RECONCILING TRADITION AND INNOVATION: AN ANALYSIS OF INDIGENOUS IRON AND LEAD USE, MODIFICATION, AND REMANUFACTURE AT THE ONÖNDOWA'GA:' (SENECA IROQUOIS) WHITE SPRINGS ARCHAEOLOGICAL SITE, CIRCA 1688–1715

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Arts

by

Alexandra Diane Walton

August 2021

© 2021 Alexandra Diane Walton

ABSTRACT

This thesis analyzes 366 iron and lead artifacts from the Onöndowa'ga:' (Seneca Iroquois) White Springs archaeological site (c. 1688–1715) in conjunction with Hodinöhsö:ni' (Haudenosaunee/Iroquois) burial data and the ethnohistoric record. Artifacts were identified by consulting reference materials, visually comparing fragmentary artifacts to complete objects at the Rochester Museum and Science Center (RMSC), and taking digital radiographs of highly corroded objects. Thirty-one of these European trade items were modified into more "traditional" forms. This represents a unique opportunity to reconcile the seemingly contradictory concepts of tradition and innovation by applying a practice-based approach to the White Springs assemblage.

White Springs artifacts are compared to iron and lead assemblages from earlier Hodinöhsö:ni' sites and to the subsequent Onöndowa'ga:' Townley-Read site (c. 1715–1754) in order to examine iron and lead use, modification, and remanufacture through time. The White Springs and Townley-Read assemblages contain higher quantities of nails and hardware, while assemblages from earlier sites are comprised of more tools, implements, and modified iron. Nail, iron, and lead densities were calculated for each spatial area of the White Springs site to identify the activities performed across different spaces. An examination of the iron and lead White Springs objects additionally provided evidence of Onöndowa'ga:' construction methods, warfare tactics, hunting practices, and lead smithing techniques.

Ultimately, this thesis attempts to answer several related research questions, such as, why did the Onöndowa'ga:' modify iron and lead obtained from colonial traders? How were iron and lead objects repaired and remanufactured? How were iron and lead used? Did the use of iron and lead change warfare tactics and hunting practices? How were nails used in construction? Were European or Indigenous blacksmiths present at White Springs?

BIOGRAPHICAL SKETCH

Alexandra Walton is a master's candidate in archaeology at Cornell University. Her research is centered around the archaeology of Indigenous peoples and is focused on Indigenous object modification, colonialism, cultural entanglement, and Indigenous autonomy.

Alexandra received her BA in anthropology from the University of California, Berkeley graduating with the highest distinction (roughly equivalent to *summa cum laude*). As an undergraduate, she participated in the Undergraduate Research Apprenticeship Program (URAP) conducting geoarchaeological and historical analyses for Dr. Laurie Wilkie and Dr. Lisa Maher. She also completed an independent research project during her senior year, which examined American frontier mythology by analyzing a historic assemblage of artifacts from the Fort Davis archaeological site. Results were presented to the annual meeting of the Society for Historical Archaeology in 2018. She has worked on archaeological digs in Kefalonia, Greece; Grand Portage, Minnesota; Santa Cruz, California; and Ithaca, New York

ACKNOWLEDGMENTS

This project owes its existence to many people. First and foremost, I would like to thank my advisor Kurt Jordan, who alerted me to the possibility of working with the White Springs iron and lead assemblages. Without your mentorship, this thesis would not exist; thank you for your invaluable feedback, support, and guidance. Thank you to my other committee member, Frederic Gleach, for your ideas and edits.

To the Rochester Museum and Science Center (RMSC), thank you for allowing me to work with the Hodinöhsö:ni' (Haudenosaunee/Iroquois) collections in person. These artifacts were an irreplaceable resource that undoubtedly shaped this project. I would like to personally thank Elizabeth Pietrzykowski and George Hamell for helping me get situated and for making me feel welcome. Thank you to the Cornell Institute of Archaeology and Material Studies (CIAMS) committee for providing funding via a Hirsch Research Travel Grant, which made the trip to the RMSC possible. I would also like to thank the Cornell University Hospital for Animals for taking the digital radiographs of the highly corroded iron artifacts.

Thank you to my master’s cohort; your friendship, advice, and encouragement was tremendously appreciated. Thank you to my best friend Ritchie for your numerous draft edits and for your long-lasting friendship. Lastly, thank you to my husband Kevin, who has always supported my dreams and ambitions. Your encouragement, patience, and love has guided me throughout my entire educational journey; none of this would be possible without you.

TABLE OF CONTENTS

BIOGRAPHICAL SKETCH iii
ACKNOWLEDGMENTS iv
LIST OF FIGURES viii
LIST OF TABLES iv
LIST OF GRAPHS v
Introduction 1
Important Terminology: Iroquoian, Iroquois, Haudenosaunee, and Seneca 2
The Introduction of Iron and Lead Trade Items 4
Problematic Conceptions of Tradition 6
Hodinöhsö:ni' Iron and Lead Modification Patterns 7
Hodinöhsö:ni' Iron Modification: 1550-1687 CE 7
Hodinöhsö:ni' Lead Modification: 1605-1687 CE 13
The White Springs and Townley-Read Sites 15
The White Springs Site 16
Archaeological Excavations at White Springs 17
The Townley-Read Site 21
Archaeological Excavations at Townley-Read 22
The White Springs Iron Assemblage 23
Identifying Onöndowa'ga:' Component Artifacts 23
Assemblage Overview 25
Unmodified White Springs Iron Artifacts (n=246) 28
Structural Components: Fasteners (n=155) and Hardware (n=6) 29
Tools and Implements: Awls (n=14), Possible Awls (n=9) 30
Tools and Implements: Wire (n=2) 31
Tools and Implements: Punch or Graver (n=1) 31
Tools and Implements: Multi-tool (n=1) 31
Tools and Implements: Handle (n=1) 31
Tools and Implements: Unknown Tools (n=4) 31
Tools and Implements: Scissor Fragments (n=3) 32
Tools and Implements: Strike-A-Lights (n=2) 32
Firearm Fragments (n=9) 32
Food Preparation: Knives (n=21) and Possible Knives (n=5) 33
Food Preparation: Kettle Hooks (n=3) 35

Clothing and Adornment: Belt Buckles (n=2) and Clothing Fragments (n=2) 35
Recreation: Mouth Harps (n=3).. 36
Containers: Iron Crucible (n=1) 36
Containers: Snuff or Mirror Box (n=1)... 36
Manufacturing Debris: Sheet Iron (n=1) 36
Modified White Springs Iron Artifacts (n=31) 37
Structural Components: Iron Spikes (n=3) 37
Tools and Implements: Axe Fragments (n=4)... 38
Tools and Implements: Iron Rods (n=4) 39
Tools and Implements: Sword Blade (n=1).. 40
Tools and Implements: Implement Fragment (n=1).. 40
Tools and Implements: Wire Fragments (n=5) 40
Food Preparation: Kettle Bails (n=6).. 41
Food Preparation: Knives (n=4)... 42
Firearm Fragments (n=3) 43
White Springs Iron Assemblage Analysis and Interpretations 43
Iron Smithing at White Springs... 43
Domestic Context Nail Density Analysis.. 46
Nail Use in Construction and Structural Maintenance.. 48
Domestic Context Iron Density by Locus 51
The White Springs Lead Assemblage 56
Assemblage Overview... 56
Unmodified White Springs Lead Artifacts (n=65).. 58
Lead Shot: Musket Balls (n=42).. 58
Lead Shot: Birdshot (n=3)... 60
Manufacturing Debris: Splashing Fragments (n=6) 61
Manufacturing Debris: Lead Waste (n=5).. 61
Manufacturing Debris: Scrap Fragments (n=2).. 61
Manufacturing Debris: Sheet Lead (n=1) 61
Unutilized Lead: Lead Bars (n=3) 61
Bale Seals (n=3) 62
Modified White Springs Lead (n=24) 62
Lead Shot: Musket Balls (n=20).. 63
Ornaments (n=3) 64

Manufacturing Debris: Scrap Fragments (n=1) 64
White Springs Lead Assemblage Analysis and Interpretations 65
Domestic Context Lead Density by Locus 65
Lead Smithing at White Springs 67
Warfare Tactics and Hunting Practices 68
Domestic Context Nail, Iron, and Lead Density Analysis 71
Concluding Remarks 74
Applying a Practice-Based Approach to the White Springs Assemblage 74
Conclusion 76
REFERENCES 78

LIST OF FIGURES

Figure 1: White Springs Excavation Map Illustrating Areas of Investigation.............................. 20

Figure 2: Radiographs of Iron Objects from the Cornell Assemblage. 25

LIST OF TABLES

Table 1: The White Springs Loci 18
Table 2: White Springs Modified/Unmodified Iron Artifacts Organized by Function 26
Table 3: Comparison of the White Springs and Townley-Read Iron Assemblages 27
Table 4: Nail Density per Square Meter of Excavated Area by Locus 46
Table 5: White Springs House Post-Mold Diameters 51
Table 6: Domestic Iron Artifact Density Organized by Locus 52
Table 7: Iron Artifacts Found in Houses and Other High-Density Loci 53
Table 8: White Springs Modified/Unmodified Lead Artifacts Organized by Function 57
Table 9: Domestic Lead Artifact Density Organized by Locus 65
Table 10: Color-Coded Nail, Iron, and Lead Density Figures 71

LIST OF GRAPHS

Graph 1: Nail Density Linear Regression 72
Graph 2: Nail Density Linear Regression Outliers Removed 72

Introduction

This thesis analyzes an assemblage of 366 iron and lead artifacts from the Onöndowa'ga:' (Seneca Iroquois) White Springs archaeological site (c. 1688–1715) in conjunction with Hodinöhsö:ni' (Haudenosaunee/Iroquois) burial data and the ethnohistoric record.[1] White Springs artifacts were primarily identified by consulting standard reference sources. Damaged objects were visually compared to the numerous more complete artifacts from multiple Onöndowa'ga:' sites at the Rochester Museum and Science Center (RMSC) in person. Digital radiographs or "x-rays" were also taken of the highly corroded objects to reveal overall object shape for classification.

An analysis of Indigenous object use, modification, and remanufacture presents a unique opportunity to investigate the apparent dichotomy of tradition and innovation. Although several publications have examined these concepts, few have explored how they intersect with Indigenous iron and lead object use and modification. Many of these works also fixate on elements of Indigenous life that have remained the same throughout time. Deviations from established static "traditions" are often incorrectly considered evidence of cultural loss and gradual decline (Silliman 2009). This analysis avoids these pitfalls by incorporating Pauketat's (2001) practice-based approach, which views tradition as dynamic, negotiated, and constructed.

The White Springs artifacts are compared to assemblages from numerous earlier Hodinöhsö:ni' sites and the subsequently occupied Onöndowa'ga:' Townley-Read site in order to provide a more holistic interpretation of iron and lead use and modification. These sites are unique because they represent a sequence of consecutively occupied settlements containing

[1] Although I am ethically opposed to excavations of Indigenous graves, I justify my use of preexisting mortuary data by stating that its intended purpose is to illuminate domestic activities and challenge preconceived notions of Indigenous cultural loss and decline.

temporally specific practices and institutions; each site was only occupied from 15–40 years and should be considered a “local political economy” (Jordan 2008).

I begin my analysis by reviewing the important terminology commonly utilized in studies of the Hodinöhsö:ni' followed by a discussion of the different types of iron and lead trade items, the concept of tradition, iron and lead object modification patterns from earlier Hodinöhsö:ni' sites, and background information regarding White Springs and Townley-Read. Next, I examine the White Springs iron assemblage and calculate the domestic context nail and iron densities to investigate the various activities performed across the site, such as iron smithing, food preparation, and tool manufacture and modification. I also discuss nail use in relation to home construction. I then analyze the White Springs lead assemblage and calculate the domestic lead densities to identify changes in Onöndowa'ga:' lead smithing techniques, warfare tactics, and hunting practices. Lastly, I apply a practice-based approach to the White Springs assemblage.

