SUBSISTENCE STRATEGIES OF THE ONEOTA TRADITION IN SOUTHWESTERN WISCONSIN: A NUTRITIONAL PROFILE

by

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In the La Crosse region, the Oneota people utilized a variety of wild animal and plant resources, as well as their own domesticated plants. Did this population suffer from nutrition related diseases or were there any nutritional gaps in their diet? The Oneota used a particular set of subsistence strategies when they chose highly nutritious foods to put in their diet, which created a stable way of life as the first farmers of Southwestern Wisconsin. This paper explores the overall health of the Oneota people in La Crosse and the different nutritional values of the native animal and plant resources found in this region. Two food profiles are established to demonstrate the balanced diets, by contemporary standards by the USDA, of both a "mixed economy" and "primarily wild economy" food plan for an Oneota individual who lived 400 years ago.

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INTRODUCTION

The main goal of this paper is to understand the diet and health of the Oneota people who occupied southwestern Wisconsin in late prehistoric times. This investigation focuses on the nutritional value of their food resources. Were these populations getting sufficient essential nutrients from agriculture, hunting, and the gathering of wild resources? If not, what were the nutritional gaps? More importantly, what will this investigation tell us about the prehistoric diet and health of the Oneota population? To explore diet and health I conducted a comparative analysis of floral and faunal remains from sites that date to the Oneota tradition in the La Crosse Locality, approximately AD 1300 to 1650, to explore their various food resources.

In order to understand diet and health a complete nutritional profile must not only include caloric intake over time, and also incorporate proteins, fat, carbohydrates, water, vitamins and minerals. This investigation evaluates if the Oneota were receiving adequate levels of nutrition in their diet based upon the archaeological evidence that has been previously reported within the La Crosse, Wisconsin locality. What kinds of resources did these people have available to them and how did they get the most nutritional benefits out of these resources?

The Oneota tradition is the name given by archaeologists to the late prehistoric populations who thrived throughout a 10 state area of the Prairie Peninsula of the Upper Midwest from A.D. 1250 to 1650. The Oneota tradition is characterized as having the first true farmers in Wisconsin. Although they were not the first to grow corn, squash, tobacco or other domesticated seedy plants, they were the first to incorporate these crops, along with domesticated beans, into an extensive field agricultural system while still maintaining a mixed economy that utilized

many wild plant and animal resources. They lived in large villages on the extensive sandy terraces of the La Crosse locality, with agricultural fields located nearby, often in the fertile low lying soils at the base of the bluffs.

Oneota burials are found both within the villages and in adjacent cemeteries (Boszhardt 1994:179). Several sites, such as the Pammel Creek Site, have yielded important information about the seasonality of the occupation. Subsistence evidence suggests the settlements were occupied for most of the year. However, the Pammel Creek report argues that at least some of the population abandoned the site during the winter to go west on bison hunts, returning in the spring to use the stored crops to get through the late winter and spring seasons (Arzigian et al. 1989:142-146;273-279).

One generally accepted theory on Oneota origins argues that local terminal Late Woodland groups transformed into the Oneota tradition as a result of contact and acculturation with Middle Mississippian peoples from Cahokia (Boszhardt and Theler 2003: 157-160). The Oneota culture as a whole dates from A.D. 1250 to contact of European settlers. The Oneota occupied many different localities along the Mississippi River, beginning in the Red Wing locality about A.D. 1200 to 1250 and then moving down to the La Crosse locality about A.D. 1300 to 1650 (Boszhardt 1994: 199;Theler and Boszhardt 2003:165).

There are three sequential phases that describe the Oneota tradition in the La Crosse locality: the Brice Prairie Phase A.D. 1300-1400, the Pammel Creek Phase A.D. 1400-1500, and the Valley View Phase A.D. 1500-1625 (Boszhardt 1994:180; Tubbs and O'Gorman 2005: 127). Large ceramic vessels tempered with shell instead of grit have been used to distinguish Oneota pottery from earlier Midwestern traditions (Boszhardt 1994: 185). Chipped-stone tool technologies included small triangular projectile points and scrapers, manos and metates,

sandstone abraders, celts, sheet-copper pendants, catlinite disk pipes and bison scapula hoes (Boszhardt 1994 Theler and Boszhardt 2003:162). Lithic raw materials were predominantly local cherts and silicified sandstones, but with some exotic materials (Boszhardt 1994: 212-214). The exotic lithics and other goods such as marine shell beads indicate that the Oneota were trading with other groups in a broad region of the Midwest and along the Mississippi Valley (Boszhardt and Theler 2003: 160). By about A.D. 1625 to 1650, all Oneota sites in La Crosse had been abandoned. Though the exact date of abandonment is unknown, there is no evidence of European trade items found at any Oneota site in La Crosse. The people appear to have moved west into southeastern Minnesota and Iowa (Boszhardt 1994: 214).

There have been extensive archaeological surveys and excavations researching the Oneota tradition in the La Crosse locality, and archaeologists have examined and made inferences about recovered floral and faunal remains to determine subsistence patterns. However, these studies have not often considered the specific dietary needs of the people and how the subsistence patterns could have met those needs. It is critical to understand the culture of the Oneota tradition within the context of their health and well-being because it allows researchers to evaluate how subsistence may have evolved from earlier hunting-gathering-horticultural patterns into the Oneota agricultural system.

Nutrition is important to understand and examine because if a population does not have sufficient available resources with essential nutrients in them, those populations will suffer. When archaeologists think about subsistence strategies, they are not only aiming to describe the food remains found archaeologically, but are also trying to understand the various factors that are important to dietary food selection. For example, dietary selection has several factors that influenced prehistoric populations: readily available types of food, nutritional value, ease of

harvest and preparation, and taste (Arzigian 1993: 2-3). The two most important factors this study considers are the readily available food resources in southwestern Wisconsin and the nutritional value of those resources.

Sites discussed in this investigation from the La Crosse area include the Pammel Creek Oneota Site (47Lc61), the Gundersen Site (47Lc394) and the Tremaine Site Complex: which includes the Tremaine Site (47Lc95), the OT Site (47Lc262), and the Filler Site (47Lc149) (Figure 1). The site excavations and subsequent reports by several archaeologists include full analyses of ceramics, lithics, and both wild and cultivated floral and faunal utilized by these populations. These sites will be used to examine prehistoric diets in terms of their nutritional value for the appropriate populations.

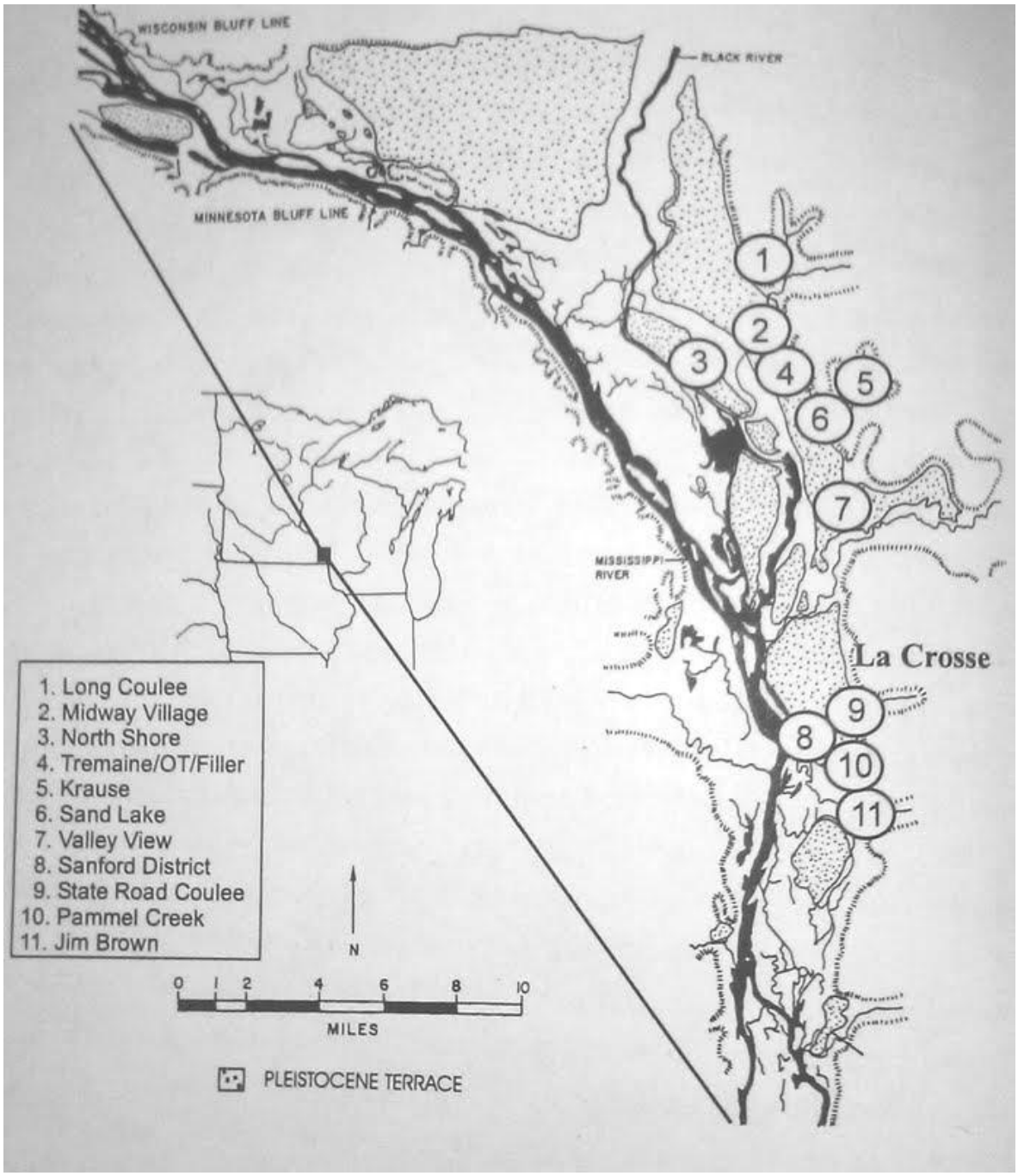

Figure 1: The La Crosse Locality and various Oneota Sites. The Oneota sites discussed in text include the Tremaine Complex (Tremaine, OT, and Filler) indicated by number 4, the Pammel Creek Site indicated by number 10, and the Gundersen Site within the Sanford District, indicated by number 8 (Taken from Boszhardt and Theler 2003, Figure 11.7).

BACKGROUND

The La Crosse locality is located in southwestern Wisconsin in the area known as the Driftless Region, which is characterized by an abundance of river valleys and a diversity of habitats. The Driftless Region is surrounded by glaciated territories, but this area was not covered by the last glacial advance (Martin 1965**)**. Geographically, southwestern Wisconsin was filled with woodlands, marshes, maple and oak forests, prairie grasslands, and floodplains. Prior to European contact, the area contained large quantities of deer, small mammals, fish, freshwater mussels, and large amounts of nuts, wild seeds, and berries (Arzigian 1993:1).

Oneota Health

A recent review of La Crosse Locality Oneota skeletal remains (Tubbs and O'Gorman 2005) summarized current knowledge of health and disease in this population. As population density increased through time in the La Crosse Locality, community life changed. This would have had the potential to negatively impact the health of the Oneota people. Infectious diseases are a constant worry in sedentary societies because densely populated villages are more susceptible to the spread of parasites (Tubbs and O'Gorman 2005:150). An increase in population density would have a significant impact on the sanitation with the community living spaces (Tubbs and O'Gorman 2005:150-152). Skeletal evidence from the Tremaine Complex Sites indicated some nutritional stress, which was recorded as enamel defects and chronic stress of the teeth, as Tubbs and O'Gorman argue (2005:145-150). This was most likely due to the abundance of maize in these populations' diets, which would have eventually caused maize-related anemia. However,

Tubbs and O'Gorman (2005:149) suggest that a diet rich in mussels, which contain large amounts of iron, would have offset the phytate content of maize. Overall, the populations at the Tremaine Site, the OT Site and the Filler Site seem to have been moderately healthy and it does not appear that these populations were severely lacking in essential nutrients. Because this Site Complex has such a large database, it is arguable that the data can be applicable to other Oneota sites in this locality.

