	0.00	0.00	0.00	0.02	11.00
Bundy-Bodwell.......	58.66	5.58	0.00	0.39	0.42	9.96
Cooper..................	0.00	0.00	0.00	0.00	4.20	70.82
C. Smith..............	33.57	0.00	0.00	4.90	0.18	36.37
Donovan..............	42.32	3.85	0.00	24.60	0.19	4.05
Stratford..............	0.00	66.52	0.00	0.00	0.06	8.44
Wood..................	43.36	28.09	0.00	3.56	0.00	0.00
Misener................	8.51	41.68	0.00	0.00	0.26	24.56
Haley's Pond.........	1.81	41.96	0.00	0.00	0.95	30.30
Hamilton..............	0.00	0.00	22.35	12.42	0.00	40.25
Hood....................	0.00	0.02	38.19	2.09	0.00	34.71
Robertson.............	0.00	0.00	15.90	4.67	0.22	54.22
Freelton...............	0.00	0.00	11.31	40.47	3.19	20.04
Christianson..........	0.00	0.00	38.52	7.35	0.00	29.14
Mills....................	0.00	0.00	17.02	43.31	0.00	14.69
Kralt....................	0.00	6.68	9.26	15.95	2.39	40.74
Bogle 1................	0.00	10.31	7.71	17.58	0.00	39.42
Bogle 2................	0.00	21.75	16.16	37.10	0.00	0.00
Fairchild-Big Creeks Cluster Summary						
sum sites..............	334.22	239.72	0.63	108.87	14.72	277.05
sum towns............	81.99	52.05	0.63	75.40	8.44	81.56
sum villages..........	250.42	145.72	0.00	33.47	5.33	165.19
Hamlet.................	1.81	41.96	0.00	0.00	0.95	30.30
Spencer-Bronte Cluster Summary						
sum sites..............	0.00	38.76	176.43	180.94	5.80	273.21
sum towns............	0.00	0.02	76.44	19.19	0.22	129.18
sum villages..........	0.00	6.68	76.11	107.08	5.58	104.62
sum hamlets..........	0.00	32.07	23.88	54.67	0.00	39.42
All Sites Summary						
sum all sites..........	334.22	278.48	177.06	289.80	20.52	550.26
sum all towns.........	81.99	52.07	77.07	94.59	8.66	210.74
sum all villages......	250.42	152.39	76.11	140.54	10.91	269.81
sum all hamlets.......	1.81	74.02	23.88	54.67	0.95	69.72

Table 9: Land Use Potential Variables 500-1000m

Site	Area in Hectares by category					
	Silt Loam	Sand Loam	Loam	Wetlands (all types)	Water	Other
Walker................	112.04	2.11	0.00	49.90	0.39	69.99
Smith-Haley...........	26.90	26.10	0.00	9.52	0.43	171.48
Daniels................	42.42	0.00	0.00	126.85	0.63	64.52
Sealey.................	32.54	49.44	5.15	0.00	8.04	139.26
Westbrook............	142.81	8.46	0.00	3.47	0.77	78.91
Bundy-Bodwell.......	180.53	18.95	0.00	0.97	0.04	33.93
Cooper.................	5.57	7.83	0.05	0.00	5.55	215.42
C. Smith..............	102.37	5.32	0.00	61.58	2.01	63.14
Donovan..............	114.17	4.48	0.00	74.83	4.20	36.75
Stratford..............	16.08	132.02	0.00	0.12	0.33	85.88
Wood..................	117.39	67.19	0.00	25.45	0.00	24.39
Misener................	18.86	107.00	0.00	0.00	1.19	107.38
Haley's Pond.........	60.81	90.62	0.00	0.00	0.14	82.85
Hamilton..............	0.00	0.00	96.19	60.65	0.44	77.15
Hood....................	0.00	21.46	96.52	14.43	0.00	102.02
Robertson.............	0.00	0.00	52.73	44.69	0.97	136.03
Freelton...............	0.00	0.00	56.14	78.47	0.20	99.61
Christianson..........	8.11	1.11	76.22	58.14	0.00	90.85
Mills....................	0.00	0.00	53.42	85.86	0.00	95.14
Kralt....................	0.00	49.53	58.10	112.70	0.00	16.24
Bogle 1................	0.00	3.97	86.11	42.37	3.13	98.85
Bogle 2................	0.00	3.60	76.80	12.94	3.13	137.95
Fairchild-Big Creeks Cluster Summary						
sum sites..............	972.49	519.52	5.20	352.69	23.73	1173.91
sum towns............	213.90	77.64	5.15	186.27	9.50	445.25
sum villages..........	697.77	351.26	0.05	166.42	14.09	645.81
Hamlet.................	60.81	90.62	0.00	0.00	0.14	82.85
Spencer-Bronte Cluster Summary						
sum sites..............	8.11	79.67	652.22	510.26	5.74	853.83
sum towns............	0.00	21.46	245.44	119.77	1.41	315.19
sum villages..........	8.11	50.64	243.88	335.17	0.00	301.84
sum hamlets..........	0.00	7.57	162.90	55.31	6.27	236.80
All Sites Summary						
sum all sites..........	980.60	599.19	657.42	862.94	29.47	2027.74
sum all towns.........	213.90	99.10	250.59	306.04	10.91	760.44
sum all villages......	705.88	401.90	243.93	501.59	12.15	947.65
sum all hamlets.......	60.81	98.19	162.90	55.31	6.40	319.65

Table 10: Land Use Potential Variables 1000-5000m

Site	Area in Hectares by category					
	Silt Loam	Sand Loam	Loam	Wetlands (all types)	Water	Other
Walker................	3197.94	338.49	165.47	668.01	121.92	3319.21
Smith-Haley...........	2277.00	2135.33	0.00	730.98	48.13	2619.60
Daniels................	2997.04	1145.80	0.00	1440.33	26.08	2201.79
Sealey..................	1685.42	1022.82	272.20	2.47	126.47	4701.67
Westbrook............	2819.03	1019.53	95.74	548.92	111.41	3216.41
Bundy-Bodwell.......	2680.61	1292.47	95.08	529.44	104.02	3109.41
Cooper..................	1325.89	1269.06	96.08	21.23	152.67	4946.12
C. Smith...............	2426.90	1033.21	0.00	1534.18	26.52	2790.24
Donovan...............	2311.83	822.41	0.00	1451.05	28.08	3197.67
Stratford................	2036.44	2135.27	18.71	140.38	80.21	3400.03
Wood..................	2709.99	1736.67	156.65	293.22	6.43	2908.08
Misener.................	1465.57	2790.49	18.71	86.42	49.05	3400.81
Haley's Pond.........	2142.11	2141.42	4.73	409.38	69.34	3044.06
Hamilton...............	13.68	312.17	1813.52	2348.05	37.67	3285.95
Hood.....................	0.00	649.45	1756.81	1632.51	39.92	3732.36
Robertson..............	104.54	390.32	1270.31	2404.32	30.72	3610.83
Freelton................	0.00	182.47	1810.06	2506.49	40.64	3271.37
Christianson...........	224.15	713.18	917.60	1845.30	30.99	4079.82
Mills......................	0.00	57.99	1721.62	2757.54	40.10	3233.79
Kralt......................	225.38	542.84	1107.21	1737.54	60.42	4137.65
Bogle 1.................	26.17	686.07	1724.82	1936.62	36.78	3400.58
Bogle 2.................	21.97	699.89	1749.93	1882.10	36.83	3420.32
Fairchild Big Creeks Cluster Summary						
sum sites...............	30075.77	18882.97	923.37	7856.02	950.33	42855.09
sum towns.............	10157.40	4642.43	437.67	2841.80	322.61	12842.26
sum villages...........	17776.26	12099.11	480.96	4604.84	558.39	26968.77
Hamlet..................	2142.11	2141.42	4.73	409.38	69.34	3044.06
Spencer Bronte Cluster Summary						
sum sites...............	615.88	4234.37	13871.89	19050.46	354.10	32172.68
sum towns............	118.22	1351.94	4840.64	6384.88	108.31	10629.14
sum villages..........	449.53	1496.47	5556.50	8846.87	172.16	14722.64
sum hamlets..........	48.14	1385.96	3474.75	3818.71	73.62	6820.90
All Sites Summary						
sum all sites..........	30691.65	23117.34	14795.25	26906.48	1304.43	75027.78
sum all towns.........	10275.61	5994.37	5278.31	9226.68	430.92	23471.40
sum all villages......	18225.79	13595.59	6037.46	13451.71	730.55	41691.42
sum all hamlets.......	2190.25	3527.38	3479.48	4228.10	142.96	9864.96