Important Terminology: Iroquoian, Iroquois, Haudenosaunee, and Seneca

Several centuries ago, a political confederacy was established in northeastern North America united by the Great Law of Peace. It was initially comprised of five nations—the Onoñda'gegá' (Onondaga), Onöndowa'ga:' (Seneca), Gayogo̱hó:nǫ' (Cayuga), OnΛyoteʔa·ká (Oneida), and Kanien'kehá:ka (Mohawk) (Williams 2018:1). In 1722, the Skarù·rę̀ʔ (Tuscarora) became the confederacy's sixth nation after being sponsored by the OnΛyoteʔa·ká. Collectively, these six nations are known in the Onöndowa'ga:' language as the Hodinöhsö:ni' (more commonly referred to as the Haudenosaunee or Iroquois).

Scholars commonly use the terms “Iroquoian” or “Iroquois” when referring to the Hodinöhsö:ni'. However, both are problematic. "Iroquoian" refers to all Iroquois-speaking nations in the northeast. Because this includes non-members of the confederacy, such as the ᏣᎳᎩ

(Cherokee) and Wa^{n}dát (Huron), it should not be used interchangeably with the term Hodinöhsö:ni' in reference to the Six Nations. Although “Iroquois” more specifically refers to the confederacy, its exact etymology is unknown. One possibility is that the word has its origin as an Algonquian–Basque pidgin, a derogatory term spoken by Basque whalers and various Algonquian peoples that roughly translates to “the killer people” (Bakker 1991:1121–1122). Loewen (2016:61) also suggests that the term has a Basque origin but argues that the actual translation of “Iroquois” is the “walled-town people.” Regardless of the exact meaning, continued usage of the term is inappropriate. It is not a self-name and potentially connected to European colonialism and the Algonquians, historical enemies of the Hodinöhsö:ni'. For these reasons, both “Iroquois” and “Iroquoian” are not used in this paper.

The Onöndowa'ga:'-language rendering of Haudenosaunee, Hodinöhsö:ni', is instead used when discussing the confederacy. I have decided to use Hodinöhsö:ni' as opposed to the English word Haudenosaunee because the former is an endonym while the latter is an exonym, and because I focus on Onöndowa'ga:' history. Hodinöhsö:ni' roughly translates to "the people of the extended longhouse" (Williams 2018:62). Before entanglements with Europeans, the longhouse was a residential building where multiple families lived together, related through a clan system based on women's lineages. Besides referencing a physical structure, the longhouse is used as a metaphor (Shannon 2016:200; Williams 2018:60–62). When the confederacy was established, each nation agreed to live peacefully under the rafters of a symbolic longhouse that stretched across what is now New York state. The rafters of this metaphorical structure could always be extended if another community was adopted by the confederacy (Williams et al., 2019).

The term “Seneca” is thought to originate from Algonquian speakers and was applied to the Hodinöhsö:ni' living in their western direction (Houghton 1922:39). The first documented instance of Europeans using this name occurs on a map submitted to the States General of the Netherlands in 1616. However, in this instance, they were likely referring to the OnΛyoteʔa·ká (Houghton 1922:42). The Dutch commonly applied the words "Seneca" and "Sinneken" to all Hodinöhsö:ni' peoples living in New York (except for the Kanien'kehá:ka). Today, "Seneca" is used by the general public and by members of the Hodinöhsö:ni' in designation of the westernmost nation of the confederacy. In their own language, the Seneca call themselves Onöndowa'ga:', which translates to the "Great Hill People." In keeping with the use of self-names, Onöndowa'ga:' will be used as opposed to the term Seneca. Self-names are also utilized in discussions of other Indigenous peoples. However, because numerous archaeological sites are mentioned in this paper, common site names are used in order to avoid confusion.

The Introduction of Iron and Lead Trade Items

Starting in the 16th century, a system of mutual exchange with European colonists known as the fur trade developed. It was in this context that the Hodinöhsö:ni' obtained a variety of European goods. Objects of iron were of central importance and often remanufactured into more Indigenous tools and forms. During the early 17th century, a wide variety of new tools were traded to the Hodinöhsö:ni' (Bradley 2005:139). One such item was the iron axe. Originally most axes were generally quite large and of simple construction. After 1650, smaller and lighter versions began to appear more regularly (Bradley 2005:140). Another standard trade item was iron knives, desired because they were lightweight and portable. Unlike axes, knives were available in a wide variety of forms. A third stock trade item was the iron awl. Because awls were easy to carry, they were commonly bartered and given as gifts. Once they were introduced to the Hodinöhsö:ni', they were readily incorporated into Hodinöhsö:ni' culture.

The last major category of iron trade items was the firearm. The colony of New

Netherland introduced the Hodinöhsö:ni' to matchlock muskets and wheellock guns in the 1620s. However, neither weapon was widely used because of lengthy loading time, expensive cost, and lack of durability (Silverman 2016:24).[2] This changed with the introduction of the flintlock. By the 1660s, the Dutch were manufacturing these firearms specifically for the Hodinöhsö:ni'. Trade flintlock muskets were lighter (7.5 pounds) and shorter (50 to 67.5 inches in length) than their European counterparts, which could weigh over 16 pounds and were typically more than 5 feet in length (Silverman 2016:28). Some also included a sear. This kept the firing mechanism partially cocked to fire more rapidly at moving targets. These muskets became a standard trade item well into the early 1800s.

Lead shot and powder were required to operate muskets, and both became common trade items and gifts. Musket balls and casting waste first occur at the Onoñda'gegá' Shurtleff site (1630–1640 CE) and represent the earliest instance of recovered lead artifacts with a secure provenience (Bradley 2005:116,152). However, musket balls and casting waste become increasingly common on later sites. Archaeologists have also found spare gun parts, bar lead, casting molds, stem cutters, and Indigenous gunflints on multiple Onöndowa'ga:', Onoñda'gegá', and Kanien'kehá:ka sites from the mid-to late 17th century. This implies that the Hodinöhsö:ni' could make minor firearm repairs and also had assumed some control over gunflint and shot manufacture (Silverman 2016:31). Another common lead artifact is the cloth bale seal. They began appearing on Onoñda'gegá' sites during the second quarter of the 17th century and were used on textiles to identify the town of manufacture (Bradley 2005:152). Some also contained information regarding cloth type, length, and quality.

---

[2] Charles Wray identified a possible wheellock spanner from the Cameron site (1575-1595 CE per Sempowski and Saunders; 1580-1601 CE per Birch et al.). If correctly identified, this represents the earliest evidence of firearms from a Onöndowa'ga:' site (Wray et al. 1991:325).

Although axes, knives, awls, and firearms represent the most important iron object categories during this time, other iron objects have also been found on Hodinöhsö:ni' sites. For example, swords and daggers were sometimes given as gifts or exchanged for furs (Bradley 2005:145). Blade fragments, pommels, and crossguards have been recovered from a few sites. A steady flow of additional European iron goods such as chisels, mouth harps, files, chains, and hardware were introduced in the early 1600s.

Problematic Conceptions of Tradition

The adoption of European goods by Indigenous peoples, such as iron and lead, is often viewed as evidence of dependence, acculturation, inauthenticity, and cultural loss. This can be attributed to an intense fixation on "traditional" artifacts and practices and a problematic view of "tradition." In contexts of colonialism or cultural entanglement, traditional practices are typically defined as those "authentic" practices that predate the arrival of Europeans. It should be noted that I follow Rani T. Alexander's (1998) definitions of colonialism and cultural entanglement. Colonialism is defined as "an extreme case of core-periphery interaction" where the colonizing group exerts political and economic control of the peripheral group, while cultural entanglement is "a long-term gradual process of interaction" that does not result in subordination (1998:481,485).

In the specific case of the Onöndowa'ga:', a focus on cultural survivals, or "Indigenisms" as termed by Jordan (2008:11), was reinforced by Wray and Schoff (1953). Wray and Schoff examined artifact assemblages from numerous Onöndowa'ga:' sites and determined that the proportion of European objects increased over time. They interpreted this as evidence of cultural loss and decline as opposed to positive innovation. In order to avoid the simplistic dichotomy of continuity and change perpetuated by Wray and Schoff, I utilize Rogers' (1990) five material culture processes (maintenance, replacement, addition, rejection, and transformation), which provides a more refined approach in assessing the adoption and rejection of European trade goods by the Onöndowa'ga:' With this approach, European objects could be incorporated into Onöndowa'ga:' culture while "maintaining their indigneity" (Jordan 2008:11).

In addition, I avoid comparing Indigenous practices to a precontact baseline because it "assumes that all social agents—young or old, male or female, economically stable or impoverished—draw from the same suite of knowledges, practices, and memories regardless of the passage of time" (Silliman 2009:222). Knowledge, memory, and practices are in constant motion and do not remain static. Silliman (2009) additionally points out that this is an arbitrary scale of analysis that could have been meaningless to everyday people. Individuals often draw upon and recall more proximate memories (personal, familial, or generational) when it comes to making decisions and creating meaning (Silliman 2009:216).

A generational view of tradition can be realized by utilizing Pauketat's practice theory, which views tradition as dynamic and constantly renegotiated through performance. A tradition is specifically defined as a "practice brought from the past into the present" that requires both agency and memory (Pauketat 2001:2). By viewing tradition as active, the seemingly contradictory concepts of tradition and innovation can peacefully coexist. For these reasons, I apply practice theory to the White Springs iron and lead assemblages.

Hodinöhsö:ni' Iron and Lead Modification Patterns

Hodinöhsö:ni' Iron Modification: 1550-1687 CE

It is unclear when the Hodinöhsö:ni' first worked iron, but they actively modified this material during the last half of the 16th century. The introduction of iron scissors and knives allowed for the reduction of sheet metal and for the working of malleable wrought iron through cold working techniques such as scoring, folding, or cutting. The first step in this process was to hammer the metal to the desired thickness and size. After it was roughly shaped, it was trimmed and fashioned into the preferred form (Bradley 2005:74). Rough edges were the ground off with traditional abrasion techniques and could be strengthened utilizing long-established annealing methods such as cold-working. Once this was completed, the finished product was polished.

Iron was initially utilized as a stone substitute and commonly reworked into three basic object types—formalized blades, unformalized edged tools, and perforators for tasks such as cutting, perforating, scraping, and chopping (Bradley 2005:75; Jordan 2001:3). Formalized iron blades are either rectangular or trapezoidal in shape and bear a resemblance to traditional lithic celts and adzes. Unformalized tools are mostly irregular pieces of iron with one utilized edge and are typically made from large iron pieces (Bradley 2005:76). Perforators were made by wearing down spikes or kettle bails to a tapered point. A few of these modified tools were recovered from the Onoñda'gegá' Quirk (1550–1575 CE), Sheldon (1550–1575 CE), Chase (1575–1600 CE per Bradley 2005; 1574–1606 CE per Birch et al., 2020), and Dwyer (1575–1600 CE) sites (Bradley 2005:49–50).[3]

A variety of iron objects were recycled in order to obtain the raw iron material necessary for manufacturing formalized blades, unformalized tools, and perforators. In the 16th century, dismantling complete axes appears to be the most widespread and systematic method for reusing iron because they contained large quantities of iron and were easily obtained (Bradley 2005:146). Celts, for example, were fashioned by scoring the blade and removing triangular sections that could be ground down. Scrapers and knives were manufactured by cutting the socket open,

[3] The Dating Iroquoia Project has redated several Hodinöhsö:ni' sites by utilizing improved radiocarbon dating methods (Accelerator Mass spectrometry or AMS). These newer dates (published in Birch et al. 2020) are listed alongside the older and more well-known dates.

flattening it with a hammer, and reducing the newly formed sheet iron (Bradley 2005:147). Ultimately, the goal of these reduction processes was to transform clunky and impractical pieces of iron into more useful Indigenous tools (Bradley 2005:148).

