

CONSTANT CHANGES: A STUDY OF ANTHROPOGENIC VEGETATION  
USING POLLEN AND CHARCOAL ON THE  
EASTERN PEQUOT TRIBAL NATION RESERVATION,  
NORTH STONINGTON, CONNECTICUT

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by

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## ABSTRACT

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European colonists and writers portrayed land in the Americas as unused to justify their acquisition of it, but land was far from idle prior to the arrival of Europeans. Native Americans administered their landscapes and employed strategies to maintain resources on their lands in varying degrees. Their land management practices actively engaged the environment in physical and cultural ways and continued to do so during the period of colonialism. However, would colonialism affect indigenous land and resource management techniques, and would Native American responses to colonialism affect the ways in which they managed their natural resources?

My research explored this question as it pertains to the environmental and cultural history of the Eastern Pequot Tribal Nation whose community members continue to occupy their reservation located in North Stonington, Connecticut that was granted in 1683. This study consisted of a pollen analysis of a sediment core taken from the 225-acre reservation, and also included an inspection of charcoal densities, a current

vegetation survey, a documentary review of land use, and a comparison to other pollen studies of the region. My research reconstructed the vegetation and fire history of the reservation and compared the period spanning the Early Archaic to Late Woodland, to colonial times, paying close attention to the period surrounding the establishment of the reservation in the late 17<sup>th</sup> century. This study reviews three types of land and resource management techniques – burning regimes, deforestation and forest regrowth, and horticulture and subsistence strategies - employed by the Eastern Pequot and their ancestors.

The results of my analysis reveal a longstanding history of land and resource management techniques conducted by the Eastern Pequot and their ancestors. Over time, they became more resourceful, throughout periods of stressful climatic events and increasing populations to the area. My research indicates that during the onset of colonialism, the Eastern Pequot maintained many of the same land and resource management practices as their ancestors. The Eastern Pequot worked to preserve their land management techniques, often by employing variations to them and most likely as a result of a limited land base, and to continue their mixed economic strategies.

DEDICATION

FOR GABRIEL AND MARY JACOBUCCI, MY PARENTS

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# CHAPTER 1

## INTRODUCTION

Land did not lie idle prior to the arrival of Europeans to the Americas. Native Americans administered their respective landscapes and employed strategies to their lands to maintain resources in varying degrees. As such, Native American land practices engaged the environment in cultural, economic, and spiritual ways. However, European colonists and writers portrayed just the opposite. Their writings, laced with propaganda and misunderstanding, depicted the landscape as unused and the native people indigenous to these lands as having made no changes or impact to their landscape and neglecting the potential of their environment (Calloway 1997: 135; Day 1953: 329; Jennings 1971: 519-521; Thomas 1976: 1). Interestingly, this falsehood continues today in popular writing and in scholarly works (e.g., Raup 1941; Russell 1983; Salisbury 1982; Sale 1990; and Shelter 1991).

On the other hand, Bragdon (1996), Calloway (1997), Jennings (1971), Williams (1936), and others maintain that lands were populated and utilized by Native Americans, and interconnected by frequently traveled trails for a long period prior to the arrival of Europeans to the Americas. Native American landscapes also contained recognized boundaries that separated various groups of people (Bragdon 1996: 46; Jennings 1971: 523; Williams 1936: 95), a cultural approach to the landscape that is supported by archaeological data (see Dincauze 1990; Hoffman 1990; Snow 1976). Native borders were acknowledged by neighboring groups of indigenous people. Native Americans were only able to pass from one landscape to the next by negotiating first, with other groups of people they encountered, and secondly, with the

characteristics of the landscape. With the arrival of Europeans, indigenous people also negotiated with colonialism, a process that had the potential to impact access to land, uses of resources, relationships to landscape, and community structures. Would colonialism affect Native American land and resource management techniques, and would Native American responses to colonialism affect the ways in which they managed their natural resources?

My research explores this twofold question as it pertains to the environmental and cultural history of the Eastern Pequot Tribal Nation and of their ancestors in southern Connecticut. This study focuses on changes in vegetation and reveals that vegetation in the region encompassing the Eastern Pequot Tribal Nation Reservation was not idle, but was constantly transforming prior to and after the arrival of Europeans to the area. In particular, this analysis focuses on vegetation and landscape changes throughout a long interlude before initial European colonization to the present day, paying close attention to the period surrounding the establishment of the reservation in 1683. The research concentrates on the occupants of the region of the reservation by revealing how their land management activities were directly responsible for the nature of many changes and continuities in plant types leading up to contact with Europeans and through the period of colonization. I have accomplished this by reconstructing the vegetation and fire history of the area containing the Eastern Pequot Tribal Nation Reservation in North Stonington, Connecticut, from the Early Archaic (9,000 - 8,000 BP) to Late Woodland (1000 – 400 BP) periods to serve as a dynamic baseline, and have compared the composition of the vegetation from this period to the complexion of the vegetation that existed during colonial times. Vegetation patterns are also explored as they relate

to the Pequot's maintenance resource strategies to their land during the period of colonization. A University of Massachusetts Boston field school, led by Professor Stephen Silliman, has conducted archaeological excavations on the Eastern Pequot Tribal Nation Reservation during the summers of 2003, 2004, and 2005, and my study participates within this broader Eastern Pequot Archaeological Field School project.

My research consists primarily of a pollen and charcoal density analyses of a sediment core taken from the northwest quadrant of the 225-acre reservation in a perennially damp area that appears to capture a large section of the reservation watershed and includes an inspection of charcoal densities. Accompanying this analysis is a current vegetation survey of the immediate vicinity from where the core was taken. The study is coupled with a documentary review pertaining to land use for the area and a comparison to other pollen studies of the region. With these data, the investigation examines land use choices made by the Eastern Pequot and their ancestors in the context of broader environmental changes. The study compares native land use decisions employed in the immediate area before and after the establishment of the reservation, and reconstructs this ongoing relationship with their landscape. Three areas of land and resource management techniques – horticulture and subsistence strategies, burning regimes, and deforestation and forest re-growth – employed by the Eastern Pequot and their ancestors are examined by this study with the implications of these techniques applied to demographics and colonialism.

This body of research provides a greater understanding of subsistence for the Eastern Pequot. Mason (1966: 7), for example, and others provide “eyewitness” accounts of recently planted corn in the region during the Pequot War (1637-1638).

McBride (1994: 18) points towards archaeological evidence showing that noteworthy alterations in native foodways and technologies had taken place by the middle of the 18<sup>th</sup> century at Mashantucket (southeastern Connecticut), Narragansett (Rhode Island), and Gay Head (Martha's Vineyard) communities. The existing primary-source literature reveals that the Eastern Pequot shielded their crops from intruding cattle (DeForest 1964: 432). Due to the nature of the pollen and charcoal data, my analysis does not speak directly to maize horticulture or to changes in Eastern Pequot foodway technologies, nor does it identify some of the crops that the Eastern Pequot protected. What this study does is reconstruct the floral history of the immediate reservation area by revealing what types of vegetation were available for Eastern Pequot use and couples this information with historic documentation and archaeology to address the issue of foodways in general.

One of the components of native land management practices in southern New England is described as the burning of land in order to clear fields and to alter forests to increase deer densities (e.g., Bragdon 1996; Cronon 1983; Starna 1990; Salisbury 1982; Wagner 2003; Wood 1977). Wood (1997: 30) explains that native inhabitants burned land to suppress underbrush. Wagner (2003: 138) points out that the intention behind burning fluctuated throughout New England and occurred as a result of several factors such as various vegetation associations, natural fire regimes, manners of subsistence, and population density. Did the Eastern Pequot modify or preserve traditional modes of land management practice in the wake of colonialism? Minute pieces of charred wood, or charcoal, frequently appear in sediment cores. Charcoal appears in every processed sample of the sediment core taken from the Eastern Pequot

Tribal Nation Reservation. The analysis of these particles addresses this question and explores how burning may have related to the active management of land.

Pollen grains from the sediment core were examined to detect periods of deforestation and forest re-growth for the reservation and immediate surrounding area. An earlier vegetation study undertaken at Lantern Hill Pond, which is adjacent to the reservation, indicates an increase in grass pollen approximately 300 years ago (Trent 1981: 11). These data suggest a reduction in tree cover during the period of colonialism. My study identifies an increase in grass pollen for the reservation during the same period, but not to the same degree. Possible reasons for this occurrence are explored. This study also reveals periods of deforestation and forest re-growth prior to the arrival of Europeans to the region and examines the relationship between these periods and burning.

Intentional deforestation in the more recent portion of the core, for instance, may have occurred as a result of multiple factors, such as people's need for firewood and building materials, clear-cutting for agriculture, or the sale of wood outside of the reservation. Deforestation could have also come about simply as a result of the Eastern Pequot trying to live mainly as their ancestors had lived prior to colonization. Since the Eastern Pequot were forced to reside on a much smaller parcel of land in the otherwise large area than they had inhabited prior to colonization, the effects of their continued land management practices may have become much more pronounced than they had been before.

In addition, this study provides insight on human demographic data. Periods of deforestation accompany documented increasing populations in the area, and times of

forest re-growth coincide with recorded lower populations. For example, a period of forest re-growth detected in the Eastern Pequot sediment core corresponds with the end of the 18<sup>th</sup> century, when a considerable segment of the Mashantucket population decreased due to the loss of some of their land and the Brotherton Indian Movement (McBride 1996: 89-91). Periods of deforestation and re-growth are analyzed to give a greater understanding of the Eastern Pequot and their ancestors' settlement patterns.

This research focuses on how the Eastern Pequot maintained resource management strategies on their landscape in the wake of colonialism. By only exploring social associations to examine how “people create and re-create their livelihood,” a study may be somewhat limited (Cronon 1983: 13). Ecological relations had a very real impact and should also be consulted in order to ascertain particular information that is not accessible through an examination of other materials (Harris 1994: 444). A lived landscape is a set of relationships, some cultural and social while others are biological, that need to be examined. (Thomas 2001: 173). Cronon (1983: 13) maintained that the relationship between people and their environment is a dialectical one. The Eastern Pequot and their landscape were not mirror images of each other. Instead, they both appear to have been reactive to one another, and neither would have existed in their current form if it had not been for the other. Choices, “both intentional and thought out and . . . routine and comfortable,” were made by the Eastern Pequot and their ancestors regarding their landscape (Silliman 2004: 281). These choices not only affected the Eastern Pequot landscape, but consequences of their management techniques on the land, in turn, affected them.

This study explores some of the selections made by the Eastern Pequot and their ancestors regarding the active management of their land, and it also concentrates on the relationship between land and human demography. To date, no environmental or landscape research of this scope has been conducted on the Eastern Pequot Tribal Nation Reservation. While this study enriches the field of historical archaeology by adding to our understanding of colonial processes in this region, it also reconstructs a portion of the Eastern Pequot and their ancestors' history not yet uncovered. Ingold (1993: 152) maintains, "for both the archaeologist and the native dweller, the landscape tells or rather is – a story." This study addresses issues concerning land use within and around the Eastern Pequots' reservation that accompanied colonization. While the inhabitants of the reservation maneuvered the terrain of colonialism, they made conscious choices pertaining to how they would maintain their lands. This theme is central to the story. Land management selections implemented by the Eastern Pequot and their ancestors have left over the years, and continue to leave today, impressions inscribed onto the area encompassing their reservation land as well as upon them. These impressions are material culture that "adds a texture, a reality, to the surfaces of the past" for the people who inhabited the area (Beaudry et al. 1991: 294). My research attempts to detect and interpret these impressions in order to release their stories from the land.

## CHAPTER 2

### THEORETICAL FRAMEWORKS

#### Landscape Theory

Since the meaning of the word “landscape” has transformed over time (Hirsch 2003: 2) and its concept is not “universal” (Thomas 2003: 166; Thomas 1995: 19-20; Taçon 1999: 33), it would stand to reason that landscape archaeology could not be composed of a singular scheme. Landscapes are deconstructed and contextualized in a variety of fashions. They are interpreted as reconstructions of environments, defined as systems by placing them within “settlement-subsistence systems,” exploited “in relations of domination and resistance,” and experienced from the perspective of how the previous occupants of environments may have comprehended their respective landscapes and infused them with significance (Preucel and Hodder 1996: 32-33). Not only has the meaning of “landscape” metamorphosed but so has the role it plays in archaeological interpretation.

Landscapes were once considered primarily as inert backgrounds of archaeological sites (Ashmore and Knapp 1999: 1-2). In time, this space was no longer viewed simply as “containers” that surrounded people, and became included in the realm of an inhabitant’s “dwelling” space (Thomas 1993: 28). With this perspective, the seemingly distant gap which existed between landscapes and the people who inhabited them appeared to be bridged (Thomas 1993). The relationship between the two was considered to be much more as an intimate association than it was previously thought of, or was it?

Has landscape archaeology truly narrowed this gap or has it remained captive, as Küchler (1993: 85) maintained, to enduring beliefs regarding the characteristics of landscape as a “record of, or stage for, significant human actions”? It is difficult to divorce this assumption from our thinking. In essence, both entities seem to be quite separate from each other. However, the inhabitants of a landscape actually reside within their landscape. For example, they derive subsistence from their landscape and they change it.

The inhabitants’ world is composed of makeshift collages that they construct out of their environment. Their patchwork existence is fashioned out of materials they select from their environment and locations they inhabit. The impact of their existence on the environment remains long after their demise. The materials and locations adopted by the inhabitant are not only internalized by the individual who selects them, but also by the community in which the individual resides. The inhabitants experience the materials and locations and assign familiar alternate meanings to them. It is this association that Thomas defines as “social relations structured by meaningfulness, not mechanical relations between things” (Thomas 1993: 29). Even though the boundaries between landscapes and inhabitants appear to be visible, in fact, they are also invisible, just like the boundaries that existed between groups of native people to the European eye. Items from the environment and places inhabited by people become personalized and transform into extensions of the inhabitants. Therefore, the margins between the inhabitant and the personalized environment are fluid, making it difficult to examine one in its totality without taking a look at the other.

Are landscapes both passive and active at once? The landscape records the activities of its inhabitants and reduces these actions to events that are represented as particular points of time. For example, archaeological sites can date to specific events and spans of time. However, the landscape stores the residue of many events. Because the residue or points of time fit together to form an interconnected unremitting chain of the inhabitant's activities for a specific site, which represent "a continuous flow of conduct," the passive events are also active and are propelled in motion by time (Giddens 1979: 55). Therefore, landscapes are passive and active at once, an end product of the two extremes. Landscapes possess continuous testimonies of human behaviors and ecological conditions (Thomas 1993: 19), and as a result by no means could they ever be absolutely passive. Landscapes are both the driving force in the fabrication of culture as well as the "powerful agent[s] in the production of culture" (Harris 1999: 435), where "people engage with it, re-work it, appropriate and contest it" (Bender 1993: 3).

Landscapes take on a variety of meanings for specific periods of time. Kealhofer (1999: 61) points out that Tilley defines "space" as "the medium of action" in that it is "situationally empowered with temporally specific and often contradictory meaning" and presents a "middle ground between the economic, objectifying view of space and the idealist view of space as individually subjective." For example, a stand of oak (*Quercus*) trees exists in its natural form, but assumes another reality in the minds of people viewing that stand. The stand of oak trees could, for example, symbolize a monetary gain for members of a community who may be looking to earn a profit on the lumber harvested from it, but for an associate of the same community, the stand could

also represent a memory of a special place that perhaps served as a playground to them and their friends when they were young. For the associate, the stand of oak trees takes on a more familiar intimate meaning. Kealhofer (1999: 61) interprets this “middle ground” as dialectic in nature “where people create places which define space, and people’s identities are in turn defined by their place.” It is here in this “middle ground” that the conflict between opposites, objectivity and subjectivity, blend into one another to form something else (Engels 1940: 153, 206-207). Passivity and activity also intermingle in this “middle ground.” Thus a landscape is personified by the behaviors and tendencies of the inhabitants who dwell upon it (Thomas 2001: 174), but the landscape also shapes the inhabitant’s actions and inclinations towards it.

Landscapes are unique not only in their physical state, but also in how their inhabitants perceive them, and for the manner in which archaeologists try not to internalize not only the landscapes by assigning their own personal meaning on to them, but also the people who inhabit them by basing their interpretations on preconceived notions. A critical component to knowledge about landscape archaeology is the way that archaeologists view landscapes (Thomas 1993: 24-25). By dissecting and defining specific locations of the environment, do we run the risk of representing our interpretations of these locales as “the whole story, the full picture” of the past (Thomas 1993: 24)? Can archaeologists disconnect the manner in which they distinguish the present from the way they interpret the past (Nassaney 1989: 89)? Are we capable of being truly objective when we look at landscapes, or do we unconsciously imbue and map our own impressions onto them, confusing our notions with those belonging to the inhabitants under study, to create something else that is

neither the inhabitants' impressions of the landscape nor our own? Interpretations laden with assumptions and preconceived notions must be cautiously considered.

Redman (1999) maintains that humans repeatedly formulate choices regarding land use, which overpoweringly shape the form of their immediate landscape, thereby circumscribing their own fate. Redman (1999: 7-11) provides an extreme example of this and outlines land management activities of the inhabitants of Easter Island, which ultimately sealed their future. We need to keep in mind that all people shape their landscape, but the array of human impact on the environment is highly variable (Rambo 1985: 28). This study will explore the choices and possible reasons behind the selections made by the Eastern Pequot regarding land use and will also examine the repercussions of their choices on the environment. The sediment core obtained from the Eastern Pequot Tribal Nation Reservation reveals an active landscape before and during colonization, and data contained within it highlight some of the land use selections enacted upon by the Eastern Pequot and their ancestors to mold and contour their landscape. McBride (1994: 8) maintains that "native responses to European contact must be seen within the context of this long history of adaptation to changes in the natural and social environment." My study views Eastern Pequot responses to European contact in this manner.

I do not pretend that my interpretation of the Eastern Pequot landscape represents the "full picture" of their past as this study only examines a portion of their landscape history. Nor do I intend to infuse my own biases into the analysis. My research scheme in particular reconstructs and explores the "middle ground" between the reservation landscape and the immediate area and the Eastern Pequot and their

ancestors as it is defined by the vegetation and charcoal history of the reservation land, the archaeological record, and historical documentation. A comparison is made between the nature of this “middle ground” for the period before colonization and throughout it. It is here in this “middle ground” that the history of land management activities for the Eastern Pequot and their ancestors, set within broader ecological changes and continuities, are examined in this study.

The vegetation and fire history of this area will be examined as interconnected moving points of time in order to catch a glimpse of the relationship that has existed between the Eastern Pequot and their ancestors and the region containing the reservation land. The implications of why the Eastern Pequot and their ancestors shaped the region’s vegetation and burned in the manner that they did will be examined. The role that the vegetation and fire history played in defining the Eastern Pequot’s land management practices will be studied in hopes of recognizing how they and their ancestors may have comprehended and infused this history with significance (Trigg 2003: 65).

### **Phytogeography**

Daubenmire (1968: 13) maintained that members of various vegetation species are not aimlessly sprinkled about a landscape. Instead, they are dispersed in patterns that function as a system, and he suggests that living entities comprising a pattern are ecologically related (Daubenmire 1968: 13). For Daubenmire (1968: 1), various species are complementary in their use of environmental resources, but remain constantly in competition with each other for these resources. Tilman (1988: 5)

expressed that visible patterns in the environment are as a result of limitations placed on vegetation by the “physical and biotic environment” and by the concessions made by vegetation to cope with the restrictions.

Some of the restrictions facing vegetation are twofold. “All species are consumers of resources, some of which may be in short supply” (Tilman 1988: 5). Plants need, for example, mineral nutrients, water, carbon dioxide, and light in order to perpetuate (Tilman 1988: 5). However, plants are ingested by herbivores, afflicted by parasites and pathogens, and interrupted by assorted disturbances to their environment (Tilman 1988: 5). As mentioned, the environment has also been distressed by actions of human beings. Climatic variation is characterized as a main disruption to the environment and it has a differential impact on species (Bartlein et al. 1986: 53).

Daubenmire (1968: 16) classified vegetation types as either “dominants” or “subordinates.” For example, taller plant species, for the most part, can be considered as dominants for the main reason that they are capable of blocking light from shorter species. However, in the case of a young forest, the playing field is altered. Vegetation usually considered as subordinates are not affected as much by plants typically considered as dominant types, resulting in a different floral pattern than one usually controlled by dominant species (Daubenmire 1968: 16). For instance, red maple (*Acer rubrum*) is capable of attaining a taller height at 20 years of age than red oak (*Quercus rubra*); however, the pace of height development for red maple diminishes more quickly than that of red oak, which accelerates. Therefore, by 40 years of age, the “relative canopy positions” of the two species are overturned (Hibbs 1983: 1395). “A

kind of plant very rarely has a monopoly of an area, but must share it with others”  
(Gleason and Cronquist 1964: 58).

Both Daubenmire and Tilman agree that a succession in plant types in a particular area can be seen over time, as numerous vegetation types achieve stages of fleeting supremacy before being displaced by other types of flora (Tilman 1988: 211; see also, Egler 1954; Hibbs 1983; Niering 1987). Over longer periods, climatic change is often responsible for the migration of vegetation types into new areas (Gleason and Cronquist 1964: 92). Succession and migration of flora in a specific location comprise vegetation patterns. My research reveals continuously changing vegetation patterns on the Eastern Pequot Tribal Nation Reservation and surrounding area, and it is these patterns that will be discussed in greater detail as they related to climatic change, vegetation succession history, and human activity.