The only sure way for archaeologists to know if a communal population showed evidence of malnutrition is to analyze the skeletal remains. Typical indicators for malnutrition include porotic hyperostosis and cribra orbitalia. Porotic hyperostosis is defined as "the thinning and often complete destruction of the cranial vault caused by pressure atrophy of the inner and outer tables, resulting in a sieve-like appearance of the affected outer area," (Steinbock 1976: 214-215). But in the case of the Tremaine Site Complex, only 26 percent of the total populations showed signs that might be porotic hyperostosis (Tubbs and O'Gorman 2005:148-149). Evidence from the Tremaine Site Complex suggests there were indications of only temporary lapses in nutrition, more likely from crop failure in a given year, but not enough to suggest that these populations had many cases of nutritional deficiencies (Tubbs and O'Gorman 2005). Thus, this research considers how the available food resources served to fulfill the nutritional demands of the population.

Nutrients

In order for the human body to function properly, it must have sufficient amounts of necessary nutrients within the diet. Every organism requires the proper mix of protein, fat, vitamins, minerals, carbohydrates, and water. Variety in a diet is a key factor to survival because it allows for the inclusion of potential nutrients that would not otherwise make it into the human body. A

variety of different but essential nutrients were found in every food resource that would have been available for the Oneota.

Detailed nutritional information for each species is publicly available on the United States Department of Agriculture (USDA) website. According to the USDA, the necessary amount of daily caloric intake is approximately 2,000 calories, but will vary by age, sex and activity level (USDA 2013). This paper not only focuses on caloric intake of the Oneota, but looks at all of the essential nutrients needed in a diet. Table 1 provides detailed information on the specific amounts of nutrients needed in the diet. The following section explains the various essential nutrients and their abundance in the La Crosse area. Dietary information about essential nutrients, vitamins and minerals were taken from publicly available databases from the Mayo Health Clinic System (MCHS) and the United States Department of Agriculture.

Protein

Protein serves as the main structural components of human cell growth and is responsible for building and repairing body tissue. Amino acids are the building blocks of protein and there are nine amino acids that are known as essential amino acids specifically needed in the human body (Mayo Clinic Health System 2013). These must be provided in a diet because the body can not synthesize them. Protein is found in most meats, nuts, and beans. These would have been readily available for the Oneota populations.

According to the USDA, daily requirement of protein intake for women is 46 grams and for men is 56 grams (USDA 2013). There are two different types of proteins, complete and incomplete protein. A complete protein has all twenty-two of the essential amino acids and can be found in meat, fish, eggs and milk (Eaton 1989). On the other hand, an incomplete protein is lacking in some of the essential amino acids. Incomplete proteins can be found in grains, seeds,

nuts, and corn. In many cases, it can be beneficial to incorporate multiple incomplete proteins into a diet so the multiple incomplete proteins can create a complete protein (Eaton 1989).

Table 1: RDA (Daily Dietary Allowance) values for Males and Females aged 19-30 from the USDA, (Adapted from Tubbs and O'Gorman Table 8, 23: 2004).

Nutrient	RDA Females	RDA Males	Nutrient	RDA Females	RDA Males
Carbohydrates g	45-130	45-130	Calcium mg	1000	1000
Protein g	46	56	Magnesium mg	310	310
Fiber g	25	38	Thiamin (B1) mg	1.1	1.2
Luecine g	2.42	2.94	Niacin mg	14	16
Lysine g	2.19	2.66	Manganese mg	1.8	2.3
Phenylalanine +			Copper mg	0.9	0.9
Tyrosine g	1.9	2.31	Riboflavin mg	1.1	1.3
Valine g	1.38	1.68	Selenium mg	55	55
Threonine g	1.15	1.4	Folate mg	400	400
Isoleucine g	1.09	1.33	Vitamin A mg	700	900
Methionine +			Vitamin B6 mg	1.3	1.3
Cystine g	1.09	1.33	Vitamin B12 mg	2.4	2.4
Histidine g	0.81	0.98	Vitmain C mg	75	90
Tryptophan g	0.29	0.35	Vitmain D mg	600	600
Phosphorus mg	700	700			

Fat

Like protein, fat is essential in small amounts because it serves as an energy source. Wild game animals and gathered plant resources would have contained low amounts of essential fats. Consuming these resources would have kept populations healthy and provided adequate nutrition. Evidence shows the Oneota did not have serious nutritious deficiencies, as will be discussed later. Fat also contains essential vitamins such as vitamins A, D, E, and K. But if too much saturated fat is consumed, there will be negative effects to an individual's health. The

USDA recommends that men and women keep fat intake to a minimal, by contemporary standards. The human body requires some fat in its diet, but the Oneota would not have access to fatty processed foods that lack vitamins and minerals. However, in the case of the Oneota, there is no evidence to suggest that these populations were overweight, even though there were many types of starchy seed remains found at the Pammel Creek Site (Arzigian et al. 1989: 111-152).

Carbohydrates

Carbohydrates are arguably one of the most important nutrients to the human body because they serve as the main energy source for the brain. Carbohydrates come from fruits, grains, vegetables and some sugars (Eaton 1989: 134-135). Fiber reduces the risk of heart disease and helps maintain a normal level of blood glucose. There are five important functions that carbohydrates serve in the human body: providing energy and regulation of blood glucose, sparing use of protein for energy, breaking down fatty acids, being used as a sweetener for flavor, and having dietary fiber properties (MCHS 2013). All of these, except for refined sugars, would have been available for the Oneota occupations, but maize would have provided a particularly abundant supply. The USDA recommends that both men and women should get 45-130 grams of carbohydrates daily (USDA 2013).

Water

Above all, water is the most basic need for human beings. Nearly 90% of the cells in the human body contain water molecules (MCHS 2013). Water helps maintain homeostasis in the body and provides transportation of nutrients within the body. Without water, the human body can only survive three days before it will perish of thirst (MCHS 2013). The water resources in the La

Crosse locality are rich in calcium and other minerals, see Table 2 (City of La Crosse 2011). The total of calcium needed in a diet is approximately 1000g (USDA 2013). It is possible that these calcium levels from the water resources would have provided adequate amounts of calcium in the Oneota diet (City of La Crosse 2011). The Mississippi River would have provided an excellent source of fresh water and also a variety of riverine animal resources that were utilized by the Oneota. In addition to the Mississippi River, there are smaller rivers and freshwater sources that would have been used by the Oneota during their occupation in the La Crosse area as seen in Figure 2**.** The USDA recommends that men receive at least 3.7 liters of water daily and women should receive at least 2.7 liters of water daily (USDA 2013).

Table 2. Minerals found in Water Resources from La Crosse Wisconsin. The measurement of "ppm" is an abbreviation for parts per million. Taken from the City of La Crosse 2011.

Mineral	Range of Results	Average
Calcium	45-91 ppm	76.5 ppm
Chloride	7.3-112 ppm	53.7 ppm
Iron	0-.2 ppm	0.05 ppm
Magnesium	11.9-35.1 ppm	27.6 ppm
Manganese	0-0.46 ppm	0.14 ppm

Figure 2: View of Southwestern Wisconsin exhibiting the Mississippi River system and bodies of freshwater resources available to the Oneota (Source: Google Earth).

Vitamins and Minerals

Vitamins and minerals are important to incorporate into a healthy diet as they support the immune system and play many other roles in the human body. The key vitamins include A, B, C, D, and E. Important minerals are calcium, iron, and zinc. Vitamins, which are needed for the metabolism system, are compounds containing carbon and are found in various quantities in wild game and plant resources (MCHS 2013). Because vitamins cannot be made within the human body, they must be obtained from the diet, with the exception of vitamin D which can be absorbed from the sun into the human skin.

Vitamin A

Vitamin A and beta-carotene help improve eyesight, maintain normal bone structure, and help maintain the body's epithelial surfaces (which is thought to prevent lung and bladder cancers). Vitamin A and beta-carotene occur naturally in dairy products, yellow vegetables, tomatoes, broccoli, spinach, carrots and in many fruits (MCHS 2013). The USDA recommends that women get a daily dose of 700.00 milligrams and men should receive 900.00 milligrams of vitamin A (USDA 2013).

Vitamin B Complex

Vitamin B_1, or Thiamine, is required in the daily diet because it cannot be stored in the body over long periods of time and depletion of this nutrient can occur quickly, usually within 14 days (MCHS 2013). Thiamine serves several functions in the human body including the nervous system, muscle functioning, carbohydrate metabolism, and production of hydrochloric acid which is necessary for proper digestion (MCHS 2013). Food resources such as nuts, whole grains, beans and leafy vegetables are good sources of thiamine. All of these sources of thiamine would have been available for the Oneota. The USDA recommends that women have a daily dose of 1.10 milligrams of Thiamine per day and men should receive 1.20 milligrams per day (USDA 2013).

Vitamin B_{12} is a water-soluble vitamin that is bonded with the proteins in foods and found in such resources as fish, and meat (Eaton 1989: 129). This vitamin is important for building proteins in the body, red blood cells and a proper function of the nervous tissue system in the human body (MCHS 2013). Unlike thiamine, B_{12} can be stored in the human body for long periods of time. Typically, only the elderly and young individuals see a deficiency of this

nutrient in their diet. The USDA recommends that women get 2.40 milligrams of vitamin B_{12} and men should receive 2.40 milligrams as well (USDA 2013).

Vitamin C

Vitamin C, or ascorbic acid, is necessary for the synthesis of collagen, which provides enough structure for blood vessels, bone and ligaments, and also aids in the absorption of iron. Dietary sources of vitamin C include fruits and vegetables, especially citrus fruits (Eaton 1989: 130-131). These fruits include oranges, strawberries, grapefruit, melons and others. Although rare, a deficiency in vitamin C will result in scurvy and often is fatal (MCHS 2013). It is known that the Oneota were eating a variety of wild berries, strawberries, cherries and grapes which would have provided vitamin C in their diets. But these sources were only seasonally available and it's possible the Oneota were storing berries for the winter perhaps as part of pemmican. But more likely they were utilizing other sources to get vitamin C during the winter months. Sumac berries may have been used to fill this gap as they are highly rich in vitamin C and could easily be eaten whole or infused as a tea (Arzigian et al. 1989: 135). The USDA recommends that women get at least a daily dose of vitamin C of 75 milligrams and men should receive 90 milligrams daily (USDA 2013).

Vitamin D

Vitamin D, or Calciferol, helps regulate calcium and phosphorus levels in the blood stream which allows for calcium absorption and encourages proper function and maintenance of the bones and teeth. This vitamin can be found in fish, eggs, milk, and sunlight (Eaton 1989: 126). It is suggested that even as much as 10 minutes of exposure to sunlight provides enough to prevent deficiency (MCHS 2013). The Oneota would have had access to fish resources and

exposure to the sunlight that would have provided this vitamin. The USDA recommends that women should receive at least 600 milligrams of vitamin D per day and men should receive at least 600 milligrams of vitamin D as well (USDA 2013).

Vitamin E

Vitamin E, or alpha-tocopherol, is known for being an antioxidant which has been proven to help prevent breast and lung cancer (Eaton 1989:126). Vitamin E can be found in a variety of different types of foods such as cereals, fruit, green leafy vegetables, meat, nuts, beans, oils and whole grains (MCHS 2013). Many of these food resources would have been available for the Oneota. The USDA recommends that men and women should get at least 25 milligrams daily (USDA 2013).

Calcium

Calcium plays a central role in blood clotting and bone formation and is found in every bone in the body. Calcium can be found in starchy seeds, weedy seeds, nuts and freshwater mussels that were all utilized by the Oneota. Calcium could also have been extracted from drinking water in this region, which is naturally quite high in hard calcium and other minerals (City of La Crosse 2011) (see water heading and Table 2). The USDA recommends that men and women should get at least 1000 milligrams of calcium per day (USDA 2013).

Iron

Iron is an essential nutrient, as it is present in all of the cells in the human body. Its main function is an oxygen carrier found in the red blood cells, where nearly 70% of all iron is found in the human body (MCHS 2013). Iron deficiency is the most common cause of anemia throughout the world (MCHS 2013). Iron is found in most red meats, organ meats, and fish

(Eaton 1989: 119-121). Vitamin C allows for the absorption of iron, so therefore a diet rich in meats and fish would allow for both vitamin C and iron (MCHS 2013). The USDA recommends that women receive at least 18 milligrams of iron per day and men should receive at least 8 milligrams per day (USDA 2013). A few archaeologists, such as Tubbs and O'Gorman, have suggested that the Oneota would have received sufficient amounts of iron from freshwater mussels.