Additional recycled objects include swords, knives, nails, spikes, and kettle bails. Swords were typically hafted onto spears or notched and transformed into barbed harpoons (Bradley 2005:149). New unifacial blades could also be attached to the tanged end once the sword blade was removed in order to create a short but sturdy adze-like tool. Knives were reused once the blade broke in a manner similar to an edged lithic tool. Iron kettles were transformed and cut into ornaments, arrowheads, and other objects. Nails, spikes, and kettle bails were reused and made into perforators. In some instances, they were also fashioned into fishing hooks. Several of these modified tools were found on the Onöndowa'ga:' Culbertson (1560–1575 CE) and Adams (1565–1575 CE) sites (Wray et al., 1987; Sempowski and Saunders 2001a).

During the last half of the 16th century, a slight change in Onöndowa'ga:' iron use occurred. Certain trade objects from the Onöndowa'ga:' Tram (1570–1590 CE per Sempowski and Saunders 2001; 1553–1584 CE per Birch et al., 2020) and Cameron (1575–1595 CE per Sempowski and Saunders 2001; 1580–1601 CE per Birch et al., 2020) sites were somewhat less likely to be dramatically reworked (Wray et al., 1991:122). This is true of knives at Tram and axes at Cameron. Modified knives and axes were still found during this time period, just in lesser quantities compared to the Culbertson and Adams sites. It should be recognized that this was a gradual shift and that axes were still the most commonly modified object during this time.

By the first quarter of the 17th century, the Hodinöhsö:ni' began experimenting with innovative jointing techniques such as riveting, splicing, and lacing. This led to the production of a new variety of implements and ornaments (Bradley 2005:176–177). The Hodinöhsö:ni' also had success with simple forms of hot-working such as the flattening of old musket barrels for use as hide scrappers (Bradley 1980; 2005:152). Evidence from Onoñda'gegá' sites suggests that less successful attempts to anneal occurred (Bradley 2005:152). This could indicate that the Hodinöhsö:ni' had difficulty in hot-working iron, but there is a problematic tendency to assume that "crude" objects were only manufactured by Indigenous peoples. These items could have been made by a shoddy European smith or by an individual learning to forge. If these objects were, in fact, manufactured by the Onoñda'gegá', the main difficulty in forging iron is consistently maintaining high temperatures. Iron has a melting point of 1536° C; this is significantly higher than wood-burning fires, which can only reach 950° C (Rapp 2002:155,163,172). Without the ability to hot-work iron, technical repairs requiring welding or tempering could not be performed without the assistance of a trained smith.

During the latter half of the 17th century, the shift in iron use identified at the Tram and Cameron sites became much more pronounced. An assortment of new trade objects was introduced to the Hodinöhsö:ni' after direct interactions with Europeans, including prefabricated awls, shafted projectile points, small celts, belt hatchets, ornamental iron cones, spikes, and buckles (Sempowski and Saunders 2001a:207). Iron goods such as awls, chisels, knives, and hardware were much more abundant and significantly less likely to be modified; many of these objects were probably used for their European-intended functions.

This is evident at the Onöndowa'ga:' Factory Hollow (1610–1625 CE per Sempowski and Saunders 2001; 1597–1617 CE per Birch et al., 2020) site, where only a few modified objects were found (Sempowski and Saunders 2001b: 314; Birch et al., 2020:80). Specific items include one spike that was transformed into a punch, resharpened axe blades, and reworked knives. Factory Hollow axes were not considerably reworked like the ones from earlier Onöndowa'ga:'

sites, but the knives were significantly modified. A similar pattern also appears at the Onöndowa'ga:' Pompey Center (1600–1620 CE per Bradley 2005, 1619–1639 CE per Birch et al., 2020) site. Axes are more complete with fewer modifications, while reworked knives appear more commonly (Bradley 2005:139).

Sempowski and Saunders (2001a:19) identified another change in iron modification at the Onöndowa'ga:' Dutch Hollow (1605–1620 CE) site. Large celts are noticeably absent, indicating a shift from manufacturing sizable celts produced from complete or split axe blades to smaller and thinner celts and adzes that were more casually made (Sempowski and Saunders 2001b:501). Most of these new tools exhibit only slight modifications. Sempowski and Saunders argue that this shift occurred because the Onöndowa'ga:' obtained more full-sized trade axes, which served the same functions as the larger modified tools. The Dutch Hollow site is also marked by an increase in secondary tool manufacture; these implements were reworked from other types of prefabricated European trade items, particularly iron bars, spikes, kettle bails, and sword blades.

James Bradley (2005) examined iron artifact distributions from multiple Onoñda'gegá' sites, including Pratt's Falls (1620–1630 CE), Shurtleff (1630–1640 CE), Carley (1640–1650 CE), and Lot 18 (1650–1655 CE). He concluded that complete axes, knives, and awls more commonly appear after 1600, indicating that these objects were less likely to be significantly modified (Bradley 2005:141). However, specific objects were still modified extensively. At Lot 18, a scissor blade was manufactured into a saw by serrating the blade, and a broken knife was bent and resharpened into a crooked knife for carving (Bradley 2020:221). These assemblages also contain more subtle forms of iron reworking. For example, many of the knife blade fragments at Shurtleff only display evidence of regrinding. The conversion of kettle bails into awls also required little effort, and the production of these tools dramatically increased at Shurtleff and Carley (Bradley 2005:152).

The patterns identified by Sempowski, Saunders, and Bradley are applicable to the iron assemblage from the Onöndowa'ga:' Dann site (1655–1675 CE). Of the 27 identified iron objects from the Eugene Frost Collection, three were modified. The first item is a small celt with a "unifacially worked chisel-shaped tip" that was manufactured from an axe blade (Ryan and Dewbury 2010:31). Two are projectile points. One is a thick and heavy lanceolate point fashioned from an axe through cold-hammering; the second is a heavily corroded triangular point possibly made from sheet iron (Navias 1995:30; Ryan and Dewbury 2010:31). The unmodified objects are 11 nails, 6 knives, 3 awls, 1 fork, 1 mouth harp, 1 buckle, and 1 sword pommel.

It is unclear whether the patterns identified by Sempowski, Saunders, and Bradley can be applied to the iron assemblage from the Onöndowa'ga:' Ganondagan (or Boughton Hill) site (1670–1687 CE). A report published by Charles Wray and Robert Graham (1985) analyzed over 300 iron artifacts from the site but did not explicitly examine iron modification. However, drawings from this report, artifact photos from the University of Michigan (UM) Museum of Anthropological Archaeology archives, and artifact descriptions from Frederick Houghton (1912) indicate that at least a few objects were modified. In the Wray and Graham (1985:30) report, this includes one knife. The blade is extremely short with an asymmetrical point, which indicates that it was probably resharpened after the original blade broke from use. Two gun barrels were recycled into scrapers; each object has one flattened and one serrated edge (UM Museum). In his own work, Houghton states that some trade axes had dented and flattened heads, arguing that this was "evidence that they have been used as hammers" (Houghton 1912:455). Several graves also contained iron wire bracelets likely made from scrap iron

(Houghton 1912:434).

Hodinöhsö:ni' Lead Modification: 1605-1687 CE

The Hodinöhsö:ni' began experimenting with the cold working of lead objects into new forms during the 17th century (Bradley 2005:153,155). Similar to iron, lead was also cut, pounded, folded, scored, and perforated. These attempts became more ambitious with the introduction of casting technology during the second quarter of the century. Cast effigy figures and other small cast objects were commonly made between 1650 and 1665 (Bradley 2020:221). The adoption of this new technique became fairly widespread because lead was much easier to manipulate. It has a low melting point of 327°C, which is four times lower than iron and is easily liquefied over a wood-burning fire (Rapp 2002:155,163,172; Reinprecht 2016). During the end of the century, stone and wooden pipes were decorated with lead casting inlays, and a wide range of sophisticated lead brooches, medals, and effigies were produced (Bradley1987:153,178).

Lead artifacts first appear at the Onöndowa'ga:' Dutch Hollow (1605–1620 CE) site. Although most were surface-collected and the provenience is questionable, they are discussed in detail because they could date to the Onöndowa'ga:' occupation period. A total of three musket balls and four melted manufacturing scrap fragments were recovered (Sempowski and Saunders 2001a:227). One of the lead balls has traces of sprue and pronounced mold lines from casting. The presence of sprue indicates that the ball was cast, but not yet prepared for firing (Hamilton 1976). This suggests that the Onöndowa'ga:' may have manufactured their own musket balls. One scrap fragment is also of interest because it appears reworked. The object is rolled into a tubular form similar to brass or iron 'tinkling' cones. If this is a modified Onöndowa'ga:' object, it represents the first instance of experimentation with lead hot-working techniques.

Modified lead gaming pieces, pendants, and a bear effigy were found at the

Kanien'kehá:ka Bauder site (1635–1646 CE) (Rumrill 1985:12; Snow 1995:304). The bear effigy is similar to an artifact that was recovered from the Onoñda'gegá' Carley site, where cold-working methods were utilized to transform a lead musket ball into a turtle effigy. Animal effigies (representing turtles, otters, and white-tailed deer) manufactured from molded lead and musket balls were additionally found at several other Kanien'kehá:ka sites—Rumrill-Naylor (1635–1646 CE), Mitchell and Janie (1646–1666 CE), and Horatio Nellis (1646–1666 CE) (Snow 1995). Some of the effigies were perforated, suggesting that they were worn on necklaces. The Horatio Nellis site also contained one musket ball with a small hole drilled through it, possibly for suspension (Rumrill 1985:34).

The Rumrill-Naylor site contained several other modified objects, including half a dozen lead bars with axe cut marks, three lead fragments with drilled holes (possibly for suspension), and several whizzers. Whizzers are flattened pieces of lead with holes drilled through them that produce a whizzing sound (Rumrill 1985:14). These objects were typically manufactured by reworking a musket ball or lead bar.

Numerous lead balls, bullet molds, casting sprues, sows, splatters, and lead bars with axe markings were found at the Onoñda'gegá' Lot 18 (1650–1655 CE) site (Bradley 2020:184,197). The balls were produced in various sizes and lacked caliber standardization. Because few pistol gun parts were recovered and wheel-lock musket parts were abundant, Bradley (2020:183) argues that ammunition of any size was primarily used with wheel-lock muskets. This particular style of musket is also typically found on other Hodinöhsö:ni' sites from the same time period.

Various modified lead artifacts were found at the Onöndowa'ga:' Dann site (1655–1675 CE). The Frost Collection contains 32 lead balls, and most were likely cast by the Onöndowa'ga:' (Ryan and Dewbury 2010:30). This is suggested by other artifacts that provide direct evidence of lead casting such as 12 splashing fragments, 2 lead bars, 1 ingot, and 1 bullet mold. Charles Wray (1985:105) additionally collected 520 casting waste fragments from the site over a period of six years. Other modified objects include a broken red stone calumet smoking pipe repaired with cast lead, a pipe bowl liner decorated with inverted lead triangles, and a lead rear sight (Bradley 2020:215; Ryan and Dewbury 2010:28,31). The rear sight is an early example of Native gun repair; these objects were not typically made from lead.