### **Fire History**

The effect of humans on the landscape can be studied by not only examining pollen, but also by analyzing charcoal remains (Pearsall 2000: 6). Charcoal dust or charcoal particles are by-products of burning wood and other vegetation types, and the fires that produced these particles can be categorized as either naturally occurring or human provoked (Faegri et al. 1989: 183). Charcoal has been analyzed to recreate fire histories for specific areas, resulting in the recognition of “the dynamics of vegetation and of human interaction with the environment” (Clark 1982: 523). There are many studies that use microscopic charcoal remains to investigate fire as a land management tool (see Clark and Royall 1996; Larsen and MacDonald 1998; Patterson and Sassaman

1988; Robinson 1987; Whitlock 2001). This study considers charcoal particles detected from some of the samples of the Eastern Pequot sediment core as a byproduct of Eastern Pequot and their ancestors land management.

First-hand accounts outline native burning regimes of the Northeast during the period of exploration by Europeans (see Bromley 1935; Williams 1936; Wood 1977); however, debate continues about whether or not native populations practiced burning regimes prior to the arrival of Europeans (see Russell 1983). In a study that focused on several native sites in New England, Parshall and Foster (2002: 1305) believe climate, “which has a direct effect on the physical conditions conducive to fire ignition and spread and an indirect effect of fire through its control on the distribution of vegetation at this spatial scale,” was largely responsible for the allocation of fire across the region. Their findings indicate that charcoal was more abundant at sites located at lower elevations, in well-drained outwash deposits, and in pitch pine forests rather than in northern hardwood forests, and that certain “landscape attributes” may have impacted fire incidence about these sites (Parshall and Foster 2002: 1312, 1315). Even though their study is limited to the past 1500 years, they maintain that the amount of recovered charcoal increases significantly upon the arrival of Europeans to the area (Parshall and Foster 2002: 1313). Still, they indicate it is “likely” that Native Americans “influenced the local occurrence of fire” (Parshall and Foster 2002: 1305). Not all known Native American sites in northeastern North America that were sampled by Clark and Royall (1996: 365) revealed any charcoal; however, some of these sites contained obvious amounts of charcoal during their occupation. Patterson and Sassaman (1988: 113) report that lightning is the chief source of natural ignitions in the United States, but its

impact on the eastern portion of the country is not as significant as elsewhere. They maintain lightning fires are uncommon along the coast and in southern New England, possibly due to the plentiful moisture connected with coastal thunderstorms, and credit human land management practices as being the reason why charcoal is recovered from these locations (Patterson and Sassaman 1988: 113). Patterson and Sassaman (1988: 113) maintain that fires seem to be most widespread where population densities are greatest, and they believe that this “pattern” was evident, as verified by the archaeological record, before the arrival of Europeans to the area.

Parshall and Foster (2002), like Patterson and Sassaman (1988), maintain that Native American burning regimes had a more localized versus regional impact on the landscape. The charcoal recovered from the Eastern Pequot sediment core speaks to a localized impact on the landscape. A climax in a charcoal particle curve in a pollen diagram could indicate unintentional forest fires that were either set by human hand or by nature; whereas, the mere habitual occupancy of an area with associated cultivation practices creates more of a homogeneous, unremitting arc in the charcoal curve (Faegri et al. 1989: 183). It is likely that a low accumulation of charcoal for an area not possessing environmental and climatic conditions conducive to natural fire probably reflects the “natural or quasi-natural regional fire activities under the environmental conditions of that time” for the area (Tinner et al. 2005: 1219-1220). My study focuses on the peaks, arcs, and dips of the charcoal particle curve, which was created out of recovered data from the Eastern Pequot sediment core. It also takes into consideration environmental factors conducive to burning in the region and archaeological data from the immediate area. This study discusses whether the peaks, arcs, and dips of the

Eastern Pequot charcoal particle curve could be the result of an unintentional act of nature or intentionally set fires by the inhabitants of the landscape.

## **CHAPTER 3**

### **HISTORY**

#### **Location of Subject**

The Eastern Pequot Tribal Nation Reservation, located in North Stonington, Connecticut, is situated in the southeast corner of the state and is approximately 16 km from Long Island Sound. The reservation currently has a size of roughly 91 ha (225 acres). It is included within the Old Mystic U.S.G.S. Quadrangle and the Coastal Slope region geological zone. The bedrock of this area is characterized as crystalline in nature, and is composed mainly of schists, gneiss, and to a lesser extent of granites and other comparatively resistant rocks (Canavan and Siver 1995: 21). The topography of the reservation is steep and has a recorded elevation of approximately 29 m (95') above sea level along its westernmost boundary, while an elevation of about 122 m (400') above sea level is recorded along the reservation's northeast corner. Composed primarily of quartz, Lantern Hill, having a highpoint elevation of approximately 146 m (478') above sea level, is a major physiographic feature that lies to the immediate northwest of the reservation, and another, Long Pond, at roughly 29 m (95') above sea level is located directly west of the reservation.

#### **Vegetation History**

Prentice and others (1991: 2054) consider climatic changes over the previous 18,000 years for eastern North America as "substantial, continuous, and responsible for the large vegetational changes that are a major feature of the Late-Quaternary pollen record including the Holocene." Newby and others (2000: 365) record a major change

at both the Makepeace Cedar Swamp located in southeastern Massachusetts near Carver, and at the Pequot Cedar Swamp situated near Ledyard, Connecticut, which borders the town of North Stonington, from an open-water basin during the late Pleistocene to a mire in the late Holocene, which indicates a period of warmer and drier conditions. A key characteristic of the vegetation history for southern and central New England during the Holocene is the development and expansion of the deciduous forest and the movement of northern mixed conifer and hardwood forest northward in response to warming climatic trends (Doucette and Cross 1997: 18). Some of the latest research signifies that regions during this period were not homogenous. Areas probably contained spaces of “treeless vegetation,” which co-occurred with “mosaics of trees” (Doucette and Cross 1997: 18-19), perhaps reflecting a transition from an herb pollen zone to a spruce pollen zone and then to a spruce-oak pollen zone (Davis 1969: 415). A pollen study conducted for Rogers Lake, a large (107 ha) lake situated approximately 30 km WSW of the Eastern Pequot Tribal Nation Reservation, reveals that some of the oldest sediments dated to 14,300 to 12,150 BP were comprised mostly of herbs including sedges, grasses, sages (*Artemisia*), sorrels (*Rumex*), and rues (*Thalictrum*) (Davis 1969). Arboreal pollen was present during this period, but numbers for it were represented by very few pollen grains. Davis (1969: 415) contends that they were present only as a result of the low pollen output by herbs that were unsuccessful in masking the distant transported tree pollen present in the sediment.

Arboreal pollen increases at Rogers Lake approximately 12,000 BP. Birch (*Betula*) expanded into northeastern North America at this time (Prentice et al. 1991: 2046), and maximum values for it were reached at Rogers Lake at 9,150 and 9,500 BP.

Davis (1969: 415) notes a zone, which is characterized by a majority of birch pollen and increasing amounts of spruce (*Picea*) and poplar, is also visible in pollen diagrams from numerous sites located in Connecticut and central Massachusetts at this time. Newby and others (2000) acknowledge a second spruce pollen increase at the Makepeace Cedar Swamp to be 12,550 BP, which correlates to the same peak represented for Rogers Lake at 12,530 BP (Davis 1969: 359).

In a previous study, pollen was extracted and studied from two sediment cores taken from Lantern Hill Pond, a small (6 ha) glacial kettle pond in Ledyard, Connecticut, situated approximately 800-1,000 m NW of the location of the sediment core that I analyzed (Trent 1981). Processed pollen from Lantern Hill Pond revealed between 10,200 to 11,160 BP that spruce, representing 35% of the vegetation, and pine (*Pinus*) were broadly present in the region. Maximum values for birch were reached here between 10,200 to 10,600 BP. An initial rise in pine pollen at the Makepeace Cedar Swamp was recorded at 11,480 BP (Newby et al. 2000: 359). Pine pollen became more numerous at Lantern Hill Pond approximately 10,200 BP (Trent 1981: 8). By 12,000 BP, alder (*Alnus*) was restricted to more northerly portions of eastern North America due to warming conditions in the southeast (Prentice et al. 1991: 2050). Alder peaked at Lantern Hill Pond around 10,600 BP with a value representing 35% of the vegetation, while the pollen deposition rate for this species increased at Rogers Lake from between 9,100 to 12,200 BP. Interestingly, Trent (1981: 8 and 17) maintains that the majority of pine pollen represented in the Pine-Oak zone at Lantern Hill Pond, dated from 8,700 to 10,200 BP is of white pine origin, as eastern white pine, for

example, “colonizes burns if a seed source is nearby”

([http://www.fs.fed.us/database/feis/plants/tree/pinstr/fire\\_effects.html](http://www.fs.fed.us/database/feis/plants/tree/pinstr/fire_effects.html) 1).

Oak spread northward in North America around 12,000 BP due to temperature increases for winter and summer seasons (Prentice et al. 1991: 2046). Newby and others (2000: 359) note a rise in oak for the Makepeace Cedar Swamp at 10,110 BP, while for Rogers Lake the rise is recorded to have occurred at 10,750 BP (Davis 1969). Numbers for oak begin to increase at Lantern Hill Pond from 8% at 10,200 BP to 50% at 8,700 BP and remained at this level until 200 BP (Trent 1981: 9-10). Maple (*Acer*) first appeared at Lantern Hill Pond at 10,200 BP and reached values close to 5% of the pollen sum around 8,700 BP. Red maple first appeared around 9,000 BP at Rogers Lake (Davis 1969: 419). At Rogers Lake, pollen of poplar, birch, alder, hop-hornbeam (*Ostrya*), oak, hemlock (*Tsuga*), and fern spores reached maximum values over previous ones from 7,900-8,100 BP, while pollen percentages of spruce, fir (*Abies*), and larch (*Larix*) rapidly decreased at this time. Davis (1969: 418) attributes these dramatic alterations in the vegetation to climatic changes and also notes a rise in ragweed (*Ambrosia*) at 8,000 BP. She believes this increase is as a result of “decreased density of forest, brought about by climatic changes associated with the expansion of prairie in the Great Lakes region 8,000 years ago” (1969: 419). During the middle Holocene, 8,000-5,000 BP, “sediments and plant macrofossils document a drying period” (McWeeney 1999: 9). A pollen study conducted at Kirchner Marsh, located near Minneapolis, Minnesota, exhibits a spike in herb pollen from 8,000 to 5,000 years ago in response to these climatic conditions (Webb 1980: 759). A spike in ragweed pollen is also recorded at Lantern Hill Pond, but at a later date of 6,700 BP. Newby and others

(2000: 365) record a period of slow sediment accumulation and drier conditions at Makepeace Cedar Swamp from 10,000 to 8,000 cal yr BP and at Pequot Cedar Swamp between 8,400 and 5,000 cal yr BP.

Beech (*Fagus*) stretched into northeastern North America around 9,000 BP and increased after 6,000 BP due to amplified precipitation (Prentice et al. 1991: 2049). At Lantern Hill Pond, this species reached numbers around 7% of the pollen sum around 6,700 BP (Trent 1981: 11). The appearance of beech at Rogers Lake is recorded at 6,500 BP. Davis (1969: 421) maintains that there were “successive immigrations” to Connecticut of “first beech, then hickory (*Carya*), and then chestnut (*Castanea*)” with dated higher frequencies for each species in chronological succession between 4,500 to 2,000 BP. Hickory followed oak and spread from the southeastern portion of North America into the Appalachian region between 9,000 and 6,000 BP due to warming summers and increased precipitation (Prentice et al. 1991: 2047; Webb III and Bartlein 1992: 152). It first appeared in the Lantern Hill Study from 3,300 - 5,500 BP when it amounted to more than 5% of the pollen sum. Hickory was present 5,500 BP at Rogers Lake (Davis 1969: 419). During 5,600 to 250 cal yr BP, grass pollen dominated at Makepeace Cedar Swamp before declining from 40% to 15%, while hemlock also declined during this period and a renewed peat deposition was noted (Newby et al. 2000: 362).

Davis (1969: 421) proposes that forest communities of southern Connecticut are of a “recent origin” and adequately analogous to pollen assemblages from only 2,000 years ago. Of course chestnut (*Castanea*) pollen would appear in the modern day pollen spectrum in limited numbers due to blight in the early 1900s that greatly

decimated this species (Paillet 1982; Paillet 2002; Russell 1987). However, numerous, fairly “short neoglacial periods” were present within the “long-term climatic record of the last 10,000 years,” and these periods had an effect on vegetation (Webb 1980: 762). One of these periods, characterized by cooler weather in North America and Europe, was called the “Little Ice Age,” and it lasted from A.D. 1450 to 1850 (Murphy and Nance 1999: 494). At Kirchner Marsh, as mentioned situated near Minneapolis, Minnesota, percentages for hemlock, pine, and spruce were two to ten units higher from A.D. 1430 to 1860 than they previously were, and Webb (1980: 765) attributes the increases of these taxa to the “Little Ice Age.” Increased amounts of spruce and hemlock were recorded at Makepeace Cedar Swamp as well as ragweed, birch, and chestnut pollen from 250 cal yr BP (Newby et al. 2000: 362). At one time, chestnut numbers exploded in New England, and it comprised approximately 25% of the trees in the area (Tindall et al. 2004: 2555). Davis records an increase of chestnut at Rogers Lake about 2,000 BP (Davis 1969: 419). While for Lantern Hill Pond, the increase in this species is not evident until 300 BP (Trent 1981: 14).

### **Cultural History**

Archaeological evidence supports a continuous native presence in southern New England starting as early as 12,000 to 11,000 years ago (Dincauze 1990: 19). Paleoindians, also dubbed “Pioneers” by Dincauze (1990: 20), were the earliest inhabitants to the area. The archaeological sketch of the lifeways of these people is limited at best. Paleoindians have been characterized in archaeological literature as having lived in small campsites, most likely for short-term occupations, as hunters of

large and small game, and collectors of vegetation (Hoffman 1990: 35-36). The population during this time is considered to have been of low density; however, larger encampments like the Bull Brook site in Ipswich, Massachusetts, have been revisited to see what additional information that may have been missed can be gleaned of these people (Dincauze 1990: 20).

From 10,000 – 9,000 years ago, because of the scanty archaeological record in southern New England, populations appear to have decreased perhaps as a result of seasonal extremes experienced in the region (Dincauze 1990: 23; Hoffman 1990: 68). Around 8,000 years ago things began to change and remained that way until approximately 5,500 years ago. Dincauze describes the inhabitants of the area at this time as having transitioned from a highly mobile “Pioneer Phase” to more of a sedentary “Early Settler period” due to evidence of larger populations residing “in archaeologically more-visible groups”, groups that did not relocate as often as they had before (Dincauze 1990: 23-24). Numerous dated sites have been recovered during this time, such as the Neville site located in southern New Hampshire (Dincauze 1976), the Green Hill site situated in the Blue Hills south of Boston, Massachusetts (Rosser 1980), the Assanappet Pond site located in Carver, Massachusetts with approximately 45 other Early to Middle Archaic sites located within a 16 km radius to this site on record with the Massachusetts Historical Commission inventory (Doucette 2005), and sites associated with Mashantucket, located in Ledyard, Connecticut (Jones 1999, 2002).

Snow (1976) maintains that natural resources in the New England region became increasingly more essential during the Early to Middle Archaic periods. Many sites dated to this time were located in wetland areas (Doucette 2005) and along fall lines of

significant rivers (Hoffman 1990). They contained artifacts such as stone plummets and grinding stones, perhaps also supporting a reliance on local vegetation and animal species as food sources. An examination of the contents of possible storage pits recovered at the Cedar Swamp-9 site in Westborough, Massachusetts, also shows increased reliance on local food resources during this period (Hoffman 1990).

Populations are characterized as having increased substantially during the Late Archaic (6,000 – 3,700 BP) and into the Transitional (Terminal) Archaic (3,700 – 2,700 BP) in New England. However, according to McBride (1995: 15-16), the lowest incidence of archaeological sites at the Mashantucket Pequot Reservation date to the Late Archaic Period (6,000 – 4,000 BP), while the highest density of prehistoric sites corresponded to the Middle and Transitional Archaic Periods. Conversely, Jones (2002: 17, 18, 20-22) reports that at Mashantucket, 38 out of a total of 119 recovered prehistoric components were dated to the Late Archaic based upon 243 diagnostic artifacts and 10 radiocarbon dates. Because of the “number of small temporary or task specific sites,” Jones (2002) and McBride (1995) believe hunting may have been an important activity at this location during this time.

Villages during the close of the Late Archaic into the Transitional Archaic are usually found in close proximity to an abundance of natural resources; for example they were located within forest clearings and among numerous types of nut trees. At Cliff Palace Pond in Kentucky, nutshells of acorns, hickories, black walnut, butternut, and chestnut were the most plentiful of macrobotanical remains dated not only to the Early Archaic, but also spanning the past 4,000 years (Delcourt et al. 1998: 263, 266). Because “eastern forests are capable of yielding enormous amounts of mast,” it is

probable that native inhabitants of southern New England may have “managed tree stands” by “thinning the forest around productive trees” (Gardner 1997: 170-171). On Hunter Island, Bronx County, New York, Loeb (1998) maintains that native inhabitants of the area planted hickory. Carbonized hickory shell and oak acorn dated to the Late Archaic and Transitional Archaic have been found at sites situated in the Narragansett Bay region (Bernstein 1992: 4). Roasting pits for hickory nuts were found at a North Kingston, Rhode Island site dated from 4,500 to 4,000 BP (Bernstein 1992: 6).

Dincauze (1990: 24) believes “life seems to have been good, and perhaps relatively easy at this time.” Overcrowding has even been interpreted at the Wapanucket 6 site in Middleborough, Massachusetts, dated to 4,300 BP, as the remains of several dwellings were located outside of the probable boundary of the village (Hoffman 1990). Faunal remains from this period reveal more of a variety in “resource use” than earlier times (Crawford and Smith 2003: 192). Jones (2002: 22) references research (Perry 2000a, 2000b) that was conducted on the carbonized remains of aquatic tubers such as cat-tail (*Typha latifolia*), water lily (*Nymphaea odorata*), water plantain (*Alisma*), wild rice (*Zizania palustris*), wild leek (*Allium tricoccum*), and Indian cucumber (*Medeola virginiana*), among other edible plant taxa, which were recovered from Preston Plains, a large Late Archaic site located at Mashantucket. Two sites situated in the Connecticut River valley, one located in Old Lyme, Connecticut, which yielded a radiocarbon date of 4,775 +/- 120, indicate that chenopodium was gathered and possibly stored at that time in subterranean pits (Bendremer 1999: 146; George and Dewar 1999: 122). Water lilies and the fruit of the channeled Solomon’s seal (*Polygonatum canaliculatum*) were also collected (Bennett 1955: 390). A charred stem

of a water lily was also recovered at Cedar Swamp, in Westborough, Massachusetts (Largy 1992: 34).

Different types of dwellings and facilities like fishweirs appear in the archaeological record as well as elaborate grave goods and woodworking tools (Dincauze 1990). Increased ceremonialism has been detected at this time as indicated by red ochre burials, further implying that the inhabitants were connected to their landscapes in a spiritual way (Dincauze 1990: 25; Hoffman 1990: 163). Stone mullers, mortars, and pestles have been excavated from sites dating to this period. Artifacts that had emerged at earlier periods such as anvils, grinding stones, and nutting stones were also included in these assemblages, perhaps indicating an increased and continual dependence upon nuts and plants. As a result of escalating populations and evidence of increased ceremonialism and trade in the archaeological record, social relations are thought to have intensified between neighboring groups of people (Dincauze 1990: 25; Hoffman 1990: 174).

The Woodland periods in southern New England are distinguished by ground and polished stone tools, villages, and pottery possibly as a result of the need for storage (Dincauze 1990: 28), domesticated plants and animals (Moeller 1987: 9), and horticulture as evident not only by the remains of cultigens like tobacco and maize, but also by artifacts including triangular and stem hoes. Like burning regimes, “the relative importance of maize horticulture varied in different parts of southern New England” (Bendremer 1999: 134). There are approximately 48 prehistoric sites in New England where the remains of tropical cultigens such as maize (*Zea mays*), beans (*Phaseolus vulgaris*), squash (*Cucurbita* sp.), and an indigenous cultigen, sunflower (*Helianthus*

*annuus*), have been found (Bendremer 1999: 136). Nuts and plants continued to be gathered at this time and are present in the archaeological record (Bendremer 1999; Bernstein 1992; Largy 1992). A single carbonized hazelnut fragment was found on an Early Woodland Mashantucket site; however, several “enigmatic inverted bell-shaped pits” dated to this period are believed to have served as winter nut storage facilities (Jones 2002: 22-23). Eight subterranean storage pits containing fragments of carbonized acorns, hazelnuts, and hickory nuts dated to about 2000 BP were recovered from a North Kingstown, Rhode Island site (Bernstein 1992: 6). Some of the Middle Woodland sites excavated at Mashantucket contained cat-tail, wood fern (*Dryopteris spinulosa*), nutsedge (*Cyperus esculentus*) and channeled Solomon’s seal (Jones 2002: 23). The Goldkrest Site located in East Greenbush, New York, yielded numerous nutshells of butternut (*Juglans cinerea*) from three features dated to the Late Woodland/Early Historic period (Largy et al. 1999: 79). Charred wood remains possibly representing remnant firewood of both white and red oak, hickory, and chestnut dated to the Middle Woodland period were recovered from Cedar Swamp, in Westborough, Massachusetts (Largy 1992).