Table 11: Suitable Agricultural Soils in Overlaps with 1000m Catchments of Pre-Fur Trade Neutral Sites

NAME	Area (HA) of overlap 100-1000	Total area (Ha) of suitable soils in overlap	% of site suitable soils	Area (Ha) of overlap 100-5000	Total area (Ha) of suitable soils overlap	% of site suitable soils
Walker..............	0.00	0.00	0.00	0.00	0.00	0.00
Smith-Haley........	0.00	0.00	0.00	0.00	0.00	0.00
Daniels.............	15.84	8.37	18.17	426.84	286.19	6.91
Sealey..............	0.00	0.00	0.00	0.00	0.00	0.00
Westbrook.........	0.00	0.00	0.00	0.00	0.00	0.00
Bundy-Bodwell....	0.00	0.00	0.00	0.00	0.00	0.00
Cooper.............	0.00	0.00	0.00	0.00	0.00	0.00
C. Smith............	0.00	0.00	0.00	442.68	294.56	8.51
Donovan...........	0.00	0.00	0.00	277.07	144.05	4.60
Stratford............	0.00	0.00	0.00	309.11	118.64	2.83
Wood...............	0.00	0.00	0.00	876.06	453.40	9.25
Misener............	0.00	0.00	0.00	815.19	410.46	9.60
Haley's Pond......	0.00	0.00	0.00	177.77	80.76	1.88
Hamilton...........	0.00	0.00	0.00	0.00	0.00	0.00
Hood................	0.00	0.00	0.00	0.00	0.00	0.00
Robertson..........	0.00	0.00	0.00	0.00	0.00	0.00
Freelton............	0.00	0.00	0.00	0.00	0.00	0.00
Christianson.......	0.00	0.00	0.00	0.00	0.00	0.00
Mills.................	0.00	0.00	0.00	0.00	0.00	0.00
Kralt.................	0.00	0.00	0.00	0.00	0.00	0.00
Bogle 1............	0.00	0.00	0.00	0.00	0.00	0.00
Bogle 2............	0.00	0.00	0.00	0.00	0.00	0.00

Table 12: Suitable Agricultural Soils in Overlaps with 1000m Catchments of Prehistoric Neutral Sites

NAME	Area (HA) of overlap 100-1000	Total area (Ha) of suitable soils in overlap	% of site suitable soils	Area (Ha) of overlap 100-5000	Total area (Ha) of suitable soils overlap	% of site suitable soils
Walker................	0.00	0.00	0.00	611.81	174.48	4.71
Smith-Haley..........	0.00	0.00	0.00	0.00	0.00	0.00
Daniels................	0.00	0.00	0.00	427.20	245.62	5.93
Sealey.................	0.00	0.00	0.00	874.84	489.76	16.43
Westbrook...........	0.00	0.00	0.00	574.17	274.57	6.98
Bundy-Bodwell......	0.00	0.00	0.00	402.91	224.83	5.53
Cooper................	143.15	1.29	9.57	667.71	209.29	7.78
C. Smith..............	0.00	0.00	0.00	175.12	70.28	2.03
Donovan..............	0.00	0.00	0.00	43.13	16.80	0.54
Stratford..............	0.00	0.00	0.00	13.92	3.28	0.08
Wood..................	0.00	0.00	0.00	826.50	496.80	10.79
Misener..............	0.00	0.00	0.00	0.00	0.00	0.00
Haley's Pond........	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton.............	0.00	0.00	0.00	0.00	0.00	0.00
Hood..................	0.00	0.00	0.00	69.56	2.82	0.12
Robertson............	0.00	0.00	0.00	0.00	0.00	0.00
Freelton..............	0.00	0.00	0.00	0.00	0.00	0.00
Christianson.........	0.00	0.00	0.00	0.00	0.00	0.00
Mills....................	0.00	0.00	0.00	0.00	0.00	0.00
Kralt....................	0.00	0.00	0.00	0.00	0.00	0.00
Bogle 1................	0.00	0.00	0.00	0.00	0.00	0.00
Bogle 2................	0.00	0.00	0.00	0.00	0.00	0.00

Table 13: Scored Food Procurement Variables by Category - 100-1000m

	CLI/OLI scores by category			
Site	**Silt Loam CLI**	**Sand Loam CLI**	**Loam CLI**	**Deer OLI**
Walker................	48.164	12.457	0.000	1859.07
Smith-Haley...........	25.354	31.817	0.000	2023.31
Daniels................	23.040	0.000	0.000	2475.53
Sealey.................	28.362	24.215	2.889	2475.53
Westbrook............	79.750	3.534	0.000	2475.53
Bundy-Bodwell.......	85.044	9.181	0.000	2475.53
Cooper..................	2.991	3.360	0.038	2075.24
C. Smith..............	87.237	3.993	0.000	2166.09
Donovan..............	82.537	6.251	0.000	2475.53
Stratford...............	9.857	100.639	0.000	2475.53
Wood..................	80.376	71.462	0.000	2475.53
Misener................	14.225	92.167	0.000	2391.98
Haley's Pond.........	33.341	77.257	0.000	1856.65
Hamilton..............	0.000	0.000	97.926	1879.18
Hood....................	0.000	16.110	98.123	1856.65
Robertson.............	0.000	0.000	65.276	1856.65
Freelton...............	0.000	0.000	62.720	1937.40
Christianson..........	4.054	0.836	92.402	1393.66
Mills.....................	0.000	0.000	70.446	1984.29
Kralt.....................	0.000	42.151	36.438	1547.81
Bogle 1................	0.000	10.711	78.710	1845.80
Bogle 2................	0.000	19.013	80.495	1852.81
Fairchild-Big Creeks Cluster Summary				
sum sites..............	600.279	436.332	2.927	29701.04
sum towns............	124.920	68.488	2.889	8833.43
sum villages...........	442.017	290.587	0.038	19010.96
Hamlet.................	33.341	77.257	0.000	1856.65
Spencer-Bronte Cluster Summary				
sum sites..............	4.054	88.821	682.537	16154.25
sum towns...........	0.000	16.110	261.325	5592.48
sum villages..........	4.054	42.987	262.007	6863.17
sum hamlets..........	0.000	29.724	159.206	3698.61
All Sites Summary				
sum all sites..........	604.333	525.154	685.465	45855.29
sum all towns.........	124.920	84.599	264.214	14425.91
sum all villages......	446.071	333.573	262.045	25874.12
sum all hamlets.......	33.341	106.982	159.206	5555.25