Zinc

Zinc is a micronutrient that serves many functions, such as its ability to synthesis both DNA and RNA. It is necessary for tissue growth, wound healing and it is a component in pancreatic enzymes used in digestion (MCHS 2013). Zinc can be found in meat, liver, fish, and whole grains (Eaton 1989: 121). A higher allowance of this mineral can be dangerous because it can lower beneficial HDL (high density lipoprotein) levels and cause anemia. HDL or more commonly known as "good" cholesterol, carries LDL (low density lipoprotein), "bad" cholesterol, to the liver where it is eliminated from the body (MCHS 2013). When taken in the right amounts, this mineral is quite beneficial and useful. The USDA recommends that women receive at least 8.00 milligrams of zinc per day and men should receive at least 11.00 milligrams as well (USDA 2013).

METHODOLOGY

This research focuses on understanding the diet and health of the Oneota people who occupied southwestern Wisconsin. More specifically, this investigation focuses on the nutritional value of their food resources. Were these populations getting all of their essential nutrients from their local biomes in the La Crosse Locality, and if not, what were the nutritional gaps? There do not seem to any vital nutrient that the Oneota populations would not have access too, and therefore would not be deficient in any of these nutritional areas. What does this investigation tell us about the prehistoric diet and health of the Oneota population? It takes a comparative analysis of floral and faunal remains from sites that date to the occupation of the Oneota people. Then a nutritional food profile is established that is based upon the daily nutritional recommendations from the United States Department of Agriculture (USDA).

Primary data has been used from the Pammel Creek site and the Gundersen site, as well as the Tremaine Site Complex. Many articles written about Oneota culture and the occupation of the Oneota people have been used to help understand this nutritional profile. This profile does not take into account the seasonality of various food resources used by the Oneota. These primary archaeological sources have been used to assess the diet in terms of the USDA's recommended amounts of nutrients in a balanced diet (Table 1). This paper also seeks to understand the subsistence strategies of the Oneota, or in other words determining why the Oneota chose the food resources they did and how those choices affected their health.

Concepts and other ideas have been used from Tubbs and O'Gorman, who have done a similar investigation assessing Oneota diet and health in the La Crosse Locality. However, their

analysis of the sites located in the Tremaine Site Complex focused only on the overall potential of the Oneota diet to have provided sufficient nutrients and did not evaluate the contribution of specific individual resources. (Tubbs and O'Gorman 2005).

Before a nutritional profile is established, a full analysis of the floral and faunal remains is presented that considers which resources present at archaeological sites were likely contributing each to each of the particular nutrients to the diet. This analysis of the agricultural strategies of the Oneota will provide a framework which has been used by these researcher to determine advantages and disadvantages of a hunter and gatherer versus an agricultural lifestyle. Lastly, information from *Buffalo Bird Woman's Garden* (Wilson 1987) was used to explain some of the traditional agricultural methods and plants used by traditional native populations in the Midwest, which are likely to be comparable to what the Oneota were practicing. Some of the plant resources used by the Oneota might not have survived into the archaeological record and these first hand reports from *Buffalo Bird Woman's Garden* can be used to fill in some of these gaps (Wilson 1987).

ONEOTA FOOD SUPPLIES UTILIZATION

The Oneota economy of the La Crosse area can be described as a mixed economy, utilizing both wild and domesticated plant food resources. These populations used a variety of subsistence strategies which included mixed agriculture, wild plant harvesting, riverine exploitation, and upland seasonal hunting strategies (Arzigian 1994:53). While examining various Oneota sites, it becomes apparent that wild plant and animal resources were utilized quite extensively and were arguably an important aspect of their mixed economy. Wild plant resources that were utilized

included starchy seeds, grasses, fruits, berries, nuts and wild animal resources as well. One of the main benefits received from a mixed economy is that these populations would extract essential vitamins and minerals from their diets that would not have been available from all-meat and all-corn diets (Arzigian 1994).

Archaeo-botanists have defined domesticated crops as those that have been genetically modified to such an extreme that their propagation depends on humans and cultivated crops as those that are occasionally planted and tended by humans but still grow naturally in the wild (Ford 1985:3-4,6). There are six domesticated species that the Oneota utilized; corn, beans, squash, gourd, tobacco, and sunflower with two possible cultivations of little barley and barnyard grass (Arzigian et al. 1989). As it has been noted earlier, at least the Gundersen and Pammel Creek site have yielded specific information which suggests year round occupation in these villages with storage and processing pits used for food crops (Arzigian 1989:142-146). This means that the Oneota were consciously selecting staple food crops to be stored and used at a later time.

The following section lists and discusses typical animal and plant resources generally found in the archaeological record at Oneota sites in La Crosse. This section is organized into floral and faunal categories. Following this discussion includes a detailed section of both plant and animal food resources found at the Pammel the Creek site, the Gundersen site, and the Tremaine Site Complex. Despite many different names given to the floral assemblages by each investigating archaeologist at these sites, there seems to be seven taxonomic categories of plant foods that were important in the Oneota diet: nuts, fruits, seeds, corn, squash, beans and weedy plants.

Likewise, there are six taxonomic categories of animal food resources that were important in the diet: mussels, fish, mammals, birds, reptiles, amphibian and gastropods (only small amounts of amphibian/gastropod have been recovered). These five sites food supply assemblages have been compared against each other to determine if their food supplies were similar to each other's assemblages, or if there were many differences. This information is then used to create an overall nutritional food profile for the general Oneota population in the La Crosse area. Any values of minerals or vitamins that have been taken from the USDA come from a large online nutrient database.

Domesticated Food Crops

Corn *(Zea mays)*

The earliest evidence of corn in the Driftless Area was found in the Late Woodland period at approximately A.D. 1000 (Arzigian 1987). Three parts of the plant are typically recovered in the archaeological record, the kernels, the cupules and less commonly the cobs, which are the fragments of the corn where the kernels are actually held. The kernels are remnants of food preparation and their charring is typically due to accidental loss. On the other hand, cupules are waste products that may have been intentionally burned to dispose of them efficiently (Wilson 1987). According to ethnographic data from Buffalo Bird Woman, the first harvest of green corn was in August and then mature corn was harvested and stored in pits around September (Wilson 1917:44).

Extensive ridged field agricultural systems are associated with many Oneota sites in the La Crosse region which suggests that the Oneota practiced intensive agriculture (Boszhardt et al. 1985). Large crops of corn and other food crops were likely grown during the spring and

summer months to provide a surplus of food supplies for the winter months when many food resources would have been limited (Wilson 1987). Many of the storage pits found at both the Pammel Creek site and the Gundersen site would have initially stored these crops.

Nutritionally, a diet based on corn has its drawbacks. Many times populations whose staple crop is corn will have niacin deficiencies, which ultimately leads to pellagra and eventually death (MCHS 2013). While niacin does exist in corn, it can only be extracted from it by the process of nixtamalization, in which the grain is soaked or cooked in an alkaline solution or traditionally in limewater (Benchley 2003:131). In many cases, a diet high in corn will require additional food resources to supplement the corn's deficiency in the amino acids lysine and tryptophan, and also in vitamins making, it a poor protein crop (Katz et al. 1974). Yellow corn has a good amount of protein, high levels of potassium, phosphorous, and vitamin A (USDA 2013).

Squash *(Cucurbita pepo)* and Gourd *(Lagenaria siceraria)*

Most early accounts of Indian agriculture describe corn, beans, and squash being grown intermixed - where squash was typically grown around corn hills in order to reduce the evaporation of water from the soil. Unlike other field crops, squash tend to grow independently and require little effort to have a large yield of produce (Wilson 1987). Squash can be eaten as a raw vegetable, or cooked and boiled, or cut up and dried. Any of these preparation methods might result in some accidental charring and preservation which can be indicated in the archaeological record (Arzigian 1989: 117-119).

Gourds, which are related to squashes, have edible seeds but it is likely that those seeds would have been quite bitter to taste. It is thought that because of their taste, gourds would have

been more likely used as containers for other food supplies (Arzigian 1989: 119). Squash have high levels of potassium, calcium, magnesium, phosphorus and vitamins A and C (USDA 2013).

Common Beans *(Phaseolus vulgairs)*

Beans are an excellent source of protein and contain many missing amino acids that corn does not possess i.e., lysine and tryptophan. Therefore eating a balanced diet of beans and corn will provide more complete proteins than consuming these food supplies separately. Beans and corn are traditionally grown together, where the corn plant's stalk can support the bean plant by providing it as a stalk to grow upright onto. Beans also help to fix nitrogen levels in the soil, which makes agricultural fields maintain their fertility (Wilson 1987). Beans occur late in the archaeological record. Their earliest appearance dates to the upper Midwest in the context of the Oneota people about A.D. 1300 (Arzigian 1994: 54-55). Beans are typically found in Oneota sites in significantly fewer quantities than corn and other food supplies. Beans have high amounts of protein, niacin, potassium and vitamin C (USDA 2013).

Tobacco *(Nicotiana rustica)*

Few tobacco seeds have been recovered from the Gundersen site, the Pammel Creek site, and the Tremaine site complex. Small pipes have been recovered from these sites as well, which suggests that smoking a variety of different plants was commonly practiced with the Oneota (Arzigian 1994). The small relative abundance with these seed remains might not accurately reflect the importance of tobacco to the population, as most of the flowering plants would have been used for smoking purposes. Today, most tobacco flowers are pinched from the plant prior to its seeding to encourage the growth of leaves. Because of this, only a few plants were allowed

to propagate. This would not leave behind many seeds to be identified in the archaeological record (Arzigian 1994: 55).

Wild and Cultivated Plants

Other than domesticated plant food crops, a variety of other plant resources were utilized by the Oneota. A majority of these wild plant resources tended to be starchy seeds, and some of them are considered to be cultivated which include goosefoot, little barley, possibly knotweed and barnyard grass. All of the plants listed above are members of the starchy seed complex. However, the most important of these plant resources was wild rice.

Little Barley *(Hordeum pusillum)*

Little barley is a short grass (approximately 10 - 40cm) that produces edible seeds in May and June. This plant is a winter annual - typically found at Illinois sites - which germinates in the fall, stays green throughout the winter and is ready for harvest in the spring (Arzigian 1994:55). Little barley was probably more than just a "camp weed" (a weedy plant that typically sprouts around villages), given that cultivated remains of this plant have been found at 2,000 year old Hohokam sites and became significantly important between Archaic and Woodland sites in the Midwest (Arzigian et al. 198: 120). It appears too common at the Pammel Creek and Gundersen sites to be considered a "camp weed". Little barley is associated with other small seeds that would have been used for horticulture practices and may have even cultivated itself (Arzigian 1994: 55).

Barnyard grass *(Echinochloa muricata)*

Small seeds of barnyard grass have been recovered from many sites in the Midwest, but have only recently begun to be properly identified. Hunter (Hunter 1990b) suggests that the

abundance of this particular plant at many different archaeological sites indicates its possible use as a food plant for populations. The distribution of barnyard grass is similar to that of little barley at other Oneota sites, such as the Pammel Creek Site, which this plant may have been intentionally grown and stored (Arzigian 1994: 55).

Knotweed *(Polygonum* sp.)

Knotweed prefers disturbed habitats and may have easily grown on trampled ground near campsites. The plant flowers and produces fruit throughout the entire summer up until October (Arzigian et al. 1985: 121). Knotweed is an important member of the starchy-seed taxonomic family and has been documented in other Oneota sites as well (Tubbs and O'Gorman 2005). Knotweed can be difficult for archaeo-botanists to identify, but many seeds have been recovered in the upper Mississippi and Illinois valleys. Knotweed would have been a wild plant resource that the Oneota would have utilized in their diets (Arzigian 1994).

Wild Rice *(Zizania aquatic)*

Wild rice appears to be the most common and utilized wild food plant used by the Oneota people, as it is abundantly represented in La Crosse sites. Wild rice prefers to grow in moist muddy banks in water, and typically requires flooded fields to grow in at least 1-10cm deep. The seed heads typically emerge in July and then ripen over a 10-14 day period through late August or early September (Arzigian et al. 1989: 121). After harvest, these grains would have been parched and stored in case of high water levels which would have caused crop failure during certain years. Each patch of wild rice would have had a different growth cycle which would operate independently from each other (Arzigian et al. 1989: 121). Because the plant was so productive, it would be quite easy to find an abundant amount of wild rice plants. Wild rice has

been well documented as fulfilling food resources for both modern and historic Indian populations in Southwestern Wisconsin (Arzigian et al. 1989: 121). The Oneota utilized wild rice intensively, as it is fairly common at many sites in the La Crosse area.