Approximately 2,500 years ago the archaeological record indicates that there were increasing population densities along the coast and estuaries, which eventually resulted in the formation of year-round rather than only seasonal villages (McBride 1994: 8). However, around A.D. 1500 – 1600, diminutive and multifaceted seasonal camps appeared possibly as a result of individual households setting out from villages for part of the year in search of resources were recovered (McBride 1994: 12), thereby attesting to the longevity of the seasonal round. Several of these seasonal camps have been

located at Mashantucket, and were used as “a hunting or foraging area” by people who occupied permanent homes “in large, occasionally fortified, long-term settlements located farther downriver near Long Island Sound along the lower Mystic and Thames Rivers” (McBride and Grumet 1996: 15, 17).

By A.D. 1630, written accounts acknowledge that a group of native inhabitants, called Pequot, had populated an extensive area consisting of the present day Connecticut Valley as far north as Windsor, Connecticut, and included eastern Long Island as well. Although the degree of the Pequot’s reliance on maize agriculture just prior to colonization is debated (see Bendremer 1999; Bragdon 1996; Chilton 1999; Thorbahn 1988), horticulture in this region was reported to be at the heart of their subsistence, while hunting, gathering, and fishing were complementary to it. A wide variety of wild plants and fruits continued to be utilized (Starna 1990: 34-36).

After the Pequot War in 1637-1638, natives were prohibited from gathering in large groups in this region until the 1650s (McBride 1990: 97). Even though native people were forbidden from the area, some of them remained and interacted with colonizers. For example, Thomas Stanton traded with Natives and operated a trading house at Pawcatuck in 1642 (<http://www.rootsweb.com/~ctnewlon/billc1625.html> 14). Pequot presence continued to be felt in the region as evident by the colonizers initially referring to former Pequot lands, as “Pequot” or “Pequot territory” until the name of the area became to be later known as “Southerton,” then to “Mystic,” and finally in 1666, the General Court of Connecticut renamed it Stonington (<http://www.rootsweb.com/~ctnewlon/NLHistoricalChurch3.htm> 3). Tracts of former Pequot lands were granted to some of the colonizers. Captain John Mason for one, who

led the attack on the Natives during the Pequot War, was granted a 500-acre tract of their land in 1641 (<http://www.rootsweb.com/~ctnewlon/billc1625.html> 13).

Archaeological evidence indicates that Pequot use of Mashantucket temporarily moderated in the years immediately following the Pequot War; however throughout the second half of the seventeenth century, the region yet again developed into a significant hunting and foraging location for Pequot people (McBride and Grumet 1996: 15).

After the Pequot War, two persevering Pequot groups continued to seek out political sovereignty during the 1600s. One of these groups, the Pawcatuck Pequot (Eastern Pequot), was granted a 113.32 ha (280-acre) reservation in North Stonington where their descendants reside today, on slightly less acreage (McBride 1996: 79). Following through on his deceased brother's wishes, James Minor, a colonist from England, saw to it that his brother Sam's land was "made available to one Momohoe, an Indian, with his company to dwell upon and use during the courts' pleasure" (Public Records of the Colony of Connecticut, May 1717-October 1725 Vol. 6: 352). That is, this land was finally returned to the original inhabitants of it.

### **Fire and Human Disturbance**

A survey of documented human impacts on the environment can complement the archaeological and documentary histories summarized above. As mentioned earlier, several studies argue the overall effect that fire regimes practiced throughout prehistoric times in northeastern North America had on the environment (see also Abrams and Seischab 1997; Clark and Royall 1996; Clark 1997). For example, Clark and Royall (1996) did not detect an indication of fire in their sampled areas of mixed oak forests,

where it has been believed that fire is an essential component for oak recruitment, which thereby increases percentages of this species (see Brown Jr. 1960; Dorney and Dorney 1989). However, there is no doubt that burning alters vegetation distribution and composition (see Brown Jr. 1960; Cronon 1983; Dorney and Dorney 1989; Kirwan and Shugart 2000; Niering and Dreyer 1989; Swain 1973; Tinner et al. 2005).

Davis (1969) discusses Niering and Goodwin's (1962) view regarding the effects of fires set by Native Americans during prehistoric times. They proposed that as native burning became more and more frequent, fire-sensitive species such as white pine, hemlock, beech and maple were limited to further sheltered sites, while xerophytic types including oak, hickory, and chestnut became more widespread (Davis 1969: 420; Niering and Goodwin 1962: 45-46). Interestingly, Delcourt and Delcourt (1997: 1010) maintain that "fire suppression" in the southern Appalachians is generally believed to be the cause for a decline in regeneration of oak and fire-adapted species. Motzkin and others (1993), describe vegetation changes related to pre-European fire occurrences on an Atlantic white cedar (*Chamaecyparis thyoides*) wetland on Cape Cod, Massachusetts. Cedar pollen percentages along with moss (*Sphagnum*) and fern allies are inversely related for this study. Cedar pollen decreased as amounts of charcoal increased, while percentages of moss and fern spores increased (Motzkin et al. 1993: 397). Nevertheless, the studies by Abrams and Seischab (1997), Clark and Royall (1996), and Clark (1997) are necessary to help consider additional factors that could be responsible for altering vegetation.

A study conducted by Oldfield (1978) in Nova Scotia cited a rise in alder and a decrease in hemlock as indicators of human disturbance (Russell et al. 1993: 648).

Hemlock first declined at Rogers Lake approximately 4,630 BP, but the incidence for it has been low since 2,000 BP, while the regularity of chestnut during this same period is higher (Trent 1981: 12; Davis 1969: 419-420). The hemlock decline at Lantern Hill Pond is recorded between 5,500 to 4,800 BP (Trent 1981: 12). Several studies suggest that the decline of hemlock and beech during the mid-Holocene may have occurred as a result of human disturbance (Davis 1969; Russell et al. 1993), while Bhiry and Filion (1996) believe phytophagous insect activity was responsible. Still others maintain that decreases were due to climate (Gajewski et al. 1987; Jacobson & R. Davis 1988).

For the Linsley Pond study in North Branford, Connecticut, Brugham (1978a: 358) reports that across the European colonization horizon, lower percentages for hemlock pollen existed in comparison to other arboreal types, excluding beech pollen, which had decreased during a much earlier time. Russell and others (1993: 651) maintain that increases in ragweed appeared in the upper sections of pollen cores obtained from areas in Maine where there was hardly any evidence for agriculture, while pollen percentages for white pine and hemlock dramatically decreased. However, their findings are interpreted from 55 sites located in the northeastern United States, which revealed an increase in spruce and pine and a decrease in birch and beech approximately 325 years before colonization (Russell et al. 1993: 655). Perhaps the increase of spruce and pine detected by their study is an indication of cooler climate brought on by the “Little Ice Age” or an indication of fire as some species of pine; for example, white pine, as mentioned earlier, colonizes burned areas. Russell and others (1993: 655) began to see a decline in spruce and pine from A.D. 1650 – 1750 as well as increases in birch and maple during this period.

Rogers Lake shows increasing evidence of human disturbance in its youngest dated pollen samples, which Davis (1969) attributes to land being cleared by European settlers. She makes note of declining numbers of ash (*Fraxinus*) and oak, while red maple, ragweed, and other types of herbs increase and the occurrence of cereal pollen and maize are rare probably due to pollen of these taxa being dispersed close to its originating source (Davis 1969: 420). Davis (1969: 420) also acknowledges a decline in total non-arboreal pollen from the topmost samples for her study as well as one for chestnut due to a blight that occurred in the early 1900s (Brugham 1978a: 350). At Lantern Hill Pond, Trent reports a sharp oak decrease between 0 – 200 BP, as numbers for grasses and ragweed rise dramatically. She sees an increase in chestnut during this period, but does not record a decline in this species as was noted at Rogers Lake (Trent 1981: 14).

Brugham (1978a: 349) attributes indications of human disturbance at Linsley Pond to increases in pollen types such as ragweed and sorrel and the initial appearance of maize and oat (*Avena*) pollen grains. He maintains that his study does not detect human disturbance prior to the arrival of European settlers and reports that the sources of pollen examined for his study were local and not regional. However, he does acknowledge testimonies from early settlers to the area who reported widespread regions, about 2 km northwest of Linsley Pond, that native inhabitants burned (Brugham 1978a: 351). Brugham (1978a: 357-358) further reports that ragweed increased only after European settlement and that grasses appeared during this period for the first time, and he records a decline in ragweed pollen around A.D. 1900 at Linsley Pond, which he credits to land abandonment.

It is clear from some of the examples given that evidence of human disturbance on the environment does not carry an identical signature from one location to another. However, some overall trends are present, such as an inverse relationship between arboreal pollen amounts and grasses and weeds. Faegri and others (1989: 179) report that humans affect vegetation in three manners, plant cultivation, animal husbandry, and the technical utilization of resources, with these three manners creating a distinctive vegetation pattern. Nevertheless, they maintain that “geographical, ecological and ethnological differences” produce diverse patterns that contain “certain common features” and it is these patterns on which my study focuses (Faegri et al. 1989: 180).

## CHAPTER 4

### METHODS

The Eastern Pequot continue to dwell in a portion of the same region that they and previous native groups before them had occupied. With their land base greatly reduced, the introduction of Eurasian crops and livestock, and colonization continuing, how would the Eastern Pequot manage their natural resources? Using a combination of palynological analysis and an examination of charcoal densities from a sediment core on Eastern Pequot lands, my study begins to address this question. Pollen analysis was originated in the early 1900s as a means to study lake and bog deposits with the goal of reconstructing vegetation changes during the Late Quaternary (Faegri et al. 1989: 1). Since that time, it has been increasingly applied to other uses, many of which are attentive to data incriminating “human interference in natural systems, even in the distant past” (Dincauze 2000: 343; see Brugam 1978a and 1978b; Davis 1969; Russell et al. 1993; Trent 1981). In addition, for those of us scanning pollen grains under a microscope, charcoal can be a common sight. The analysis of charcoal fragments allows fire histories of sites to be examined (e.g., Clark and Royall 1996; Clark and Royall 1995; Motzkin et al. 1993; Swain 1973; Tinner et al. 1998, Tinner et al. 2005), and several studies have shown how fire histories corresponded to vegetation and human settlement histories for sites, which will be a focus for my study (Clark 1982: 523).

The results of the pollen analysis and examination of charcoal densities of the sediment core collected from the Eastern Pequot Tribal Nation Reservation serve as a solid base for my research, and provide a preliminary view of the prior vegetation and

fire histories for the area inclusive of the reservation. My research also contains a current vegetation survey for the immediate sediment core location to tie in with the findings of the pollen analysis for the most recent section of the sediment core. In addition, my research involves comparing the results of the pollen and charcoal analyses to other regional pollen and fire history studies, many of which have already been introduced in previous chapters.

As fingerprints left behind at a crime scene can implicate the name of the perpetrator who committed the misdeed, recovered pollen grains from a sediment core allow for the types of vegetation that produced them to be identified. Even though a pollen grain's outer wall is composed of a vigorous, organic material, called sporopollenin, these grains sometimes do not preserve well; are difficult to identify due to being ripped, folded, crumpled or degraded; are not consistently represented with certain soil matrices and environmental conditions including the presence of bacteria, fungi, and other soil organisms which feed on them; have various pollination strategies; and vary in deposition modes and therefore recovery (Bryant Jr. et al. 1993: 281; Dincauze 2000: 345-346; Faegri et al. 1989: 11-38; King et al. 1975: 181; Pearsall 2000: 251-252). In some respects, pollen grains are as fragile as partial fingerprints.

Since "pollen analysis is based upon the assumption of the great quantity and high degree of uniformity in the dispersal of pollen grains," pollen fossils are all considered to be "comparable" to one another, where as macrofossils are not; therefore pollen fossils' "relative frequencies are comparable" (Faegri et al. 1989: 3). Since the survival of all of the pollen grain types produced in a specific locality cannot be

guaranteed, their presence and absence allows for a limited identification of the vegetation. Nevertheless, a reconstructed, although sometimes biased, environmental reconstruction can be produced for a specific area long after the vegetation, which had existed there, deteriorated (Pearsall 2000: 279). From the reconstructed vegetation, secondary deductions regarding climate and human disturbance can be inferred (Faegri et al. 1989: 2).

I have recovered these fingerprints, or pollen grains, and charcoal particles from a sediment core that was taken during the summer of 2004 from the Eastern Pequot Tribal Nation Reservation in North Stonington, Connecticut. The core was obtained from a location that we anticipated would be suitable for pollen preservation. The immediate area from where the core was taken from was swampy and believed to be consistently wet over a long period of time. The area also possessed some depositional depth, which would likely increase the potential for the sediments to contain pollen and was situated just beyond a mainstream course to reduce the possibility of sampling pollen from too short a duration of time due to a greater sedimentation rate or to be affected by episodes of erosion exhibited by mainstream courses (Faegri et al. 1989: 57; King et al. 1975: 187). As mentioned earlier in this paper, the sediment core was located approximately 800-1000 m in a straight line distance to Lantern Hill Pond and was in the vicinity of where the University of Massachusetts Boston archaeological field school focused their efforts in 2004. That is, it occurred near grid point N710 E460, less than 200 m southwest of a 19<sup>th</sup>-century house foundation that underwent excavation.

## **Cultural Material from the Eastern Pequot Tribal Nation Reservation**

The University of Massachusetts Boston field school has conducted archaeological excavations on the Eastern Pequot Tribal Nation Reservation during the summers of 2003, 2004, and 2005. Several members of the Eastern Pequot Tribal Nation have participated in the field school. Some of the artifacts recovered from around two 19<sup>th</sup>-century house foundations consist of charcoal, fire cracked rock, ox shoes, bone tool handles, buttons, and a variety of European ceramics, several artifacts possibly dating to the Late Archaic such as two steatite fragments and a groundstone celt (Cipolla 2005; McNeil 2005), and an argillite projectile point possibly dating to the Middle Woodland. A recovered faunal assemblage from both foundations is comprised of mammal bones - both large and small and domestic and indigenous - with domestic mammals comprising the bulk amount of the identifiable faunal assemblage, bird, fish, turtle, and shellfish (Cipolla 2005). Other points recovered from the reservation date from the Middle Archaic to Middle Woodland.

## **Current Vegetation Study**

On July 26, 2005, under the direction of Heather Trigg, a current vegetation survey was conducted around the immediate location from where the Eastern Pequot sediment core was extracted. The core location as mentioned was situated in a wetland area, presumed to be permanently moist, adjacent to a slow-moving small stream. Vegetation in the area was characteristic of wetland varieties. It was estimated that vegetation in the locale represented 50 years or less due to the presence of young trees. A 13-m line intercept survey was conducted, which provided tree and

shrub densities. Maple predominated in this survey and its leaf canopy covered the entire length of the line. Leatherwood (*Direa palustris*) blanketed approximately 10 m of the line intercept. Other arboreal and shrub species such as butternut (*Juglans cinera*) and pepperbush (*Clethra alnifolia*) were present with butternut covering 5 m of the line and branches of pepperbush blanketing smaller segments of it.

Within a 10-m x 10-m sample area situated to the northwest of the core, 5 maple trees, 2 butternuts, and 1 elm (*Ulmus*) were counted. Other vegetation present within the sample “box” were sweetbriar (*Rosa rubiginosa*), which is an introduced species, cat briar (*Smilax glauca*), and jack in the pulpit (*Arisaema*). Within a 1-m x 1-m grid square designed to sample herb coverage, a number of vegetation species were identified. Violets (*Viola*), mosses, ferns, skunk cabbage (*Symplocarpus foetidus*), arrowhead (*Sagittaria cristata*), grasses, channeled Solomon’s seal, and impatiens (*Impatiens*) were identified.

Many tulip trees (*Liriodendron tulipifera*) were present in an area, upland from the core location. There were also a couple of maples, oaks, a hickory, several elms, and sassafras (*Sassafras*) visible. Patches of grass were evident along with sporadic ferns and mosses. Wintergreen (*Pyrola*), wild ginger (*Asarum*), and Indian pipe (*Monotropa uniflora*) also occurred.

### **The Eastern Pequot Sediment Core**

The sediment core measured 50 cm in length and was 6.41 cm in diameter. It was collected in a white, opaque PVC pipe. Both ends of the pipe were capped to prevent contamination after collection, and it was transported to the University of

Massachusetts, Boston where it was stored in an upright position until it was later sectioned into samples. The sediment core was removed from the PVC pipe and visually divided into 5 subsections or strata based on the stratigraphic layering of the core (see Table 1). To avoid the possibility of contamination, the top 2 cm and the sides of the core, which were adjacent to the PVC pipe, were discarded. Since clay was present at the bottom or deepest portion of the core, hypothesized to be the result of the last glaciation, it was originally surmised that the core likely represented a great deal of time depth. This was later confirmed by C-14 dating.

**Subsections of the Eastern Pequot Tribal Nation Reservation Core  
Table 1**

<b>Core Subsections</b>	<b>Munsell Color Notation</b>	<b>Description</b>
Stratum 1	5 YR 2.5/1	Silty
Stratum 2	5 YR 2.5/1	Silty, Organic layer contains large organic pieces
Stratum 3	7.5 YR 2.5/1	Silty, much finer organics
Stratum 4	N/A	Mottled with alternating dark and light gray bands
Stratum 5	10 YR 6/2, 10 YR 4/2	Yellow gray layer transitions to a red gray section near the base of the column

The sediment core was then physically divided from the surface or upper section, to the bottom, into 24, 2-cm samples or as close to 2-cm samples as could be obtained with the exception of Sample 4. Sample 4 measured 6 cm in length because a stone was contained within that portion of the core. All sectioned samples were kept under refrigeration until they were processed for pollen and charcoal. All samples were weighed (see Table 2) before being processed using standard pollen extraction techniques (see Appendix 1). To date Samples 1-6, 8-11, and 14 have been processed for pollen and charcoal (see Table 2). The entire content of Samples 4, 10, and 14

were utilized in the process and approximately half of Samples 1-3, 5, 6, 8, 9, and 11 were consumed as well. The entire content of Samples 7 and 13 were sent off for radiocarbon dating. All of the unprocessed samples are being kept under refrigeration.

Pollen residue for each processed sample was stored in capped glass vials. A couple of drops of glycerol and one or two drops of saffarin were added to each vial to assist in viewing pollen grains especially since saffarin highlights structural details and improves detection of broken grains (Pearsall 2000: 301). Depending on pollen concentration and the clarity of the sample, three or four slides of pollen residue were made and scanned for every processed sample. Each slide was put together in the same manner, by first placing a drop of glycerol in the center of a clean glass slide. Using a pre-wrapped sterilized glass pipette, a drop of suspended pollen residue was extracted from each sample vial and deposited on top of the glycerol. A clean glass cover-slip was then placed on top of the mixture and all slides were labeled with the appropriate sample information before they were scanned.

**Processed Pollen Samples of the Eastern Pequot Tribal Nation Reservation Core  
Table 2**

<b>Sample</b>	<b>Stratum</b>	<b>Depth</b>	<b>Weight of Sample</b>
1	1	0-2 cm	8.98 g
2	1	2-4 cm	7.09 g
3	2	4-6 cm	6.83 g
4	2	6-12 cm	26.84 g
5	2	12-14 cm	8.80 g
6	2	14-16 cm	10.19 g
8	2	18-20 cm	11.33 g
9	3	20-22 cm	8.43 g
10	3	22-24 cm	20.01 g
11	3	24-26 cm	10.55 g
14	4	30-32 cm	23.83 g

For each sample, I deemed 300 pollen grains to be a sufficient amount to count per sample, following the guidance provided by other studies (Bryant Jr. et al. 1993: 281; Pearsall 2000: 303; Trigg et al. 2003: 35), and these 300 grains were counted and scanned at 400x. The added control spike was not included in this number, and amounts for the spike were tracked to calculate pollen preservation for each sample, pollen density, and charcoal accumulation rates (Larsen and MacDonald 1998: 819). Pollen grains were identified by comparing them to online images contained on the following websites, [www.geo.arizona.edu/palynology/pid00024.html](http://www.geo.arizona.edu/palynology/pid00024.html), [www.paldat.botanik.univie.ac.at/index.php](http://www.paldat.botanik.univie.ac.at/index.php), [www.pollen.anu.edu.au/pollenshow.phtml](http://www.pollen.anu.edu.au/pollenshow.phtml), and

[www.pollen.usda.gov/AtlasSEMPlates](http://www.pollen.usda.gov/AtlasSEMPlates), to published sources (Kapp 1969; Kapp 2000), and to a type collection housed at the University of Massachusetts, Boston.