Table 14: Stream Length by Order 200m

Borden	Name	Total length in Meters of stream segments by Strahler Order – 200m catchment							Highest Order within 200m
		1	2	3	4	5	6	7	
AgHa-9	Walker..............	72.6	0.0	268.2	0.0	477.8	147.1	0.0	6
AhHa-5	Smith-Haley.......	383.3	0.0	0.0	0.0	0.0	0.0	0.0	1
AhGx-12	Daniels.............	499.6	237.3	0.0	0.0	0.0	0.0	0.0	2
AgHa-4	Sealey..............	112.7	0.0	0.0	0.0	0.0	0.0	382.0	7
AgHa-6	Westbrook.........	672.4	22.1	0.0	0.0	0.0	0.0	0.0	2
AgHa-7	Bundy-Bodwell....	74.3	0.0	0.0	0.0	559.1	0.0	0.0	5
AgHb-18	Cooper.............	0.0	0.0	0.0	0.0	0.0	0.0	270.3	7
AhGx-15	C. Smith............	171.8	650.4	0.0	0.0	0.0	0.0	0.0	2
AhGx-22	Donovan............	0.0	393.3	257.0	0.0	0.0	0.0	0.0	3
AhHa-25	Stratford...........	175.8	0.0	429.3	0.0	0.0	0.0	0.0	3
AhHb-10	Wood................	119.2	0.0	0.0	0.0	71.5	0.0	0.0	5
AhHa-9	Misener............	0.0	0.0	378.1	0.0	0.0	0.0	0.0	3
AhHa-58	Haley's Pond......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
AiHa-5	Hamilton............	0.0	0.0	343.4	0.0	0.0	0.0	0.0	3
AiHa-7	Hood..................	0.0	0.0	0.0	258.2	0.0	0.0	0.0	4
AiHa-12	Robertson..........	39.3	0.0	0.0	325.9	0.0	0.0	0.0	4
AiHa-14	Freelton............	0.0	14.6	260.3	0.0	0.0	0.0	0.0	3
AiHa-2	Christianson.......	0.0	0.0	0.0	401.7	0.0	0.0	0.0	4
AiHa-8	Mills.................	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
AiHa-18	Kralt.................	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
AiHa-10	Bogle 1.............	0.0	0.0	0.0	500.1	0.0	0.0	0.0	4
AiHa-11	Bogle 2.............	8.2	0.0	0.0	549.3	0.0	0.0	0.0	4

Table 15: Surface Curvature Scores by Distance from Site

Site	Curvature				
	100m	200m	Difference 100-200m	500m	Difference 200-500m
Walker................	0.0454	0.0193	0.0261	-0.0090	0.0284
Smith-Haley..........	-0.0050	-0.0025	-0.0025	-0.0003	-0.0023
Daniels................	0.0375	-0.0170	0.0545	-0.0005	-0.0165
Sealey.................	-0.0110	-0.0343	0.0233	-0.0081	-0.0262
Westbrook...........	0.0072	-0.0062	0.0134	0.0020	-0.0082
Bundy-Bodwell.......	-0.0069	0.0108	-0.0177	0.0037	0.0071
Cooper................	0.1955	-0.0656	0.2611	-0.0036	-0.0620
C. Smith..............	0.0054	-0.0116	0.0169	0.0014	-0.0129
Donovan..............	-0.0308	0.0039	-0.0347	-0.0004	0.0043
Stratford..............	-0.0190	0.0205	-0.0394	-0.0004	0.0208
Wood..................	0.0439	0.0354	0.0085	-0.0066	0.0420
Misener...............	0.0262	0.0000	0.0261	0.0004	-0.0003
Haley's Pond.........	0.0050	-0.0015	0.0066	0.0009	-0.0024
Hamilton..............	0.0313	-0.0222	0.0536	0.0040	-0.0262
Hood...................	0.0500	0.0171	0.0329	-0.0046	0.0217
Robertson............	-0.0083	-0.0329	0.0246	0.0070	-0.0399
Freelton...............	0.0127	-0.0067	0.0194	-0.0014	-0.0053
Christianson.........	0.1626	-0.0841	0.2467	0.0054	-0.0895
Mills....................	0.0017	-0.0082	0.0099	-0.0007	-0.0075
Kralt.................	-0.0017	-0.0046	0.0029	0.0009	-0.0055
Bogle 1................	0.0230	-0.0102	0.0333	0.0181	-0.0283
Bogle 2................	0.0103	-0.0156	0.0259	-0.0100	-0.0056
Fairchild-Big Creeks Cluster Summary					
Mean sites...........	0.023	-0.004	0.026	0.00	0.00
Mean towns..........	0.017	-0.009	0.025	0.00	0.00
Mean villages.......	0.028	-0.002	0.029	0.00	0.00
Hamlet..............	0.005	-0.002	0.007	0.00	0.00
Spencer-Bronte Cluster Summary					
Mean sites...........	0.031	-0.019	0.050	0.00	-0.02
Mean towns.........	0.024	-0.013	0.037	0.00	-0.01
Mean villages.......	0.044	-0.026	0.070	0.00	-0.03
Mean hamlets......	0.017	-0.013	0.030	0.00	-0.02
All Sites Summary					
Mean all sites......	0.026	-0.010	0.036	0.00	-0.01
Mean all towns......	0.020	-0.010	0.030	0.00	-0.01
Mean all villages...	0.033	-0.010	0.043	0.00	-0.01
Mean all hamlets...	0.038	-0.027	0.022	0.01	-0.04

Appendix B: Statistical Results

Table 16: Expected Versus Observed Results 100-1000m by Site Class

100-1000m catchments		Suitable Agricultural Soils	Wetlands	Water	Other	Sum of absolute values
Sample:	Fairchild-Big Creeks vs Background					
Class:	*Towns*					
	Number of expected sites	1.51	0.47	0.05	1.97	4.00
	Number of observed sites	1.39	0.85	0.06	1.70	4.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	34.85	21.14	1.45	42.56	100.00
	Percent of difference	-2.85	9.41	0.21	-6.78	0.00
	Villages					
	Number of expected sites	3.02	0.94	0.10	3.95	8.00
	Number of observed sites	4.67	0.65	0.06	2.62	8.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	58.38	8.07	0.78	32.76	100.00
	Percent of difference	20.68	-3.65	-0.45	-16.58	0.00
	Hamlets					
	Number of expected sites	0.38	0.12	0.01	0.49	1.00
	Number of observed sites	0.63	0.00	0.00	0.37	1.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	63.08	0.00	0.35	36.57	100.00
	Percent of difference	25.38	-11.73	-0.88	-12.77	0.00
Sample:	Spencer-Bronte Creeks vs background					
Class:	*Towns*					
	Number of expected sites	1.13	0.46	0.04	1.37	3.00
	Number of observed sites	1.11	0.45	0.01	1.44	3.00
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	36.99	14.97	0.18	47.87	100.00
	Percent of difference	-0.56	-0.53	-1.17	2.25	0.00
	Villages					
	Number of expected sites	1.50	0.62	0.05	1.82	4.00
	Number of observed sites	1.25	1.43	0.01	1.31	4.00
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	31.14	35.73	0.29	32.84	100.00
	Percent of difference	-6.41	20.24	-1.05	-12.78	0.00
	Hamlets					
	Number of expected sites	0.75	0.31	0.03	0.91	2.00
	Number of observed sites	0.73	0.36	0.02	0.89	2.00
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	36.58	17.77	1.01	44.63	100.00
	Percent of difference	-0.96	2.28	-0.33	-0.98	0.00

Table 17: Expected Versus Observed Results 100-500m by Site Class

100-500m catchments		Suitable Agricultural Soils	Wetlands	Water	Other	Sum of absolute values
Sample Class:	Fairc:hild-Big Creeks vs Random					
	Towns					
	Number of expected sites	25.48	4.90	0.81	27.81	59.00
	Number of observed sites	1.80	1.01	0.11	1.09	4.00
	Percent of expected sites	43.18	8.30	1.38	47.14	100.00
	Percent of observed sites	44.88	25.13	2.81	27.18	100.00
	Percent of difference	1.70	16.83	1.44	-19.96	0.00
	Villages					
	Number of expected sites	25.48	4.90	0.81	27.81	59.00
	Number of observed sites	5.28	0.45	0.07	2.20	8.00
	Percent of expected sites	43.18	8.30	1.38	47.14	100.00
	Percent of observed sites	66.01	5.58	0.89	27.53	100.00
	Percent of difference	22.83	-2.73	-0.49	-19.62	0.00
	Hamlets					
	Number of expected sites	25.48	4.90	0.81	27.81	59.00
	Number of observed sites	0.58	0.00	0.01	0.40	1.00
	Percent of expected sites	43.18	8.30	1.38	47.14	100.00
	Percent of observed sites	58.34	0.00	1.27	40.39	100.00
	Percent of difference	15.16	-8.30	-0.11	-6.75	0.00
Sample: Class:	Spencer-Bronte Creeks vs random					
	Towns					
	Number of expected sites	11.82	7.90	0.50	12.78	33.00
	Number of observed sites	1.02	0.26	0.00	1.72	3.00
	Percent of expected sites	35.82	23.94	1.53	38.71	100.00
	Percent of observed sites	33.98	8.53	0.10	57.40	100.00
	Percent of difference	-1.85	-15.41	-1.43	18.69	0.00
	Villages					
	Number of expected sites	11.82	7.90	0.50	12.78	33.00
	Number of observed sites	1.10	1.43	0.07	1.39	4.00
	Percent of expected sites	35.82	23.94	1.53	38.71	100.00
	Percent of observed sites	27.59	35.68	1.86	34.87	100.00
	Percent of difference	-8.23	11.75	0.33	-3.85	0.00
	Hamlets					
	Number of expected sites	11.82	7.90	0.50	12.78	33.00
	Number of observed sites	0.75	0.73	0.00	0.53	2.00
	Percent of expected sites	35.82	23.94	1.53	38.71	100.00
	Percent of observed sites	37.29	36.44	0.00	26.27	100.00
	Percent of difference	1.47	12.50	-1.53	-12.44	0.00