Over 100 lead balls were recovered from the Onöndowa'ga:' Ganondagan site (1670–1687 CE). Wray and Graham's (1985) site report describes 60 as large musket balls with a sprue, 55 as musket "swan shot," and 12 as medium musket balls. "Swan shot" is approximately the same diameter as buckshot and is used to hunt large fowl and small animals (Whitney 1914). Such a large quantity of balls with sprues indicates that many were cast onsite by the Onöndowa'ga:'. Forty additional objects provide further evidence of casting: 31 were cataloged as melted "lead scrap" drippings or splashing fragments created in the manufacturing process of casting lead; 6 are listed as "hunks," 2 as lead strips formed during the production of musket balls, and 1 as a "cross". The term "hunk" likely refers to an irregularly shaped piece of lead, while the "cross" is probably an ornament, not a religious item. It is more accurately described as an x-shaped object with a center perforation that was either cast or cold-worked.

The White Springs and Townley-Read Sites

Throughout this thesis, comparisons are drawn between the White Springs and Townley-Read sites for two main reasons. Both sites were constructed by the same group of people, and they were occupied during contrasting political and economic circumstances. White Springs was founded after forced removal from Ganondagan by the French and can be viewed as a time of hardship, while Townley-Read was constructed during a period of relative peace, presenting a rare opportunity to observe how the Onöndowa'ga:’ responded to fluctuating political and economic conditions. This type of investigation is possible because a detailed report on the Townley-Read iron was authored by Jordan (2001).

The White Springs Site

White Springs was a palisaded nucleated village site that served as the primary eastern Onöndowa'ga:' Hodinöhsö:ni' community from 1688 to 1715 (Gerard-Little 2011:2). In a nucleated village, “the amount of extramural, communal space is limited and highly organized” (Jordan 2004:27). It was founded in the aftermath of the 1687 Denonville invasion, which destroyed existing Onöndowa'ga:' settlements. Archaeological data and documentary sources suggest that multiple Onöndowa'ga:' communities consolidated into two large towns at the White Springs and McClure sites. These communities included the principal settlements of Ganondagan and Rochester Junction, a few local satellite villages (Beal and Kirkwood), and three Onöndowa'ga:' communities from the North shore of Lake Ontario (Ganestiquiagon, Teiaiagon, and Quinaouatoua) (Konrad 1981; Wray 1983; Poulton 1991; Jordan 2008:98,100).

White Springs was established approximately 35 km southeast of previous settlements, away from the environmental region the Onöndowa'ga:' modified since 1550 (Jordan 2018:181). This area was undoubtedly less productive than the place they left; no village-sized population had lived there since about 1400. The Onöndowa'ga:' were also unable to complete the multi-year preparations usually involved in a village move, including evaluating soils, gathering building materials, and clearing fields (Trigger 1990:32; Jordan 2008:52). However, they were closer to their Gayogo̱hó:nǫ' allies.

Promptly after White Springs and Snyder-McClure were established, the Onöndowa'ga:' became engulfed in King William's War in 1689, causing economic and military distress. The

Five Nations allied themselves with the English, but they received few provisions and were forced to confront French and western Indian attacks alone. These attacks became frequent in 1691, leaving the Onöndowa'ga:' with less access to disputed hunting territories. In 1700 and 1701, the Hodinöhsö:ni' negotiated neutrality with western Indian nations, New France, and New York. The Onöndowa'ga:' also received goods from other western nations in exchange for passage across their territory to Albany, thereby obtaining a new economic role as "geographic middlemen" (Jordan 2008:60). Despite this, 1701–1713 is characterized by Jordan (2008:63) as a time of "uncertainty" due to the threat of another French-English conflict called Queen Anne's War and additional conflicts with western Indians.

These events initiated transient demographic, military, and economic crises scholars have commonly cited as evidence of Hodinöhsö:ni' colonial domination (Kuhn et al., 1986; Richter 1992; Snow 1994). However, the actual circumstances of the time do not agree with the conventional view of colonization. European territorial encroachment did not occur in the Onöndowa'ga:', Onoñda'gegá', and Gayogo̱hó:nǫ' homelands until after the American Revolution (Jordan 2008:7). Permanent European outposts were also far from Onöndowa'ga:' villages and only a "handful of traders, diplomats, soldiers, smiths, and missionaries were within Onöndowa'ga:' territory at any given time" (Jordan 2008:6–7). This strongly indicates that the Onöndowa'ga:' maintained political and economic autonomy.

Archaeological Excavations at White Springs

Archaeological excavations at White Springs occurred from 2007–2015 and were led by Dr. Kurt Jordan of Cornell University. The purpose of the project was to examine whether warfare and challenging economic and political circumstances impacted Onöndowa'ga:' community structures, residential buildings, and material practices. Fieldwork consisted of shovel-test, test-unit, and trench excavations, in addition to surface investigations of plowed areas. The site was divided into 24 zones or loci (see Table 1 and Figure 1).

Ithaca College's Ground-Based Remote Sensing Group, led by Dr. Michael Rodgers, conducted a high-resolution archaeogeophysical survey of an area over five hectares in and around the site. Based on evidence from shovel testing, surface-collection, and trench and test unit excavation, Jordan estimates that White Springs was approximately 3.4 hectares in size and likely housed 1,700–2,000 people. All fieldwork was conducted in collaboration with members of the Onöndowa'ga:' descendant community, who reviewed the project's field methods and decided that a minimally invasive approach would be taken. Less than 1% of all domestic space was excavated.

Table 1: The White Springs Loci

Locus	Units
Ridgetop Minimal Feature Area	TU 1, TU 10-TU 13, TU 15, TU 39, TU 40, ST 1
Ridgetop Domestic	TU 14, TU 14 Ext., TU 16, TU 19, TU 19 Ext., TU 21, TU 37, TU 38, TU 41, TU 45, TU 54, TU 55-TU 59, TU 68, TU 69, TU 72, TU 68 & 72, TU 77
Feature 2 Area	TU 3, TU 5, TU 8, TU 8 Ext.
Feature 3 Area	TU 6, TU 9, TU 9 Ext., TU 17, TU 17 Ext., Feature 3 Area
Feature 6 Area	TU 20, TU 20 Ext., TU 20 & 20 Ext.,
House 1 Area	TU 7, TU 18, TU 34, TU 42, TU 47-TU 49, TU 53, TU 61
House 4 Area	TU 22-TU 24, TU 35, TU 36, TU 43, TU 44, TU 46, TU 50, TU 52, TU 60, TU 62
Space Between House 1 and House 4	TU 51, TU 70
Eastern Slope Disturbed Area	TU 2, TU 4, TU 2/4 Ext., TU 25-TU 33, Farm Lane

Northeast Lawn Domestic	TU 63-TU 67, TU 71, TU 73, TU 82, TU 83, ST 49-ST 57, ST 126-ST 129, ST 132, ST 142, ST 143-ST 165, ST 167-ST 174
House 3 Area	TU 84, TU 85, TU 88, TU 89, TU 98, TU 100, TU 101, TU 107, Backhoe Trench #1
Northeast Lawn Town Exterior	ST 58-ST 60, ST 130, ST 131, ST 133-ST 141
House 3 Immediate Exterior	TU 114, TU 115, TU 114 & TU 115, TU 116
House 2 Area	TU 90, TU 93, TU 94, TU 96, TU 103, TU 104, ST 23
Palisade Area	Trench #2, TU 91, TU 91 Ext., TU 92, TU 95, TU 97, TU 99, TU 92 & TU 99, TU 102, TU 105, TU 106, TU 109, ST 18, ST 61, MD 6
Northwest Lawn Domestic	TU 111-113, ST 12, ST 25-ST 36, ST 39-ST 46, ST 86, ST 110-111, ST 113-ST116, ST 118, ST 120-ST 125, MD 14
Northwest Lawn Town Exterior	TU 74-TU 76, TU 78-TU 80, ST 5-ST 9, ST 37, ST 38, ST 47, ST 48, ST 74, ST 75, ST 78-ST 81, ST 88, ST 98, ST 109, ST 112, ST 117, ST 119, MD 1, MD 2, MD 3, MD 4
Northwest Lawn Exterior Artifact Clusters	TU 81, TU 110, ST 2, ST 3, ST 4, ST 10, ST 76, ST 77, ST 99, ST 100, ST 101, ST 102, 103, ST 104, ST 105, ST 107
Northern Cemetery Area	ST 82
Southwest Lawn Domestic	TU 86, TU 87, TU 86 & TU 87, TU 108, ST 19-ST 22, ST 24, ST 62-ST 73, MD 11, MD 12, MD 13
Southwest Lawn Town Exterior	ST 11, ST 13-17, ST 106, ST 108, MD 5, MD 7-MD 10
Southwest Vineyard Domestic	M1A–M1L, M2A–M2L, M3A–M3L, M4A–M4L, M5A–M5L, M6A–M6L, M7A–M7L, M8A–M8L, M9A–M9L, M10A–M10L, M11A–M11L, M12A–M12L, M13A–M13K, M14A–M14K, M15A–M15J, M16A–M16J, M17A–M17I, M18A–M18D, M19A, M20A
Southwest Vineyard Town Exterior	M1M, M1N, M2M, M2N, M2O, M2P, M4M, M11N, M11P, M11T, M12M, M12N, M13L, M14L, M14O, M14Q, M15K, M15L, M16K, M16L, M17J, M17K, M17L, M18E–M18L, M19B–M19L, M20B–M20L, M21A–21L, M22A–M22L, M23A, M23D–M23L
Southwest Vineyard Possible Cemetery	M23B, M23C

Table created by Kurt Jordan, 2017.

Figure 1: White Springs excavation map illustrating areas of investigation. Created by Andrew Crocker, 2016.

The White Springs iron assemblage consists of 351 objects that possibly date to the Onöndowa'ga:' component; 290 are currently located at Cornell University, while 61 are housed at the RMSC. This includes artifacts that were surface-collected, metal-detected, or have unknown provenience. I discuss these poorly-provenienced objects in the assemblage overview section because they potentially date to the Onöndowa'ga:' component. Since it is unlikely that all of them are Onöndowa'ga:', the artifacts with questionable provenience are not discussed in any other sections of this thesis unless objects were identified as specifically belonging to the Onöndowa'ga:' component.[4] Omitted artifacts include 48 objects from the Cornell assemblage

[4] Five gun parts with questionable provenience were identified as belonging to the Onöndowa'ga:' component.

and 26 from the RMSC collections. This decreased the size of the analyzed White Springs iron assemblage to 277. Analysis of this assemblage reveals that most of the iron was used for tools, hardware, and fasteners. However, 31 objects were modified into more Indigenous forms.

The Townley-Read Site

The residents of White Springs relocated from their nucleated hilltop settlement in about 1715 due to resource depletion and established at least six segmented “neighborhoods” organized along the Burrell Creek (Jordan 2008:198). The largest of these neighborhoods likely contained 150–200 people (Jordan 2008:178). This collection of settlements included the Townley-Read, Brother, Rippey, Rupert, Zindall-Wheaton, and Hazlet sites and is referred to as the New Ganechstage Site Complex by Jordan (2008).

Townley-Read was located approximately 3.5 km from White Springs and occupied from roughly 1715–1754 (Jordan 2008:97). The Onöndowa'ga:' role as "geographic middlemen” greatly expanded after the Treaty of Utrecht was signed in 1713 (Jordan 2008:64,71). The number of western Indians traveling through Onöndowa'ga:' territory to Albany dramatically increased and resulted in greater economic and diplomatic benefits. This unique position allowed access to sheltered and profitable hunting grounds. Unlike the 1701–1713 period, this was also a time of relative peace. Warfare rarely occurred within Onöndowa'ga:' territory, and the British and French gifted the Onöndowa'ga:' a variety of European goods and services in an attempt to maintain friendly relations.