Since no additional processing was required to extract charcoal particles from the sediment core, charcoal particles were tabulated alongside pollen grains for each sample were counted. Each charcoal particle was also measured across its largest area. Various publications regarding the methods of charcoal estimation were consulted (Carcaillet et al. 2001; Clark 1982; Clark and Royall 1995; Gillson 2004; Patterson et al. 1987; Swain 1973; Tinner and Hu 2003; Whitlock 2001), before I chose a modified method described by Tinner and Hu (2003: 292). In the span of time that it took to count 300 pollen grains per sample, all charcoal particles encountered, which were black in color and not brown, were tracked and measured. For this study, the number of charcoal particles tallied is represented as a percentage of the pollen sum, and the implications of the measurements of the charcoal particles will be discussed in the analysis section of this paper (Clark 1982: 524). To insure data reliability, pollen grains and charcoal particles for each of the processed samples were tabulated twice to verify pollen identifications and counts.

For this study, I mainly do not differentiate between species belonging to the same plant families. For example, pines and spruces were grouped together under the family category of Pinaceae, just as tulip trees were grouped in the Magnoliaceae family. However, there are several exceptions to this rule. Because some pollen grains are easier to identify than others, the following species were divided into finer-grained categories: black walnut (*Juglans nigra*), box-elder (*Acer negundo*), butternut, chestnut, and hazel (*Corylus americana*). On one of the pollen diagram sum

charts presented in the next chapter, Compositae were split into two categories: Low Spines and High Spines. Field horsetail (*Equisetum arvense*) and scouring-rush (*Equisetum hyemale*) were grouped by family as well as mouse-ear-cress (*Arabidopsis thaliana*), toothwort (*Cardamine concatenata*), and yellow cress (*Rorippa palustris*) even though numbers for each respective species were tabulated. For the purpose of discussion in the analysis section of this study, I have grouped all pollen species and families into five main vegetation categories: trees, shrubs, herbs, aquatics, and cryptogams (mosses and ferns). However, I do highlight individual species and families as the presence or absence of their numbers warrant.

### **Radiocarbon Dates and Periodization of the Samples**

Two radiocarbon dates for this study were obtained to help bracket the chronology represented within the core. Sample 7, at a depth of 16-18 cm, and Sample 13, at a depth of 29-30 cm, were sent to Beta Analytic Radiocarbon Dating Laboratory in Miami, Florida. Two AMS dates were acquired. Sample 7, Beta – 198321, dates to  $650 \pm 40$  BP, Cal AD 1280 to 1400, while Sample 13, Beta – 198322, dates to  $8060 \pm 60$  BP, Cal BC 7160 to 6810. Instead of modeling my study after Brugham's (1978a) fine-grained meticulous assessment of pre-settlement and post-settlement assemblages that he interpreted from a 2-m core taken from Linsley Pond in North Branford, Connecticut, my study will provide greater time depth of environmental reconstruction for an examination of longer term land use practices and will serve as a baseline for future environmental history studies conducted on the Eastern Pequot Tribal Nation Reservation and nearby environs.

The two radiocarbon dates have assisted in connecting vegetation changes with historical, archaeological, and environmental events in the area. The dates have also allowed me to calculate estimated sedimentation rates for the rest of the processed core samples. The first sedimentation rate was calculated for the section of the core located between Sample 1 and Sample 7, where one radiocarbon date was obtained, and a second rate of sedimentation was calculated for the segment of the core located between Sample 7 and Sample 13, where the other radiocarbon date was acquired. The second rate of sedimentation was also applied to Sample 14, as the organics in the sample's stratum were similar to those from the stratum containing Sample 13. The higher sedimentation rate in the younger portion of the core could be due to increased forest clearing at this time. For the purpose of this study, it is assumed that the sedimentation rates for each section of the core remained consistent from sample to sample and that is why two sedimentation rates were utilized. Even though Dincauze (2000: 356) believes that this assumption is "unrealistic and usually untestable", the assumption of a constant rate of deposition between dated points is basic to the method and will be compared to historical, archaeological and environmental events in the area in the analysis section of this paper (see also Larsen and MacDonald 1998).

For the sections above Sample 7, I divided the base 650-year date by 18 cm, with this measurement inclusive of the top 2 cm of the core that was discarded to eliminate the possibility of contamination. This calculation yielded a result of 36.11 years/cm, rounded down to 36 cm/year for the purpose of my study. For the section of the core represented by samples 8 through 14, I have taken the base date of Sample 7

(650) and subtracted this figure from the base date of Sample 13 (8,060). I then divided the difference between these two figures of 7,410 by 11 cm, which represents the distance from the starting measurement of Sample 8 or 20 cm to the starting measurement of Sample 13 or 31 cm and arrived at a figure of 674 years/cm, with this same rate as mentioned applied to Sample 14. All calculated years were then rounded up or down to the nearest decade. As a result of these calculations, it is my estimation that Sample 4 represents the period of time during which the Eastern Pequot Tribal Nation Reservation was established (see Table 3).

**Range of Years Corresponding to Processed Samples of the  
Eastern Pequot Tribal Nation Reservation Core  
Table 3**

<b>Sample Numbers</b>	<b>CM</b>	<b>Years Ago</b>
Discarded	1-2	0-70 (A.D. 2004-1934)
Sample 1	2-4	70-140 (A.D. 1934-1864)
Sample 2	4-6	140-220 (A.D. 1864-1784)
Sample 3	6-8	220-290 (A.D. 1784-1714)
Sample 4	8-14	290-500 (A.D. 1714-1504)
Sample 5	14-16	500-580 (A.D. 1504-1424)
Sample 6	16-18	580-650 (A.D. 1424-1354)
Sample 7	18-20	650 ± 40 BP, Cal AD 1280 to 1400
Sample 8	20-22	650-2000 BP
Sample 9	22-24	2000-3350 BP
Sample 10	24-26	3350-4700 BP
Sample 11	26-28	4700-6040 BP
Sample 12	28-31	6040-8060 BP
Sample 13	31-32	8060 ± 60 BP, Cal BC 7160 to 6810
Sample 14	32-34	8060-9410 BP

## CHAPTER 5

### RESULTS AND ANALYSIS

#### **Scale: Local Pollen vs. Regional Pollen**

Pollen grains extracted from the Eastern Pequot Tribal Nation Reservation sediment core collectively represent both a regional and local vegetation history for the reservation land and the area encompassing it simply because the area from where the core was extracted from was not a contained environment. As a result, the core cannot guarantee either an absolute local or regional representation. This study remains mindful of the loaded implications of the production methods and dispersal capabilities that the recovered pollen species have on influencing the geographical scale sampled by the sediment core. Many wind-dispersed arboreal pollen types, such as pine, which also is a species inclined to generate a great quantity of pollen and also capable of scattering it over a broad area, were present in each of the Eastern Pequot processed core samples. Because of the pollen dispersal mechanism and physical properties of this species, pine's presence is typically considered to represent regional vegetation (Dincauze 2000: 344-345). However, I cannot rule out the possibility that the presence of pine also indicates a local occupation for this species.

Pollen-representation factors or "R-values" have been computed for several general taxa (Faegri et al 1989; Pearsall 2000). Because some plant taxa "are always less well represented in the pollen record than others, the precise representation factor differs among species and among data taken from different vegetation formations" (Pearsall 2000: 334). Since the values are not constant and they differ with environmental conditions, a "numerical reduction based upon a division of pollen types

into three groups” centered around pollen production rates has also been used (Faegri et al 1989: 126). Although some palynologists have attempted to use conversion factors to account for differential production (Faegri et al 1989), diachronic changes in the relative proportions of different taxa will be more instructive than attempts to model absolute pollen frequencies.

Dincauze notes that heavier arboreal pollen types such as beech and larch will stay nearby their originating vegetation source, and she also cites a study by Brasier, whose examination confirmed that 99% of wind-dispersed pollen grains remain contained inside a 1-km radius of their origin (Dincauze 2000: 349). Other models of pollen source area are more species- and distance- specific. Research conducted by Larsen and MacDonald (1998: 817) advocated the following distances to originating pollen source for some species detected by their study: “50% of heavy pollen (e.g. larch) comes from within 250 m, relatively heavy pollen (e.g. birch and black spruce) comes from within 350 m, relatively light pollen (e.g. pine) comes from within one km, and light pollen (e.g. alder) comes from within 10 km.” The Eastern Pequot core also detected pollen grains of flora subscribing to other pollen dispersal means such as Compositae (e.g. sunflowers), for example. Because some Compositae are insect-pollinated, these are believed to represent more of a localized pollen species (Faegri 1989: 12-13).

Besides pollen preservation, which was discussed in the previous chapter, the selection of a sediment core site also speaks to the spatial scale to which material from it will represent. Sediment cores taken from bodies of water usually have the best preservation, but they possess more of a regional vegetation scale due to the fact that

they drain a larger watershed (Faegri et al. 1989: 56). In addition to being situated beyond a main stream course to reduce the possibility of sampling from a broader area, the locality of the Eastern Pequot core was also positioned in the approximate center of a forested basin beneath an arboreal canopy. It is guaranteed to drain *only* the reservation property due to the nature of local topography. Jackson and Wong (1994: 89) maintained that pollen series taken from sediments as described “have been widely applied in studies of long-term vegetation dynamics at fine spatial scales.” The results of the Eastern Pequot pollen analysis will also be closely compared to studies completed at nearby Lantern Hill Pond, Rogers Lake, and other regional locations in order to glean a more local vegetation picture of the subject study area.

Temporal scale is also an issue. A rate of sedimentation was estimated for the Eastern Pequot core as a result of two radiocarbon dates obtained for this study and comparisons made between the core data and dated vegetation trends witnessed in other regional studies. As a result, each sample from the Eastern Pequot core represents an intermediate range of time. Therefore, my interpretation presents a more general depiction of vegetation patterns over time rather than a fine-grained portrayal, which would likely notice slight nuances in vegetation patterns.

### **Results: Overall Patterns**

The amount of counted pollen grains for the majority of identified pollen types, represented in the 11 processed samples, increase, decrease, vanish, and reappear over time from one sample to the next. Out of the 11 samples, 73 taxa were identified. The richness of pollen types for each sample rises from the bottom of the core with Sample

14 to the top of it, and Sample 14 contains the fewest number of pollen types. The assortment of taxa peaks with 37 different types, or 50.68% of the total identified taxa, present in Samples 1 and 2 (see Table 4). Davis (1983: 557) maintains that in northeastern United States, “the forest vegetation gained species gradually through time.” Even though there is not much of a significant difference in the number of identified taxa between many of the Eastern Pequot sediment core samples, there is a noticeable difference in the number of taxa detected between Sample 1, which represents the youngest section of the core, and Sample 14 that represents the oldest section of the core. The number of taxa, for the majority of the samples, increase through time; however, Samples 8 and 9 contain a higher number of identified pollen types than Samples 3, 4, 5, and 6. Could there be a differential preservation for the identified pollen types from the Eastern Pequot sediment core due to time? If the number of unidentifiable grains of pollen (pollen grains recovered in each sample that could not be identified due to their physical condition) detected in the Eastern Pequot core increased dramatically through time, then perhaps there is differential preservation for various species represented by the core; however, the number of detected unidentifiable pollen grains remained consistent through time. Also, maple, which is generally poorly preserved (<http://www.geo.arizona.edu/palynology/pid0021.html> 2), was found near the bottom of the core, and was better represented in some of the older samples than in several of the younger samples.

Seventeen pollen types, representing approximately 23% of the recovered taxa, were detected in 9 out of the 11 processed samples at varying amounts from sample to sample (Table 5). Even though the 17 types represent a minority of the total

recovered pollen species, they are present in approximately 82% of the processed samples.

**Species Richness**  
**Table 4**

Sample Number	Number of Pollen Types
1	37
2	37
3	33
4	33
5	32
6	31
8	35
9	34
10	31
11	27
14	21

Eleven pollen types, representing approximately 15% of the recovered taxa, were detected in each of the processed samples. Approximately 54% of the pollen types belonging to this group are of the arboreal variety and include birch, chestnut, maple, Magnoliaceae, oak, and pine. Herbs including grasses (Gramineae), ragweed (*Ambrosia*), and lily (Liliaceae), as well as peat moss (Sphagnaceae), and wood fern (*Dryopteris spinulosa*, Dryopteridaceae) round out the 11 types. Fourteen pollen taxa were present in 10 of the processed samples. In addition to the above 11 pollen types, box elder, hickory, and an herb, Cheno/Am (Chenopodiaceae/Amaranthaceae), were included. Alder, butternut, and willow family (Salicaceae), round out the 17 taxa that are present in 9 out of 11 processed samples. It is interesting to note that these final three taxa are all lacking from Sample 14.

**Percentages of the 17 Most Common Types of Pollen Represented in 82% of the  
Processed Core Samples  
Table 5**

**All values represented in the table not inclusive of “Other Taxa” were rounded up or down to the nearest whole number with the exception of values less than .50. All values represented are percentages. “S” designates sample. “Other Taxa” represents all other pollen grains counted for each sample.**

Pollen Type	S1	S2	S3	S4	S5	S6	S8	S9	S10	S11	S14
Alder	2.00	1.00	1.00	0.32	1.00	1.00	0.00	1.00	0.00	3.00	13.00
Birch	9.00	4.00	6.00	7.00	8.00	10.00	6.00	16.00	14.00	11.00	4.00
Maple	7.00	9.00	4.00	3.00	4.00	3.00	4.00	1.00	13.00	7.00	2.00
Oak	6.00	7.00	6.00	8.00	9.00	5.00	7.00	11.00	5.00	9.00	1.00
Chestnut	6.00	31.00	42.00	35.00	23.00	22.00	7.00	2.00	3.00	3.00	0.32
Pine	8.00	4.00	4.00	6.00	3.00	4.00	7.00	16.00	14.00	6.00	3.00
Magnoliac eae	2.00	2.00	0.64	1.00	1.00	1.00	1.00	1.00	3.00	1.00	2.00
Hickory	3.00	1.00	0.32	2.00	1.00	1.00	1.00	2.00	2.00	2.00	0.00
Butternut	4.00	2.00	2.00	3.00	2.00	1.00	1.00	0.30	0.00	0.33	0.00
Willow	1.00	2.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	3.00	1.00
Box Elder	1.00	0.28	1.00	1.00	1.00	0.27	0.28	0.00	3.00	1.00	0.32
Grass	8.00	4.00	4.00	4.00	4.00	2.00	9.00	7.00	5.00	23.00	14.00
Ragweed	2.00	1.00	1.00	2.00	2.00	0.27	1.00	2.00	4.00	2.00	4.00
Cheno/Am	3.00	1.00	1.00	0.32	1.00	2.00	0.00	1.00	1.00	0.33	0.32
Lily	1.00	1.00	0.32	1.00	1.00	2.00	3.00	4.00	5.00	1.00	3.00
Sphagnum	2.00	1.00	1.00	1.00	2.00	3.00	3.00	1.00	2.00	1.00	1.00
Wood fern	2.00	1.00	0.32	1.00	1.00	3.00	4.00	6.00	2.00	3.00	31.00
Types totaled	67.00	72.28	76.00	76.00	65.00	62.00	55.28	65.30	76.00	77.00	80.00
Other Taxa	33.00	27.72	24.00	24.00	35.00	38.00	44.72	34.70	24.00	23.00	20.00

At minimum, these 17 pollen types collectively constitute 55% of the total counted pollen grains for Sample 8, while at a maximum they comprise 80% of the

total counted pollen grains for Sample 14. The percentages of pollen grains for arboreal, herb, and cryptogams alter from sample to sample (see Table 6). For these 17 taxa, arboreal pollen was more numerous than other pollen type categories for all, except Sample 14 where cryptogams dominated.

**Arboreal, Herb, and Cryptogam Percentages Within the 17 Most Common Pollen Types**  
**Table 6**

Values represented in this table were rounded up or down to the nearest whole number. “S” designates sample. “Other Types” represents all other pollen grains counted for each sample.

Pollen Categories	S1	S2	S3	S4	S5	S6	S8	S9	S10	S11	S14
Arboreal	49%	63%	68%	66%	54%	49%	35%	51%	57%	45%	27%
Herbs	14%	7%	6%	6%	8%	6%	13%	14%	15%	26%	21%
Cryptogams	4%	2%	1%	2%	3%	6%	7%	7%	4%	4%	32%
Other Types	33%	28%	25%	26%	35%	39%	45%	28%	24%	25%	20%

Acknowledging the possibility of long distance pollen taxa represented in these vegetation types, would it be fair to say that some of the identified pollen grains may belong to a unique vegetation community as defined by Daubenmire (1968)? For example, many of the 17 highlighted taxa thrive in moist environments, but they also interplay, compete, and nurture each other, in essence maintaining relationships with one another. Gray birch for example, acts as a “nurse tree,” protecting pine, and allowing it to become established (Hosie 1969: 380). In addition, other species, red maple for one, increase after disturbances such as windthrows, clearcutting, and fire until they are overshadowed by swifter growing species like northern red oak ([www.fs.fed.us/database/feis/plants/tree/acerub/botanical\\_and\\_ecological\\_characteristics.html](http://www.fs.fed.us/database/feis/plants/tree/acerub/botanical_and_ecological_characteristics.html) 2).

Pollen types and percentages from no two samples of the Eastern Pequot sediment core are identical. This supports the notion that the vegetation on the reservation and surrounding area was by no means static. The Eastern Pequot core reveals vegetation patterns. The processed pollen from the core indicates that these patterns comprised a continually changing blanket of vegetation, one that covered the Eastern Pequot Tribal Nation Reservation and surrounding area over a great period of time. The scope of this study is to identify the vegetation patterns that were shaped by climatic means and those affected by human disturbance.

### **Temporal Trends in Vegetation Communities**

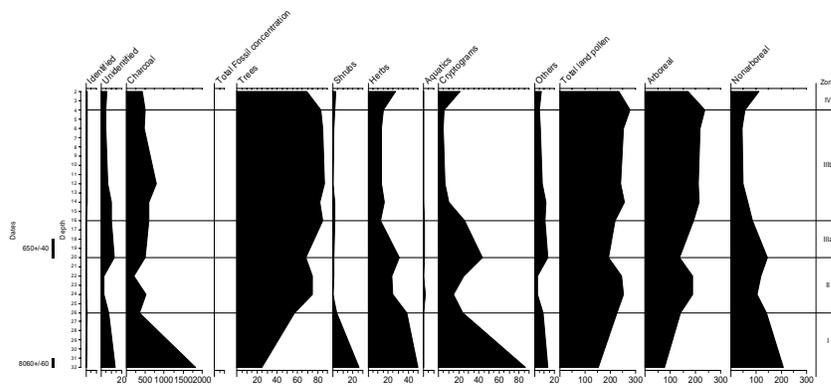
After the pollen taxa and charcoal particles for the 11 processed samples were counted, the data were entered into a computer database (Tilia 2.0). This database calculated percentages of the pollen grains and charcoal particles and generated pollen sum diagrams for the processed samples (see Table 7 and Figures 1, 2, and 3).

**Charcoal Data from the Eastern Pequot Tribal Nation Reservation Core  
Table 7**

Sample	# of Pieces	Pollen Grains	Range of Charcoal Size (µm)	Charcoal/Pollen	Mode (µm)	Median (µm)	Mean (µm)
1	425	300	2.22-99.9	1.42	15.54	37.74	24.14
2	495	305	2.22-190.92	1.62	11.10	35.52-37.74	18.29
3	477	300	4.44-111	1.59	8.88	33.30-35.52	18.08
4	797	300	2.22-166.50	2.65	11.10	39.96	17.95
5	589	305	2.22-75.48	1.93	11.10	31.08	15.67
6	592	301	2.22-111	1.97	11.10	31.08-33.30	15.10
8	506	307	4.44-128.76	1.65	11.10	37.74-42.18	16.62
9	200	315	2.22-199.80	.63	11.10	26.64	18.57
10	528	300	2.22-199.80	1.76	15.54	35.52-37.74	22.02
11	356	301	4.44-48.44	1.18	8.88	22.20	13.56
14	1823	309	2.22-44.40	5.90	4.44	17.76-19.98	8.00

## Figure 1 Total Pollen

Figure 1: Total Fossil Concentration of Trees, Shrubs, Herbs, Aquatics, Cryptogams, and Charcoal.