Table 18: Expected Versus Observed Results 500-1000m by Site Class

500-1000m catchments		Suitable Agricultural Soils	Wetlands	Water	Other	Sum of absolute values
Sample:	Fairchild-Big Creeks vs random					
Class:	*Towns*					
	Number of expected sites	1.51	0.47	0.05	1.97	4.00
	Number of observed sites	1.27	0.79	0.04	1.90	4.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	31.64	19.86	1.01	47.48	100.00
	Percent of difference	-6.06	8.13	-0.22	-1.85	0.00
	Villages					
	Number of expected sites	3.02	0.94	0.10	3.95	8.00
	Number of observed sites	4.48	0.71	0.06	2.75	8.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	55.94	8.87	0.75	34.44	100.00
	Percent of difference	18.24	-2.86	-0.48	-14.90	0.00
	Hamlets					
	Number of expected sites	0.38	0.12	0.01	0.49	1.00
	Number of observed sites	0.65	0.00	0.00	0.35	1.00
	Percent of expected sites	37.70	11.73	1.23	49.34	100.00
	Percent of observed sites	64.60	0.00	0.06	35.34	100.00
	Percent of difference	26.90	-11.73	-1.18	-13.99	0.00
Sample:	Spencer-Bronte Creeks vs random					
Class:	*Towns*					
	Number of expected sites	1.13	0.46	0.04	1.37	3.00
	Number of observed sites	1.14	0.51	0.01	1.34	3.00
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	37.95	17.03	0.20	44.82	100.00
	Percent of difference	0.41	1.54	-1.15	-0.80	0.00
	Villages					
	Number of expected sites	1.50	0.62	0.05	1.82	4.00
	Number of observed sites	1.29	1.43	0.00	1.29	4.01
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	32.27	35.74	0.00	32.19	100.21
	Percent of difference	-5.27	20.25	-1.35	-13.43	0.21
	Hamlets					
	Number of expected sites	0.75	0.31	0.03	0.91	2.00
	Number of observed sites	0.73	0.24	0.03	1.01	2.00
	Percent of expected sites	37.54	15.49	1.35	45.62	100.00
	Percent of observed sites	36.36	11.80	1.34	50.51	100.00
	Percent of difference	-1.19	-3.70	-0.01	4.89	0.00

Table 19: Expected Versus Observed Results 1000-5000m by Site Class

1000-5000m catchments		Suitable Agricultural Soils	Wetlands	Water	Other	Sum of absolute values
Sample:	Fairchild-Big Creeks vs Random					
Class:	*Towns*					
	Number of expected sites	26.17	4.49	0.57	27.77	59.00
	Number of observed sites	1.95	0.36	0.04	1.64	4.00
	Percent of expected sites	44.36	7.60	0.97	47.07	100.00
	Percent of observed sites	48.77	9.10	1.03	41.10	100.00
	Percent of difference	4.41	1.49	0.06	-5.96	0.00
	Villages					
	Number of expected sites	26.17	4.49	0.57	27.77	59.00
	Number of observed sites	3.89	0.59	0.07	3.45	8.00
	Percent of expected sites	44.36	7.60	0.97	47.07	100.00
	Percent of observed sites	48.58	7.37	0.89	43.16	100.00
	Percent of difference	4.22	-0.23	-0.08	-3.91	0.00
	Hamlets					
	Number of expected sites	26.17	4.49	0.57	27.77	59.00
	Number of observed sites	0.55	0.05	0.01	0.39	1.00
	Percent of expected sites	44.36	7.60	0.97	47.07	100.00
	Percent of observed sites	54.90	5.24	0.89	38.97	100.00
	Percent of difference	10.54	-2.36	-0.08	-8.09	0.00
Sample:	Spencer-Bronte Creeks vs random					
Class:	*Towns*					
	Number of expected sites	10.86	6.09	0.22	15.83	33.00
	Number of observed sites	0.81	0.82	0.01	1.36	3.00
	Percent of expected sites	32.92	18.44	0.67	47.97	100.00
	Percent of observed sites	26.93	27.25	0.46	45.36	100.00
	Percent of difference	-5.99	8.80	-0.21	-2.61	0.00
	Villages					
	Number of expected sites	10.86	6.09	0.22	15.83	33.00
	Number of observed sites	0.96	1.13	0.02	1.88	4.00
	Percent of expected sites	32.92	18.44	0.67	47.97	100.00
	Percent of observed sites	24.01	28.32	0.55	47.12	100.00
	Percent of difference	-8.91	9.87	-0.12	-0.84	0.00
	Hamlets					
	Number of expected sites	10.86	6.09	0.22	15.83	33.00
	Number of observed sites	0.63	0.49	0.01	0.87	2.00
	Percent of expected sites	32.92	18.44	0.67	47.97	100.00
	Percent of observed sites	31.42	24.44	0.47	43.66	100.00
	Percent of difference	-1.50	6.00	-0.20	-4.30	0.00

Table 20: Kolmogorov-Smirnov Two-Sample Test Results for Sites Compared by Cluster

Fairchild Big Creeks N = 13 Spencer-Bronte N = 9							
Variable	Max. Neg. Diff.	Max. Pos. Diff.	p-level	Mean Fairchild Big Creeks Sites	Mean Spencer Bronte Sites	Std.Dev. Fairchild Big Creeks Sites	Std.Dev. Spencer Bronte Sites
Silt Loam	0.00	0.92	p < .001	32.48	0.29	25.28	0.87
Sand Loam	0.00	0.48	p > .10	18.87	4.25	21.22	6.16
Loam	-1.00	0.00	p < .001	0.14	29.75	0.52	8.29
All suitable	-0.15	0.62	p < .05	51.50	34.30	24.45	9.97
Wetlands	-0.62	0.08	p < .05	11.47	24.82	18.40	12.89
Water	-0.10	0.40	p > .10	0.96	0.41	1.53	0.48
Other	-0.50	0.15	p > .10	36.07	40.47	23.74	11.26
Silt Loam CLI	0.00	0.54	p < .10	19.23	10.00	9.54	0.00
Sand Loam CLI	0.00	0.31	p > .10	17.69	11.11	10.92	3.33
Loam CLI	-1.00	0.00	p < .001	10.00	31.11	0.00	6.01
All Suitable CLI	-0.38	0.08	p > .10	29.23	34.44	12.56	5.27
Deer OLI	0.00	0.85	p < .001	2284.70	1794.92	251.18	193.29

Table 21: Kolmogorov-Smirnov Two-Sample Test Results for Fairchild-Big Creeks Sites 100-1000m

Town sites compared to Random locations

Fairchild-Big Creeks Towns N=4 Fairchild-Big Creeks random N=59

	Max Neg Diff.	Max Pos Diff.	p-level	Mean Towns	Mean Random	Std.Dev. Towns	Std.Dev Random
Silt Loam	-0.39	0.34	p > .10	23.91	26.73	17.82	20.51
Sand Loam	-0.34	0.09	p > .10	10.48	16.80	9.98	17.43
Loam	-0.22	0.03	p > .10	0.47	2.79	0.93	7.09
All suitable	-0.44	0.15	p > .10	34.85	46.31	17.12	23.38
Wetlands	-0.02	0.33	p > .10	21.14	9.12	28.30	14.11
Water	-0.21	0.41	p > .10	1.45	1.22	2.49	2.15
Other	-0.30	0.21	p > .10	42.56	43.35	22.14	21.05
Silt Loam CLI	-0.36	0.00	p > .10	12.50	21.86	5.00	13.06
Sand Loam CLI	-0.15	0.00	p > .10	12.50	15.76	5.00	10.86
Loam CLI	0.00	0.00	p > .10	10.00	10.00	0.00	0.00
All Suitable CLI	-0.64	0.00	p < .10	17.50	32.37	5.00	15.12
Deer OLI	-0.31	0.17	p > .10	2208.36	2173.31	315.70	511.18