In 1724, the New York government established a new trading post at Oswego in order to create a more direct relationship between New Yorkers and their suppliers. Although this likely changed the routes western Indians used to trade with the British, it was still necessary to travel through Onöndowa'ga:' territory. This allowed the Onöndowa'ga:' to maintain their role as “geographic middlemen.” Despite this, the Onöndowa'ga:' experienced multiple hardships in the form of epidemics, famines, and incidents of factionalism (Jordan 2008:91–92). Disunity was mainly caused by the physical distance between Genesee and Finger Lake Onöndowa'ga:', making their economic and political position more complicated.

Archaeological Excavations at Townley-Read

The Townley-Read/ New Ganechstage Project (TR/NG) was initiated by Kurt Jordan in 1996 as part of his doctoral dissertation at Columbia University, which was supervised by Dr. Nan Rothschild. Fieldwork was sponsored by Columbia University from 1998–1999 and by the Hobart and William Smith Colleges in 2000. The goal of the project was to investigate settlement preferences, household activities, and the political and economic circumstances of the time by locating and excavating domestic deposits within a Onöndowa'ga:' neighborhood (Jordan 2008:93).

Field methods were developed in collaboration with G. Peter Jemison, a member of the Onöndowa'ga:' Heron Clan and then Chair of the Haudenosaunee Standing Committee on Burial Rules and Regulations. He served as a liaison to the Onöndowa'ga:' Nation. Jemison’s primary concern was that cemetery areas and grave goods were not disturbed by archaeologists. In order to differentiate the mortuary from the domestic areas, nonintrusive methods including systemic surface examination and collection and geophysical techniques (ground-penetrating radar [GPR], proton magnetometer, and soil conductivity surveys) were utilized (Jordan 2008:124–125). Intrusive methods, including shovel-test pit and test-unit excavation, soil core sampling, metal detection survey, and plowzone stripping by earth-moving machinery were used on the identified domestic-context areas. No graves were disturbed throughout the entirety of the project.

The Townley-Read iron assemblage from the Onöndowa'ga:' component consists of 283 total objects (Jordan 2001:27). Over the course of the TR/NG project, 84 artifacts were excavated from domestic contexts and 14 were surface-collected. The RMSC collections contain the remaining objects—95 from mortuary contexts, 51 from surface-collected contexts, and 39 from unknown provenience contexts. Because 36 of these artifacts could not be precisely identified, I omitted them from the Townley-Read analysis. This decreased the size of the analyzed Townley-Read iron assemblage to 247 objects. Like White Springs, the majority of these items are fasteners, hardware, and tools.

The White Springs Iron Assemblage

Identifying Onöndowa'ga:' Component Artifacts

A total of 2,370 iron objects were excavated or recovered from the White Springs site; 2,309 are located at Cornell University, and 61 are housed at the RMSC. Three hundred fifty-one are thought to date to the Onöndowa'ga:' component. Cornell artifacts were recovered from domestic contexts, while the RMSC collection includes material from surface, burial, and unknown contexts. The RMSC artifacts are a part of the museum's collection documenting the sequence of Onöndowa'ga:' villages from 1550 to 1840. Examination of the burial objects is essential to this analysis because they include types that are not well represented in the Cornell assemblage and because they are mostly complete and have secure provenience. In addition, these items are fully functioning objects that provide a representation of daily life (Jordan 2001).

It should be noted that each institution has its own cataloging format. Objects from the Cornell assemblage begin with the New York State Museum site number 1952, followed by the letters WH, the context number, and the artifact number. An example of a complete catalog number is "1952.WH389.2." For brevity, I will be using the shortened version, which does not include the site number. RMSC artifacts have a catalog number and a denominator referring to the specific site where the objects came from. For White Springs, this is 168. A complete catalog number would be "6014/168."

Many of the stratigraphic layers and contexts from the White Springs site are mixed as a result of plowing and other disturbance activities. Only 45 objects can be definitively placed in the Onöndowa'ga:' component, which includes 31 RMSC objects exhumed from burials and 14 Cornell artifacts excavated from intact Onöndowa'ga:' domestic feature contexts. However, an additional 227 Cornell artifacts from domestic plowzone contexts and 5 with questionable provenience likely date to the Onöndowa'ga:' component increasing the iron assemblage to 277 artifacts. This was determined by visiting the RMSC in person and visually comparing the museum's more complete objects to the Cornell assemblage. After I identified a potential object type, measurements of the Cornell and RMSC objects were taken and analyzed. Standard reference sources such as Stone (1974), Wray and Graham (1985), Wray et al. (1987; 1991), Sempowski and Saunders (2001), and Bradley (2005) were utilized to confirm identifications.

Heavily corroded objects could not be identified with these techniques; their original form was obscured, and they lacked any distinguishing features. Digital radiographs or "x-rays" were instead taken of these objects at the Cornell University Hospital for Animals using the Agfa DX-G CR machine (see Figure 2). This particular method was utilized because radiographs are non-destructive, cost-effective, and provide a detailed and permanent archival record of the unstable and deteriorating White Springs artifacts. The radiographs provided enough information to identify and classify 29 White Springs objects.

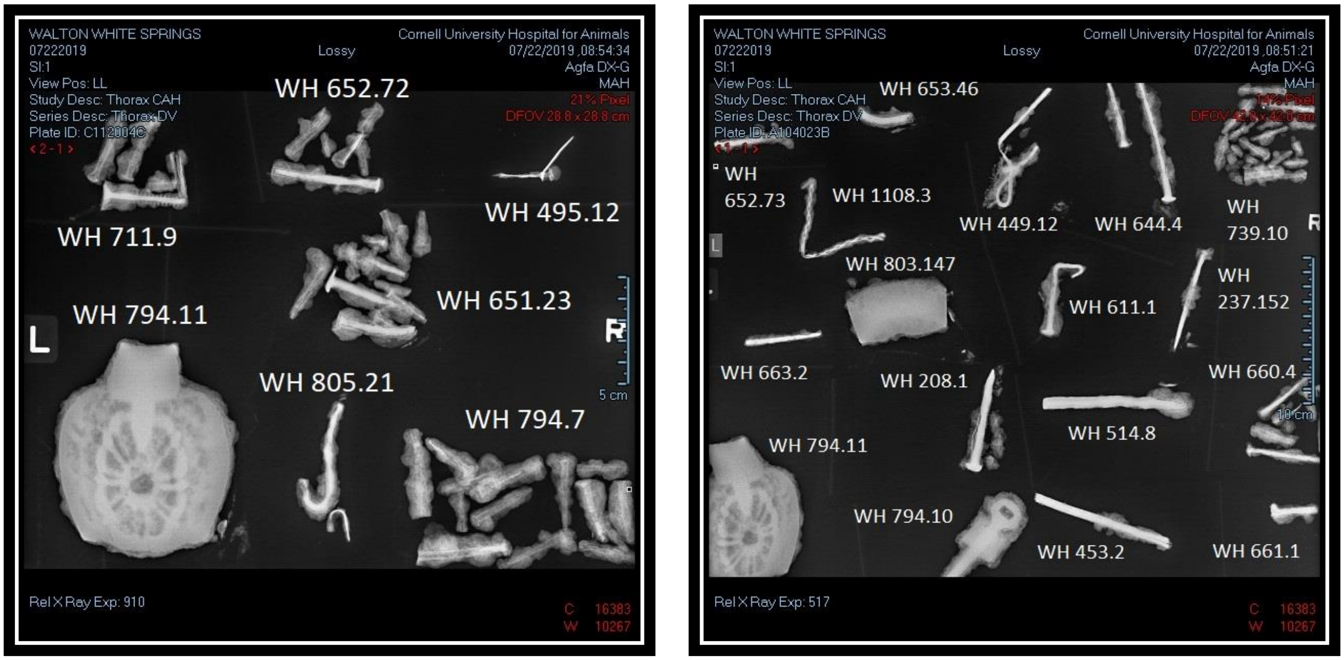


Figure 2: Radiographs of Iron Objects from the Cornell Assemblage.

Assemblage Overview

To better understand iron use at White Springs, I organized all 351 artifacts into seven functional categories (Table 2): clothing and adornment, containers, food preparation, gun parts, hardware and fasteners, recreation, and tools and implements. These categories were influenced by Jordan (2001), but there are a few notable differences between the two classification systems. I added adornment to the clothing category and made distinctions between tools and implements and hardware and fasteners. I also included knives in the food preparation category instead of the tool category because they were primarily used in food preparation.

Table 2 illustrates that most of White Springs objects are hardware and fasteners, which represent 49% of the total assemblage. Tools and implements are the second-highest category at 20%, while food preparation is third at 16%. However, if the White Springs knives are added to the tool category, tools represent 35% of the assemblage and food preparation represents 1%. Gun parts are 2% of the total iron assemblage and 5% of the RMSC iron assemblage.

Table 2: White Springs Modified/Unmodified Iron Artifacts Organized by Function

Functional Category [a]	**Artifacts Represented in Each Category**	**WS Domestic Contexts (Cornell)**	**WS Unknown + Surface Contexts (Cornell)**	**WS Unknown + Surface Contexts (RMSC)**	**WS Mortuary Contexts (RMSC)**	**Totals**
Clothing and Adornment	Buckles, Clothing Fragments, Bracelet, Band or Strap	2 Clothing Frags., 2 Buckles	1 Band or Strap, 1 Buckle	3 Buckles, 1 Bracelet	0	10
Containers	Crucible, Jewelry Box	1	0	0	1	2
Food Preparation	Knives, Kettle Hooks, Kettle Rim Fragment	9 Knives + 5 Possible Knives + 2 Kettle Hooks	5 Knives, 1 Kettle Rim Fragment	16 Knives	16 Knives + 1 Kettle Hook	55
Gun Parts (Iron and Brass)	Gun Finials, Spring, Trigger Guards, Butt Plate, Flintlock Plate, Flintlock Bolt	5	1	4	0	10
Hardware and Fasteners	Nails, Screws, Locks, Spikes, Tacts, Hooks, Cotter Pin, Bolt, Rivet, Strapping, Staples	145 Nails, 10 Fasteners, 7 Hardware	3 Hasp Locks, 2 Staples, 1 Door Lock, 1 Hook	3 Nails	0	172
Recreation	Mouth Harps	3	0	0	0	3
Tools and Implements	Awls, Chisels, Punches, Scrapers, Multi-tool, Poker, Beamer, Chopper, Harpoon, Digging Tools, Scissors, Axe, Strike-A-Lights, File, Drill, Wire, Handles	43 Tools, 6 Implements	4 Tools, 1 Implement	3 Tools	10 Tools, 3 Implements	70
Manufacturing Debris	Sheet Iron	1	28	0	0	29
Totals	All Artifacts	241	49	30	31	351

[a] *Modified artifacts were placed into the functional categories representing the objects they were transformed into, not their original form.*

Table 3 compares the White Springs and Townley-Read iron assemblages. 45% of the Townley-Read assemblage is comprised of hardware and fasteners; this is similar to White Springs. Compared to earlier sites, both White Springs and Townley-Read contain a much larger quantity of hardware and fasteners. Interestingly, lock components were found at both sites, although most, unfortunately, have unknown provenience. Three hasp lock fragments and one possible door lock fragment were found at White Springs, while three possible hinges, one door latch, one door lock were recovered from Townley-Read.