## Figure 2 Arboreal Pollen

**Figure 2: Total Fossil Concentration of Arboreal Pollen.**

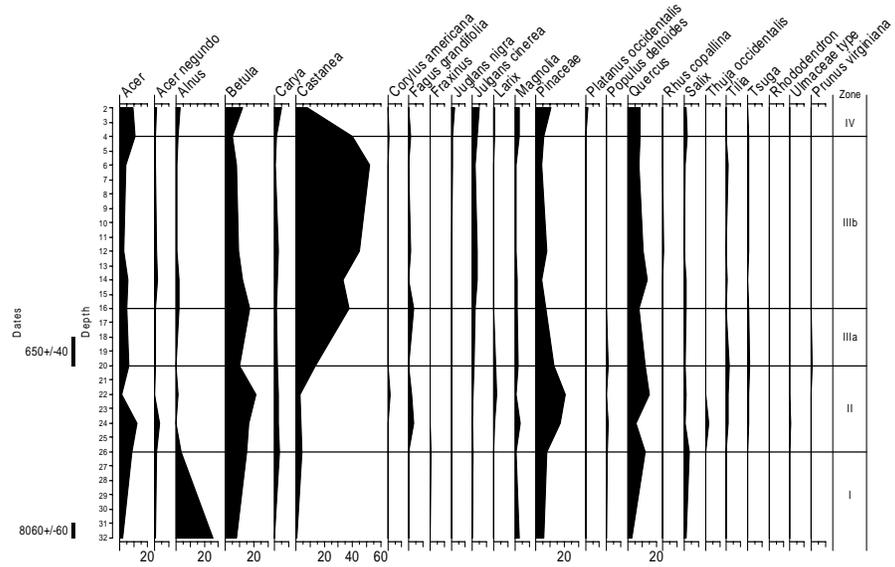
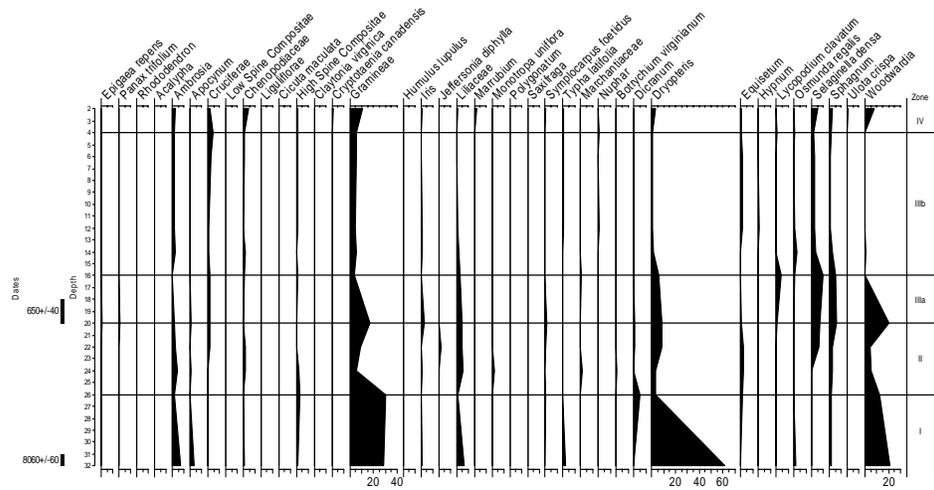


Figure 3

Non-Arboreal Pollen

Figure 3: Total Non-Arboreal Pollen.



## CHAPTER 6

### RESULTS AND ANALYSIS: AN EXAMINATION OF POLLEN ZONES

#### Introduction

The results of the pollen and charcoal analysis as they relate to vegetation patterns are explored along two lines. First, a description that includes percentages of recovered pollen taxa and the amounts and sizes of charcoal particles are presented for four pollen zones (Zone I-IV) with Zone III split into two sub-zones, Zones IIIa and IIIb; and second, the implications of pollen percentages and burning trends are discussed. The four pollen zones or biozones were determined using the “subjective approach,” as zone lines were placed in sequence where “several concurrent changes in pollen type” or “sequence within a diagram, characterized by its flora” are observed (Faegri et al. 1989: 106; Pearsall 2000: 323). The approach is commonly used to simplify long pollen sequences into smaller units and to avoid constructing “extra” zones by numerical analysis “that are usually zones recognized but ignored by the analyst as being of little interpretive importance” (Faegri et al. 1989: 104; Pearsall 2000: 322-324). To give a sense of vegetation change through time from the distant past to the present, I begin by presenting the results of Zone I and will work my way up the core, discussing the findings of each zone and concluding with Zone IV.

#### Zone I

Zone I dates approximately from 6,040 to 9,410 BP and encompasses pollen data from Sample 14 only. This zone is characterized by the domination of grasses, ferns, and alder. As mentioned, ferns played a dominant role in the vegetation cover

at this time and represented 41.99% of the Total Counted Pollen (TCP) of Sample 14, while mosses comprised only 0.64%. Grasses and ragweed were also numerous and represented 14.10% and 3.53% of the TCP, respectively. Conceivably the high percentages of ferns acted as a dominant species and could have filtered and delayed the re-growth of many of the arboreal pollen types (George and Bazzaz 1999), which only made up 24.99% of the TCP of the zone.

### ***Arboreal Pollen***

Alder, representing 12.82% of the TCP of the zone, comprised over 50% of the arboreal species. Birch, maple, Magnoliaceae, pine/spruce, willow, and oak represented 3.85%, 1.60%, 1.60%, 2.88%, 0.64%, and 1.28% of the TCP for the sample, respectively. Perhaps a partial to moderate open arboreal canopy existed over the area during this time, which may have assisted alder in attaining a high percentage of representation among the arboreal pollen types. Alder is known to be a fast-growing species at distressed sites, possibly indicating some sort of a disturbance to the landscape (Tilman 1988: 214). Birch also attained numbers higher than the other remaining arboreal types and is known to flourish under escalating light levels over time (George and Bazzaz 1999: 852; Larsen and MacDonald 1998). However, oak seedlings are reported to grow more favorably beneath a fern understory than birch or maple seedlings. So if a fern understory was present over the majority of the area as indicated by their high percentage for this zone, then why were numbers for oak lower than those recorded for birch and maple (George and Bazzaz 1999: 852)?

Lorimer et al. (1994) maintained that tall understory trees, such as maple, act as hindrances to the maturity of oak seedlings. Conceivably some of the other arboreal

species, like alder, may have contributed to keeping down numbers for oak. Or perchance, the forest was also spatially inconsistent or patchy regarding the understory cover. As a result, the arboreal seedling bank would have a strong spatial structure, thus supporting other arboreal species like birch to have a chance to excel upon a moderately bare forest floor (George and Bazzaz 1999: 853; Houle and Payette 1990). In areas where the forest floor was void of much vegetation, birch would have better odds than oak in attaining higher representation.

### ***Herb Pollen***

Some herbs, including Compositae, lily, Iridaceae, and Chenop/Am would have also had a more favorable chance to grow in areas without an understory cover impeding their progress. Herbs comprised 4.49% of the TCP for Sample 14. Therefore, the understory and canopy surrounding and encompassing the reservation may have been patchy. The climate during this time may have been cooler and received increased rainfall as alder, a taxon favorable to cool and moist conditions, flourished at this time (Harlow 1957: 129; Prentice et al. 1991: 2050).

### ***Charcoal***

Numbers for charcoal particles were the greatest in this zone over all others. Because of the high representation of charcoal, because of the low number of arboreal pollen grains counted for the sample, and because this sample has the lowest species richness than all others, I lean towards the possibility that a devastating fire took place around the core location during the period of time represented by this sample. An exception to the limited number of arboreal pollen grains found is alder. Because this species is capable of nitrogen fixation, it may have become an initial dominant to the

area, especially an area ravaged by fire (Tilman 1988: 214). Other studies (Larsen and MacDonald 1998) reveal positive correlations between fire and alder within a 5-year period following a peak in macroscopic charcoal. Grasses represent a respectable percentage for this zone, and an increased presence for these species also follows a fire (Daubenmire 1974; Larsen and MacDonald 1998).

The mode, median, and mean average size of the charcoal particles recovered for this zone, are the lowest as recorded for the other processed samples. Patterson and others (1987: 5) confirm that the more dynamic a fire, the finer ash particles produced by it would be. However, they also discuss how difficult it is to predict the location of a fire source due to factors such as wind and water movement. They describe several models of burning. In one model, an increased amount of charcoal is deposited near a fire source during episodes of lower wind, which results in the dimension of charcoal particles produced from it diminishing with distance from the fire source (Patterson et al. 1987: 6). Since Sample 14 contains a great quantity of smaller charcoal particles, it is evident that there was likely a fire in the vicinity of the subject area that made quite an impact on the vegetation. Unfortunately, there is no way to determine if this fire was set by human hand or if it occurred by a catastrophic act of nature. However, when compared to the other samples, the charcoal results from this sample are somewhat revealing, as discussed later.

### ***Discussion***

The arboreal pollen percentages represented in Zone I do not indicate that there was a closed tree canopy at this time. Without a closed canopy, grasses had a chance to flourish and perhaps took advantage of the situation, as indicated by their

percentages for Sample 14. However, ferns were also overwhelmingly present in this sample, too, and some ferns prefer full to partial shade ([www.ces.ncsu.edu/dcots/hort/consumer/factsheets/hardyferns/dryopteris\\_carthusiana.html](http://www.ces.ncsu.edu/dcots/hort/consumer/factsheets/hardyferns/dryopteris_carthusiana.html) 1). As a result, alder may have provided enough of a diffused canopy to allow ferns to develop. Ferns could have thrived during this period, as they are a “decomposer species that may have benefited from the dying leaves and roots of alder” and other vegetation types destroyed by fire (Tilman 1988: 215). According to Houle and Payette (1990: 677), “where there are openings the conditions differ from those under the intact canopy.” Perhaps the canopy over the Eastern Pequot sediment core area possessed openings, which would have produced conditions that encouraged ferns and grasses to excel at the same time.

The arboreal canopy above the area may have been open for a while or was sporadic at best, which allowed ragweed and herbs to prosper in addition to grasses and ferns. A combined percentage for all of these vegetation types total 64.11% of the TCP for Sample 14. Fire probably reduced forest litter, and this aspect may have also contributed to the elevated percentages for herbs as a result of reduced competition for these vegetation types. Moss is hardly represented within the zone, possibly because of its requirement for moisture to germinate (Wilson and Loomis 1967: 490). Since arboreal pollen only represents 24.99% for Sample 14, there may not have been enough shade to keep the ground from drying out; therefore the landscape was not moist enough to support substantial numbers of moss (Wilson and Loomis 1967: 489-497).

Zone I represents the oldest processed section of the Eastern Pequot sediment core. Since I do not have a processed sample comparable in age to some of the older dates recorded by Trent (1981) and Davis (1969) in their studies, Zone I could coincide with the tail end of the climax of alder in the region. Numbers for alder are higher than all other arboreal species detected by Sample 14, but they do not signify as high a representation for this species as reported at Lantern Hill Pond around 10,600 BP and for Rogers Lake from 9,100 – 12,200 BP. Percentages of oak for Sample 14 are much lower than they were for this arboreal type at Lantern Hill Pond and Rogers Lake. However, the amount of maple pollen grains from the Eastern Pequot core corresponds to the amount detected by the other two studies. Possibly the difference in percentages of oak points to the Eastern Pequot core surveying more of a local vegetation than the flora represented by the other two studies. The Eastern Pequot core also detects a rise in ragweed during this period. Davis (1969) notes an increase of this taxon at Rogers Lake, which she specifies was as a result of climatic changes. Perhaps these changes coupled with the high evidence of charcoal detected for Zone I of the Eastern Pequot core may have helped to keep the percentage of arboreal pollen down.

The time period represented by Zone I corresponds to the Early Archaic (9,000 – 8,000 BP) and Middle Archaic (8,000 – 6,000 BP). Early Archaic sites are recorded at the Great Cedar Swamp; however, there are an increased number of them dated to the Middle Archaic at this location (Jones 1999: 112). Many of the artifacts recovered from these sites indicate a “repeated temporary use” of the area with activities “focused on hunting and butchering” (Jones 1999: 112, 116). The widespread fire

that was captured by Zone I of the Eastern Pequot sediment core may have created an attractive environment for wildlife. For instance, a study conducted in Wisconsin by Vogl and Beck (1970: 272) revealed a dramatic increase in deer sightings at a subject area, an area that was severely impacted by a devastating fire some nine growing seasons earlier, in comparison to unburned surroundings. It is possible the devastating fire that affected the area sampled by the Eastern Pequot core attracted wildlife as well as people pursuing game.

## **Zone II**

Zone II includes Samples 8-11, and corresponds to a period of time spanning 650 – 6,040 BP. Zone II can best be characterized as a zone in flux. Grasses, including field horsetail and scouring-rush, were more abundant during the years corresponding to the beginning of this zone than they were for Zone I. Grasses represented 23.53% of the TCP for this portion of Zone II dated from 4,700-6,040 BP, a much higher percentage for these taxa than was recovered for the rest of all of the processed samples. The forest canopy may have continued to remain open during the early years of Zone II due mainly to climate as cited by Davis (1969) and a combination of factors. However, mosses also increased at this time and represented 5.23% of the TCP for this period, an increase of approximately 5% since the previous zone, while ragweed decreased by approximately 2%. Ferns decreased substantially from Zone I to Zone II by 30.56%. Between 3,350 – 4,700 BP, grasses diminished greatly in Zone II and represented just 7% of the TCP at this time, while mosses and ferns dipped to 2.33% and 7.33% of the TCP respectively, but ragweed increased by

2% during this period. Grasses increased slightly to 9.01% of the TCP for the portion of the zone dated from 2,000 – 3,350 BP and remained at about this amount or at 9.35% of the TCP for the segment of the core corresponding to the close of the zone or 650 – 2,000 BP. Ragweed decreased again and by the close of Zone II made up a nominal amount or 0.85% of the TCP. Both ferns and mosses increased by the end of Zone II and represented 15.58% and 7.94% of the TCP, respectively. Some species of moss often support fern types

([www.strengthenperspective.com/Jpmoss/MOSS/MpixAsHab.htm](http://www.strengthenperspective.com/Jpmoss/MOSS/MpixAsHab.htm) 1), which could account for an increase in both ferns and mosses during this period.

The substantial decrease of ferns at the start of Zone II may be as a result of additional sunlight reaching the forest floor, with this assumption supported by the increasing percentages of grasses for this portion of the sediment core. However, numbers for alder, a shorter arboreal species that may have filtered out sunlight during the period represented by Zone I and created a more ideal environment for some species of ferns decreased greatly at the start of Zone II. As a result, some of the taller arboreal species were able to gain a better foothold. The increase in mosses at the beginning of Zone II was possibly as a result of increased forest litter, which may have existed due to decreasing amounts of charcoal recovered at this time.

### ***Arboreal Pollen***

As indicated, arboreal pollen rose from the end of Zone I to Zone II by 20.43% and comprised 45.42% of the TCP at this time. Alder as mentioned has decreased from Zone I to II by 10.21% possibly as a result of drier conditions as this species is widespread along streams and commonly found in swamps (Harlow 1957: 129).

Alder could have also been squeezed out in competition for sunlight by some of the taller vegetation types as numbers for birch, maple, pines/spruce, willow, oak, and chestnut, all of which increased by 7.59%, 5.59%, 2.67%, 1.97%, 7.87%, and 2.62% respectively. Birch increased since the previous zone, perhaps as a result of this species taking advantage of the arboreal canopy above the area remaining open, and it favors moist, but not wet conditions preferred by alder and mosses (Harlow 1957). Even though ferns decreased since Zone I, perhaps their presence created enough shade that kept arboreal numbers in check, as the overall percentage for arboreal pollen at the beginning of Zone II remained under 50%. It is also probable that arboreal numbers were constrained as the region was reported to endure many lengthy dry spells during the period represented by the beginning of Zone II (<http://www.pequotmuseum.org/TheNaturalWorld/84000YearsAgo/> 1). As mentioned, drier conditions in the region are also supported at the Pequot Cedar Swamp from 8,400 to 5,000 cal yr BP (Newby et al. 2000: 365).

Also lending credence to the possibility of a somewhat partially open or patchy canopy for the earlier portion of Zone II is the increasing numbers of oak pollen. Oak in time does better with a fern understory than birch and maple do (George and Bazzaz 1999). Perhaps the fern understory that existed at this time was patchy like the tree canopy, and possessed vacant areas, which allowed birch to continue to increase, but was present in other areas allowing oak to rise at a greater rate than both birch and maple. Hickory, butternut, cottonwood (*Populus*), and ash (*Fraxinus*) manifested for the first time during the early years of Zone II. Hickory appears earlier in the Eastern Pequot core data than it did at Lantern Hill Pond; however, the timing

of its presence for the Eastern Pequot study corresponds to the same period for when it first occurred at Rogers Lake. Hickory may indicate more of a local species as its pollen is heavy and is usually situated in close proximity to its source.

During 3,350 – 4,700 BP, arboreal pollen soared to 62.97% of the TCP for this portion of Zone II. Alder disappeared entirely probably because the tree canopy continued to close and the region may have remained dry. Birch, maple, Magnoliaceae, pine/spruce, and cottonwood increased by 2.56%, 6.14%, 2.68%, 8.78%, and 1%, respectively. Birch, maple, and pine/spruce made up the bulk of the arboreal pollen at this time. Their percentages of the TCP stood at 14%, 13.33%, and 14.33%, respectively. Willow and oak decreased, while beech (*Fagus grandifolia*), basswood (*Tilia americana*) and cedar (Cupressaceae) appeared for the first time. Beech became visible here approximately 2,000 years later than it did at Lantern Hill Pond and Rogers Lake, conceivably reflecting the local nature that the Eastern Pequot core represents, due to beech being a heavier arboreal pollen type that would have remained closer to its originating source. Percentages for chestnut remained about the same and represented 3% of the TCP at this time.

From 2,000 – 3,350 BP, arboreal pollen decreased and represented 56.15% of the TCP during this period. Alder reappeared in limited amounts, possibly indicating a disturbance or cooler climate, and represented 0.90% of the TCP. Beech, chestnut, maple, and Magnoliaceae decreased by 1.50%, 0.90%, 12.13%, and 2.73%, respectively. However, birch, larch (*Larix laricina*), oak, pine/spruce, and willow increased by 1.92%, 1.17%, 6.44%, 1.29%, and 1.20%, respectively, also possibly indicating a return to cooler climatic conditions at this time. Climate during the Late

Holocene (5,000 – 400 BP) varied as there were several “Little Ice Ages” recorded during this period (McWeeney 1999: 10). For instance, one of the “Little Ice Ages” was recorded at 2,550 BP (McWeeney 1999: 10), with this date correlating to a period assigned to this section of the Eastern Pequot sediment core. While numbers for hickory stayed relatively similar to those exhibited earlier, black walnut (*Juglans nigra*) and hazel (*Corylus americana*) materialized for the first time and represented 1.20% and 0.30%, respectively of the TCP. The increasing number for ferns may have created a filter that dramatically suppressed percentages for maple, kept birch fairly in check, but allowed oak to flourish (George and Bazzaz 1999).

A decreasing trend in arboreal pollen continued during the period 650 – 2,000 BP. Arboreal pollen represented 37.12% of the TCP at this time, a noticeable reduction of 19.03%. Alder, hazel, and black walnut were absent. Birch, pine/spruce, larch, willow, and oak have all decreased to 5.67%, 7.08%, 0.85%, 0.57%, and 6.80% of the TCP, respectively. However, pollen grains for chestnut and maple rose to 7.37% and 3.68%, respectively.

### ***Herb Pollen***

Herbs, consisting of Compositae, Liliaceae, Chenop/Am, Cruciferae, and skunk cabbage (*Symplocarpus*) make up only 3.92% of the TCP at the beginning of Zone II. However, percentages for Compositae, Cruciferae, and skunk cabbage increased since the previous zone. Perhaps the decreased overall herb numbers are as a result of a combination of factors during this period such as an increasing developing arboreal canopy, competition with grasses, and drier climatic conditions.

From 3,350 – 4,700 BP, herbs consisting of Compositae, Liliaceae, Iridaceae, Umbelliferae, Chenopodiaceae, and channeled Solomon's seal (Convallariaceae) represented 9.32% of the TCP. As previously indicated, Native Americans residing in what is today southern New England utilized a variety of plants at this time. Archaeological evidence indicates that between 4,000 and 3,000 years ago, Native Americans sowed and cared for a variety of plants, which were gathered to supplement their diet (Smith 1992). Perhaps herbs increased during this segment of the Eastern Pequot sediment core because they were being coaxed to do so by human intervention. Not all herbs were eaten. Some of the Eastern Pequot core samples contained pollen grains of India hemp (*Apocynum cannabinum*), which the Pequot were reported to have used to make twine during historical times, but there is no reason to believe that it was not utilized much before then (Chamberlain 1901: 4). Other resources such as the common cat-tail and grasses were also used to construct baskets and mats (<http://www.pequotmuseum.org/NativeLifeways?BasketsandMats/1>).

From 2,000 – 3,350 BP, the percentage of herbs including Liliaceae, Iridaceae, Chenopodiaceae, skunk cabbage, Cruciferae, and channeled Solomon's seal dropped. Herbs comprised 6.90% of the TCP at this time. The reduced percentage of herbs was possibly a result of the arboreal pollen percentages remaining over 50% and competition with increased numbers of ferns and mosses for forest floor space. From 650 – 2,000 BP, a larger variety of herbs were included at this time. Dwarf ginseng (*Rhus copallina*), trailing arbutus (*Epigaea repens*), Cruciferae, Compositae, Liliaceae, Iridaceae, skunk cabbage, common cat-tail, and may apple (*Podophyllum*

*peltatum*) were present. The percentage of herbs increased slightly to 7.36% of the TCP.

### ***Charcoal***

Charcoal numbers for the beginning of Zone II decreased dramatically. For every counted pollen grain, approximately 1 piece of charcoal was recorded. The drop in charcoal particles at this time leads me to believe that the occurrence of or severity of fires greatly diminished. As a result, the arboreal canopy was allowed to expand without disturbances due to fires. Interestingly, the period designated by this portion of the Eastern Pequot pollen core correlates to a time (4,000 - 6,000 BP) as previously mentioned characterized by Kevin McBride of having lower human population numbers in the region. Jones (1999: 103), for example, surmised that the lower water table documented by Newby and others (2000) at the Great Cedar Swamp during this period, created a decreased variety and quantity of useful natural resources. If smaller populations inhabited the region, perhaps the limited amount of charcoal detected in Sample 11 was due to this. It is possible that the amount of charcoal detected for this sample positively correlates to population. Perhaps like the environment at the Great Cedar Swamp, sustenance derived from the landscape sampled by the Eastern Pequot sediment core could also not have supported a large population. As mentioned earlier, the number of herbs detected at this time, for instance, was the lowest recorded for all processed samples of the Eastern Pequot core.