Village sites compared to Random locations

Fairchild-Big Creeks Villages N=8 Fairchild-Big Creeks random N=59

	Max Neg Diff	Max Pos Diff	p-level	Mean Villages	Mean Random	Std.Dev. Villages	Std.Dev. Random
Silt Loam	-0.12	0.40	p > .10	38.30	26.73	29.28	20.51
Sand Loam	-0.20	0.32	p > .10	20.08	16.80	24.60	17.43
Loam	-0.29	0.00	p > .10	0.00	2.79	0.01	7.09
All suitable	-0.11	0.33	p > .10	58.38	46.31	25.83	23.38
Wetlands	-0.22	0.11	p > .10	8.07	9.12	12.32	14.11
Water	-0.15	0.23	p > .10	0.78	1.22	1.06	2.15
Other	-0.39	0.13	p > .10	32.76	43.35	26.81	21.05
Silt Loam CLI	-0.17	0.27	p > .10	22.50	21.86	10.35	13.06
Sand Loam CLI	-0.03	0.22	p > .10	18.75	15.76	12.46	10.86
Loam CLI	0.00	0.00	p > .10	10.00	10.00	0.00	0.00
All Suitable CLI	-0.15	0.23	p > .10	33.75	32.37	11.88	15.12
Deer OLI	0.00	0.24	p > .10	2376.37	2173.31	162.26	511.18

Table 22: Kolmogorov-Smirnov Two-Sample Test Results for Spencer-Bronte Creeks Sites 100-1000m

Town sites compared to Random locations

Spencer-Bronte Towns N=3 | Spencer-Bronte Random N=33

	Max Neg Diff	Max Pos Diff	p-level	Mean Town	Mean Random	Std.Dev. Town	Std.Dev. Random
Silt Loam	-0.36	0.00	p > .10	0.00	10.02	0.00	17.98
Sand Loam	-0.52	0.00	p > .10	2.31	13.62	4.01	18.32
Loam	-0.03	0.79	p < .10	34.67	11.01	11.13	13.01
All suitable	-0.24	0.33	p > .10	36.99	34.65	14.19	21.15
Wetlands	-0.36	0.21	p > .10	14.97	21.54	9.18	21.36
Water	-0.27	0.18	p > .10	0.18	0.91	0.20	2.85
Other	-0.18	0.45	p > .10	47.87	42.90	12.20	19.10
Silt Loam CLI	-0.24	0.00	p > .10	10.00	15.45	0.00	11.48
Sand Loam CLI	-0.27	0.00	p > .10	10.00	15.45	0.00	11.75
Loam CLI	0.00	1.00	p < .01	36.67	10.00	5.77	0.00
All Suitable CLI	-0.24	0.48	p > .10	36.67	29.39	5.77	16.76
Deer OLI	-0.48	0.33	p > .10	1864.16	1684.65	13.01	653.44

Village sites compared to Random locations

Spencer-Bronte Villages N=4 | Spencer-Bronte Random N=33

	Max Neg Diff	Max Pos Diff	p-level	Mean Village	Mean Random	Std.Dev. Village	Std.Dev. Random
Silt Loam	-0.27	0.00	p > .10	0.66	10.02	1.31	17.98
Sand Loam	-0.30	0.00	p > .10	4.63	13.62	9.02	18.32
Loam	-0.06	0.76	p < .05	25.85	11.01	7.50	13.01
All suitable	-0.36	0.33	p > .10	31.14	34.65	10.23	21.15
Wetlands	-0.21	0.61	p > .10	35.73	21.54	9.83	21.36
Water	-0.23	0.17	p > .10	0.29	0.91	0.54	2.85
Other	-0.55	0.14	p > .10	32.84	42.90	9.73	19.10
Silt Loam CLI	-0.24	0.00	p > .10	10.00	15.45	0.00	11.48
Sand Loam CLI	-0.09	0.00	p > .10	12.50	15.45	5.00	11.75
Loam CLI	0.00	1.00	p < .005	27.50	10.00	5.00	0.00
All Suitable CLI	-0.24	0.48	p > .10	32.50	29.39	5.00	16.76
Deer OLI	-0.36	0.18	p > .10	1715.79	1684.65	290.51	653.44

Table 23: Kolmogorov-Smirnov Two-Sample Test for Fairchild-Big Creeks All Sites 100-1000m

All sites compared to Random locations – Fairchild Big Creeks

Fairchild-Big Creeks Sites N=13 Fairchild-Big Creeks random N=59

	Max Neg Diff	Max Pos Diff	p-level	Mean FBSite	Mean FBRand	Std.Dev. FBSite	Std.Dev. FBRand
Silt Loam	-0.11	0.24	p > .10	32.48	26.73	25.28	20.51
Sand Loam	-0.12	0.25	p > .10	18.87	16.80	21.22	17.43
Loam	-0.22	0.00	p > .10	0.14	2.79	0.52	7.09
All suitable	-0.06	0.17	p > .10	51.50	46.31	24.45	23.38
Wetlands	-0.13	0.14	p > .10	11.47	9.12	18.40	14.11
Water	-0.10	0.28	p > .10	0.96	1.22	1.53	2.15
Other	-0.26	0.08	p > .10	36.07	43.35	23.74	21.05
Silt Loam CLI	-0.17	0.03	p > .10	19.23	21.86	9.54	13.06
Sand Loam CLI	-0.03	0.16	p > .10	17.69	15.76	10.92	10.86
Loam CLI	0.00	0.00	p > .10	10.00	10.00	0.00	0.00
All Suitable CLI	-0.19	0.00	p > .10	29.23	32.37	12.56	15.12
Deer OLI	-0.09	0.11	p > .10	2284.70	2173.31	251.18	511.18

Towns compared to Villages - Fairchild-Big Creeks

Fairchild-Big Creeks Towns N=4 Fairchild-Big Creeks Village N=8

	Max Neg Diff	Max Pos Diff	p-level	Mean fbTown	Mean Village	Std.Dev. Town	Std.Dev. Village
Silt Loam	-0.38	0.38	p > .10	23.91	38.30	17.82	29.28
Sand Loam	-0.38	0.25	p > .10	10.48	20.08	9.98	24.60
Loam	0.00	0.25	p > .10	0.47	0.00	0.93	0.01
All suitable	-0.63	0.13	p > .10	34.85	58.38	17.12	25.83
Wetlands	0.00	0.38	p > .10	21.14	8.07	28.30	12.32
Water	-0.38	0.38	p > .10	1.45	0.78	2.49	1.06
Other	-0.13	0.38	p > .10	42.56	32.76	22.14	26.81
Silt Loam CLI	-0.63	0.00	p > .10	12.50	22.50	5.00	10.35
Sand Loam CLI	-0.38	0.00	p > .10	12.50	18.75	5.00	12.46
Loam CLI	0.00	0.00	p > .10	10.00	10.00	0.00	0.00
All Suitable CLI	-0.88	0.00	p < .05	17.50	33.75	5.00	11.88
Deer OLI	-0.50	0.00	p > .10	2208.36	2376.37	315.70	162.26

Table 24: Kolmogorov-Smirnov Two-Sample Test for Fairchild-Big Creeks Sites 100-500m

Town sites compared to Random locations

Fairchild-Big Creeks Towns N=4 | Fairchild-Big Creeks random N=59

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Random	Std.Dev. Town	Std.Dev. Random
Silt Loam	-0.11	0.27	p > .10	27.33	24.18	24.10	21.10
Sand Loam	-0.29	0.38	p > .10	17.35	16.52	12.17	20.26
Loam	-0.14	0.11	p > .10	0.21	2.48	0.42	7.97
All suitable	-0.16	0.22	p > .10	44.88	43.18	30.67	26.54
Wetlands	0.00	0.31	p > .10	25.13	8.30	40.39	15.96
Water	-0.09	0.28	p > .10	2.81	1.38	5.25	3.13
Other	-0.46	0.03	p > .10	27.18	47.14	21.99	24.00