Fruits and Berries

A variety of fruits and berries have been found at many Oneota sites in the La Crosse region. These food resources may have easily provided critical amounts of vitamins and minerals into their diets. While some sites, such as the Pammel Creek site and the Gundersen site, may have limited amounts of fruit and berries recovered, this may not accurately represent the actual consumption of these sources. For example, fruits and berries could have easily been consumed as a whole off site, such as someone grabbing a handful of blackberries off a bush, which would not be represented in the archaeological record (Arzigian et al. 1989: 134).

Cherry (*Prunus* sp.) and American Plum (*P. americana*)

Either black cherry or pin cherry and plum would have been available in the La Crosse area. Identification of fragmented pieces of cherries and plums is difficult as they appear to be quite similar in the archaeological record. Cherries grow in oak forests and require a long period of time before the tree matures to a larger size in order to produce fruits. Plums are high in potassium, and vitamins A and C, and cherries are high in calcium, potassium, as well as vitamins A and C (USDA 2013). Harvesting dates for these ripened fruits vary, but it is estimated that cherries might have been collected anytime from August to October (Arzigian et al. 1989: 134).

Blackberry and raspberry (*Rubus* sp.)

Blackberries and raspberries are not easily identifiable as separate species in the archaeological record because these species are very similar in their genetic makeup. The plants are common in most oak forests and even are able to grow in disturbed areas as well. Depending on the species, blackberries are produced in June and raspberries are typically produced in September (Arzigian et al 1989). Blackberries and raspberries grow on bushes that produce the fruits annually and are extensively eaten by birds and mammals. Raspberries are rich in calcium, phosphorus, potassium, as well as vitamins A and C (USDA 2013). Blackberries have high amounts of calcium, phosphorus, magnesium, potassium, as well as vitamins A, C and K (USDA 2013).

Sumac (*Rhus* sp.)

Sumac shrubs are common in oak forests and prairies that produce large quantities of fruits that ripen around the beginning of September. Sumac berries would have remained on their shrubs throughout the entire winter months (Arzigian 1994: 56). Sumac berries yield high amounts of vitamin C and would have been important to many wildlife species, as it was to the Oneota (USDA 2013). The seeds of this shrub can be stored and can be made into a sour lemonade-like beverage which would be saved for later use during the winter months when food would be scarce (Arzigian et al. 1989: 135).

Hawthorn (*Crataegus sp.*)

Hawthorn species tend to tolerate more disturbed habitats than other species, such as forest edges, along streams, pastures and in the oak forests. This plant is similar to hazel and cherry, and is more abundant in contemporary times than they probably were prehistorically (Arzigian

1994: 56). This plant typically has fruits that ripen anytime from September to October and remain on the tree over the winter months (Arzigian et al. 1989: 134).

Black nightshade (*Solanum americanum*)

This type of seed was the most common fruit seeds at many of the Oneota sites in La Crosse. The plant is found in disturbed and open habitats along the bluffs, streams, fields, pastures along roadways and possibly could have grown nearby to Oneota sites (Arzigian et al. 1989: 135). The fruit is fully ripened by midsummer to early fall. Cooked black nightshade fruit were likely eaten by later historic settlers in the region and may have easily been important in the Oneota diet, which may have even had medical uses (Arzigian 1994: 56). However, if the nightshade berry is not cooked properly or boiled, it is poisonous.

Blueberry and cranberry (*Vaccinium* sp.)

Blueberries and cranberries are difficult to identify to a certain species, as they as quite similar in their genetic makeup. However in Wisconsin, archaeologists identify cranberry remains in the same family as blueberries. These berries would have been available to the Oneota from July through September and are found most commonly in open wooded areas (Arzigian et al. 1989: 135).

Nuts

A variety of nuts were also exploited by the Oneota people including hickory, walnut and acorn. Eating a diet that is high in nuts will provide essential proteins that are typically acquired through meats (USDA 2013). Many nut remains found at Oneota sites are fragmented which makes identification difficult. Nuts are a good source of minerals such as zinc, iron and calcium.

Shagbark hickory (*Carya ovate*) and bitternut hickory (*C. cordiformis*)

Hickory trees are quite common in the oak forests and savannas in southwestern Wisconsin. There are two species that grow in this region, shagbark and bitternut hickory. Both of these nutshells would have ripened from September through October, and then continued to be harvested throughout November (Arzigian 1994: 56). Very often, boiling was a method to separate the nuts from the shell so little would effort would be needed to extract the meat of the nut to make them edible (Arzigian et al. 1989: 138). Nutshells were also very oily, and would have made for good fire tinder and were probably intentionally burned therefore increasing the likelihood of preservation. Hickory nuts are a good source of minerals including calcium, iron, magnesium, phosphorous, and potassium (USDA 2013).

Black walnut (*Juglans nigra*)

Like hickory shells, walnuts would have been boiled to retrieve the meat of the nut and the shell would have also been burned in fires (Arzigian 1994: 56). Walnut trees typically grow best in deep soils along hillsides which are moist in nature. Walnuts are a good source of calcium, magnesium, phosphorous, potassium and zinc (USDA 2013).

Acorn (*Quercus* sp.)

Both bitter black, red oak, and sweet white oak acorns are present in the La Crosse region (Arzigian 1994: 56). Black and red oak acorns tend to germinate quickly once reaching the ground which makes collection from the ground somewhat difficult. White oak acorns take a longer time to germinate, typically two years, which would mean that these acorns could be collected over longer periods of time and there would be less competition from animals for them

(Arizigian et al. 1989: 138). Acorns are a good source of potassium and phosphorous (USDA 2013).

Wild Animal Resources

While domesticated and wild food resources were extensively used by the Oneota, they also exploited a variety of wild animals and only domesticated the dog. There are seven taxonomic categories of wild animals that were important in the Oneota diet: mussels, fish, mammals, birds, reptiles, amphibian and gastropods. In the Gundersen site report, there is a breakdown of all of the wild animal resources organized by these seven taxonomic categories, which also determines the useable meat of each type in kilograms that can be used in a food profile (Theler 1994: 39, 45).

Mammals

There are an abundant amount of mammal remains that have been typically found at various Oneota sites in this area. The most common mammal represented at these sites are white-tailed deer (*Odocoileus virginianus*), elk (*Cervus canadensis*) and beaver (*Castor Canadensis*) (Theler 1994: 40). White-tailed deer would have served more than just one function as a meat source, their antlers could be made into tools and their hides could be used for clothing and warmth. Wild game venison meat by the pound is filled with high levels of protein, phosphorous, potassium, sodium, niacin and vitamin B_{12} (USDA 2013). On average, an entire deer could yield an estimated amount of 193.0 kilograms of usable meat (Theler 1994: 39). Wild game elk meat by the pound is filled with high levels of protein, phosphorous, potassium, and sodium (USDA 2013). On average, an entire elk could yield an estimated amount of 317.6 kilograms of usable meat (Theler 1994: 39). Beaver meat by the pound is filled with high levels of protein,

magnesium, phosphorous, potassium, sodium, and contain little fat. On average, an entire beaver could yield an estimated amount of 66.0 kilograms of usable meat (Theler 1994: 39). Other mammals that have been found at Oneota sites include muskrat, gopher, squirrel, domesticated dog, wolf, black bear, mink, river otter, and bison.

Birds

There are few bird remains found at Oneota sites, which generally include different species of ducks, turkeys and some Canadian geese (*Branta Canadensis*). In the most general sense mallard and teal ducks are the most abundant bird species at Oneota sites (Theler 1994:39). Wild duck meat is filled with high levels of protein, magnesium, phosphorous, potassium, sodium and contain smaller amounts of calcium, iron and zinc (USDA 2013). On average, an entire duck could yield an estimated amount of 0.8 kilograms of useable meat (Theler 1994:39).

Reptiles

Turtles represent the reptile assemblage at Oneota sites and were utilized quite extensively. There are various species that were utilized: snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys* picta) and softshell turtle (*Trionyz* sp.) (Theler 1994:45). Wild turtle meat is filled with high levels of phosphorous, potassium, calcium, as well as vitamin A and B_{12} (USDA 2013). On average, an entire turtle could yield an estimated amount of 0.83 kilograms of usable meat (Theler et al. 1994:184).

Fish

Concerning species, fish bones are the most abundant type of animal resource recovered from Oneota sites. There is a variety of many species that have been recovered: sturgeons (*Acipenser fulvescens*), gars (*Lepisostedidae*), bowfin (*Amia calva*), pikes (*Esocidae*), catfish (*Ictaluridae*),

sunfishes (*Centrarchidae*), suckers (*Castostomidae*), walleye (*Stizostedion* sp.) and freshwater drum (*Aplodinotus grunniens*). The three most abundant fish species that were recovered from many Oneota sites in this investigation are pikes, catfish and bowfin (Theler 1994:45). Pike have high levels of calcium, phosphorous, potassium, as well as vitamins A, C and D (USDA 2013). On average, an entire pike – depending on size – could yield an estimated amount of 3.43 grams of useable meat (Theler 1994:45). Catfish have high levels of phosphorous, potassium, as well as vitamins A and D (USDA 2013). On average, an entire catfish could yield an estimated amount of 0.50 kilograms of useable meat. An entire bowfin fish could yield an estimated amount of 3.01 grams of useable meat (Theler 1994:45).

Freshwater Mussels

The most common species of freshwater mussels recovered from Oneota sites in this study is the ebonyshell (*fusconaia ebena*), which would have been found in the mixed sand and gravel soils in the active channels of the Mississippi River (Theler et al. 1989:204). Among the ebonyshell mussel, there are four other common species found in this region: Wabash pigtoe (*Fusconaia flava*), the pimpleback (*Guadrula p. pustulosa*), the threeridge (*Amblema p. plicata*) and the round pigtoe (*Pleurobema coccineum*). On average, one ebonyshell mussel could have yieled an estimated amount of 0.029 kilograms of useable meat. Pimpleback mussels could have yielded an estimated amount of 0.018 kilograms of useable meat. And threeridge mussels could have yielded 0.042 kilograms of useable meat (Theler et al. 1989:160). Freshwater mussels have relatively high levels of protein, calcium, phosphorous, potassium, sodium, niacin, iron and vitamins A and B (USDA 2013).

Amphibian and Gastropods

The assemblages of both amphibians and gastropods are small in comparison to other food resources used by the Oneota. Amphibians include a small number of remains that belong to frog and toads.

Gastropods

The gastropod assemblage consisted of three different species of crayfish: papershell crayfish (*Orconectes immunis*), northern crayfish (*Orconectes virilis*) and devil crayfish (*cambarus Diogenes*). Very few specimens have been recovered from Oneota sites, many of which are incomplete with evidence of only a pincer found in the Pammel Creek context (Theler et al. 1989:203). A single crayfish has little protein, but have relatively high values of potassium, phosphorous and vitamin A (USDA 2013). Because crayfish are so small there is no data to determine an estimated value of useable meat.

THE PAMMEL CREEK SITE (47Lc61) PLANT AND ANIMAL ANALYSIS

The Pammel Creek Site is now known to be at least 25,000 m^2 with the Overhead site doubling the area to approximately 50,000 m^2 (Arzigian et al. 1989: 25). The majority of the material culture at the Pammel Creek Site is Oneota. Only a few Woodland sherds were recovered and evidence from the site suggests that the Oneota occupation was relatively short term. Radiocarbon dates from one occupational time frame between A.D. 1400 and 1450, and the Pammel Creek site is the type site for the Pammel Creek phase (Arzigian et al. 1989: 33).