Charcoal numbers for the portion of the core spanning 3,350 – 4,700 BP increased, as for every counted pollen grain, 1.76 or almost 2 pieces of charcoal were

recorded. The charcoal mean average increased at this time, but what is more interesting to note is that the charcoal mean average size for this portion of the core is higher than the mean average for Samples 9 through 2. This finding is contrary to the trend of increasing mean averages towards the top of the core or to Zone IV.

Increased charcoal numbers at this time may indicate a relatively litter-free forest floor, which could be the reason for the decrease in both ferns and mosses and the increase in herbs, and it may also explain reduced oak percentages. The increased mode, median, and mean average size of charcoal particles at this time, may indicate the occurrence of fire in closer proximity to the Eastern Pequot core site (Patterson et al. 1987). If the fire(s) originated during the growing versus the dormant season, which may very well be the case, oak would be severely impacted

([www.fs.fed.us/database/feis/plants/tree/quealb/all.html](http://www.fs.fed.us/database/feis/plants/tree/quealb/all.html) 13-14), while birch and maple considered to be pioneer species would be capable of sprouting on disturbed sites ([www.fs.fed.us/database/feis/plants/tree/acerub/all.html](http://www.fs.fed.us/database/feis/plants/tree/acerub/all.html) 2; [www.fs.fed.us/database/feis/plants/tree/betpop/all.html](http://www.fs.fed.us/database/feis/plants/tree/betpop/all.html) 4).

Charcoal particles corresponding to the period 2,000 – 3,350 BP decreased. For every pollen grain counted, only 0.63 pieces of charcoal were tallied. The mode, median, and mean average size of particles for this sample decreased as well. Even though charcoal numbers are the lowest recorded for all of the processed samples at this time, a decrease in arboreal pollen of 6.82% is recorded. Could some of the arboreal species been altered by other means besides fire and climatic factors? This period of the Eastern Pequot sediment core corresponds to the Transitional Archaic to Middle Woodland, which was characterized by an increase in native populations to

the area based on the abundance of dated sites. Could the decrease in arboreal pollen signify a period of slight deforestation for the study area as a result of Native American land management practices? McWeeney maintains that oak and pine were “dominant fuelwood choices into the Terminal Archaic period (3,800 to 3,000 BP) based on the charcoal identified from the Millbury site in Rhode Island” (McWeeney 1999: 11). Pollen percentages for oak and pine/spruce at this time for the Eastern Pequot sediment core only show slight increases; however, percentages for maple greatly decrease. Wood working tools like gouges, full-grooved axes, and celts have been dated to sites in southern New England during this period (Hoffman 1991) and as previously mentioned, a celt was recovered from the Eastern Pequot Tribal Nation Reservation. Perhaps the notion that charcoal particles positively correlate to population does not always hold true, and whether it is true may also depend on Native Americans’ use of fire. Other factors, which may reflect population figures, i.e., deforestation versus burning, need to be considered. As mentioned, percentages of herbs at this time decreased. Possibly larger populations inhabited the area during this period, which resulted in herbs being heavily utilized since maize horticulture, according to the archaeological history, had not yet been introduced.

Charcoal numbers increased for the closing segment of Zone II. For every pollen grain counted at this time, 1.65 pieces of charcoal were tallied. The mode of charcoal particle size remained the same, while the median increased and the mean average decreased. The increase in charcoal numbers could have contributed to a more open arboreal canopy for this period as the percentage of herbs and grasses only increased slightly. However, ferns, which prefer shade, increased more noticeably. If

fire were the sole reason behind the decrease in arboreal pollen types, why did ferns increase and why didn't alder reappear as it had in all the previous times that featured higher amounts of charcoal, except during 3,350 – 4,700 BP? Possibly the burned areas of land were kept clear for a period of time, and as a result, species like alder were not permitted to become reestablished. However, maple, which usually increases after disturbances such as fire, rose, while other arboreal species such as pine/spruce and oak declined.

The Eastern Pequot core exhibits a decrease in pine/spruce much earlier than for the other studies cited in this paper by approximately 1,550 BP (Davis 1969; Russell et al. 1993; Trent 1981). The core also records an increase in maple that occurred earlier than it did for some of the other studies, which attributed the increase of this species to the arrival of Europeans (Russell et al. 1993). So perhaps an increase in maple is not always indicative of the arrival of Europeans. The burning which was recorded at the end of Zone II could be of a controlled nature because certain taxa that increase as a result of fire -- for example, maple -- flourished, while other taxa known to increase after fire, like pine/spruce and oak, did not. There was also a recorded climatic cooling period during this time dated to 1,550 BP (McWeeney 1999: 10). A cooler climate, would have favored pine/spruce, and if so, why did pollen numbers for pine/spruce decrease at this time in the Eastern Pequot sediment core by 7.08%?

The burning that is recorded in this portion of the core could have been conducted by increasing native populations to the area. The period of time represented by this segment of the Eastern Pequot sediment core corresponds to the Middle to Late Woodland. The archaeological record acknowledges the introduction

of maize agriculture during this period and reveals that large base camps may have been occupied for most of the year in the region (Dincauze 1990: 29). However, there is a decrease in the number of archaeological components dated to the Early and Middle Woodland periods at Mashantucket, while they increase slightly during the Late Woodland possibly indicating an elevated intensity of usage of the region encompassing the Mashantucket's Cedar Swamp (Jones 2002: 23). Jones (2002: 26) cites the decrease of components in the Early and Middle Woodland due to "social reconfiguration" at this time, where as, the large base camps of the Pequot and other inhabitants to the area were located on the coast or estuarine and river flood plains. Mashantucket and the immediate surrounding area may have been used as hunting or foraging areas during the Early, Middle, and Late Woodland periods and the decrease in pine/spruce pollen recorded by the Eastern Pequot sediment core could indicate a more regional rather than local vegetation representation for this taxa (McBride 1994; McBride and Grumet 1996). It is interesting to note that the current vegetation survey conducted during 2005 did not record any pine/spruce trees in the vicinity from which the Eastern Pequot sediment core was extracted.

Burning, as suggested earlier, could have also been utilized as a land management technique to increase wildlife species for hunting (Cronon 1983: 51). At this time, a variety of animals were hunted and consumed by indigenous inhabitants of the region (Starna 1990: 35). Perhaps areas of the landscape were intentionally burned to create an "edge effect," regions which bear a resemblance to a border that exists between forests and grasslands, a location where various "plant communities, successional stages or stand conditions" become intertwined to create a perfect

environment for a multitude of wildlife species (Cronon 1983: 51; [www.dep.state.ct.us/burnaltr/wildlife/factshts/openings.htm](http://www.dep.state.ct.us/burnaltr/wildlife/factshts/openings.htm) 1). A favorite food of the white-tailed deer, for example, is tree seedlings (Russell et al. 2001: 13). What better way is there to attract a species such as this, which was one of the most hunted animals by Native Americans in southern New England, to a region than to produce preferred foods for their consumption?

All of these activities -- maize agriculture and the creation of large base camps in the region, and efforts to increase wildlife species to an area -- may have incorporated more widespread burning to the region. In essence, the activities would have altered the landscape. However, possibly a portion of the region sampled by the Eastern Pequot core could have been intentionally spared from burning. This would have allowed floor litter to accumulate, arboreal species to remain intact, and mosses to perpetuate.

### **Zone IIIa**

Pollen information obtained from Sample 6 is represented in Zone IIIa. This zone is characterized by the dramatic rise of chestnut, while other arboreal taxa, for example, pine/spruce and oak, declined, an increase in charcoal, and a decline in ferns and herbs. Zone IIIa is dated approximately 580 to 650 BP (A.D. 1354-1424). Grasses decreased greatly and comprised only 3.74% of the TCP at this time, while field horsetail, scouring-rush, and ragweed were absent. Ferns decreased since Zone II and represented 3.75% of the TCP, while mosses increased, and made up 11.23% of the TCP.

### ***Herb Pollen***

Herbs represented 4.54% of the TCP for Zone IIIa. Included in this percentage were Cruciferae, Compositae, Liliaceae, Iridaceae, Chen/Am, and channeled Solomon's seal. Perhaps the increasing percentage of mosses competed for forest floor space and in the process inhibited herbs from expanding in number. The increase in charcoal for this portion of the core, which will be discussed shortly, may have also assisted in keeping numbers for herbs down.

### ***Arboreal Pollen***

Arboreal pollen increased to 51.16% of the TCP during Zone IIIa. Alder reappeared, but in smaller amounts possibly indicating some kind of a disturbance in the area or perhaps a somewhat moister climate. Birch, chestnut, beech, butternut, and willow all increased since the last sample. However, the rise of chestnut from 7.37% of the TCP at the close of Zone II to 21.93% of the TCP of Zone IIIa was the underlying reason behind higher numbers for arboreal pollen, but nevertheless, the overall arboreal pollen percentage increased by approximately 14%. If percentages of chestnut were omitted from the findings so that this taxon would not drown out the other arboreal taxa, arboreal pollen for Zone IIIa would only represent 29.23% of the TCP, and this amount would reveal a continuous decreasing trend for the majority of arboreal species, which began during Zone II at 2,000 – 3,350 BP. Pollen grains for Magnoliaceae, maple, oak, and pine/spruce have all decreased since the close of Zone II (650 – 2,000 BP), but larch, oak, and pine/spruce have been on a decreasing trend since 2,000 – 3,350 BP.

How is Native American deforestation reflected in the pollen record and what distinguishes it from European deforestation? Faegri and others (1989: 184) describe a study which examined consecutive forest clearings conducted by the Huron Indians and then Europeans from a pollen core collected from a lake in Ontario. Native deforestation was seen by way of a decrease in arboreal species such as beech and maple along with an increase in light-craving ferns and herbs. A period of forest regrowth next occurred indicating that the Huron had left the area before European deforestation, which was characterized by the appearance of introduced vegetation species, a wealth of ragweed and grasses, and a sudden decrease in arboreal species began. As previously mentioned for Zone IIIa of the Eastern Pequot core, ragweed was not present and arboreal pollen had decreased, for example pine/spruce and oak, since the close of Zone II, with maple also diminishing by a negligible amount. However, herbs, as mentioned, decreased since the close of Zone II and beech increased slightly. Perhaps these results support the notion that different groups of Native Americans did not practice deforestation consistently. Deforestation practiced by both the Huron and Eastern Pequot appears to have had a similar overall affect in that, for example, there was a recorded decrease in arboreal pollen; however, different arboreal species for both cases were affected. Native land management practices were dynamic and variable, and it is the variableness that sets them apart from land management activities practiced by European settlers.

### ***Charcoal***

Charcoal increased in Zone IIIa, possibly as a result of populations in the area being maintained and the immediate region utilized more frequently throughout the

Late Woodland (Jones 2002). For every pollen grain counted, 1.97 pieces of charcoal were tallied. The mode remains the same since the close of Zone II, while the median and mean average of charcoal particle size decreased. The increase in charcoal may explain the decreasing percentages for grasses, ferns, and herbs. However, the increase in moss percentages is interesting and could be as a result of the expanding arboreal canopy, which increased by 14.04% since the end of Zone II, due mainly to the dramatic rise in chestnut.

Even though charcoal numbers rose, it is perplexing why arboreal pollen percentages also increased. Chestnut, for example, is reported to increase with fire (Russell 1987) as well as some of the other fire-sensitive arboreal species like alder. However, too much fire, as witnessed with Zone I, is not beneficial to many arboreal species. Perhaps the burning that is recorded during the period of time represented by Zone IIIa was of a more controlled nature as certain arboreal species were spared and others, such as chestnut, were possibly encouraged to grow over some of the others.

### ***The Chestnut Factor***

As mentioned, chestnut was present in all processed samples of the Eastern Pequot sediment core, but only in limited amounts in Samples 9 through 14 and in Sample 1. Other pollen studies support this observation and reveal that chestnut pollen was present in low numbers in New England for a great period of time before this species skyrocketed 2500 – 2000 BP (Paillet 1982, 2002; Russell 1987). The longevity of chestnut in the vegetation record of southern New England may be due to a couple of factors. Paillet (2002: 1521) suggested that because chestnut pollen is diminutive, pollen grains of this species riding on top of the forest canopy could have

been carried over great expanses from locations to the south of the subject area before the species migrated to the region. However, there is no concrete evidence indicating this had occurred. Since chestnut pollen is created in early summer after the forest canopy has sprouted for the season and since this species is insect pollinated, its presence could also indicate more of a local vegetation cover (Paillet 2002: 1521; Russell 1987: 188). Therefore, the appearance of chestnut grains in the early and middle Holocene could also be as a result of a meager population of the species persisting in the subject area (Paillet 2002: 1521).

For Zone IIIa of the Eastern Pequot core dated from 650 – 2,000 BP, the species represented approximately 43% of the arboreal pollen. Perhaps this finding attests to the local implications that this species had. The vivid increase in chestnut in the Eastern Pequot core is recorded to have occurred slightly later than it had at Rogers Lake, but much earlier than at Lantern Hill Pond. But, why did this species dramatically rise in southern Connecticut when it did?

Several studies have attributed the increase to a combination of climatic change and human intervention. Some examinations credit the rise in chestnut to human disturbance, which occurred with the onset of European agriculture (Brugam 1978a; Francis and Foster 2001: 304; Paillet 2002; Trent 1981). On the other hand, other investigations, including this one, detect that this increase transpired earlier than European agriculture and could be the result of land management practices conducted by Native Americans (Cronon 1983; Davis 1969; Russell 1987; Tindall et al. 2004). Chestnut produces an edible fruit, and written accounts highlight native practices of drying it to preserve it (Williams 1936: 95). However, the archaeological record for

southern New England does not support the recovery of charred chestnut shells. This may be due to preservation and identification issues (Largy 2006). Chestnut was also considered to be a commodity by some Native American groups of New England who were reported to have used it as a trade good (Cronon 1983: 92). The timber from this species was quite popular, not only for indigenous people, but also for Europeans upon their arrival to the region (Cronon 1983: 92, 109, 120; Wood 1977: 39). With such a valued tree for both its fruit and wood, why wouldn't landscape management systems practiced by Native Americans take this into consideration? Possibly the Native Americans residing in the vicinity of the Eastern Pequot core location conducted a discriminatory deforestation and as a result spared and helped to propagate chestnut through selective burning.

### **Zone IIIb**

Zone IIIb includes Samples 5 through 2 and is dated from 220 BP (A.D. 1864) to 500 BP (A.D. 1424). This zone is characterized by a dip in arboreal taxa, specifically at the beginning of the zone for pine/spruce, but later for oak. Chestnut remained in check at the beginning of the zone, increased, and then decreased, while charcoal increased, but then decreased throughout the remainder of the zone. Herbs appeared consistently throughout the zone and showed more of a variety. By my calculation, the earliest portion of this zone, dated from 500 – 580 BP, represents the period directly before the onset of European colonialism in the area. Grasses decreased slightly from the end of Zone IIIa and represented 3.66% of the TCP. Field horse tail and scouring-rush continued to be absent since 2,000 – 3,350 BP. Ragweed

reappeared and represented 2.09% of the TCP for Zone IIIb. Ferns and mosses both decreased to 2.62% and 3.93%, respectively, for the TCP of this section of the core. For the section of Zone IIIb dated to 290 – 500 BP (A.D. 1504 – 1714), grasses continued to increase slightly from the last section and reflected 3.81% of the TCP. Field horse tail and scouring-rush reappeared and made up 0.95% of the TCP. Ambrosia decreased since the last section and represented 1.59%. Ferns and mosses continued to decrease and comprised 1.26% and 2.85% respectively of the TCP for this section of the core.

For the section of Zone IIIb dated approximately 220-290 BP (A.D. 1714 – 1784), grasses continued to rise and represented 4.47% of the TCP. Perhaps this increasing trend signifies more of an open or partially open tree canopy. Field horse tail and scouring-rush were present and constituted 0.96% of the TCP. Ferns and mosses continued to decline with percentages of 0.32% and 2.56%, respectively, of the TCP.

Ragweed decreased slightly since the first section of Zone IIIb and comprised 1.28% of the TCP for the section of the zone dated from 220 – 290 BP (A.D. 1714 – 1784). This observation is not consistent with other studies, namely Brugam's analysis of pollen grain data at Linsley Pond in North Branford, Connecticut, for his study reports a marked increase in the pollen of weed species at approximately 1700 (Brugam 1978a: 355). The rise of ragweed for the Eastern Pequot core is marked at Sample 5, which corresponded to the section of Zone IIIa that is dated from 500 – 580 BP (A.D. 1424 – 1504), when percentages for this species reach 2.09% of the TCP for that sample and with Sample 1, when they attained 2.15% of that sample's respective

TCP. These figures from the Eastern Pequot core, even though dated earlier, are more in line with the rise of ragweed to only 3% at Makepeace Cedar Swamp near Carver, Massachusetts, which took place approximately 250 years ago (Newby et al. 2000: 362). The rise in ragweed for the Eastern Pequot core may suggest the spread of Native American agriculture in the area.

For the section of Zone IIIb dated from 140 to 220 BP (A.D. 1784 – 1864), grass and field horse tail/scouring rush declined somewhat as they represented 4.16% and 0.55% respectively of the TCP. The amount of ragweed remained relatively unchanged. Mosses decreased slightly and represented 2.22% of the TCP for this section of Zone IIIb dated from 140 to 220 BP.

### ***Arboreal Pollen***

Arboreal pollen stood at 54.71% of the TCP for the start of Zone IIIb with chestnut making up 22.51% of this amount. If we were to omit chestnut pollen so that its numbers would not overwhelm the other arboreal pollen types, all other arboreal pollen would represent 32.20% of the TCP, a slight increase of approximately 3% since the end of Zone IIIa. Pollen percentages for alder, maple, butternut, Magnoliaceae, willow, and oak have increased, while birch decreased and pine/spruce continued its downward trend since 2,000 – 3,350 BP. I have already discussed how alder, maple, and oak may flourish after burning. Fire can also enhance the seedling establishment for Magnoliaceae, a great survivor arboreal species of the past, which was widespread during Upper Cretaceous times (Wilson and Loomis 1967: 577; [www.fs.fed.us/database/feis/plants/tree/lirtul/all.html](http://www.fs.fed.us/database/feis/plants/tree/lirtul/all.html) 7). However, butternut does not fair well with fire and budding from the root crown or stump is infrequent for this

species, so perhaps a fire regime intentionally avoided it ([www.fs.fed.us/database/feis/plants/tree/jugcin/all.html](http://www.fs.fed.us/database/feis/plants/tree/jugcin/all.html) 6). Cronon (1983: 50) explains with regular burning, “fires moved quickly, burned with relatively low temperatures, and soon extinguished themselves.” He also maintains that native burning did not usually destroy larger trees “and so they rarely grew out of control” (Cronon 1983: 50).

Arboreal pollen increased to a staggering 67.03% of the TCP for the section of Zone IIIb dated to 290 – 500 BP (A. D. 1504 – 1714) although chestnut pollen represented 34.92% of this amount. All other arboreal pollen types represent 24.86% of the TCP at this time. Clearly a decreasing trend can be seen for many arboreal pollen types since the section of Zone IIIb dated from 500 – 580 BP (A.D. 1424 – 1504). Specifically, alder, birch, maple, Magnoliaceae, and oak have all declined, while only hickory, black walnut, and pine/spruce increased.

Perhaps the Eastern Pequot core discloses a heightened selective deforestation in response to colonialism. With the Eastern Pequot taking up permanent residence on the reservation, they may have had an increased need to intentionally preserve tree species most beneficial to them. The nuts from butternut, chestnut, hickory, and black walnut could have been valued as a supplemental food source, and it is possible that the Eastern Pequot selectively decided not to bring these nut bearing trees down. They may have encouraged nut-producing trees to grow by clearing the forest from around them of non-productive trees. Perhaps, the Eastern Pequot cultivated and tended nut-producing trees as the indigenous inhabitants of Hunter Island, New York, had planted hickory.

The increase in pine/spruce in this section of the core is interesting. The period of time represented by this section of Zone IIIb (290 – 500 BP or A.D. 1504 – 1714) corresponds to some of the “Little Ice Age” (A.D. 1430 – 1860). Climate may have had an impact in increasing numbers for pine/spruce with the reduction in seasonal temperature. Perhaps the increased numbers also coincide with elevated burning, which is discussed below. Since pine could either be a distant or local species, increasing numbers of it may very well portray the few specimens that were located on the reservation grounds and as a result were spared from harvest by European colonists.

Percentages for arboreal pollen increased since the last section of Zone IIIb and represented 69.35% of the TCP for this section dated from 220 – 290 BP (A.D. 1714 – 1784). However, chestnut comprised 42.17% of this percentage, leaving just 27.18% of this amount to be made up of the rest of arboreal taxa present in the section. Specifically birch, hickory, butternut, Magnoliaceae, pine/spruce, and oak all decreased, while alder, maple, black walnut, willow, sycamore, and basswood increased. All of these decreasing taxa, except maple and sycamore, possess softer woods that instead of being valued as building materials, they have been utilized for more precise applications like hand carving and pulpwood (Harlow 1957: 129-130; <http://www.fs.fed.us/database/feis/plants/tree/tilame/all.html> 4). Maple could have been coveted for its sap, and as a result percentages for this species and alder could have increased due to large-scale land maintenance activities of the subject area (Harlow 1957: 241). Perhaps the increase of these two species, which may indicate disturbance, along with the decrease in mainly pine/spruce and oak that could have

been harvested because of their potential as building materials, signifies widespread deforestation possibly as a result of an increased, more confined population inhabiting the reservation lands.