Village sites compared to Random locations

Fairchild-Big Creeks Villages N=8 | Fairchild-Big Creeks random N=59

	Max Neg Difference	Max Pos Difference	p-level	Mean Village	Mean Random	Std.Dev. Village	Std.Dev. Random
Silt Loam	-0.04	0.47	p < .10	41.73	24.18	34.05	21.10
Sand Loam	-0.10	0.20	p > .10	24.28	16.52	33.20	20.26
Loam	-0.15	0.00	p > .10	0.00	2.48	0.00	7.97
All suitable	-0.06	0.47	p < .10	66.01	43.18	31.52	26.54
Wetlands	-0.13	0.07	p > .10	5.58	8.30	11.29	15.96
Water	-0.15	0.32	p > .10	0.89	1.38	1.91	3.13
Other	-0.52	0.11	p < .05	27.53	47.14	31.21	24.00

Town sites compared to Village sites

Fairchild-Big Creeks Towns N=4 | Fairchild-Big Creeks Villages N=8

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Village	Std.Dev. Town	Std.Dev. Village
Silt Loam	-0.38	0.25	p > .10	27.33	41.73	24.10	34.05
Sand Loam	-0.38	0.38	p > .10	17.35	24.28	12.17	33.20
Loam	0.00	0.25	p > .10	0.21	0.00	0.42	0.00
All suitable	-0.50	0.13	p > .10	44.88	66.01	30.67	31.52
Wetlands	0.00	0.38	p > .10	25.13	5.58	40.39	11.29
Water	-0.13	0.25	p > .10	2.81	0.89	5.25	1.91
Other	-0.25	0.25	p > .10	27.18	27.53	21.99	31.21

Table 25: Kolmogorov-Smirnov Two-Sample Test for Spencer-Bronte Sites 100-500m

Town sites compared to Random locations

Spencer-Bronte Creeks Towns N=3 Spencer-Bronte Random N=33

	Max Neg Difference	Max Pos Difference	p-level	Mean sbTown	Mean Random	Std.Dev. Town	Std.Dev. Random
Silt Loam	-0.27	0.00	p > .10	0.00	12.07	0.00	22.26
Sand Loam	-0.48	0.00	p > .10	0.01	13.46	0.02	20.49
Loam	-0.03	0.79	p < .10	33.97	10.29	15.29	17.10
All suitable	-0.30	0.42	p > .10	33.98	35.82	15.31	28.91
Wetlands	-0.39	0.27	p > .10	8.53	23.94	7.16	28.39
Water	-0.21	0.12	p > .10	0.10	1.53	0.17	5.27
Other	-0.09	0.67	p > .10	57.40	38.71	13.40	24.90

Village sites compared to Random locations

Spencer-Bronte Creeks Towns N=4 Spencer-Bronte Random N=33

	Max Neg Difference	Max Pos Difference	p-level	Mean Village	Mean Random	Std.Dev. Village	Std.Dev. Random
Silt Loam	-0.27	0.00	p > .10	0.00	12.07	0.00	22.26
Sand Loam	-0.36	0.00	p > .10	2.22	13.46	4.45	20.49
Loam	-0.03	0.70	p < .10	25.37	10.29	17.87	17.10
All suitable	-0.33	0.30	p > .10	27.59	35.82	16.18	28.91
Wetlands	-0.15	0.45	p > .10	35.68	23.94	23.79	28.39
Water	-0.06	0.41	p > .10	1.86	1.53	2.19	5.27
Other	-0.27	0.27	p > .10	34.87	38.71	15.21	24.90

Table 26: Kolmogorov-Smirnov Two-Sample Test for Fairchild-Big Creeks Sites 500-1000m

Town sites compared to Random locations

Fairchild-Big Creeks Towns N=4 | Fairchild-Big Creeks random N=59

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Random	Std.Dev. Town	Std.Dev. Random
Silt Loam	-0.33	0.29	p > .10	22.81	27.54	16.88	21.31
Sand Loam	-0.32	0.04	p > .10	8.28	16.89	9.92	17.34
Loam	-0.22	0.03	p > .10	0.55	2.89	1.10	6.96
All suitable	-0.56	0.20	p > .10	31.64	47.31	13.98	23.64
Wetlands	-0.03	0.36	p > .10	19.86	9.38	24.63	14.23
Water	-0.22	0.41	p > .10	1.01	1.17	1.61	2.07
Other	-0.14	0.31	p > .10	47.48	42.14	22.44	21.52

Village sites compared to Random locations

Fairchild-Big Creeks Towns N=8 | Fairchild-Big Creeks random N=59

	Max Neg Difference	Max Pos Difference	p-level	Mean Village	Mean Random	Std.Dev. Village	Std.Dev. Random
Silt Loam	-0.15	0.37	p > .10	37.21	27.54	27.96	21.31
Sand Loam	-0.18	0.32	p > .10	18.73	16.89	21.94	17.34
Loam	-0.29	0.00	p > .10	0.00	2.89	0.01	6.96
All suitable	-0.11	0.32	p > .10	55.94	47.31	24.35	23.64
Wetlands	-0.22	0.13	p > .10	8.87	9.38	13.09	14.23
Water	-0.15	0.25	p > .10	0.75	1.17	0.88	2.07
Other	-0.36	0.13	p > .10	34.44	42.14	26.24	21.52

Town sites compared to Village sites

Fairchild-Big Creeks Towns N=4 | Fairchild-Big Creeks Villages N=8

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Village	Std.Dev. Town	Std.Dev. Village
Silt Loam	-0.50	0.38	p > .10	22.81	37.21	16.88	27.96
Sand Loam	-0.50	0.13	p > .10	8.28	18.73	9.92	21.94
Loam	0.00	0.25	p > .10	0.55	0.00	1.10	0.01
All suitable	-0.75	0.13	p < .10	31.64	55.94	13.98	24.35
Wetlands	0.00	0.38	p > .10	19.86	8.87	24.63	13.09
Water	-0.38	0.38	p > .10	1.01	0.75	1.61	0.88
Other	-0.13	0.50	p > .10	47.48	34.44	22.44	26.24

Table 27: Kolmogorov-Smirnov Two-Sample Test for Spencer-Bronte Sites 500-1000m

Town sites compared to Random locations

Spencer-Bronte Creeks Towns N=3 | Spencer-Bronte Random N=33

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Random	Std.Dev. Town	Std.Dev. Random
Silt Loam	-0.36	0.00	p > .10	0.00	9.37	0.00	17.25
Sand Loam	-0.48	0.00	p > .10	3.05	13.67	5.28	18.14
Loam	-0.06	0.82	p < .10	34.90	11.24	10.74	12.62
All suitable	-0.24	0.33	p > .10	37.95	34.28	14.17	19.79
Wetlands	-0.33	0.24	p > .10	17.03	20.77	10.01	20.25
Water	-0.24	0.24	p > .10	0.20	0.72	0.21	2.10
Other	-0.24	0.33	p > .10	44.82	44.24	12.61	18.37

Village sites compared to Random locations

Spencer-Bronte Creeks Towns N=3 | Spencer-Bronte Random N=33

	Max Neg Difference	Max Pos Difference	p-level	Mean Village	Mean Random	StdDev Village	Std.Dev. Random
Silt Loam	-0.27	0.00	p > .10	0.86	9.37	1.73	17.25
Sand Loam	-0.27	0.01	p > .10	5.40	13.67	10.49	18.14
Loam	-0.06	0.82	p < .025	26.01	11.24	4.41	12.62
All suitable	-0.30	0.33	p > .10	32.27	34.28	10.99	19.79
Wetlands	-0.09	0.67	p < .10	35.74	20.77	9.62	20.25
Water	-0.48	0.00	p > .10	-0.21	0.72	0.47	2.10
Other	-0.48	0.17	p > .10	32.19	44.24	16.91	18.37