The site was studied over a 15 year span, from 1975 to 1990. The site was excavated twice during 1983 and again in 1989. Several pieces of evidence suggest that corn, beans and squash were being grown and stored on the site, as was wild rice, little barley, and perhaps barnyard grass (Arzigian et al. 1989: 142-146). Of the 206 features identified at the site, many were interpreted as originally having been storage pits, suggesting that the occupants were storing food to ensure their survival through the harsh winter and spring months. The Oneota likely selected specific food types to put into storage. Corn would have been a staple, and along with beans and squash would probably have made up the majority of the stored resources. Wild rice and little barley would have provided additional nutrition, but it is unknown whether these were ever harvested in large enough quantities to have been stored. Other wild plant resources were utilized such as fruits, berries, nuts, and starchy seeds (Arzigian et al. 1989: 111-152). Animals that were hunted included deer, bear, small mammals, turkey, turtles, fish and freshwater mussels (Arzigian et al. 1989: 157-237).

The Floral Assemblage

At Pammel Creek, there are six domesticated species that the Oneota utilized: corn, beans, squash, gourd, tobacco and sunflower. Corn was ubiquitous, it was present in 98 percent of samples from the 1989 excavation and a total of 28 grams was recovered (Arzigian et al. 1989:140). Squash and beans were only present in 19 percent of samples taken from the 1989 excavation. Limited quantities of tobacco were recovered from the sample. The starchy seed complex (which encompasses wild rice, little barley, sunflower, barnyard grass and possibly knotweed) was the most represented at Pammel Creek. In the 1989 sample, wild rice was the most abundant seed and the most ubiquitous as it is present in 68 percent of the samples (Arzigian et al. 1989:140). Little barley, barnyard grass, and knotweed were less abundant,

about two percent of the seeds, but were still widely distributed at about 41 percent of the sample size.

All of the seeds/fruits/berries occurred in relatively low frequencies (two percent or less) at Pammel Creek, expect for black nightshade which had a ubiquity level of 5 percent or less (Arzigian et al. 1989:141-142). Nuts were recovered Pammel Creek as well and 0.82 grams of nuts were represented in the 1989 sample. Nuts were present in 18 percent of the proveniences of the 1983 samples and 61 percent from the 1989 sample (Arzigian et al. 1989:142). The role that nuts played in the Oneota economy is still unclear. The remaining unidentified seeds most likely came from weeds grown on or near the villages (Arzigian et al. 1989:142). The actual number of each food resource from the 1989 excavation can be found in Table 4.

Table 4: Totals taken from 1989 Sample at Pammel Creek of floral remains (Arzigian et al. 1989: 136-137), information taken from tables 4.4 and 4.5.

Resource	Total Weight	Sample Percent
Corn	24.9 gm	98%
Beans	.80 gm	94%
Hickory	.39 gm	47.60%
Walnut	0.07 gm	8.50%
Acorn	0.11 gm	13.40%

Resource	Total Number	Sample Percent
Squash	17	0.30%
Tobacco	13	0.30%
Blackberry	2	<1%
Cherry	67	1.20%
Nightshade	107	2%
Sumac	6	0.10%
Sunflower	1	<1%
Wild Rice	1124	20.80%
Little Barley	89	1.60%
Barnyard Grass	91	1.70%
Goosefoot	461	8.50%
Knotweed	125	2.30%

The Faunal Assemblage

The Pammel Creek site faunal assemblage consisted of 1,527 non-artifactual mammal bones from 17 different taxa. The most abundantly identified mammal was the white-tailed deer that were shown by 84 bones that exhibited at least five individuals. These five individual animals would have yielded a total of 193 kg (425 pounds) of useable meat (Theler et al. 1989:169). Many of the deer mandibles were modified into cutting and scraping tools that are generally called "deer jaw sickle" (Arzigian et al. 1989:169). Elk were represented by four bones at the Pammel Creek Site. An adult elk can provide about 159 kg (350 pounds) of usable meat, and the two elk individuals represented at the Pammel Creek site could yield a total of 318 kg (700 pounds) of useable meat (Theler et al. 1989: 170). Black bear was identified by three bear elements that may exhibit a total of two different individual animals which would have yielded 165 kg (345 pounds) of useable meat (Theler et al. 1989:170).

Bison is uncommon at Oneota sites, and Pammel Creek site is no exception. There is only a single bison horn core recovered from the site, which might suggest that bison was brought back villages after hunting expeditions (Theler et al. 1989:170). Beavers were evidenced by 23 specimens which were exhibited two individuals based on two mandibles recovered. Muskrats were uncommon at the Pammel Creek site with only eight bones recovered which represent only one individual. There were three bones of mink that may represent two individuals. Three elements of river otter bones were recovered which represents at least one individual. Lastly, there were three raccoon bones recovered which represents at least one individual (Theler et al. 1989:171).

A domesticated dog was indicated by one mandible and a set of four paws. A timber wolf was shown by a single bone which shows evidence of possible cut marks that are common

when butchering. Theler (1989:171) outlines other small mammals recovered which include: a plains pocket gopher (*Geomys bursarius*), eastern mole (*Scalopus aquaticus*), ground squirrel (*Spermophilus tridecemlineatus*), a deer mouse (*Peromyscus maniculatus*), and voles (*Microtus pensylvanicus*). Besides the two human burials found at Pammel Creek, there were also four isolated human bones found in feature contexts.

Pammel Creek produced 387 bird bones with a total of 9 bird taxa which represent 17 individuals. Theler (1989:182) estimates that these birds could have provided 14.3 kg (32.3 pounds) of useable meat. The bird species are as follows: Canada goose, wood ducks, green or blue-winged teal ducks, and mallard ducks. The four individual ducks together could have contributed about 2 kg (4.4 pounds) of useable meat (Theler et al. 1989: 182). Three turkey bones have been recovered from Pammel Creek which represents at least one turkey. Theler (1989:184) estimates that a single turkey could have provided 4.1 kg (9 pounds) of useable meat.

Pammel Creek's faunal assemblage contained 516 turtle bones which could have represented at least 13 turtles. Theler (1989:184) estimates that these 13 turtles could have potentially contributed 10.8kg (23.8 pounds) of usable meat. The most important species of turtle was the snapping turtle as it contributed 64 percent of the useable turtle meat total. Other turtles that were found at Pammel Creek include: the painted turtle, the map turtle, and the false map turtle (Theler et al. 1989:186). Additionally, a variety of fish remains were recovered from Pammel Creek, approximately 13,250 fish bones. Of these 4,432 fish bones were identifiable and represent a total of 416 individuals of 24 taxa that were estimated to have contributed 243kg (536 pounds) of usable meat. The most common fish remains recovered include bowfin, pikes, gars and catfish (Theler et al. 1989:186-203).

A single crayfish has been identified at Pammel Creek based on a burned carapace and pincer fragment. The northern crayfish is common in Wisconsin's stream pools and were once harvested for human consumption (Theler et al. 1989:203). One thousand two hundred and forty one mussel valves were recovered at Pammel Creek, which is a relatively low frequency, which represents 541 individuals and 22 taxa. The most common mussels found at Pammel Creek were ebonyshell and other species including the Wabash pigtoe, the pimpleback, the three ridge, and the round pigtoe. The 541 individuals could have contributed to 14.kg of useable meat (Theler et al. 1989:204), as shown in Table 5.

Table 5: Calculated usable meat at Pammel Creek (Adapted from Theler et al. 1989: Table 5.1). Amphibian, reptile, and gastropod have no data of usable meat from Pammel Creek.

Mammals	Useable Meat (kg)
Ground Squirrel	-
Gospher	0.1
Beaver	11
Deer Mouse	-
Vole	-
Muskrat	0.6
Domestic Dog	3.6
Wolf	15.9
Bear	78
Raccoon	4.5
Mink	0.5
River Otter	4.5
Elk	158.8
White-tailed Deer	38.6
Bison	272.2

Birds	Usable Meat (kg)
Canada Goose	2.7
Wood Duck	0.5
Green or Blue Winged Teal	0.2
Mallard	0.8
Sandhill Crane	2.2
Wild Turkey	4.1
Red-winged Blackbird	0.015
Perching bird	0.015

Mollusks	Usable Meat (kg)
Ebonyshell	0.029
Wabash pigtoe	0.019
Pimpleback	0.018
Round pigtoe	0.029
Three ridge	0.042

Fish	Usable Meat (kg)
Bowfin	3.01
Pike	3.43
Gar	-
Catfish	-
Sucker	9.8
Drum	3.15
Sturgeon	-
Bullhead	0.39

THE GUNDERSEN SITE (47Lc394) PLANT AND ANIMAL ANALYSIS

This site was excavated by the Mississippi Valley Archaeology Center (MVAC) in the spring of 1991. As at other Oneota sites, there were several human burials. The main goal of this excavation was to uncover the burials; however 700 non-burial features were also excavated (Arzigian 1994). The most common features at this site were refuse pits which were probably first dug for storage of food resources and subsequently reused for disposal of refuge. Like the Pammel Creek Site, the Gundersen site had many of the same subsistence patterns. Based on dating of ceramic vessels, the Gundersen site had two primary occupations, in the early Brice Prairie Phase (1300-1400) and the latest Valley View Phase (1500-1650) (Arzigian 1994:14). The Oneota supplemented their agricultural based diet with that of wild animal resources as a principle source of protein (Theler 1994:39). The Oneota had domesticated the dog and possibly were herding bison and deer. Other wild animal resources utilized were beaver, white-tailed deer, elk, muskrat, otter, fish, and black bear (Arzigian 1994:38-44). The domestic plant remains at this site, as were the wild plants, were consistent with plant remains from the Pammel Creek site: corn, beans, squash, and tobacco (Arzigian 1994:53-57). There are a variety of wild plant resources that were utilized at the Gundersen site and are typical of other Oneota sites. They include: cherries, sumac, hawthorn, black nightshade needs, hickory nuts, acorn and hazelnuts (Arzigian 1994:57).

The Floral Assemblage

Corn is the most abundant domesticated crop that was found at the Gundersen site. Following corn seeds was squash, beans and then tobacco. There were a variety of wild plant resources discovered at this site which include: little barley, barnyard grass, and most importantly wild rice. A variety of fruits and berries were also found at the Gundersen Site which includes: cherries/plums, hawthorn, sumac, and black nightshade. While there were not many berries and fruits found in this assemblage, the most common berry found was black nightshade (Arzigian 1994:54). A variety of nuts were recovered at the Gundersen site: shagbark hickory, bitternut hickory, acorn and hazelnut. Of these, the most represented at the site was the hickory nut (Arzigian 1994:54).

Some weedy seeds and plants were recovered from the Gundersen site, such as goosefoot and sedges. Wild goosefoot grows in disturbed habitats that could have easily been accessible to the Oneota people, or it may have grown as a camp weed around villages (Arzigian 1994:57). Sedges are a variety of wetland plants that were quite common at the Gundersen site, which suggests repeated and perhaps intensive use of these wetland plants for many purposes such as use for thatch, bedding or other construction methods (Arzigian 1994:57).

Greens, the earliest foods available, would not leave many traces in the archaeological record but should have begun to appear in May. Little barley would have been the first starchy seed available, as it would be ready to harvest about mid-June. Fruits and berries ripen from July on, depending on the species, and some actually continue to grow throughout the winter months. Corn would have been ready to harvest between August and September. Mid-August to mid-September is when wild rice could have been harvested. Mid-September to mid-October would have been the harvesting time for nuts, but the sooner those could be harvested would be

beneficial in order to avoid competition from other animals (Arzigian 1994:57). Most of the identifiable plant species could have been easily grown near the villages such as corn, beans, squash, little barley and wild rice (obtained from the Mississippi River, usually in smaller slow moving cool waters). Other resources such as goosefoot, sedges and grasses, would have been available from a short distance of the villages or in the villages themselves (Arzigian 1994:58). The total weight and number of fragments of floral remains found at the Gundersen site are summarized in Table 6.

Table 6: Total weight and fragment numbers of floral remains from Gundersen Site, represented in possible total of six features on the site (Adapted from Arzigian 1994: Table 25).