Table 3: Comparison of the White Springs and Townley-Read Iron Assemblages

Functional Category [a]	**WS Domestic Contexts**	**TR/NG Domestic Contexts**	**All WS Unknown + Surface Contexts**	**All TR/NG Unknown + Surface Contexts**	**WS Mortuary Contexts (RMSC)**	**TR/NG Mortuary Contexts (RMSC)**	**Totals [b]**
Clothing and Adornment	4	0	6	1	0	1	12
Containers	1	0	0	0	1	4	6
Food Preparation	2	1	1	4	1	2	11
Gun Parts (Iron and Brass)	5	0	5	28	0	1	39
Hardware and Fasteners	162	62	10	26	0	25	285
Recreation (Mouth Harps)	3	0	0	3	0	0	6
Tools and Implements (Knives Included)	63	5	29	31	29	53	210
Manuf. Debris	1	0	28	0	0	0	29
Totals [b]	241	68	79	93	31	86	598

TR/NG = Townley-Read/ New Ganechstage Project

[a] *Knives were placed in the tool category as opposed to food preparation in order to keep the data consistent.*

[b] *Unidentified artifacts from the White Springs and TR/NG projects are excluded from these calculations.*

Tools, including knives, are the second-highest Townley-Read iron category at 36%. This figure is about the same as White Springs. The majority of the Townley-Read tools were recovered from mortuary contexts; very few were excavated from domestic contexts. In contrast, the largest quantity of White Springs tools came from domestic contexts.

Guns represent 12% of the total Townley-Read iron assemblage and 17% of the RMSC Townley-Read iron assemblage. Compared to White Springs, these figures are substantially higher. However, the White Springs gun category is likely underrepresented for multiple reasons. First, three gun barrels were modified and placed into the tools and implements category. If these objects were added to the gun category, gun parts would represent 3% of the total iron assemblage and 10% of the RMSC iron assemblage. In addition, the RMSC White Springs iron assemblage (n=60) is substantially smaller than the RMSC Townley-Read iron assemblage (n=172). The RMSC collections contain only three White Springs gun parts compared to twenty-nine Townley-Read gun parts. These numbers suggest that White Springs gun parts are underrepresented at the RMSC. A probable explanation is that modern collectors with metal detectors removed numerous surface and plowzone artifacts from the site.

Unmodified White Springs Iron Artifacts (n=246)

The unmodified White Springs iron assemblage contains 246 objects. 206 were excavated from plowzone contexts, 22 from burial contexts (RMSC), 8 from feature contexts, 4 from unknown contexts (RMSC), 3 plowzone/feature contexts, 2 from disturbed feature contexts, and 1 from a plowzone/ modern fill context. These artifacts are arranged in seven functional categories—structural components, tools and implements, firearms, food preparation and consumption, clothing and adornment, recreation, containers, and manufacturing debris. They are further organized into various subcategories. These unaltered items represent 89% of the entire analyzed White Springs iron assemblage (n=277), which suggests that iron may have been predominately used in ways intended by their European makers.

Structural Components: Fasteners (n=155) and Hardware (n=6)

A large number of fasteners was recovered from the site. The most common type is hand-wrought nails (n=145); 138 were excavated from plowzone contexts, 3 from feature contexts, 2 from plowzone/feature contexts, 1 from a plowzone/modern fill context, and 1 from a disturbed probable drainage-related context. Thirteen of these nails are large spikes, while seven are headless brads and six are sprigs. Of the 15 nails with identifiable heads, 8 have rose heads, 5 have T-heads, and 2 have L-heads. The majority of these nails have either sharp or damaged points, but one does have a spatulate or spade point. WH340.13 is the only one that could be a hand-wrought Onöndowa'ga:'-made nail. The object is very large and thick compared to the other nails and probably made by a person with little hot-working experience. It was recovered from the plowzone within the Ridgetop Domestic locus. Other iron fasteners from the Onöndowa'ga:' component include four fragments of iron strapping, two hand-wrought screws, one bolt, one rivet, one staple, and one possible cotter pin.

A few hardware fragments are also present, including two hooks, two fragments, one tack, and one washer. The first hook (WH566.4) contains an off-centered drilled hole that was probably meant for a nail or screw. A small iron piece on the top of the object suggests that it was meant to hang off a surface as opposed to being drilled directly into a wall. It was recovered from the plowzone within House 1. The second hook (WH513.5) is circular in cross-section and has a sharp point. It was excavated from a plowzone context within the Northeast Lawn Domestic locus. The handwrought tack has a double-pointed shaft and an irregularly shaped rose head. It was found in the plowzone within the Northeast Lawn Domestic locus.

Tools and Implements: Awls (n=14), Possible Awls (n=9)

There are 14 positively identified unmodified awls. Nine are from plowzone contexts, four are from burials, and one from a feature (Feature 6). The plowzone awls were excavated from multiple loci. Three came from House 1, two from House 4, two from the Northeast Lawn Domestic, one from the space between House 1 and House 4, one from Feature 3, and one from the Ridgetop Minimal Feature area. In terms of cross-section, four of these awls are square, four are circular, two are diamond-shaped, and one is rectangular. Three are more ambiguous—two are possibly diamond or rectangular, and one is either square or rectangular.

Two of the square awls are double-pointed, and one is offset or stepped in the middle. One of the diamond-shaped awls is also stepped in the middle and double-pointed. The possibly rectangular or diamond awl is stepped as well. Sempowski and Saunders (2001b:483) argue that square and diamond-shaped awls are probably European in manufacture; they typically exhibit a high degree of standardization in length (70–80 cm) and thickness (3.0–4.0 mm). All White Springs awls are heavily corroded, but thickness is relatively uniform, ranging between 3.76 mm and 4.59 mm. Bradley (2020:189) also notes that stepped awls are typically French trade objects.

An additional nine plowzone objects are possible awls. Three were excavated from the Ridgetop Domestic area, two from the Ridgetop Minimal Feature Area, one from House 2, one from the Space Between House 1 and 4, one from Feature 3, and one from the Eastern Slope Disturbed Area. WH247.4 is circular in cross-section with a unique shape. Each end is curved in the opposite direction. The other possible awls are small, corroded fragments that could not be conclusively identified. Five appear square in cross-section, two are diamond-shaped, and two are circular.

Tools and Implements: Wire (n=2)

Two wire fragments represent WH785.4. They were recovered from the plowzone within the Northwest Lawn Domestic locus and both appear to be hand-wrought. One fragment is bent into a loop, the other is slightly curved.

Tools and Implements: Punch or Graver (n=1)

WH44.46 was excavated from the plowzone above Feature 3. This object is a short and rusted fragment with a hand-wrought shaft that is vaguely square in cross-section. One end is flat, and the other is pointed and slightly bent. This object's morphology suggests it could be a punch or graver. The diameter is consistent with punches, but the length is relatively short.

Tools and Implements: Multi-tool (n=1)

A double-pointed multi-tool (WH449.11) was excavated from the plowzone between House 1 and House 4. The object appears to be a double-pointed awl that is square in cross-section. One end of the tool tapers into a narrow point and is bent about 30° while the other end is flat and crimped. It bears a resemblance to a double-pointed awl that served as a multi-purpose tool from the Factory Hollow site (Sempowski and Saunders 2001:483–484).

Tools and Implements: Handle (n=1)

WH1188.2 is a small and delicate fragment of iron. The object is irregular in shape and seems hand-wrought. It could be a handle, possibly for a drawer. The item was recovered from the plowzone within the Northeast Lawn Domestic locus.

Tools and Implements: Unknown Tools (n=4)

Four hand-wrought tool fragments appear to be from the Onöndowa'ga:' component. WH82.6 and WH81.40 were excavated from Feature 3. WH82.6 is square in cross-section and could be either an awl or possibly a punch, while WH81.40 is square and elongated with an intentional depression in the center and a possible a hardware fragment. WH5.11 is more delicate. The proximal end is square in cross-section while the distal end has been crimped into a crude point; its exact function is unknown. It was recovered from the Ridgetop Minimal Feature Area. The last object, WH68.50, is a flat possible tool fragment that seems to be hand-wrought.

Tools and Implements: Scissor Fragments (n=3)

Two scissor fragments were recovered from plowzone contexts within Feature 3 and the Northeast Lawn Domestic locus. WH531.3 is a singular blade fragment, while WH89.39 is a broken scissor handle. Visual comparison with reference works suggests both these artifacts are Onöndowa'ga:'-era (Brain 1979:154–155). A more complete third pair of scissors (6048/168) was excavated from a burial context. The blades are relatively small and thick, but the round handles are broken.

Tools and Implements: Strike-A-Lights (n=2)

There are two strike-a-lights in the assemblage, both recovered from burial contexts. 6036/168 is a single piece of iron that has an elongated oval shape. Its morphology is similar to strike-a-lights from the Zindall-Wheadon (a part of the New Ganechstage site complex, 1715–1754 CE) and Ft. Michilimackinac (1715–1781 CE) sites (Stone 1974; Jordan 2008:160,178). 6037/168 is a smaller piece of iron with two finger holes, similar to strike-a-lights recovered from Ganondagan (1670–1687 CE), which are currently on display at the Ganondagan State Historic Site.

Firearm Fragments (n=9)

WH937.1 is a British flintlock lock plate excavated from the plowzone within the Northwest Lawn Domestic locus. The plate contains the mainspring and pan, but the frizzen, tumbler, frizzen spring, sear spring, and cock are all missing. It does not appear to be a converted snap-lock, which would date the object to ca. 1630 (Bruce Larsen 2020, elec. comm). However, it does have a horizontal slot behind the hole for the hammer screw, which is for a horizontal sear that went out of use on British flintlocks ca. 1680. This all suggests that WH937.1 has an approximate age range of 1645–1680. Because White Springs was built in 1688, WH937.1 was probably an older and possibly heavily curated flintlock. Kurt Jordan (2021, pers. comm.) suggests this could be evidence that guns were difficult to obtain.

A possible gun spring was excavated from the plowzone within the Northeast Lawn Domestic locus. WH529.5 is a small and curved fragment of iron that is rectangular in cross-section. WH128.1, the end of a trigger guard, was found in the plowzone above Feature 3. The object is flat on one side with a rusted extension. The opposite face is ornamented with an incised snowman-like shape. A second trigger guard, WH1499.1, was metal detected from the Southwest Vineyard Town Exterior and has a semi-circle shape. The interior is flat, while the exterior is convex. Two gun finials were recovered from the Ridgetop Minimal Feature Area. WH152.9 and WH379.1 are both made of cast brass. The first has an overall convex shape and is broken at the bolt perforation, while the second has a triangular shape.

Three additional gun parts from the RMSC have unknown contexts. 6118/168 is a brass butt plate, which is curved and broken. 6229/168 is a highly corroded flintlock plate fragment. It has two bolt perforations; one is large, and the other is smaller. Unfortunately, the object does not contain enough features to identify further. The last item (6230/168) is a large flintlock bolt. Threading is visible near the base, but the head is damaged.

Food Preparation: Knives (n=21) and Possible Knives (n=5)

The assemblage contains 21 positively identified unmodified knives. Thirteen were recovered from burials, six from plowzone contexts, and two from a disturbed, probable modern drainage context. Only two of the burial knives are complete with handles. 6005/168 is a small straight blade with a long and pointed tang. The tip is rounded, and the back edge curves slightly downward. 6011/168 has a straight back edge and a bone handle that is secured to the blade with four small iron pins. The tip is broken, and both the blade and shaft are thick. It is similar in morphology to Stone's Type 2 "standard" blade (1974:271, figure 163 c). Eight of the burial knives are intact blades without handles, three of which are folding clasp blades. Documentary sources indicate that folding clasp blades were French in origin and preferred trade items (Thwaites 1900, 12:119–21, 15:129). Bradley (2020:534) also notes that folding knives are often French-derived, such as those from the Onoñda'gegá' occupied Pen (1697–1701 CE) and Weston (1682–1696 CE) sites. 6057/168 is a French *jambette* blade slightly convex and pointed, while 6035/168 is an asymmetrical French *siamois* style knife (Bradley 2020:448). 6051/168, 6055/168, and 6056/168 appear to be kitchen knives. Two of the burial knives are small; 6049/168 has a curved blade and tip, while 6054/168 has a damaged and pointed tip. The three remaining burial context knives are unidentifiable blade fragments.