Town sites compared to Village sites

Spencer-Bronte Creeks Towns N=3 | Spencer-Bronte Random N=33

	Max Neg Difference	Max Pos Difference	p-level	Mean Town	Mean Village	Std.Dev. Town	Std.Dev. Village
Silt Loam	-0.25	0.00	p > .10	0.00	0.86	0.00	1.73
Sand Loam	-0.25	0.08	p > .10	3.05	5.40	5.28	10.49
Loam	-0.33	0.67	p > .10	34.90	26.01	10.74	4.41
All suitable	-0.33	0.42	p > .10	37.95	32.27	14.17	10.99
Wetlands	-0.75	0.00	p > .10	17.03	35.74	10.01	9.62
Water	0.00	0.67	p > .10	0.20	-0.21	0.21	0.47
Other	-0.08	0.67	p > .10	44.82	32.19	12.61	16.91

Table 28: Spearmans Rank Correlation for Distance to Fairchild-Big Creeks Cluster Centre by Site Size

Name	Borden	Glass Bead	Site Type	Site Area (Ha)	Distance to mean center (m)	Size Rank	Proximity Rank	d	d^2
Walker..................	AgHa-9	GBP3	Town	6.25	3450	1	4	3	9
Smith-Haley...........	AhHa-5	GBP2	Town	5.00	2613	2	1	-1	1
Sealey..................	AgHa-4	GBP3	Town	2.83	10855	3	10	7	49
Daniels..................	AhGx-12	GBP2	Town	2.50	7895	4	8	4	16
Misener.................	AhHa-9	GBP2	Village	1.60	6230	5	6	1	1
Snyder..................	AhHa-3	GBP1	Village	1.50	7567	6	7	1	1
Stratford................	AhHa-25	GBP2	Village	1.25	4638	7	5	-2	4
Wood....................	AhHb-10	?	Village	1.13	12509	8	12	4	16
C. Smith................	AhGx-15	GBP2	Village	1.00	10005	9.5	9	-1	0.25
Donovan...............	AhGx-22	GBP2	Village	1.00	10992	9.5	11	2	2.25
Westbrook.............	AgHa-6	?	Village	0.56	3284	11	3	-8	64
Bundy-Bodwell........	AgHa-7	?	Village	0.50	2945	12	2	-10	100

Sigma d^2 = 263.5
n = 12
n^3-n =1716
6 sigma d^2 =1581
rs = 1-(6 Sigma d^2/n^3-n) 0.078671
Critical value @ .05 = 0.591

rs<= .591 therefore: Failure to reject Ho - There is no correlation between site size and distance to centre of cluster.

Table 29: Spearmans Rank Correlation for Distance to Spencer-Bronte Cluster Centre by Site Size

Name	Borden	Glass Bead	Site Type	Site Area (Ha)	Distance to mean center	Size Rank	Proximity Rank	d	d^2
Bogle 2.........	AiHa-11	GBP3	Hamlet	0.25	1962	9	4	-5	25
Bogle 1.........	AiHa-10	GBP3	Hamlet	0.38	1747	8	2	-6	36
Freelton........	AiHa-14	GBP3	Village	1.01	1866	6	3	-3	9
Mills............	AiHa-8	GBP3	Village	1.13	2795	5	5	0	0
Christianson...	AiHa-2	GBP2	Village	1.60	4374	4	9	5	25
Hamilton........	AiHa-5	GBP2	Town	2.00	959	3	1	-2	4
Hood............	AiHa-7	GBP3	Town	2.70	2986	2	6	4	16
Robertson......	AiHa-12	GBP3	Town	3.00	3871	1	8	7	49
Kralt............	AiHa-18	?	Village	0.75	3432	7	7	0	0
					Sigma d^2 =				164
					n =				9
					n^3-n =				720
					6 sigma d^2 =				984
					rs = 1-(6 Sigma d^2/n^3-n)				-0.367
					Critical value @ .05 =				0.683

rs<= .683 therefore: Failure to reject Ho - There is no correlation between site size and distance to centre of cluster.

Appendix C: Methodology Details

Data preparation

With the exception of the Ministry of Culture site location data, all input data were received as digital GIS files, in either ESRI Shapefile, coverage, grid or geodatabase formats, and were received in a variety of projections.

A map projection is systematic process of converting map data from a spherical or globe representation into Cartesian coordinates, or a flat map surface. A Datum refers to a measurement of the earth's ellipsoid used to produce that calculation. The same point mapped with two different projections, or even slightly different datums, will appear in two different places. Projection and datum are attributes that average users of simple paper maps often overlook, but when we enter data into a GIS and expect to overlay data layers and examine the spatial relationships between them, it becomes a very important issue.

ESRI ArcGIS desktop software has the ability to reproject data "on the fly", meaning that datasets from different projections can be displayed together simultaneously in the same projection. This feature is acceptable for cartographic purposes or for individuals performing simple operations, but experience has shown that this feature can sometimes contribute to unreliability, and should be avoided for projects that involve complex analysis or extensive geoprocessing tasks. Additionally, some of the tasks that must be performed for this project are done faster and more efficiently using the older and simpler ArcView 3.2 software, which does not have the same dynamic reprojection capabilities. For these reasons, data received from the various sources first were reprojected into a common projection. All datasets used in this analysis were converted to ESRI shapefile format reprojected using ESRI ArcToolbox.

The majority of the data originating from MNR was supplied in Geographic, North American Datum 1983 (NAD83) coordinate system. It is most suited for dynamic "on the fly" projection by GIS software, and is the format that these provincial-sized datasets are stored in the NRVIS and LIO data warehouses. Geographic coordinate data is not suited for our analysis because of significant distortions in shape, and the inability to calculate measurements of area, since the units of measurement are recorded in decimal degrees rather than meters. Some datasets were provided in Lambert Conformal Conic, using either the NAD83 or the older NAD27 datum. Lambert is a projection that is best suited for displaying cartographic products at the provincial scale.

The study area is relatively small in size, therefore, the most appropriate projection for our data is the same as that which is used for printing topographic base maps of the area. All datasets were projected into Universal Transverse Mercator (UTM) projection, Zone 17 using the NAD83 datum with the CNT transformation as per current Ontario provincial standards. Source data that used the NAD27 datum was reprojected on the assumption that this data was based on the NTV2 Transformation, which had been the Canadian standard for data of that vintage. Once the data was converted into a common file format and projection, the ArcMap Geoprocessing Wizard was used to clip the data down to the study area boundary, as defined previously in this chapter.

Preparations also needed to be performed on the tabular attributes of the data. In some datasets, important attributes of the features were stored in tables not connected to the shapefile. These tables needed to be linked to the shapefile using a common identifier and then exported into a new shapefile to make these data fields permanent in the attribute table of the new shapefile. For example, the NRVIS waterbody segment dataset that is packaged in the Standard NRVIS Interchange Format (SNIF). SNIF Packages include spatial datasets as well as a sometimes-confusing assortment of inter-related data tables. Water body segments are attributed with a unique numerical identifier "objectid", and Geographic Unit Type (GUT) number, which indicate only if the water body segment is a permanent water body. If one wishes to determine if it is a lake or a river, it is necessary to join this table with a relate table. In this case, the relate table is called "water_body_and_segment". This table links the unique identifiers of the water body segment polygons to those of a water body. Once this connection is made, the water body number is used to connect to the waterbody table, which contains another numeric code that represents the classification of the water body as either lake or river.