For the section of Zone IIIb dated from 140 to 220 BP (A.D. 1784 – 1864), arboreal pollen decreased from 69.35% to 65.65% of the TCP. Chestnut declined from the previous section of Zone IIIb by 11.14%. With figures for Chestnut omitted from the arboreal total, the rest of the arboreal pollen represented in this section of Zone IIIb is at 34.62% of the TCP, revealing a slight increase in many arboreal types since the section of Zone IIIb dated from 220 – 290 BP (A.D. 1714 – 1784). Alder, maple, hazel, hickory, butternut, Magnoliaceae, pine/spruce, larch, willow, oak, and beech have all increased. However, birch decreased since the last section of the zone by 2.80%. The slight increase in pine/spruce may have to do with cooler temperatures reported during this period as this section of Zone IIIb catches the tail end of “Little Ice Age.” The increasing numbers for alder and maple may indicate some kind of a continuous land maintenance activity taking place, for example like logging, which is reported to have occurred on both the Mashantucket and Eastern Pequot reservations during the 19<sup>th</sup> and 20<sup>th</sup> centuries (Appendix to Comments of the State of Connecticut 2001; Glaza 2003: 12-13). There was also a hurricane that devastated the area in 1815 and may have been responsible for knocking down some arboreal species (Raup 1941: 68). The Eastern Pequot sediment core does not record widespread environmental disturbances on the reservation and immediate surrounding area at this time, but I do believe that a signature of minor disturbances and more subtle climatic

variations are recorded by the core during this period and are reflected by slight increases and decreases of arboreal pollen.

### ***Herb Pollen***

Herbs increased slightly at the beginning of Zone IIIb dated from 500 – 580 BP (A.D. 1424 – 1504) and comprised 5.34% of the TCP. Included under the umbrella of herbs were Cruciferae, Compositae, Liliaceae, Iridaceae, Umbelliferae, Portulacaceae, Labiatae, and Chen/Am. Herbs represented in this section of Zone IIIb revealed more of a variety than seen in any of the previous sections to this point, and numbers for them increased, albeit slightly, in the wake of an expanding arboreal tree canopy. It is possible that this increase and variety were as a result of human intervention.

For the section of Zone IIIb dated to 290 – 500 BP (A.D. 1504 – 1714), herbs remained relatively similar to the previous section and rose ever so slightly and comprised 5.40% of the TCP. However, they show even more of a variety than the last section and are represented by Cruciferae, Compositae, Liliaceae, Iridaceae, Chen/Am, channeled Solomon's seal, dwarf sumac (*Rhus copallina*), nettle (*Urtica procera*), common cat-tail, swamp saxifrage (*Saxifraga pensylvanica*), and yellow pond lily. It is possible as a result of Eastern Pequot land management practices that more of a variety of herbs appeared since many of these species were consumed and used in weaving by indigenous peoples of Connecticut and southern New England (Rainey 1956).

Herbs detected in the section of Zone IIIb dated from 216 – 288 BP (A.D. 1716 – 1788) continued to be diverse and included common cat-tail, trailing arbutus, Chen/Am, Cruciferae, Compositae, Liliaceae, twin leaf, three seeded mercury

(*Acalypha hederacea*), and hop (*Humulus lupulus*). Herbs comprised 5.71% of the TCP, a slight increase since the previous section of the core. For the final section of Zone IIIb dated from 140 to 220 BP (A.D. 1784 – 1864), the percentage of herbs remained relatively unchanged and included common cat-tail, Cruciferae, Compositae, Liliaceae, Cheno/Am, Umbelliferae, hop, and water lily.

### ***Charcoal***

Charcoal numbers for the earlier section of Zone IIIb, dated from 500 – 580 BP (A.D. 1424 – 1504), are on par with Zone IIIa. The mode and median of charcoal particle size stayed relatively the same, while the mean average increased slightly. Even though the arboreal canopy expanded during the period, which should have raised the probability for increased forest litter, numbers for ferns decreased and mosses dramatically diminished by 8.45% since the end of Zone IIIa. This observation lends credence to the possibility that the forest floor was intentionally burned for a variety of reasons. Burning could have occurred in order to clear brush and ferns for agricultural fields or to perhaps assist the growth of herbs and some nut-producing trees like chestnut and oak, which are both capable of sprouting heartily from their stumps after a fire (Russell 1987: 187).

The information collected from the Eastern Pequot sediment core appears to indicate that as human populations increased during this time, burning may very well have undergone a transformation and became more controlled in nature than it was before. Even though charcoal particles increased for some samples of the core, many arboreal vegetation types such as chestnut, butternut, black walnut, and oak appear to have been spared. Perhaps burning regimes intentionally avoided areas containing

concentrated amounts of nut-producing trees during the Late Woodland in order to support the increasing populations in the area at this time. After all, the fruits of these trees, butternuts, walnuts, hickory nuts, chestnuts, and acorns, were collected, consumed, and stored by Native Americans residing in the region (Rainey 1956: 11; Starna 1990: 35-36).

Charcoal increased for the section of Zone IIIb dated to 290 – 500 BP (A.D. 1504 – 1714). For every pollen grain counted, 2.65 particles of charcoal were present. The mode of the charcoal particle size is in line since the last section of Zone IIIb, while the median and mean averages increased. The increased burning may have assisted in keeping the forest floors free of ferns and mosses and could have occurred as a result of the Eastern Pequot clearing portions of the reservation for habitation sites.

The Public Records of the Colony of Connecticut dated from May 1678 to June 1689 (vol. 3: 68, 117, 125) contain several entries for the “laying out” of a “suitable tract of land,” which would be adequate for the Pequot under the leadership of Momoho to “plant upon” in Stonington, Connecticut until the contemporary reservation lands were chosen. The colonial government may not have regulated as much the early years of reservation life for the Eastern Pequot as they would in later years. Perhaps the Eastern Pequot Tribal Nation Reservation was used on a temporary basis like the Mashantucket Reservation was used at this time (McBride 1993: 67). Both groups of Pequot may have continued with their seasonal rounds as they were permitted to traverse upon a larger area. It is possible that Eastern Pequot sustenance resembled the practices of the Pequot that frequented Mashantucket, which

was composed of maize horticulture, and seasonal hunting and gathering, with their sustenance activities similar to those that they practiced before the Pequot War (McBride 1993: 66). The diary of Thomas Minor, a Stonington, Connecticut, Euro-American resident, attests to Native Americans being able to visit with him freely from 1653 to 1684 (<http://members.cox.net/trm/MinorThomasJr.htm>). Minor's diary reveals that he was frequently visited by native people during this time and had employed some of them as farm hands who assisted in the sowing of wheat and gathering of chestnuts and hops (Minor 1899). There is no reason to believe that the Eastern Pequot did not also gather chestnuts and other indigenous food sources from their reservation land.

Apparently the land settled upon for the Eastern Pequot Tribal Nation Reservation was not suitable for large-scale agriculture. Several constituents of the tribe were allowed to cultivate diminutive tracts of land in Groton, but were mandated to reside in Stonington so that they could be monitored (De Forest 1964: 422). Written accounts document the size of several cornfields cultivated by a few Pequot in 1666. The fields measured less than an acre each and the Pequot were reimbursed a monetary sum for fields that were taken away from them (Thomas 1976: 11). So perhaps as a result of some Pequot cultivating non-reservation lands at this time, while others probably cultivated small tracts of land on the reservation, there would be no need to completely deforest reservation lands. It wasn't until 1717 when colonial legislation began "tightening control over natives' lives and land," with the passage of a Christianizing mission act (Lamb Richmond and Den Ouden 2003: 201). Therefore, the Eastern Pequot sediment core revealed higher percentages of arboreal

pollen during this period, as reservation lands even though they were not suitable for large-scale agriculture were simply not needed for it. In 1713, approximately 150 individuals were listed as members of the Eastern Pequot community (De Forest 1964: 439). Possibly this increase in the amount of people inhabiting reservation lands on a continual basis was responsible for the increased amount of charcoal and for the species of arboreal vegetation that were decreasing in number.

Numbers for charcoal decreased for the section of Zone IIIb dated from 220 – 290 BP (A.D. 1714 – 1784), but remained in line with those recorded for the period dated from 500 – 2,000 BP (Samples 5 through 8). A gradual increase in the number of charcoal particles from sample to sample beginning with Sample 9 dated from 2,000 – 3,350 BP and ending with Sample 4 dated from 290 – 500 BP (A.D. 1714 – 1504). For every pollen grain counted for the section of Zone IIIb dated from 220 – 290 BP (A.D. 1714 – 1784), 1.59 pieces of charcoal were tabulated. The mode and median of the charcoal particle size decreased since the previous section, while the mean average increased. Why do charcoal numbers decrease in this section? Several factors may have been at play.

As mentioned, the colonial government sought out tighter control over the whereabouts of native people and enacted in Connecticut during May of 1717 to October of 1725 several pieces of legislation to authorize colonial control. The Colony of Connecticut Public Records (vol.: 83, 535) verify that orders were directed to several groups of Native Americans in the colony to limit and in some cases prohibit members of their native communities from hunting in woods outside of their territories, i.e. reservation lands, in order to compensate what they could hunt from

their own lands. These restrictions must have had an effect upon limiting the population on the respective reservations as native people by law had to rely almost exclusively on sustenance from their reservation lands and what provisions they could acquire from their overseers and provisions they purchased from outside sources. As a result of these restrictions and limitations, native activities such as burning lands located outside of their reservation would have been curtailed, and it is likely that the Eastern Pequot would have limited widespread burning on their own reservation due to their own people needing to actively inhabit their reservation land. Interestingly, an Act restricting burning, enacted in 1644 by the General Court of Connecticut, on common lands and the woods during portions of the year was not repealed until the late 1720s (Trumbull 1876: 87 (website); CT Public Records, May 1726 – October 1735, vol. 7: 456). In 1725 population figures provided by Governor Talcott estimated the Eastern Pequot to be composed of 218 individuals (Lamb Richmond and Den Ouden 2003: 223), which translates to approximately one acre of reservation land for each person's use, leading me to believe that overcrowding conditions probably existed on the reservation if all of the people included in this census actually resided there.

Between May, 1744, to November, 1750, The Colony of Connecticut Public Records (vol. 9: 494) verify that the Eastern Pequot filed a complaint regarding trespassers on their lands. Perhaps in response to the actions of outsiders on their reservation land and limitations placed on them by the Connecticut government in acquiring outside reservation provisions on their own, the Eastern Pequot may have developed more of a sense of urgency in conserving what natural resources they had

left on their lands for their own use. Or possibly, as recorded by De Forest, until the Eastern Pequot's complaint petition was presented to the Assembly at the May session in 1749, they were prohibited from keeping livestock, but were permitted to plant small gardens of corn and vegetables (1964: 432-433). Therefore, the Eastern Pequot may have curtailed burning that was intended to clear their land for livestock and large tracts for cultivation.

There is also some debate as to how many individuals lived within the reservation boundaries during the period represented by this portion of Zone IIIb (220 – 290 BP/A.D. 1784 – 1714) of the Eastern Pequot core. Did the population residing on the reservation dramatically decrease from 1725 to 1749 when De Forest claimed that approximately 38 people, mostly females, inhabited the reservation and then rise dramatically in 1774 when the census recorded 273 individuals (De Forest 1964: 432, 439)? Contained in a letter written on March 15, 1757 to the Honorary Commissioners for Indian Affairs in Boston, by the Reverend Joseph Fish, the correspondence begins with a brief description of the population and buildings present on the Eastern Pequot Tribal Nation Reservation. Fish writes, "In this society about four miles from my dwelling house and three from the meeting house, there is a small Indian Town consisting of 16 houses and wigwams in which are 71 persons great and small which are one branch of the Pequot" (Papers of Reverend Joseph Fish). Perhaps population figures provided by De Forest did not include children or for that matter individuals who defied colonial law and continued to work for periods of time outside of the reservation. It is also possible that De Forest's population figures as well as other lower estimations came about to downplay native populations in order to try to

get around the 1680 reservation law, which protected reservation lands from colonial encroachment (Lamb Richmond and Den Ouden 2003: 199-200).

Whatever the case, there is no denying that the population dwelling upon the reservation was having an effect upon the natural resources contained within the landscape. In later correspondence to the Honorable Andrew Oliver, Esquire, on May 3, 1768, the Reverend Joseph Fish made the following reference to the occupants of the reservation, “failure of my poor unhappy people while grows of poverty have wholly presented my support” (Papers of Reverend Joseph Fish). These comments may be biased as Fish could have made them to rationalize the necessity of his position. He may have later enhanced the emotional and spiritual plight of the Eastern Pequot to rationalize a forthcoming request from him for the construction of a schoolhouse. While on October 24, 1769, the Reverend Joseph Fish wrote with news that the “Indian Pequot at Stonington are very desirous of learning for their children (about 25 of suitable age for school)” (Papers of Reverend Joseph Fish).

If conditions upon the reservation were so bad for the Eastern Pequot as Fish formerly portrayed them to be, why would the Eastern Pequot be interested in educating their children with the ways of the colonizers? Or perhaps, Fish exaggerated his earlier report on their condition. Besides land management practices, the Eastern Pequot continued to make their own choices about their future in light of colonial conditions. In later correspondence between Reverend Fish and Honorable Andrew Oliver, we learn that a school was built in Stonington on behalf of the Eastern Pequot. In a letter dated January 21, 1772, we are informed of a neighbor to the “Indian Land,” who told the Reverend Fish, “that he would give them [already down]

timbers off his land adjoining Indian Land,” and these timbers would be enough to build the school (Papers of Reverend Joseph Fish). Besides being an act of kindness, what other reasons would there be for this neighbor to donate wood to the Eastern Pequot? Perhaps not enough suitable building materials existed on the reservation at this time that would be sufficient to construct a school. It is possible that this observation correlates to the reduced arboreal pollen species suitable for construction like pine/spruce and oak detected in the Eastern Pequot core.

For the section of Zone IIIb dated from 140 to 220 BP (A.D. 1784-1864), charcoal decreased since the last section as for every pollen grain recorded, 1.62 pieces of charcoal were accounted for. The mode, median, and mean average of charcoal particle sizes have increased since the last sample. In the 1780s many Pequot are reported to have left Connecticut for New York and Wisconsin because of the Brothertown Indian Movement (De Forest 1964: 438; McBride 1990: 108, 111-112). In 1820, De Forest maintained that the population at the Eastern Pequot reservation consisted of 50 people (1964: 442). The Overseers Documents also attest to a dwindling population for the reservation through the 1800s as well as the Eastern Pequot's reliance of staples purchased from outside of the reservation such as meal, rice, flour, potatoes, tobacco, pork, codfish, calico, cotton cloth, corn, building materials, and firewood (Overseers Documents 1800-1835). Perhaps the decreased amount of charcoal detected for this section of Zone IIIb could be as a result of decreasing population on the reservation at this time.

## **Grass**

Grass is an interesting vegetation type as indicated by percentages for this species in the pollen sum diagram. Even though grasses decrease ever so slightly from the section of Zone IIIb dated from 220 – 290 BP (A.D. 1784 – 1714) to the section dated from 140 – 220 BP (A.D. 1864 – 1784), grass pollen grain size through time is also something to consider. Kelso and Beaudry (1990: 64) assign grass pollen grain size greater than 40  $\mu\text{m}$  to be “European cereal” with this category encompassing wheat, barley, oats and rye. Other sources define cultivated species as grass grains larger than 44  $\mu\text{m}$  or 45  $\mu\text{m}$ , while maize (*Zea mays*) has a pollen grain size larger than 65  $\mu\text{m}$  or 70  $\mu\text{m}$  (Faegri et al. 1964; <http://www.geo.arizona.edu/palynology/pid00015.html> 1; Kapp et al. 2000).

Cereal size grass pollen grains larger than 44  $\mu\text{m}$  first appear with the section of the Eastern Pequot core dated from 290 – 500 BP (A.D. 1714-1504). There is one grass pollen grain from a section of Zone II dated from 2,000 – 3,350 BP that is in the size range of maize; however, maize agriculture is not known to have occurred at that late date in the southern Connecticut region. Zone IIIa dated from 580 – 650 BP (A.D. 1424 – 1354) has one grass grain that measured approximately 40  $\mu\text{m}$ . The section of Zone IIIb dated from 500 – 580 BP (A.D. 1504 – 1424) has two grass grains that measured approximately 40  $\mu\text{m}$ , and one at 42  $\mu\text{m}$  (see Table 8).

**Grass Pollen Grain Size for Samples 1-8**  
**Table 8**

<b>Sample Number/ Zone</b>	<b>Wild Grass Size &lt; 40 µm</b>	<b>Cereal Grass Size ≥ 40 µm</b>	<b>Maize Grass Size ≥ 65 µm</b>
1/ Zone IV	24	1	0
2/Zone IIIb	12	3	0
3/Zone IIIb	11	3	0
4/Zone IIIb	6	3	3
5/Zone IIIb	11	3	0
6/Zone IIIa	8	1	0
8/Zone II	33	0	0
9/Zone II	22	0	1

Grass grain size frequency of  $\geq 40 \mu\text{m}$  was the highest for Sample 4, with six grains. Interestingly, three grass pollen grains for this sample measure approximately  $66.66 \mu\text{m}$ . As mentioned by some standards, grass pollen grains of this size are considered to be *Zea mays*.

The records of the Eastern Pequot overseers contain an entry for seed corn, bushels of corn, a bushel of oats, the purchase of a scythe, hay rakes, and payment for plots of land to be plowed as well as several listings during the 1800s for receipt of income for reservation land that was rented as pasture to outsiders (Overseers Documents 1831 – 1900). For the period 1800 to approximately 1850, there are numerous entries for the purchase of pork, with a listing in June of 1832 for the purchase of pork, “dead and one alive,” verifying that pigs or at least one pig was raised on the reservation at this time (Overseers Documents 1800 – 1850). The Overseers Records mention beef and chicken, but not until 1851. The ox shoes recovered in the vicinity of a 19<sup>th</sup> century house foundation also indicate that at least one draft animal was kept on the reservation and perhaps used to till smaller fields for crops. Small piles of stone were located on the Eastern Pequot Tribal Nation Reservation and may indicate field clearing, following McBride’s (1993: 72)

attribution small piles of stones located on the Mashantucket Pequot Reservation to field clearing. The source of the detected “European cereal” and possible maize pollen grains in the Eastern Pequot sediment core possibly originated from the reservation as non-arboreal pollen commonly indicates local ground cover (Janssen 1973; Kelso 1987). However, other studies attest that even though maize pollen is heavy, and therefore as previously mentioned does not travel far from its originating source, with the right conditions, for instance, it can travel “far beyond the 200m cited in several reports” (<http://www.mindfully.org/GE/Dispersal-Maize-Pollen-UK.htm> 14). It is also probable that the larger grass pollen grains ended up in the Eastern Pequot sediment core by way of items purchased by the overseers.

It is evident that the reservation land could not produce a sufficient amount of maize that could be stored to feed the population because if it had, corn should not have appeared within the Overseers Records. It seems that the Eastern Pequot until this time continued to live as they and their ancestors had always lived. But instead of the Eastern Pequot hunting and acquiring materials that a seasonal round would have provided them with, they were now relying on resources, mainly staples, purchased by their overseers and what they could acquire on their own from outside of reservation lands. The supplies purchased by the overseers and items purchased by the Eastern Pequot from outside of their reservation were able to supplement natural resources that were available on their reservation, as indigenous animal remains have been recovered from the two excavated 19<sup>th</sup> century foundations (Cipolla 2005). The Eastern Pequot continued to maintain a broad range of subsistence strategies. However, instead of obtaining many forms of subsistence by way of seasonal rounds,

the Eastern Pequot had to employ different strategies because their landscape was bounded. Some of their strategies included raising livestock on the reservation, planting some crops on their reservation, purchasing supplies on their own from outside of the reservation, and acquiring staples through their overseers.

#### **Zone IV**

Zone IV represents Sample 1 and dates from 70-140 BP (A.D. 1864-1934). This zone is characterized by an increase in grasses and herbs, and a decrease in overall arboreal pollen due mainly to the dramatic decline of chestnut. However, many arboreal taxa increased during this zone. Grasses, field horse tail and scouring-rush, as mentioned, increased since the last section of Zone IIIb and comprised 7.69% and 0.62% respectively of the TCP. Percentages of ragweed rose and represented 2.15% of the TCP. Ferns and mosses increased since the last sample and represented 8.01% and 6.16%, respectively, of the TCP.

#### ***Arboreal Pollen***

Arboreal pollen constituted 51.98% of the TCP for Zone IV, clearly an overall decrease from final section of Zone IIIb. However, when percentages of pollen grains for chestnut are subtracted from this amount, all other arboreal pollen types represented 46.13% of the TCP for Zone IV, reflecting an enhancement in most arboreal pollen types since the previous sample. Alder, birch, hickory, butternut, black walnut, pine/spruce, and sycamore all increased by approximately 0.76%, 5.32%, 2.55%, 1.20%, 1.30%, 3.26%, and 1.23%, respectively. While chestnut, maple, hazel, Magnoliaceae, and oak declined by 25.18%, 1.21%, 0.55%, 0.34%,

0.50% respectively. Perhaps the decreasing numbers for chestnut, oak, and maple could be due to logging; however, diminishing numbers for chestnut were probably as a result of the blight caused by the introduction of a fungal pathogen in the 1930s (Paillet 2002: 1520; Tindall et al. 2004: 2554). Pollen percentages for oak seem to be in line with the previous sample.