Resource	Total Weight	Represented in Features (#)
Corn	12.745	13
Hickory	5.55	12
Acorn	0.825	10
Hazel	0.02	2

Resource	Total Number	Represented in Features (#)
Beans	12.04	4
Squash	26	8
Sunflower	2	2
Little Barley	19	5
Wild Rice	174	1
Goosefoot	78	5
Knotweed	10	4
Barnyard Grass	7	2
Nightshade	114	5
Grape	3	3
Cherry/plum	8	6
Sumac	2	2
Sedges	167	5

The Faunal Assemblage

The Gundersen site faunal assemblage contained 428 non-artifactual mammal bones from 18 different taxa, recovered from precisely 87 separate features. The most common mammal recovered from the site was beaver, and there were 190 bones recovered that may have represented at least six individuals (Theler 1994:40). Theler (1994:40) indicated that white-tailed deer were the second most common mammal recovered from the site, with 89 bones which may be representing at least five individuals. The third most common mammal found at the site was elk, 58 bones were recovered that may have represented at least two individuals (Theler 1994:40). Seven elk specimens showed cut marks on the bones, which clearly indicates that these animals were part of the Oneota diet.

Muskrat is fairly common at the Gundersen site, as it is represented 32 bones that could have been seven individuals based on mandibles collected (Theler 1994:42). There were a total of ten mandibles collected, seven were left and three were right. There were also 34 bones that were identified as domesticated dog which would represent at least four individuals. It is unclear whether these dogs were used for labor, but some evidence suggests that dogs were used for ritualistic feasting (Theler 1994:42).

The river otter were only represented by two mandibles in the faunal assemblage. Both of these mandibles show evidence of skinning marks on the bone. In other Midwestern Indian groups, such as the Ioway and Sauk, otter skins had been used for medicine bags (Theler 1994:42). There were seven black bear bones recovered from the site and typically bear bones are uncommon at other unrelated sites, but they seem to be fairly regular at Oneota sites. Bears would have provided many pounds of usable meat, but evidence show skinning markings on the

bones as well which indicates their hides were utilized (Theler 1994:42). Raccoon remains are not typical of Oneota sites, but there were five bones recovered from the site.

Mink was represented by five bones in the faunal assemblage and exhibited several skinning cut marks as well. Three bones of plains gopher were found at the Gundersen site, but were likely intrusive to the site (Theler 1994:43). There were small amounts of ground squirrel bones found at the site. Squirrels are typically uncommon at Oneota sites. Bison bones are only represented in 13 scapulas, which would have been used as gardening hoes. Theler indicates that it is somewhat unclear whether the Oneota saved these scapulas from previous hunts or if they had been receiving them through trade networks from the west. More than 85 percent of Theler's estimated 688 kg of useable meat was provided by the mammal assemblage, from contributions by deer, elk and black bear.

Birds were not typically common at the Gundersen site and are only represented by 63 identifiable bones. Many of these bones were from migratory species that stayed in La Crosse while passing through. These species includes: Canada goose, mallard duck, wood duck, coot, red-headed duck, bufflehead and northern shoveler. Other small birds were identified, such as the sora, and the red-winged black bird (Theler 1994:44). There were a total of 18 individuals that were represented at the Gundersen site which would have provided an estimated 12.4 kg of usuable meat and only would contribute to two percent of the overall diet (Theler 1994:44).

Freshwater mussels were found in relatively low numbers at the Gundersen site. A total of 1,250 mussel valves were found that represent 635 individuals of 21 different species (Theler 1994:45). The most common of these species included: the three ridge, Wabash pigtoe, and pimpleback. Fish were represented by a total of 861 remains from 16 different species and some unidentifiable remains. Fish would have provided a decent amount of usable meat (Theler

1994:45). A total amount of useable meat for all faunal remains from the Gundersen Site are summarized in Table 7.

Table 7: Number of identified specimens, minimum number of individuals and calculated usable meat from the Gundersen Site (Adapted from Theler 1994: Table 14, 21). For reference to mollusks' usable meat, see table 5).

Mammals	NISP	MNI	Useable Meat (kg)
Tree Squirrel	1	1	0.3
Gopher	3	1	0.1
Beaver	190	6	66
Muskrat	32	7	4.2
Domestic Dog	4	2	7.2
Wolf	21	-	-
Black bear	7	1	78
Raccoon	5	1	4.5
Mink	5	2	1
River otter	1	1	4.5
Bobcat	1	1	4.5
Elk	58	2	317.6
Deer	89	5	193
Bison Total	1	1	-
Total	418	31	680.9

Reptiles	NISP	MNI	Useable Meat (kg)
Snapping Turtle	5	1	-
Painted Turtle	1	1	-
False Map Turtl	3	1	-
Softshell Turtle	64	1	-
Total	73	4	-

Birds	NISP	MNI	Useable Meat (kg)
Canada Goose	2	1	2.7
Wood Duck	7	2	1
Mallard Duck	4	1	0.8
Coot	1	1	0.4
Red-headed duck	2	1	0.7
Teal	11	2	0.4
Green-winged Teal	1	1	0.2
Bufflehead	2	1	0.6
Northern Shoveler	1	1	0.6
Sora	1	1	0.1
Red-winged blackbird	8	1	<0.1
Total	40	13	7.5

Fish	NISP	MNI	Useable Meat (kg)
Bowfin	36	2	3.01
Pike	55	6	3.43
Gar	25	1	-
Catfish	49	-	-
Sucker	9	2	9.8
Drum	14	3	3.15
Sturgeon	11	1	-
Bullhead	19	8	0.39
Total	218	23	19.78

THE TREMAINE SITE COMPLEX PLANT AND ANIMAL ANALYSIS

The Tremaine Site Complex consists of three Oneota sites known as the Tremaine Site (47Lc95), the OT Site (47Lc262), and the Filler Site (47Lc149). All three sites have been extensively excavated. Based on the ceramic styles and radiocarbon evidence, the earliest occupation was during the Brice Prairie phase at the Tremaine site, but extended to the Valley View phase. The OT site dated from the Pammel Creek phase until the end of the Valley View phase. Lastly, the Filler site was only occupied during the Valley View phase (Tubbs and O'Gorman 2005: 127).

A total of 855 pit features were excavated at the Tremaine site complex, which included many food storage pits and processing pits (Tubbs and O'Gorman 2005: 128). A variety of wild plant and animal resources were utilized by these populations, as were domesticated crops. The floral assemblage has a total of seven taxonomic categories: corn, beans, squash, nuts, seeds, fruits and weedy plants (Tubbs and O'Gorman 2005: 134-135). The faunal assemblage has a total of seven taxonomic categories: freshwater mussels, fish, mammals, birds, reptiles, amphibian and gastropods (Tubbs and O'Gorman 2005: 130-134). The research done by Tubbs and O'Gorman seeks to exclusively understand the Oneota health and diet, but it does not take into account the seasonal variability of resources. They assumed that food processing and storage technologies would have helped to minimize the fluctuation of nutritional adequacy.

The Floral Assemblage

The Tremaine Complex had many different types of plant resources that are represented in the floral assemblage (see table 4). Nuts included hickory nuts (*Carya ovate*), acorns (*Quercus*

spp.), walnuts (*Juglans nigra*), and butternuts (*Juglans cinerea*) (Tubbs and O'Gorman 2005:134). The specific type of nut varies from site to site, but there were 13 percent present at Tremaine, 40 percent were found at the OT and 56.4 percent were found at Filler. Fruits found at the Tremaine Complex included mulberry (*Morus* spp.), staghorn sumac (*Rhus hirta*), huckleberry (*Vaccinium* spp.), blackberries (*Rubus* spp.), and grapes (*Vitis* spp.) (Tubbs and O'Gorman 2005:134). These types of fruits varied, but there were 24 percent at Tremaine, 53.3 percent at OT and 46.15 percent at Filler.

The taxonomic category of seeds included both starchy and oily seeds that would have been utilized by the Oneota. These types of seeds would have included little barley (*Hordeum pusillum*), wild rice (*Zizania aquatic*), sunflower (*Helianthus annuus*), marshelder (*Iva annua*), goosefoot (*Chenopodium berlandieri*), mustard and amaranth seeds (*Amaranthus* spp.) (Tubbs and O'Gorman 2005:134). Seeds were least common at OT, approximately 33 percent, and most abundant at Filler, approximately 97.4 percent. Seed ubiquity was 39 percent at Tremaine, 33.3 percent at OT and 97.4 percent at Filler.

Corn (*Zea mays*) was well represented at all three of the sites with a ubiquity percentage of 48 percent at Tremaine, 53.3 percent at OT and 79.4 percent at Filler (Tubbs and O'Gorman 2005: 135). Squash (Curcurbits), were not well represented at all of the sites but were the most common at Filler with a ubiquity percentage of 25.6 and 13.3 percentage at OT (Tubbs and O'Gorman 2005:135). Weedy plants tend to include leafy vegetables such as knotweed (*Polygonum erectum*), amaranth (*Amaranthus* spp.), bedstraw (*Galium* spp.), carpet weed (*Mollugo verticillata*), barnyard grass (*Echinochloa muricata* var. microstachya), and arrowhead (*Sagittaria* spp.) (Tubbs and O'Gorman 2005:135). Weedy plants were the most common type of plant resource recovered from the Tremaine Complex. The two most common species were

barnyard grass and knotweed, likely due its tolerance of disturbed habitats. Weedy plants had a ubiquity of 26 percent at Tremaine, 46.6 percent at OT and 97.4 percent at Filler.

Beans were represented in the lowest percentages at each of the Tremaine Complex sites. Beans had a ubiquity of four percent at Tremaine, no representations from OT, and 15 percent at Filler, seen in Table 8. Typically, beans are underrepresented simply due to preservation biases in the floatation samples (Tubbs and O'Gorman 2005:135). But this does not mean that beans were not being utilized in the Oneota diet.

Table 8: Ubiquity of plant resources utilized at the Tremaine Site Complex, organized by taxonomic categories and by site (Tubbs and O'Gorman 2005: Table 4).

	Tremaine	OT	Filler
Nuts	13%	40%	56.41%
Fruits	24%	53.33%	46.15%
Seeds	39%	33.33%	97.44%
Corn	48%	53.33%	79.49%
Squash	2%	13.33%	25.64%
Weedy Plants	26%	46.67%	97.44%
Beans	4%	0%	15%

The Faunal Assemblage

At the Tremaine Site Complex, the faunal assemblage contained high levels of freshwater mussels, thirty-eight percent at the Filler site, twenty percent at the OT site and thirty percent at the Tremaine site, as is reflected in Table 3. There were three types of mussels that were present at each site including ebonyshell and pigtoes (*Fusconaia* spp.), threeridge (*Amblema plicata*), and pimpleback (*Cyclonaias tuberculata*) (Tubbs and O'Gorman 2005:132). Fish remains were

also a large portion of the faunal assemblage at all three of the Tremaine Complex sites. Species that were included in this assemblage were bullheads and catfish (*Ictalurus* spp.), pike (*Esox* spp.), bowfin (*Amia calva*), lake surgeon (*Acipenser* spp.), gar (*Lepisosteus* spp.), suckers (Catostomidae), sunfish (*Lepomis* spp.), bass (*Micropterus* spp.), walleye/sauger (*Stizosteion* spp.), and freshwater drum (*Aplodinotus grunniens*) (Tubbs and O'Gorman 2005:132).

Mammals were the most abundant at the Tremaine site and least abundant at the Filler site. There was a large portion of mammal bones that were unidentifiable from all three sites at the Tremaine Complex (Tubbs and O'Gorman 2005:132). However, the following animals were identified: white-tailed deer (*Odocoileus virginianus*), bison (*Bison bison*), beaver (*Castor canadensis*), coyote or domesticated dog (*Canine / familiaris*), voles (*Microtus* spp.), river otter (*Lutra canadensis*), mouse/rat (Muridae), ground squirrel (*Spermophilus tridecemlineatus*), black bear (*Ursus americanus*), and muskrat (*Ondatra zibethicus*) (Tubbs and O'Gorman 2005:132.

Bird remains represent less than one percent of the Tremaine Site, two percent of the OT site and six and a half percent of Filler's faunal assemblage. Many bird bones were unable to be identified, but ducks (*Anas* spp.), passerine birds which would include cardinals (*Cardinalis* spp.), blackbirds and orioles (*Icterinae*), pigeons (*Ectopistes migratorious*), turkeys (*Meleagris gallopavo*), sand hill crane (*Grus canadensis*), Canada goose (*Branta canadensis*), swan (*Cygnus* spp.) and falcon (*Falco peregrines*) were all represented in Tremaine Complex (Tubbs and O'Gorman 2005:132). Reptiles, amphibians and gastropods rendered only a small portion of the Tremaine Site Complex faunal assemblages, even though reptiles encompassed nearly ten percent of the faunal assemblage at the OT site (Tubbs and O'Gorman 2005:132). Reptiles that were recovered were almost exclusively turtles, with a few specimens of snakes. A frog was

identified at OT, and an unidentifiable gastropod was recovered from the Filler site, which may have possibly been a crayfish (Tubbs and O'Gorman 2005:132) – as shown in Table 9.