The plowzone and disturbed context knives were excavated from Feature 6, House 4, the Ridgetop Domestic Area, the Southwest Lawn Domestic Area, the Northeast Lawn Domestic Area, and the space between House 1 and House 4. Five of these knives are mostly complete, and two of them appear to be the same type. WH558.2 and WH644.6 have a straight back edge, an oblique heel, and a convex blade (Stone 1974:266). WH567.6's morphology is similar to these knives—it has a straight back edge and convex blade, but the significant difference is that it has a round bolster. A third knife type is WH644.5. It has a straight back edge and a square tip; however, this knife does not have a bolster, heel, or tang. The fourth knife type is a folding knife. WH562.7 is a blade fragment with a rounded handle and a short and raised area on the hinge end where the plates are placed. It appears to be a French *siamois* folding blade (Bradley 2020:448).

The three remaining plowzone knives are fragmentary. WH215.1 is a partial tang and broken blade with a straight back edge. The second knife fragment (WH448.11) is the distal end of a convex knife. The last fragment (WH590.4) is a convex knife tip. In addition, there are a few artifacts that could also be thin, flat blade pieces, including WH425.3, WH391.7, WH554.12, WH171.2, and WH145.5. They were all excavated from plowzone contexts within four loci—House 1, House 4, the Ridgetop Minimal Feature Area, and the Ridgetop Domestic locus.

Food Preparation: Kettle Hooks (n=3)

There are three kettle hooks in the assemblage. WH195.8 and WH425.4 were excavated from plowzone contexts in House 1, while 6026/128 was recovered from a burial context. WH195.8 is round in cross-section but flattens into a rectangular shaft. It is possibly related to WH425.4, but this smaller hook was probably used to hang a small kettle. In contrast, WH425.4 is thicker and more pronounced, likely an Onöndowa'ga:'-made kettle hook manufactured for a large cauldron. 6026/128 has an "s" shape, but the hook's bottom portion is much bigger than the upper section.

Clothing and Adornment: Belt Buckles (n=2) and Clothing Fragments (n=2)

Two belt buckles, WH397.9 and WH562.8, were recovered from plowzone contexts in House 4 and the space between House 1 and House 4. One appears to have a hook bar attachment; the other is too corroded to identify. Two iron fragments may have been used to adorn clothing. WH793.18 and WH566.6 were excavated from plowzone contexts within the Northeast Lawn Domestic and House 3 Immediate Exterior loci. Both pieces are thin, broken, and resemble a chevron pattern that may have been sewn onto clothing for adornment purposes.

Recreation: Mouth Harps (n=3)

Three iron mouth harps were recovered from plowzone contexts within the Ridgetop Domestic locus. WH341.10 is relatively well-preserved even though the tongue is missing; it has a round head and one broken shank.[5] WH476.6 is triangular in cross-section. The tongue is missing, and the head is damaged. WH206.15 is square in cross-section. Because this object appears burned, it is unclear whether it was manufactured from brass or iron.

Containers: Iron Crucible (n=1)

WH214.2 is a possible iron crucible fragment excavated from the plowzone above Feature 6. The diameter is approximately 72 mm, which is much smaller than typical kettle rim diameters (Ft. Michilimackinac diameters are 220 mm, 300 mm, and 310 mm). In addition, kettle rim fragments typically have a collared or offset upper rim area while the White Springs fragment does not (Stone 1974:189). This all suggests that the WH214.2 could be an iron crucible fragment that would have probably been used to work lead. Lead is the most plausible because there is no evidence of molten copper working at White Springs.

Containers: Snuff or Mirror Box (n=1)

6072/168 is a possible round mirror box or snuff container recovered from a burial context. The object is fragmentary and has broken into five pieces. However, the base is intact and has a diameter of 46.07 mm. It has similar characteristics to an artifact excavated from the Canawaugus site (1790–1814 CE), which has also been identified as either an iron mirror box or snuff container ("UM Museum" 2020).

Manufacturing Debris: Sheet Iron (n=1)

WH644.7 is a corroded and thin sheet iron fragment that was excavated from a disturbed

---

[5] This object appears similar to a Fort Michilimackinac mouth harp with the taxonomic designation Series B, Type 2, Variety A.

context within the Southeast Lawn Domestic Area. The fragment has a rolled rim and one torn edge. It appears to be a scrap fragment; it is too small and thin to be a kettle rim.

Modified White Springs Iron Artifacts (n=31)

The Onöndowa'ga:' component contains 31 modified iron objects, representing approximately 11% of the analyzed White Springs Onöndowa'ga:' iron assemblage.[6] Sixteen were excavated from plowzone contexts, nine from burial contexts, four from feature excavations, one from a plowzone/ feature context, and one from an unknown context (RMSC). The majority of these artifacts were easily identified as modified because they were clearly altered from another form. A few objects were more challenging because of their irregular shape, but reference materials containing modified object measurements and photographs led me to conclude that they were also modified. These artifacts are arranged into multiple categories—structural components, tools and implements, food preparation, and firearm fragments. They are further organized into different subcategories, which are based on the object's original form.

Structural Components: Iron Spikes (n=3)

The iron assemblage contains three modified iron spikes. WH514.8 is a modified punch excavated from the plowzone within House 2. A radiograph of the object was taken, which revealed that the artifact gradually tapers along its entire length, is circular in cross-section, and has an irregular shape with a flat end and a rounded tip. The object's features and measurements are similar to reworked spikes from the western Onöndowa'ga:' Dutch Hollow site (1605–1620 CE) and the eastern Onöndowa'ga:' Factory Hollow site (1610–1625 CE per Sempowski and Saunders 2001; 1597–1617 CE per Birch et al., 2020) site (Sempowski and Saunders 2001b:491). WH453.2 appears to be a second modified punch; this object was recovered from a

[6] Unknown provenience artifacts were omitted from this calculation meaning that the Onöndowa'ga:' iron assemblage is comprised of 246 artifacts.

feature context in House 4. A radiograph revealed several features distinctive of punches. The artifact is circular in cross-section, has a blunt end, and a tip that is flattened unevenly. The last modified spike, WH378.7, is a chisel excavated from the plowzone within the Ridgetop Minimal Feature Area. WH453.2 (feature context from House 4) and WH378.7 (plowzone context from Ridgetop Minimal Feature Area) were identified as reworked spikes because their measurements align with the dimensions of the modified spikes from Factory Hollow.

Tools and Implements: Axe Fragments (n=4)

Several axe fragments exhibit evidence of modification. 6062/168 was recovered from a burial context. The object is curved and triangular, with two worked edges parallel to one another. The artifact's morphology and measurements are similar to axe fragment scrapers recovered from Factory Hollow, suggesting that this object is a recycled axe blade scraper (Sempowski and Saunders 2001b:506). 6052/168 is a modified spatulate scraper manufactured from an axe blade recovered from a burial context. The lower section has a flattened and rounded blade, and the handle is square in cross-section. The object's dimensions are similar to a spatulate scraper found at Factory Hollow.

WH663.2 appears to be a scraper manufactured from the socket portion of an axe. It was excavated from a feature context within House 3. The implement's working end has been shaped into a plano-convex section that curves slightly downward, likely reflecting the curve of the back end of an axe socket (Sempowski and Saunders 2001a:223). The butt end of the implement is thinner and appears unevenly cut. The object also resembles a Factory Hollow scraper manufactured from an axe socket.

6012/168 is a chopper-like tool possibly manufactured from a celt and recovered from a burial context (Moorehead 1917:140). The object has a flat and semi-circular spatulate blade with shoulders that angle 90° outwards from the handle. The handle is circular in cross-section and tapers to a blunt point. 6012/168's morphology is very similar to the "grove spud," a greenstone ritual axe found in a field near the Cahokia site (800–1400 CE) (Perino 1964:4). These objects are usually manufactured from stone and are typically associated with Mississippian burials dating before 1350 CE (Aid 2004:1). Mississippian axes are commonly thought to be ritual axes that were used as either spiritual or political symbols in ritual ceremonies. This resemblance to the White Springs object is intriguing, but the significant time gap between the finds and the variance in artifact sizing renders any possible connection inconclusive.

Tools and Implements: Iron Rods (n=4)

Several objects appear to be made from iron rods; three were reworked into awls. WH763.58 and WH763.7 were excavated from the plowzone context within House 3. WH763.58 is circular in cross-section, double pointed, and slightly curved. This artifact is circular in cross-section and bent about 90°. The working end appears sharpened while the other end is flat and probably cut. The third modified awl, WH406.6, was excavated from a plowzone context in the Ridgetop Domestic locus. The implement is circular in cross-section, bent 45°, and has a flattened tip. One of the ends also appears broken. All three of the White Springs awls have measurements that align with iron rod awls from Factory Hollow.

This category's last object is a chisel (6014/168) recovered from a burial context. It is circular in cross-section and long. The implement has one flat and uniform end that was probably cut; the opposite end has a broken and dull point that shows evidence of sharpening. Although the diameter of this implement doesn't quite match the dimensions of the modified rods from the Factory Hollow site, they only differ by 0.42 mm. This object's length is also much longer than the implements made from spikes, suggesting that it was manufactured from an iron rod.

Tools and Implements: Sword Blade (n=1)

6013/168 is a large sword blade that was reworked into a harpoon. It was recovered from a burial context. Two asymmetrical barbs are visible near the top of the object, and a single perforation has been drilled about 8.5 cm from the base. The perforation indicates that this object was the detachable head of a harpoon since it provides the area of attachment for the line used to retrieve the harpoon head (Sempowski and Saunders 2001b:369). 6013/168's measurements are similar to eight fragmentary sword blades excavated from the Factory Hollow site.

Tools and Implements: Implement Fragment (n=1)

WH372.6 was excavated from the plowzone within the Ridgetop Minimal Feature area. The artifact is concave, thick, and has an elliptical groove or slot. The interior edges of this groove and one of the artifact's ends appear sharpened while the opposite end is broken. These characteristics suggest that the item may be a beamer fragment manufactured from an iron implement. A beamer is a tool used to clean the hide of an animal; it scrapes away the pieces of fat and muscle that adhere to the skin.

Tools and Implements: Wire Fragments (n=5)

Five objects could be awls fashioned from iron wire. WH145.4 was found in the plowzone within the Ridgetop Minimal Feature Area. The artifact curves ~1.5 cm from the base, straightens, and then forms a 90° angle. It also has a sharp point and is circular in cross-section. The second possible wire awl is WH381.14. It was excavated from the plowzone within the Ridgetop Domestic locus. The artifact is circular in cross-section and double-pointed, but one of the ends may be broken. Three additional possible awls were excavated from the plowzone within House 1 (WH385.9). These fragments have sharpened points, and one is bent 90°.

The diameters of WH145.4, WH381.14, and WH385.9 are thin, suggesting that they were manufactured from wire as opposed to spikes or iron rods. The dimeters also closely match positively identified Euroamerican wire fragments from White Springs. It is unclear if these objects date to the Onöndowa'ga:' or Euroamerican component. However, because these fragments appear sharpened, this suggests they were originally manufactured by Europeans and subsequently modified into awls by the Onöndowa'ga:'.

Food Preparation: Kettle Bails (n=6)

The most common form of modification at the White Springs is the reworking of kettle bails. Two appear to be reworked punches. WH181.6 was excavated from the plowzone above Feature 2. The object is circular in cross-section, with one sharp end and one flat end. WH18.44 is likely another modified punch; it was recovered from a mixed feature/plowzone context within Feature 2. The artifact is also circular in cross-section, with one flat end and one pointed and tapered end. The diameters of these objects are consistent with kettle bail rods from Ft. Michilimackinac (Stone 1974:171).