### ***Herb Pollen and Charcoal***

Herbs for Zone IV, including common cat-tail, trailing arbutus, Cheno/Am, Cruciferae, Compositae, Liliaceae, Iridaceae, Umbelliferae, Portulacaceae, Labiatae, skunk cabbage, and channeled Solomon's seal, show the greatest variety than any of the other zones. Herbs comprised 10.80% of the TCP for Zone IV, which is the highest percentage recorded from all of the processed samples. Again, it is possible that the representation of herbs in this sample attests to the continued land management practices conducted by the Eastern Pequot. The number of charcoal particles decreased slightly since the final section of Zone IIIb as for every pollen grain counted, 1.42 pieces of charcoal were recovered. The mode, median, and mean average for charcoal pieces for Zone IV all increased since the final section of Zone IIIb.

### ***Discussion***

The 1870 United States Federal Census lists 28 "Indians" residing in North Stonington (<http://www.ancestry.com>). This census also provides a clue for some Eastern Pequot occupations. Many labored as farm hands, no doubt at locations outside of the reservation, while one toiled as a blacksmith (<http://www.ancestry.com>). The 1880 United States Federal Census lists Calvin

Williams' occupation as "farming," which would indicate that he made a living by cultivating some of the Eastern Pequot reservation lands (<http://www.ancestry.com>). The Overseers Records and the 1931 United States Federal Census maintain a dwindling population for the reservation. Individuals decreased from approximately 24 during August 1876 – April 1877 to 12 individuals recorded in 1931 (Overseers Records; <http://www.ancestry.com>). The Overseers Records continue to show staple items including axe handles purchased for Eastern Pequot consumption as well as several entries of payment for gardens plowed and mowing conducted.

Perhaps Zone IV of the Eastern Pequot core represents a period of forest re-growth when many fields and pastures were reforested for many arboreal species represented by the core during this time have increased in number. The decreasing reservation population trend revealed through historical documentation is supported by both the pollen and charcoal information extracted from the Eastern Pequot sediment core for this zone. However, pollen percentages for Zone IV continued to reveal land management practices even though the population of the reservation was decreasing. For instance, pollen percentages for some arboreal species that reflect local scale, i.e. oak, are kept in check during this period. Perhaps this example attests to the continued use of this species and for more recent reported logging practices. The increased percentages of herbs detected in this zone is also of utmost interest and speaks to the unrelenting Eastern Pequot land management practices as does the incessant presence of charcoal. Even though charcoal particles have decreased since the end of Zone IIIb they have done so ever so slightly, revealing that burning continued within close proximity to the Eastern Pequot sediment core.

### **Present Vegetation and Significance of the Current Vegetation Survey**

\_\_\_\_\_Maple represented 7.38% of the TCP for Zone IV of the Eastern Pequot sediment core, and this species blanketed the entire length of the 13-m line intercept survey. Perhaps this observation attests to the locality of this species as represented in the findings of the Eastern Pequot core. The significance of the survey is that it supported the notion that the Eastern Pequot core captured local representation of vegetation within close proximity to the core with the exception of a few species, namely pine. As previously mentioned, pine was nowhere to be found in this forested basin, which possibly emphasizes that the pollen grains of this species recovered in the core represent more of a regional vegetation type. The survey also verified that the environment supported many of the same species in the distant past, which were visible today. However, the survey also revealed several herbs that were never detected in the pollen core. This observation stands to remind us that the vegetation recreated by pollen remains is an incomplete recreation at best.

## CHAPTER 7

### CONCLUSIONS

Pollen grains and charcoal particles extracted from the Eastern Pequot Tribal Nation Reservation sediment core chronicled continuous climatic disturbances and human land management practices that influenced the immediate area encompassing the reservation for a long period of time. The oldest zone of the sediment core outlines a much cooler and damper landscape that had endured a devastating fire. Together, grasses, ferns, and alder were most numerous during this period. In time, the climate became much warmer and drier. Grasses covered approximately 25% of the landscape and arboreal taxa such as birch, maple, pines/spruce, willow, oak, and chestnut coexisted, while alder pollen disappeared for a period. The arboreal canopy closed and grasses decreased. Arboreal taxa continued to dominate, as species after species flourished in succession. For example, birch, maple, and pine/spruce wrestled for supremacy in the earlier samples, with numbers of pine/spruce winning out for a period of time before decreasing in the wake of increasing numbers of oak. The climate shaped the environment in overwhelming ways. It also shaped the landscape in more subtle manners, for instance, with shorter warming and cooling trends like the “Little Ice Age.” Several overall tendencies have come to light as a result of the pollen diagrams. Most obvious of them all is the interplay witnessed between arboreal species and grasses. The relationship between these two vegetation types is inversely proportionate because that is the way their relationship is constructed. For when the arboreal canopy increased, percentages of grasses decreased and vice versa.

Signatures of human land management practices as mentioned were also interwoven throughout the core, but in much more understated manners than were climatic disturbance to the landscape. The explosion of chestnut is a phenomenon that cannot be overlooked. Of course chestnut gained in presence as a result of the warming climate; however, evidence uncovered by the Eastern Pequot core suggests the very real possibility that human intervention played an important role in the increase of this species. The decreasing trend in pine/spruce appeared to have been ongoing for a great period of time represented by the Eastern Pequot core, probably because of a combination of basic climate and forest structure changes, but perhaps it was also affected by a selective deforestation employed by the occupants of the region during which time nut trees were spared. The occurrence and numbers of charcoal particles represented by the sediment core also cannot be ignored. The pollen sum diagram represented by Figure 1 reveals a dynamic nature of the deposition of charcoal. Numbers of charcoal particles seem to positively correlate with chestnut and a delay in re-growth can be seen in species like maple, birch, pine/spruce, and oak right after periods of increased burning.

I feel that the amounts of charcoal and the periods when it occurred in this study after the period of time represented in Zone I, can be mapped on to population densities, which are suggested by both the archaeological and written record. As earlier discussed, the peaks and arcs of the charcoal curve are telling. Increasing particles of charcoal correlated with documented increasing populations in the subject area, just as declining charcoal particles correlated with decreasing population densities. Of course there are exceptions to this rule. For instance, the amount of

charcoal recovered during the period of time represented by the section of Zone II represented by Sample 10 (3,350 – 4,700 BP) cannot be the only trace of a land management technique relied upon to dictate population figures. Instead, another ongoing technique, deforestation, had to be considered.

The amount of charcoal in the Eastern Pequot sediment core did increase by approximately 135% for the section of Zone IIIb dated from 500 – 580 BP (A.D. 1504 – 1424) to the segment dated from 290 – 500 BP (A.D. 1714 – 1504), representing the period of European colonialism. However, charcoal was represented with consistent numbers since the section of Zone II dated from 3,350 – 4,700 BP and climate and environmental factors as discussed do not appear to indicate widespread burning of a natural variety for the region encompassing the reservation. The charcoal particles captured by the Eastern Pequot sediment core most likely were created by human intervention. Consistent amounts of charcoal particles from sample to sample - versus dramatic rises and decreases of charcoal, with the exception of the earliest zone of the core - appear to signify the presence of a population in the area, and it is this population that appears to be responsible for the burning that created the charcoal recovered in the Eastern Pequot sediment core.

In light of an arboreal canopy and increasing percentages of charcoal, the Eastern Pequot sediment core highlighted herbs, which were maintained throughout the history captured by the core. Perhaps the amount and variety of herbs were a result of Eastern Pequot and their ancestors' land management systems. Grasses were on the rise for the Eastern Pequot core, beginning with Zone IIIa (580 – 650 BP/A.D. 1424 – 1354) and continued on this trend until Zone IV. Perhaps the increase of

grasses during this period can be credited to deforestation of the region that was begun by native hand and was continued and carried over to their reservation lands.

The Eastern Pequot sediment core does not show a marked rise in ragweed around 1700, which is present in other studies and attributed to European cultivation. However, an increase in ragweed for the Eastern Pequot core is seen earlier with the beginning of Zone IIIb, dated from 500 – 580 BP (A.D. 1424 - 1504), and if anything, this species decreased around 1700. Ragweed is known as a frequent wild plant of abandoned fields, roadsides, and vacant lots usually ascribed to European land management practices, but it is also a common occurrence among cornfields (Brugam 1978a: 356). Possibly the increased percentages of this species in the beginning of Zone IIIb, can be traced to more widespread cultivation of maize and other crops by Native Americans during this period. For we do not see a rise in this species again until Zone IV, perhaps attesting to decreasing populations on the reservations during that time that may have allowed abandoned fields to grow wild. Otherwise, during the portion of Zone IIIb dated from 140 – 500 BP (A.D. 1864 - 1504), ragweed declined possibly because land on the reservation was heavily used and maintained during this period, and as a result this species was not given a chance to increase.

What if the calculated dates for the Eastern Pequot core samples since Sample 7, for example, were later in time due to an increased rate of sedimentation for this section of the core? Suppose Sample 5, which represents the earliest section of Zone IIIb, dated from 500 – 580 BP (A.D. 1504 – 1424), were dated later in time and coincided to the period of colonialism, what would this mean? Increased numbers of ragweed represented in this sample would be in line with the observation made by

other studies that a rise in this species is linked to European colonization. Faegri and others (1989) also characterize European clearing as the appearance of introduced taxa with abundant ambrosia, grasses, and a sharp decrease of arboreal pollen. Are all of these factors characteristic of Sample 5? While Sample 5 contained a possible introduced species, horehound (*Marrubium vulgare*), it reveals an increase in arboreal pollen from the previous sample by approximately 2.97% without chestnut pollen factored in and an increase of 3.55% with chestnut pollen included. Numbers for grasses stay on par since the last sample and really do not increase much until Sample 3, dated from 220 – 290 BP (A.D. 1784 – 1714).

Perhaps the rise and fall of ragweed is not solely affected by European settlers, but also by Native American land management practices. For this study in particular, ragweed could be an additional pollen marker among others earlier discussed in this chapter, which speaks to the local scale portrayed by the Eastern Pequot core. Even though major trends in pollen deposition and absence of certain species can be seen and compared from one location to the next, each landscape under scrutiny unfolds a unique and lively pollen history specific to the area under review. Analysis of the Eastern Pequot sediment core has allowed a glimpse of probably only sections of an exclusive selective and intentional land management system that had not only undergone changes over time, but was maintained by native people inhabiting the area over the long durée.

### **Three Types of Land Management Techniques**

Three varieties of land and resource management techniques--burning regimes, deforestation and forest re-growth, and horticulture and subsistence strategies--

employed by the Eastern Pequot and their ancestors were analyzed by this study in relation to demographics and colonialism. As mentioned, burning continuously occurred on the lands encompassing the Eastern Pequot Tribal Nation Reservation as charcoal appears in every processed sample of the sediment core taken from the reservation. However, with the aid of the pollen sum diagram represented by Figure 1 as mentioned, I was able to see two types of burning trends that affected the subject area by examining the charcoal curve. The charcoal curve exhibits four noticeable peaks, which were located in Zones I (Sample 14), II (Sample 10), IIIa (Sample 6), and IIIb (Sample 4).

The peak in Sample 14 appears to represent a fire or fires, which may have burned out of control because of the amount of charcoal particles counted for each sample as compared to the number of charcoal particles contained within the adjacent samples. For after the climax of this burning episode is reached, charcoal amounts diminish greatly afterwards. The charcoal summits outlined for Samples 10, 6, and 4 are highpoints contained within a prolonged period of habitual burning, which began with Sample 10, dating to approximately 3,350 – 4,700 BP, clearly prior to the arrival of Europeans and continued throughout the period of colonialism.

The amount of charcoal particles detected for the samples carries with it many implications. For one as mentioned, I believe that much prior to colonialism, controlled burning was adopted as a land management tool for a variety of reasons such as to attract wildlife to the area, to clear forest undergrowth, to encourage the propagation of herbs, to limit some arboreal species from crowding nut and sap producing trees, and to provide for warmth generated by the burning of wood fuel.

Burning continued during colonial periods to produce most of the same end results. Burning was utilized in a controlled manner. It is also my estimation that the amount of charcoal extracted from the processed core samples positively correlates with population densities for the area with this observation applying as well to the samples dated to the period of colonialism. For Sample 3 (220 – 290 BP/A.D. 1784 – 1714) through Sample 1 (70-140 BP/A.D. 1934 – 1864) charcoal particles decreased for the most part just as recorded population figures during this time also decreased. Of course there are always exceptions to the rule. Sample 9 (2,000 – 3,350 BP), for instance, contained a small amount of charcoal as compared to the other samples, but it revealed other characteristics, which may support an increasing population to the area. Could other factors highlighted by this sample, such as decreasing arboreal pollen, positively correlate with increasing population as decreasing arboreal pollen and an increase in grasses and herbs were recorded for this sample?

Data from the Eastern Pequot sediment core indicates that a major deforestation episode occurred on the landscape now occupied by the reservation approximately 8,060 – 9,410 BP, but as previously discussed, this incident is a result of the intense fire contained within the period of time represented by the sample. Because of the nature of the fire displayed in Zone I (Sample 14), this sample will be discounted as human-induced land management deforestation. However, a period of deforestation, as mentioned, appears to begin about 2,000 – 3,350 BP, continued and intensified until around 70 – 140 BP or from A.D. 1934 - 1864, when an increase in many arboreal pollen types except chestnut were recorded. During this period, like burning, deforestation appears to have been selectively conducted and intensified as population

warranted. Deforestation especially during the older segments of the Eastern Pequot sediment core was probably a result of natural resources being used because “in local pollen diagrams forestry can be traced as temporary depressions of arboreal pollen curves, indicating clearing and, later, successions during re-establishment of climax forest” (Faegri et al. 1989: 181). However, pollen grains for certain arboreal species such as black walnut, butternut, chestnut, hickory, and oak maintain their percentages and in some instances increase in most of the samples. As mentioned, perhaps nut-producing trees were managed and planted. However, this period of deforestation ends differently than it began. Pollen grains for oak and pine/spruce were kept down for Sample 2 (140 – 220 BP/A.D. 1864 – 1784), while pollen grains for birch and chestnut decreased at this time, possibly as a result of all of these species being harvested for the sale of lumber outside of the reservation, which may have taken precedence over some of the species being spared for their potential as a source of food.

The variety of herbs and the percentages of them increase in the processed samples the closer we moved to the top or surface of the core. Perhaps this observation indicates that herbs were encouraged to grow on the reservation and were cultivated. Periods of burning and deforestation positively correlated to percentages and the variety of herbs detected in the samples. As mentioned burning may have produced an “edge effect” for areas on and surrounding the reservation, which was instrumental in creating a habitat that a variety of herbs would enjoy, while burning and deforestation both created openings in the arboreal canopy allowing additional sunlight to reach the forest floor. Introduced species were limited in the processed

samples of the sediment core indicating that the Eastern Pequot did not appear to have relied on them like they did with native species. However, European cereal grass does make its presence in Sample 4 (290 – 500 BP/A.D. 1714 – 1504) during the period of colonization, and grains of it appear in Samples 3 (220 – 290 BP/A.D. 1784 – 1714) and 2 (140 – 220 BP/A.D. 1864 – 1784). Three possible maize pollen grains were detected in Sample 4. Perhaps this evidence is verification that both European-introduced cereals and maize were cultivated on the Eastern Pequot Tribal Nation Reservation. A pollen grain of horehound as mentioned was detected in Sample 5 (500 – 580 BP/A.D. 1504 – 1424), but perhaps this grain moved down in the core or was from a section of the sample closest to Sample 4. No other pollen grains of horehound were located in the core except in Sample 1 (70 – 140 BP/A.D. 1934 – 1864), which contained four grains.

This study provided insight on how the Eastern Pequot responded to colonial changes that affected their land and resource management techniques. But along the way, the analysis of the sediment core also provided a dynamic and insightful glimpse into land and resource management practices, which had been undertaken by the Eastern Pequot and their ancestors over a great period of time. During much of the period of colonialism, the Eastern Pequot appeared to have employed many of the same land and resource management practices as their ancestors, which were probably passed down from one generation to the next. However, over time they had to become ever more resourceful initially during times of stressful climatic events and then as a result of increasing population densities to the area, until eventually the period of colonialism unfolded around them. The Eastern Pequot worked to preserve

their land management techniques, often by employing variations to them and most likely as a result of a limited land base in order to perpetuate their mixed economic pattern.

I am proud to have been a part of the first field school conducted in 2003 by the University of Massachusetts Boston, on the Eastern Pequot Tribal Nation Reservation. During one of the earlier weeks of this field school, we were digging shovel test pits within close view of a metal tree stand perched up above us in a towering oak tree. In one of the shovel test pits, a projectile point was found. This stone point, like others recovered on the reservation, not only attests to the longevity of hunting at this location, but also to the animal resources, which continue to frequent it, and more importantly to the Eastern Pequot and their ancestors. The Eastern Pequot and their land management practices have endured the test of time, traversing many obstacles along the way, including the terrain of colonialism that they continue to negotiate with to this day.

## APPENDIX

All samples were weighed before they were processed. Each sample was then placed into a glass beaker that was labeled with the appropriate sample information. Approximately 25 ml of hydrochloric acid was poured into each beaker and they were stirred with a glass rod to dissolve clots of sediment. Two Lycopodium spore tablets (batch 938934) were added to each sample to serve as a spike so that pollen and charcoal frequencies could be measured. After the spore tablets were added, the samples were again stirred with a glass rod to dissolve the tablets. If any of the samples were foaming, a little more hydrochloric acid was added to the sample not to exceed a total of 50 ml. After the Lycopodium spore tablets dissolved, the samples were left alone to sit idle for 15 minutes. Approximately 150 ml of distilled water was added to each glass beaker, and they were all briskly stirred or swirled with the glass rods. After being swirled, the samples sat for 30 – 45 seconds and were decanted to remove heavy sediments. The samples were decanted into plastic beakers with each sample labeled with the appropriate sample information. Some of the samples were decanted through a 100 $\mu$ m screen. This process was repeated three times.

Most of the liquid was decanted and poured into plastic centrifuge tubes, labeled with the appropriate sample information. The tubes were filled with the liquid to the top line. The tubes were centrifuged for seven minutes at 2500 RPM. After the tubes were centrifuged, the liquid portion was decanted off into an appropriate waste container. Once the tubes were decanted, they were filled to the top line with more liquid from their respective beakers until all of the liquid was used and the tubes were

centrifuged for seven minutes with the liquid portion decanted off. Once all of the liquid from the plastic beakers was used, the tubes were then filled to the top line with distilled water and the tubes were then centrifuged for seven minutes. The liquid was poured off into the appropriate waste container. This process was repeated three times. After the third time, the samples were checked with pH strips to see if the acid had been neutralized. If the samples were found still to be acidic, they were rinsed and centrifuged again until they tested neutral. Once the samples tested neutral, the material in the tubes was transferred back into the appropriate labeled plastic beakers by using as little distilled water as possible. Fifty milliliters of hydrofluoric acid at 48% concentration was then added to each beaker. Each beaker was stirred with a plastic straw, which were left in the beakers. The beakers were stored overnight under the fume hood.

The next morning, the hydrofluoric acid was decanted off into an appropriate waste container. A little distilled water was added to each beaker in order to transfer the contents of the beakers back into the plastic centrifuge tubes, which had been washed and dried after the last use. The tubes were then topped off with distilled water to the fill line and centrifuged for seven minutes at 2500 RPM. This step was repeated three times. After the third rinse, the distilled water was poured off and the tubes were then filled with glacial acetic acid to the fill line and they were centrifuged for seven minutes at 2500 RPM. The tubes were rinsed twice with glacial acetic acid, with the waste poured out into the appropriate container. The residue was left in the tubes.

A hot bath for the tubes was next prepared. The water was heated to 100°C. Using glass pipettes, to the centrifuge tubes was added acetic anhydride and sulfuric acid in a 9 to 1 ratio. The tubes were placed upright in the bath for five minutes and were stirred half way through the process. The tubes were removed from the bath and were filled to the line with glacial acetic acid. They were then centrifuged for seven minutes at 2500 RPM. The liquid portion contained in the tubes was decanted out into an appropriate waste container. The tubes were then filled up to 35 ml with glacial acetic acid and stirred with small glass rods to ensure that all of the sediment stuck to the sides of the tubes would be rinsed. The tubes were centrifuged for seven minutes at 2500 RPM. The glacial acetic acid was poured off and distilled water was added to the tubes up to the fill line. The tubes were then centrifuged for 7 minutes at 2500 RPM. The tubes were rinsed and centrifuged three times with distilled water. After the third time, the pH was checked and if it was not neutral, the samples were rinsed until they became neutral.

Once the samples were neutral, the liquid portion was decanted off leaving the residue in the tubes. Residue was then transferred from the tubes into appropriately labeled glass vials by adding as little an amount of ethanol and water to each tube as possible. Once the residue was transferred into the glass vials, each vial was labeled with the respective sample information. To each vial, two drops of glycerin and one or two drops of safranin were added.

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