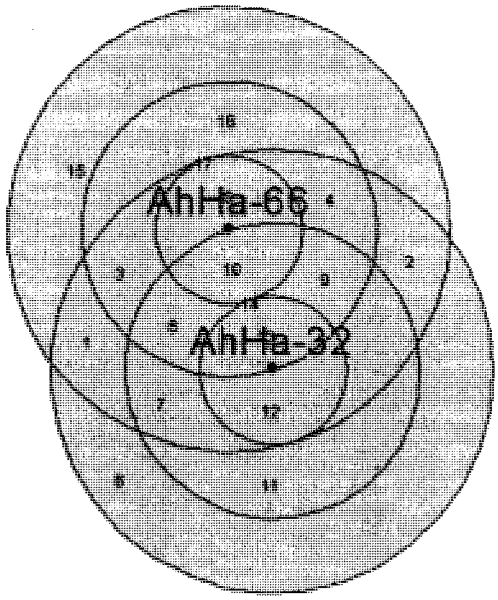
After all required tabular data was attached to the shapefiles, unnecessary data fields needed to be trimmed away in order to reduce storage space requirements and processing time. The presence of too many data fields are known to unnecessarily slow or even prevent certain analyses due to software limitations. For instance, the Ontario Land Inventory contained dozens of data fields for attributes ranging from site moisture, to tourism potential. Many of these fields were deleted.

The archaeological sites from the Ministry of Culture were not provided as a shape file. This data was provided as tables of site coordinates and separate attribute tables linking cultural affinities and site types to the site coordinates by Borden number, forming a many-to-one relationship. An additional complication was the fact that the data was provided in a mixture of projections, with an attribute field indicating the source projection. To prepare the data, the tables first had to be separated by projection. Then the table of sites with Nad83 UTM projection were converted into a shapefile by importing the table into ArcView 3.2 as a text file, adding it to the view as an Event Theme, based on the coordinate fields and finally exporting it to a new shapefile. The NAD27 UTM data were handled in the same way, but were then projected into UTM Zone 17 NAD83 CNT using ESRI ArcToolbox. Some sites with geographic coordinates were provided in degrees minutes and seconds (D.M.S). These coordinates needed to be exported to Microsoft Excel, parsed into columns and calculated into to decimal degrees (DD = D + (M/60)+(S/3600)), before they could be imported as an Event Theme, exported to a shapefile and reprojected in the same manner as the other sites.

Data Processing

Site catchment buffer polygons are attributed with a field named for the site Borden number and the value identifying the buffer distance (Figure 17). All of the buffer polygons of sites in each cluster are then joined together into a single shapefile using the Union function. The Union function joins two polygon

Figure 17: Example of site catchment segment identification



Attributes of Catchment_sample.shp

Shape	AhHa-32_buffer	AhHa-66_buffer	UniqueID
Polygon	1500	1500	1
Polygon	1500	1500	2
Polygon	1500	1000	3
Polygon	1500	1000	4
Polygon	1500	500	5
Polygon	1500	0	6
Polygon	1000	1500	7
Polygon	1000	1000	8
Polygon	1000	1000	9
Polygon	1000	500	10
Polygon	1000	0	11
Polygon	500	1500	12
Polygon	500	1000	13
Polygon	500	500	14
Polygon	0	1500	15
Polygon	0	1000	16
Polygon	0	500	17

shapefiles together, retaining the attributes fields of each shapefile as well as polygon shapes, which are broken up to reflect overlaps. A unique ID field is added to the final shapefile, and a second copy created where all attribute fields except for the unique ID are stripped. This simplified shapefile is used to perform all overlays and other functions during the processing phase. The unique ID is used in the Mircosoft Access database to connect the results back to the site and catchment after processing of raw values are complete. Records for a site or overlaps between sites by catchment distance are pulled out of the database for statistical analysis by forming queries based on the Site buffer distance and UniqueID fields.

All output layers that are in grid format are converted to polygon shapefiles. All geographic variable shapefiles are then unioned with the catchment boundaries and have their area in hectares calculated using the Xtools extension. The data table of the resulting shapefile is then imported into the Microsoft Access database and queried by grouping by each classification field and summing by area of each classification using a link table (Figure 18) of catchment fragment identification numbers to connect multiple catchment fragments to the site name and buffer(catchment) distance. The results of this query are used by a Crosstab query which converts each classification record into a column heading (Figure 19).

Statistical Analysis

Once all geographic variables are tabulated in Microsoft Access, the final tables are exported into a Microsoft Excel spreadsheet for statistical analysis. Each variable is tested to see if the results deviate from the expected background distribution of the study area by generating random points and statistically comparing their catchments with the site catchments.

The most widely used statistical test for comparing two geographic samples is the Student's t test. The test is considered to be the most powerful parametric test for this type of application (Siegel 1956:126), however in the context of geography it is often misapplied to non-parametric data (Ebdon 1997:61). The Student's t test requires that data must fit a normal distribution curve. The data for the variables used in this analysis were graphed and found to be nonparametric therefore the Students t test must be replaced with a nonparametric alternative.

Figure 18: Example of link table

Link : Table

BORDEN	BUFFER	BUF_ID
AiHa-10	10000	1199
AiHa-10	10000	1198
AiHa-10	10000	1197
AiHa-10	10000	1196
AiHa-10	10000	1205
AiHa-10	10000	1191
AiHa-10	10000	1206
AiHa-10	10000	1188
AiHa-10	10000	1187
AiHa-10	10000	1186
AiHa-10	10000	1182
AiHa-10	10000	1181
AiHa-10	10000	1179

Record: 1 of 172394

Figure 19: Example of crosstab query

Crosstab Query :

ERA	CLUSTER	BORDEN	NAME	HECTARES	100	200	500	1000	5000
Fur Trade	Spencer-Bronte	AiHa-10	BOGLE 1	0.375	0	0	66.818	203965.519	3552905.222
Fur Trade	Spencer-Bronte	AiHa-11	BOGLE 2	0.25	0	0	0	119202.477	3518786.243
Fur Trade	Spencer-Bronte	AiHa-12	ROBERTSON	3	0	0	0	18467.947	3212399.532
Fur Trade	Spencer-Bronte	AiHa-14	FREELTON	1.012	0	0	45028.945	84065.275	4371904.879
Fur Trade	Spencer-Bronte	AiHa-2	CHRISTIANSON	1.6	0	0	5035.993	74012.967	2512649.864
Fur Trade	Spencer-Bronte	AiHa-5	HAMILTON	2	0	0	0	83782.368	4028464.842
Fur Trade	Spencer-Bronte	AiHa-7	HOOD	0	0	0	0	0	3552374.595

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In similar analyses of archaeological sites, two non-parametric tests have been used: The Kolmogarov-Smirnov test and the Mann-Whitney U test. The Kolmogorav-Smirnov test determines if the cumulative distributions of two samples are drawn from the same population (Siegel 1956:127; Ebdon 1997:54). The Kolmogorav-Smirnov test was used with point data for testing the results of archaeological predictive modeling by Kvamme (1992:31-34) and also by DallaBona (1995:25-31). It has also been used for comparing areas around sites within view sheds (Christopherson et al. 1999:6). The Mann-Whitney U test has been used by Hasenstab (1990:117-118) to compare the relationship of Iroquoian sites to environmental variables. Like the two-sample variation of the Kolmogorav-Smirnov test, the Mann-Whitney U test is a non-parametric test used to determine if the distribution of two independent samples indicate that they are drawn from the same population (Siegel 1956:116; Ebdon 1997:57).

For this analysis the Kolmogorav-Smirnov test is chosen because of the small sample size (N < 40) of the data. The Kolmogorav-Smirnov test considered having a power-efficiency of 96% when compared to the Student's t test, and is considered to be more powerful for small samples than the Mann-Whitney test, which is more efficient for larger samples (Siegel 1956:136).

Variables where site catchments demonstrate significant difference from the background distribution of randomly generated point catchments are reported on by area and percentage according to the traditional method of Site Catchment Analysis. Each set of variables for sites in a cluster is compared and contrasted to the results of the neighboring site clusters. The degree of correlation between site size and catchment values will be calculated using the Spearman's rank correlation. The Spearman's rank correlation coefficient is a statistical test that measures the relationship between two ordered lists of values. It is used for nonparametric data and is capable of measuring both positive and negative correlations (Ebdon 1997:97-98).

The distributions of results are examined for changes between the centre and the periphery of each site cluster. The mean centre can be described as the centre of gravity for a distribution of points (Ebdon 1996:130). The coordinate of the mean centre of each cluster is determined by calculating the mean of all X and Y coordinates. A weighted mean centre is also calculated using site size as a surrogate for population. The linear distance to these mean centre points is calculated for each site to determine if there is a relationship between the site size variable and the proximity to the center or edge of the cluster.