Table 9: Relative frequency of animal resources utilized at the Tremaine Site Complex, organized by taxonomic category and by site (Tubbs and O'Gorman 2005: Table 2).

	Tremaine	OT	Filler
Mussels	31.59	20.67	38.4
Fish	12.4	41.65	36.14
Mammals	54.3	26.53	18.02
Bird	0.81	1.96	6.56
Reptiles	0.9	9.17	0.85
Amphibian	0	0.02	0
Gastropod	0	0	0.03
Total	100.00	100.00	100.00

COMPARTIVE DICUSSION OF FLORAL AND FAUNAL REMAINS AT ONEOTA SITES

All three of the described sites above share a similar floral and faunal assemblage, which is typical at the Oneota sites in the La Crosse region. These sites range from different time periods, which include all three of the phases, and are briefly defined. The Tremaine site complex was occupied during Brice Prairie Phase until the end of the Oneota occupation during the Valley View Phase. The Gundersen site had two primary occupations, during the early Brice Prairie Phase and latest Valley View Phase. The Pammel Creek site was occupied for a relatively short time, about fifty years during the Pammel Creek Phase.

The Tremaine Site complex gives the best relative abundance percentage of each type of species that are included in both the floral and faunal assemblages during each phase at the Oneota sites (see table 8 and 9). For example, the Tremaine site has been occupied throughout each phase, the OT site was occupied during the Pammel Creek phase which extended into the Valley View Phase, and the Filler site was only occupied during Valley View Phase as shown in Table 10. These sites may be able to represent the different plant and animal food utilization during different time periods.

Table 10: La Crosse locality Oneota phases represented at the Tremaine Site Complex (Taken from Tubbs and O'Gorman 2005: Table 1).

	Brice Prairie Phase	Pammel Creek Phase	Valley View Phase
Site	A.D. 1300-1400	A.D. 1400-1500	A.D. 1500-1625
Tremaine	X	X	X
OT		X	X
Filler			X

Brice Prairie Phase

The earliest occupational phase, which lasted from A.D. 1300-1400, is only represented by one site in this investigation, the Tremaine Site. This population has relatively high percentages of corn (48%), seeds (39%), weedy plants (26%), fruits (24%) and nuts (13%). The lowest usage of plant resources at this site is reflected by beans (4%) and squash (2%). Some domesticated crops tend to show up in low frequencies in the archaeological record at these sites. It could very well be that the time period was quite early and the occupants were relying on previous traditions that utilized mostly wild plant and animal resources. In addition to corn, the more abundant plant

remains recovered from this site seem to rely on gathered plant resources rather than cultivated or domesticated food crops. Corn, fruits, nuts, squash and weedy plants were found in the lowest frequencies at the Tremaine Site. Many essential vitamins and minerals would have been more plentiful in these natural resources than they would have been in other domesticated crops.

The most utilized animal resources recovered from the Tremaine site is a variety of mammals that encompass 54.3 percent of the total animal remains at this site. The second most important animal in the Oneota diet would be freshwater mussels that represent 31.6 percent of the total animal resources found on the site. Fish were represented by 12.4% of the total animal remains recovered from the Tremaine site. Lastly, reptiles were represented by 0.90%, birds were represented by 0.81% of the total animal resources, and amphibians and gastropod remains were not recovered from this site. Fish, bird, and reptiles were represented in the lowest frequencies at the Tremaine Site. However, mammals were recovered in the highest frequency at this site.

This evidence suggests that the Tremaine site, in the context of the Brice Prairie phase, may have relied more heavily on natural resources than domesticated and or cultivated crops in their diet. This is seen through the percentage of abundance of squash and beans, two other domesticated crops, appearing so infrequently – less than five percent of the floral assemblage. Interestingly, corn is represented by nearly half of the plant remains found at the site. All of the seeds were recovered through floatation methods, and it is possible that some of the remains were underrepresented due to biases. For example, beans were more than likely underrepresented simply due to the methods that they were processed by the Oneota and then eaten right away. Beans are also difficult to see in the archaeological record because they are processed differently than corn.

It is dangerous to eat a diet that is highly dependent on corn. In many cases, populations that are heavily relying on corn for subsistence will suffer from niacin and iron deficiencies which can lead to serious health problems. There are also other physical health risks associated with a diet based on corn, such as rotting teeth and anemia-like conditions. But if these diets are balanced with other plants that contain niacin, then these types of health problems could have been avoided. Lysine, needed in the diet, can be obtained from beans, but cannot be found in corn, in order to complete the amino acid. Otherwise corn will cause iron deficiency anemia.

Pammel Creek Phase

The middle occupation phase or Pammel Creek Phase, which lasted from A.D. 1400-1500, is represented by the Tremaine site, the OT site, the Pammel Creek site and the first half of the occupation at the Gundersen site. At OT, which dates to both the Pammel Creek and Valley View phase, there is a general increase of domesticated food crops utilized. For instance, the usage of corn increased to 53.3 percent and squash had increased to 13.3 percent of overall floral assemblage recovered from the site. However, beans were represented by a total of zero percent at the OT site, but this more than likely is due to the fact the beans do not tend to survive in the archaeological record based upon the way in which they had been processed. This population of plant resources had relatively high percentages of fruits (53.3 percent), weedy plants (46.7 percent), nuts (40 percent), and seeds (33.3 percent). However, the lowest frequencies of plant resources were reflected by squash (13.3 percent) and beans (0 percent).

The most utilized animal resource at the OT site is reflected by the fish population of 41.7 percent. The second most utilized animal resource was mammals that represent a total of 26.5 percent of the total animal resources recovered. Following mammals were mussels that represented 20.6 percent of the total faunal assemblage. Reptiles represented 9.2 percent of the

assemblage and birds represented 1.9 percent of the animal remains. It is unclear whether the reptiles were primarily just found on site from exposure or if they were being used as a meat source. However, there was no usable meat data that Theler reported (1994: 45). There were no gastropods recovered from this site, and a single toad represented amphibians at the Tremaine Site complex.

Like at OT, corn was quite common at Pammel Creek as it was observed in 98 percent of the sample taken in 1989. A total amount of 24.9 grams of corn was recovered from the site. Beans were represented at the site in 94 percent of the floral assemblage, with a total of .80 grams recovered. A total number of seventeen squash specimens were recovered from the site that represents 0.30 percent of the assemblage. The most abundant nut found at Pammel Creek was the hickory nut (0.39 grams) represents 47.6 percent of the floral assemblage, next acorn (0.11 grams) disclosing 13.4 percent of the assemblage, and finally, walnut (0.07 grams) indicated 8.5 percent of the plant remains.

The most abundant weedy plant or seed at Pammel Creek was wild rice that had a total number of 1124 specimens identified, representing 20.8 percent of the floral assemblage. The next highest frequency plant was goosefoot with a total of 461 specimens represented by 8.5 percent of the plant remains. Knotweed was present in 2.3 percent of the plant remains with a total of 125 specimens. Black nightshade was the most abundant berry, as a total of 107 specimens were identified that represented 2% of the plant remains. Cherries had relatively high frequencies at Pammel Creek as well, with a total of 67 specimens indentified that represented 1.2% of the floral assemblage.

The largest amount of usable meat from Pammel Creek would have come from bison (272.2 kg), even though this species would have been seasonally hunted in the fall. Elk would

have been hunted for their meat as they would provide at least 158.8 kilograms of useable meat. Black bear would have also been hunted, although those expeditions would have been dangerous and risky, and would provide about 78 kilograms of useable meat. Other mammals that would have contributed significant amounts of meat include white-tailed deer (38.6 kg), wolf (15.9 kg), beaver (11 kg) and domesticated dog (3.6 kg).

The largest birds found at Pammel Creek (turkey, crane, and Canada goose) would have been able to contribute usable meat to be incorporated into a diet. Wild turkey could yield 4.1 kilograms, Canada goose could yield 2.7 kilograms, and Sandhill cranes could yield 2.2 kilograms of useable meat. While other bones of smaller birds, such as song birds and perching birds, have been found there is so little usable meat on them that these populations would have ignored them as a food source. Freshwater mussels would have also yielded small quantities of usable meat and would have had to be eaten in larger quantities to get nutrients. The threeridge mussel could yield the most usable meat (0.042 kg), following that would be ebonyshell (0.029 kg) and round pigtoe (0.029 kg).

Like the OT site, fish bones were the most abundant faunal remains recovered at the Pammel Creek site. The 1989 excavation uncovered more than 13,250 fish bones, of which nearly 4.432 fish bones were identified to specific species. Catfish represent 49.5 percent of all fish remains at the site and gars indicated 32 percent of the total amount of fish remains recovered from Pammel Creek. The high amount of fish remains found at these two sites is likely due to their relatively close locations to freshwater supplies.

Valley View Phase

The late occupation phase or the Valley View phase, which lasted from A.D. 1500-1625, is represented by the Tremaine site, the Filler site, and the latter half of the Gundersen site

occupation. At the Filler site, there is general increase in most of the plant resources that were utilized and the highest percentage of weedy plants and seeds (97.4 percent). Corn was also quite common, as it consists 79.49 percent of the plant assemblage. Nuts represent 56.4 percent, fruits represent 46.1 percent, squash represent 25.6 percent and beans represent 15 percent of the total assemblage at the Filler site. Interestingly, even at the final occupational period for the Oneota it is clear that these populations were utilizing their wild plant resources then more than ever. Weedy plants and seeds have a higher frequency than corn, squash or beans.

Mussels and fish were the most utilized animal resources utilized at the Filler site. The frequency of mussels was highest at the Filler site, which is represented by 38.4% of the total faunal remains. Fish represent 36.5% of the total faunal remains, and are the second highest represented at the Tremaine site complex. Mammals exhibited the least at the Filler site with 18% of the total faunal remains. Birds were at their highest frequency at this site and represent a total of 6.5% of the total animal remains recovered. Reptiles were represented by 0.85% of the total faunal remains. The Filler site was the only site within the Tremaine site complex that had a specimen identified as a gastropod. A single crayfish was identified at the site and represented 0.03% of the total faunal assemblage. Like the other Tremaine site complex sites, the Filler site is located close to freshwater bodies of water which explain the abundant use of riverine resources.

Corn was discovered at the Gundersen site with a total weight of 5.285 grams that was represented at all 13 features that plant remains were recovered in. A total amount of 26 specimens of squash in 8 different features and 12 specimens of beans in four different features were uncovered at the site. Nuts were represented by 5.55 grams of hickory that was found in 12 features, acorn was represented 0.825 grams in 10 features and hazel was represented by 0.02

grams found in two features. A variety of seeds and weedy plants, such as little barley, goosefoot and knotweed, are represented in smaller quantities at the Gundersen site than they were shown at Pammel Creek.

Like the Filler site, the Gundersen has large amounts of fish and mussel remains recovered from excavation. The minimal number of mussel individuals identified is 635, which is much higher than the bird assemblage of 13 individuals, the mammal assemblage of 31 individuals, and the reptile assemblage with four turtle individuals. The fish assemblage was represented by 23 calculated individuals of eight different species. The high frequency of riverine resources may be in part due to relative location of the Gundersen site near fresh bodies of water.

NUTRITIONAL FOOD PROFILE FOR ONEOTA

The La Crosse locality is unique in that it is rich with an abundance of wild animals and plant resources. In order to set up a successful food profile, both minerals and vitamins (as shown in Table 11) were included in this data. The recommended daily allowance (RDA) values for adults are also given in Table 11. In both of the food plans, the domesticated crops (corn, beans, squash and sunflower) are set to 300 g and all other resources are set to a value of 100 g unless otherwise specified. The selection of nutrients were chosen based on their relative important function to provide optimal health benefits for the Oneota populations in La Crosse and are discussed in the following paragraph. The various food resources that were selected for this profile were chosen for their ability to provide the best nutrients into a diet, as seen in the archaeological record. While both of these food profiles does not document drinking water, only

water that is absorbed through plant and animal resources, it is assumed that these populations would be drinking more than 2.7 l of water a day. Further, these fresh water supplies would have provided extra minerals that would have included zinc, iron and calcium. In addition, cultivated weedy plants would have provided more nutrients into this population's diet than is represented in these food plans.

Table 11: Complete list of Vitamins and Minerals taken into account for this food profile and the RDA values.

Nutrients	RDA (Female Values)	RDA (Male Values)
Calcium	1000 mg	1000 mg
Iron	18 mg	8 mg
Zinc	8 mg	11 mg
Niacin	14 mg	16 mg
Carbohyrdates	45-130 mg	45-130 mg
Protein	46 mg	56 mg
Water	2.7 L	2.7 L

Nutrients	RDA (Female Values)	RDA (Male Values)
Vitamin A	700 mg	900 mg
Vitamin B1	1.1 mg	1.2 mg
Vitamin B12	2.4 mg	2.4 mg
Vitamin C	75 mg	90 mg
Vitamin D	600 mg	600 mg
Vitamin E	25 mg	25 mg

Calcium is important because it is essential in blood clotting and bone formation. It would have been available in berries, nuts and some meats. Iron is vital to the human body because it is an oxygen carrier in the red blood cells and is transported throughout the entire

body. Iron would have been found in freshwater mussels, some meats, and in corn, nuts and berries (but in a lower quantity). Lysine is an essential amino acid and needed in order for the body to function properly. Large quantities of lysine can be found in beans. Although beans are not typically found at Oneota sites, it does not mean that these populations were not utilizing this crop. It is more likely that charred bean remains are not found simply due to the way in which beans were processed and that they were eaten whole.

Vitamin A helps with improved eyesight, which would be important to prehistoric cultures. The Oneota could have easily gotten sufficient amounts of this vitamin through gathered blackberries. Vitamin B_1 and B_{12} help with digestion and in building proteins within the human body. Typically, these vitamins can be found in nuts and beans. Its arguable that vitamin C may have been the most important vitamin that this population would have needed because it helps with the synthesis of collagen and allows the body to easily absorb iron into the system. Berries and fruits yield high volumes of vitamin C. Vitamin D helps with the maintenance of bones and teeth and allows the body to easily absorb calcium into the system. This vitamin is easily obtained and absorbed into the system through ultraviolet rays from the sun. Finally, vitamin E is an antioxidant which helps prevent diseases from spreading into the human body and are quite plentiful in sunflower seeds.

Food Profiles

Because this investigation takes into account crop shortages or failures, two nutritional food profiles or food plans have been created. The first food plan, or the "mixed economy", exhibits what a daily food plan might look like that incorporates both wild and domesticated resources into the diet. The second food plan, or the "primarily wild economy", exhibits what a daily food plan might look like which incorporates beans, sunflower and wild resources into a diet. The

latter is an example of what a typical diet might look like if there were crop failures or shortages in a given year. These populations would have been forced back to a basic hunter and gatherer type of diet. However, both the mixed economy and primarily wild economy food profiles establish a balanced diet for the Oneota populations.

Both the "mixed economy" and "primarily wild economy" food plans do not take into account the seasonality of these settlements. Many field reports such as Pammel Creek and Gundersen argue that Oneota populations traveled in the fall and winter months into the west prairie plains in search of bison and other large herd mammals to supplement their diets. During the winter months, many of these typical wild plant resources would be scarce and hunting would be limited.

However, many of the settlements show clear evidence of mass storage of crops that would have been utilized during the winter months. Unfortunately, it was impossible to incorporate any of the cultivated weedy plants (knotweed, little barley and goosefoot) into these food plans because there is not any nutritional data available in the USDA database. However, it is well known that the Oneota populations were cultivating and eating these resources which would have added nutrition into their diets. In addition, extra amounts of vitamin D would have been obtained from the ultraviolet sun rays.

"Mixed Economy" Food Plan

This food plan is an example of a typical diet that Oneota populations would have had access to on a regular basis, which consisted of both wild and domesticated food resources as shown in Table 12. The nutritional data was taken from the USDA nutritional database and applied to this food plan. This food plan incorporates a variety of wild animal and plant resources, as well as domesticated corn, squash, beans and sunflower. Nearly all of the nutrient levels in this food

profile, as shown in Table 11 were higher than the minimal RDA requirements that are considered adequately healthy by contemporary standards. All of the listed food resources are found in the archaeological record at the Oneota sites in the La Crosse locality.

Many of the berries, fruits and nuts are important in this food plan because they provide essential vitamins and some minerals. Catfish is important in this food plan because it provides more than enough vitamin D, which is not seen in any of the other resources. Sunflower is important in this diet because it provides a majority amount of vitamin E. In addition, natural water resources would have been utilized for drinking purposes and would have provided some minerals including iron, calcium and zinc. The water documented in this food plan converts to a total of .8634 liters and it can be assumed that the remaining 2.83 liters were being extracted through drinking water resources.

Table 12. "Mixed Economy" food plan incorporating wild and domesticated food resources that demonstrates what a typical Oneota diet might have included.

	Kcal	Protein g	Water	Carb g	Niacin mg	Zinc g	Iron g	Calcium
Corn	258	9.81	228.2	56.1	5.31	1.38	1.56	6
Beans	87	12.6	272.1	12.3	8.76	1.2	2.43	51
Squash	120	2.4	26.34	31.26	2.1	0.39	2.1	99
Sunflower	582	19.33	1.2	24.07	7.042	5.29	3.8	70
Walnuts	618	24.06	4.56	9.91	0.47	3.37	3.12	61
Wild Rice	357	14.73	7.76	74.9	6.733	5.96	1.96	21
Blackberry	43	1.39	88.15	9.61	0.646	0.53	0.62	29
Catfish (1 fillet)	151	26.04	68.31	0	3.032	0.81	1.02	22
Deer (8 oz.)	272	52.07	166.9	0	14.447	4.74	7.71	11
Totals	2488	162.43	863.4	218.2	48.54	23.7	24.32	370
RDA Total	2500	56	3.5 L	45-130	16	11	18	1000

Table 12 (continued)

	Vitamin A	Vitamin B1	Vitamin B12	Vitamin C	Vitamin D	Vitmain E
Corn	27	0.465	0	20.4	0	0.21
Beans	0	1.11	0	116.1	0	0
Squash	54	0.42	0	33	0	0
Sunflower	9	0.106	0	1.4	0	26.1
Walnuts	2	0.057	0	1.7	0	0
Wild Rice	1	0.115	0	0	0	0.82
Blackberry	214	0.02	0	21	0	1.17
Catfish (1 fillet)	80	0.334	3.55	1.1	795	0
Deer (8 oz.)	0	0.499	14.31	0	0	0.45
Totals	387	3.126	17.86	194.7	795	28.75
RDA Total	700	1.2	2.4	90	600	25

"Primarily Wild Economy" Food Plan

This food plan was created to show an alternative diet plan that these populations would have had to utilize if a crop were to fail or shortages were to occur. It does utilize two types of domesticated crops, sunflowers because of the high levels of vitamin E and beans because of their nutritional value. However, this food plan is mostly reliant on wild plant and animal resources as shown in Table 13. Nearly all of the nutrient levels in this food profile, as shown in Table 11, met the minimal RDA requirements that are considered nutritionally healthy by contemporary standards. Of course, this food plan is not on the same level as the "mixed economy" food plan, but would still be a sustainable source of nutrients to keep the populations healthy. Everything found in the archaeological record directly reflects wild plant and animal resources that were available and used by the Oneota. The water documented in this food plan converts to a total of .7321 liters and it can be assumed that the remaining 2.96 liters were being extracted through drinking water resources.

Table 13. "Primarily Wild Economy" food plan that incorporates mostly wild animal and plant resources, and domesticated sunflower and bean. This food plan represents a daily diet plan substitute if a crop were to fail and if some domesticates were unavailable.

	Kcal	Protein g	Water	Carb g	Niacin mg	Zinc g	Iron g	Calcium
Beans	87	12.6	272.1	12.3	8.76	1.2	2.43	51
Sunflower	582	19.33	1.2	24.07	7.042	5.29	3.8	70
Walnuts	618	24.06	4.56	9.91	0.47	3.37	3.12	61
Wild Rice	357	14.73	7.76	74.9	6.733	5.96	1.96	21
Blackberry	43	1.39	88.15	9.61	0.646	0.53	0.62	29
Acorn (1 oz.)	144	2.3	1.43	15.21	0.682	0.19	0.29	15
Catfish (1 fillet)	151	26.04	68.31	0	3.032	0.81	1.02	22
Mussels (6 oz.)	178	29.07	126.75	10.22	2.55	1.39	5.42	53
Beaver (8 oz.)	331	54.5	160.96	0	4.309	0	15.7	34
Total	2491	184.02	731.22	156.22	34.224	18.74	34.3	356
RDA Total	2500	56	3.5 L	45-130	16	11	18	1000

	Vitamin A	Vitamin B1	Vitamin B12	Vitamin C	Vitamin D	Vitmain E
Beans	0	1.11	0	116.1	0	0
Sunflower	9	0.106	0	1.4	0	26.1
Walnuts	2	0.057	0	1.7	0	0
Wild Rice	1	0.115	0	0	0	0.82
Blackberry	214	0.02	0	21	0	1.17
Acorn (1 oz.)	0	0.042	0	0	0	0
Catfish (1 fillet)	80	0.334	3.55	1.1	795	0
Mussels (6 oz.)	12	0.323	1.24	3.4	0	6.8
Beaver (8 oz.)	0	0.136	0.204	4.5	0	0
Total	318	2.243	4.994	149.2	795	34.89
RDA Total	700	1.2	2.4	75	600	25

CONCLUSION

This paper aimed to answer several questions concerning the health of the Oneota tradition in the La Crosse locality. Were there any nutritional gaps in the Oneota diet? There seems to be little evidence from this study that suggests that this is the case. Tubs and O'Gorman argue in their study that the skeletal remains from the Tremaine Site Complex do not show evidence of malnutrition or nutrition related diseases (Tubs and O'Gorman 2005:145-150). The Oneota made a sophisticated decision settling in the La Crosse region. In doing so, they gave themselves the opportunity to get more than enough nutrients to sustain themselves for their entire occupation in this region.

Of course, the "mixed economy" food plan would be ideal because these populations would be getting more than enough nutrients from the wild and domesticated resources and it would be the ideal candidate for a balanced diet. But, what if those domesticated crops were not there? Or, what would happen to these populations if a domesticated crop were to fail in a given year? Hopefully there would have been enough surpluses of crops in storage in order to get them through the next few months. I f not, these populations would have had to resort to a traditional hunter and gatherer lifestyle.

The "primarily wild economy" food plan establishes an alternative diet plan in those situations when domesticated crops were not an option. This plan would still provide a balanced diet and exhibits how useful a wild diet actually would have been. Since it meets the requirements of the RDA values, it would still provide the vital nutrients needed to maintain the health of the Oneota. But, if a typical Oneota village consisting of at least 80 people were to

consume one of the food plans on a daily basis, than a carrying capacity issue would occur in the environment. The environment would have been affected by the Oneota's hunting patterns and exploitation of wild animals. Therefore, wild resources would have had to be used as minimally as possible in order to ensure that the environment would have not been severally affected by the Oneota populations.

A shift from a hunter and gatherer type of lifestyle to an agriculturalist way of living comes with its own risks, such as crop failure or shortages. But there are many benefits from it, such as food security and an increase in population. Both of these food plans detail how they would have provided a balanced diet, but the "mixed economy" would be more desirable.

The Oneota were very wise in their choice of settlements in the La Crosse region because of its thriving wild animal and plant life. All of the essential nutrients can be found in these resources and the Oneota populations utilized these resources, along with their domesticated crops as well. Whether or not there were seasons that these populations had to resort back to a "primarily wild economy" diet or not, it is clear that the Oneota would be considered quite healthy by contemporary standards of the USDA. This means that nutritional related diseases were not a worry for the Oneota populations and there were not any nutritional gaps in their balanced diet.

Therefore, the Oneota's primary subsistence strategy was choosing to settle in the La Crosse region. A majority of the food resources utilized were wild animal and plant resources that were only available in the La Crosse region because of the diverse habitat. The Oneota's choice of lifestyle and occupation in this region were wise in that they choose food resources with the most nutrients in them, as has been documented by these two food plans. Their choice in settlements enabled the Oneota populations to live healthy life's by contemporary standards.

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