The Feature 3 area also contains a modified kettle bail from a plowzone context. The upper portion of WH81.38 is circular in cross-section, while the lower section is square. One end has a relatively blunt point; the other appears broken. Its characteristics and measurements suggest it was used as either a punch or an awl. Another possible awl (WH805.22) was recovered from the plowzone within House 3. The implement is curved and either square or rectangular in cross-section. One end likely housed a handle, and the working end is sharp.

WH242.1 is a fifth possibly modified kettle bail excavated from a securely Onöndowa'ga:' context within the Feature 6 firepit. It has a round shank that flattens and folds over to form a relatively sharp point. The object is quite long and could be a poker.

The last modified kettle bail is WH148.5. It was found in the plowzone within the Ridgetop Minimal Feature Area. The object is square in cross-section, has two blunt ends, and a rounded hook located about 3 cm from the bottom of the implement. These characteristics suggest WH148.5 could be a reworked hook. This object is similar to four kettle bail fragments from the Adams Site (1565–1575 CE) (Wray et al., 1987: Sempowski and Saunders 2001a).

Food Preparation: Knives (n=4)

The reworking of knives is another common form of alteration at White Springs. Four blades exhibit characteristics of modification. The first is WH102.26, recovered from a securely Onöndowa'ga:' context within Feature 3. It has a flat tang without a bolster or heel (Bradley 2005:211). The blade's distal end is cleanly cut from the rest of the blade perpendicular to the length, and the broken edge appears beveled. This knife is similar to Type 1A knives that have been found at the Adams (1565–1575 CE), Tram (1570–1590 CE per Sempowski and Saunders 2001; 1553–1584 CE per Birch et al., 2020) and Dutch Hollow (1605–1620 CE) sites. These knives are relatively wide "butcher" type knives that display either a very slight or almost non-existent choil (Sempowski and Saunders 2001a:215).

A second likely modified knife (6050/168) was excavated from a burial context. The blade has an extended tang, a tapered back, and an oblique heel without a bolster or a choil. This implement closely resembles a Class II, Series B knife from Ft. Michilimackinac, a modified knife that was sharpened and reformed after it broke (Stone 1974:271,274).

The two remaining modified knives were also recovered from burial contexts. 6015/168 is a folding clasp knife blade with a large pin embedded in the shoulder. Both the blade and the back-edge are rectangular and taper towards the point, which is pointed and triangular. This is a unique shape for a folding clasp blade and likely the result of resharpening. 6058/168 appears to be modified in the same way; the tip has the same unique triangular shape. However, this blade does not appear to be a folding clasp blade. It has a flat tang without any pins and a straight back edge without a collar or heel. These characteristics are suggestive of a kitchen knife.

Firearm Fragments (n=3)

The last class of modified objects is reworked gun barrels. The first gun barrel (WH158.3) was reworked into a scraper. This object was recovered from the plowzone within the Ridgetop Domestic locus. One end of the barrel is crimped upwards and made into a working edge. The other end contains a small section of the gun barrel that was cut into a flat edge. 6257/168 is a second gun barrel scraper recovered from an unknown context (RMSC). The working end is flattened and bent slightly upwards. A third modified gun barrel (6053/168) was recovered from a burial context. The barrel end of the implement was cut into a flat edge, while the opposite end was flattened into a long straight edge. Because this edge is not bent upwards like the other gun barrel scrapers, this particular object may be a digging tool.

White Springs Iron Assemblage Analysis and Interpretations

Iron Smithing at White Springs

Archeologists and local historians often mention Townley-Read as being the first Onöndowa'ga:' site to contain a smithy. However, documentary evidence suggests that smiths were also present at either the eastern White Springs site (NYSM 1952 and 2442; RMSC Plp-18) or the western Snyder-McClure site (NYSM 2431; RMSC Plp-6), possibly both. In the early 1700s, the French extended their influence and presence primarily through Jesuit priests and the translator Louis-Thomas Chabert de Joincaire, who made several trips to Onöndowa'ga:' territory while accompanied by smiths (Jordan 2001:5). It was reported that the Onöndowa'ga:' had a French smith for "some years in their villages" in 1709 (NYCD 9:830). French smiths were additionally said to be in the Onöndowa'ga:' region in 1710, 1715, 1716, and 1717 (McIlwain 1915:64, 79, 103–104, 113, 116–117; Jordan 2008:66), all during or very close to the estimated occupation span at White Springs.

Currently, there is no direct evidence of a smith's forge at White Springs, such as traces of a forge's masonry foundation, smithing tools, or a wooden anvil base (Stine 2000; Jordan 2001:9). However, this does not necessarily indicate that they were not present or that smithing activity did not occur. It is conceivable that the forge and the smith's tools have not yet been located; only a small portion of the site was excavated. It is also likely that a smithy would not have been placed directly within a settlement composed of tightly-packed wooden buildings due to fire danger. Another possibility is that the foundation was dismantled and reused for construction elsewhere. Tools were also often recycled and transported to new smithy facilities. It is also unlikely that the anvil base will be found; wood does not typically preserve for 250 years.

Despite a lack of direct evidence, there are indirect traces of smithing activities. Approximately 1,500 slag fragments were recovered from feature contexts that could date to the Onöndowa'ga:' component. Slag is a common waste product of smithing and is the mixed remnants of oxidized flakes of metallic iron, fuel ash, and other contaminated debris such as flux and the lining of the hearth (Serneels and Perret 2003). However, the exact quantity of Onöndowa'ga:' slag is unknown. The landscape was altered due to Euroamerican farming and the construction of a manor house resulting in mixed natural stratigraphy (Moutner 2013:56). Moutner (2013:56–57) suggests that coal cinder embedded within glassy slag indicates 19th century occupation, while sandy slag is more likely to date to the Onöndowa'ga:' component. Fifty-five sandy slag fragments were recovered from feature contexts, but most of the slag is labeled as undifferentiated. Excavation director Kurt Jordan (2021, pers. comm.) asserts that most or all of this is likely to derive from the Euroamerican occupation.

Further evidence of on-site smithing can be found in several objects that could be Onöndowa'ga:'-made, including one nail, one screw, three kettle hooks, and five awls. All lack uniformity and appear to be made by an individual with little smithing experience or someone using imperfect facilities. They may represent more successful Onöndowa'ga:' attempts to forge, possibly with help from a French smith. Fasteners and hardware such as nails (n=145), spikes (n=13), rods (n=4), hooks (n=2), and screws (n=2) were the most likely objects to be made on-site. They are reasonably simple to make, and demand was probably high. Other implements possibly forged by frontier smiths are punches (n=2) and a chopper (n=1).

The majority of the iron tools and implements from White Springs were prefabricated by Europeans and acquired by the Onöndowa'ga:' through the fur trade or given as diplomatic gifts. Identified premade objects include knives (n=25), firearm components (n=9), trade awls (n=6), axes (n=4), mouth harps (n=3), scissors (n=3), strike-a-lights (n=2), and belt buckles (n=2). These objects were easily recognized because they are relatively homogeneous with standardized measurements. Particular items such as firearm parts were also difficult to make on-site. A similar pattern was identified by Jordan (2001) at the subsequent Townley-Read site.

Despite all of the documentary and archaeological evidence suggesting smithing occurred at White Springs, the iron artifacts from the site only show one type of repair method, resharpening. There are no signs of welding or tempering, two everyday smithing activities. One explanation for this is that the White Springs iron is generally quite corroded and in poor condition, which likely obscures these other repair types. A second possibility is that broken, worn, or outdated objects were melted down and transformed into more useful forms (Jordan

2001:35). This is impossible to identify in the archeological record because iron maintains the same chemical structure when it is remelted and recast.

Domestic Context Nail Density Analysis

Nail densities were calculated for each domestic locus by dividing the number of recovered hand-wrought nails by the excavated soil area in order to determine Onöndowa'ga:' structural forms and examine the extent of nail use across the site. Following Jordan (2008), calculations were made for both the positively identified nails and the possible hand-wrought nails resulting in a nail density range for each locus. Table 4 presents density ranges ordered by the positively identified nail numbers. It should be noted that the nail densities of Feature 3, the Southwest Lawn Town Exterior, the Ridgetop Minimal Feature area, and the Northeast Lawn Domestic are all likely inflated; Euroamerican barbed wire fragments were recovered from each of these loci, and some of the nails recovered in these areas were likely used to attach the wire to fenceposts. Positively identified hand-wrought nails were recovered across the site, but most concentrated in five loci—the Space Between House 1 and House 4, Feature 3, House 1, House 3, and Feature 2.

Table 4: Nail Density per Square Meter of Excavated Area by Locus

Locus	**Excavated Area (m^2)**	**17th & 18th Century Nails Recovered** [a]	**Nails/ m^2**
Space Between Houses 1 & 4	2.00	**6**—11	3.00—5.50
Feature 3 Area [c]	3.14	**9**—18	2.87—5.73
House 1 Area	8.75	**18**—30	2.06—3.43
House 3 Area [b]	8.00	**16**—233	2.00—29.13
Feature 2 Area	3.50	**7**—9	2.00—2.57
Ridgetop Domestic	18.50	**32**—54	1.73—2.92

Southwest Lawn Town Exterior [c]	0.60	**1**	1.67
House 2 Area	6.00	**9**—59	1.50—9.83
House 4 Area	12.00	**18**—42	1.50—3.50
Southwest Lawn Domestic	4.60	**4**—9	0.87—1.96
Ridgetop Minimal Feature [c]	8.10	**6**—21	0.74—2.59
NW Lawn Exterior Artifact Clusters	3.20	**2**—8	0.63—2.50
Northeast Lawn Domestic [c]	13.80	**8**—13	0.58—0.94
Palisade Area	9.18	**4**—24	0.44—2.61
Eastern Slope Disturbed Area	10.06	**4**—5	0.40—0.50
Northwest Lawn Town Exterior	8.30	**1**—2	0.12—0.24
House 3 Immediate Exterior	3.00	**0**—82	0.00—27.33
Feature 6 Area	2.00	**0**—1	0.00—0.50
Northwest Lawn Domestic	6.30	**0**—2	0.00—0.32
Northeast Lawn Town Exterior	1.40	0	0.00
Southwest Vineyard Domestic	0.00 (Surface-Collection)	0	0.00
Southwest Vineyard Town Exterior	0.00 (Surface-Collection)	0	0.00
Totals	132.43	**145**—624	**1.38**—5.67

[a] *The lower, bolded number in this range reflects positively identified hand-wrought nails. The higher number includes all possibly hand-wrought nails.*

[b] *The 28 nails found in the trench soil were excluded from these calculations because these materials were recovered selectively and the excavated area could not be determined.*

[c] *Loci containing barbed wire.*

Additional nail density ranges for Ganondagan (0.14–0.18 nails/m^2), Primes Hill (0.34 nails/m^2), Townley-Read (0.53–1.36 nails/m^2), and Egli (1.04–1.30 nails/m^2) were calculated by Jordan. Jordan's data was made consistent by only including nails from shovel test pits and test units in the calculations, while metal-detected and surface collected nails were excluded. These principles were applied to the White Springs nail densities as well. The Ganondagan, Primes Hill, Townley-Read, and Egli site densities are comparable to White Springs because all were located in plowed areas and had plowzones of approximately the same thickness (Jordan 2001:30). Excavations also focused on household spaces and recovered sub-plowzone features at each of these sites.

The nail density range for the entire White Springs site is 1.38–5.67 nails/m^2. The lower number is substantially higher than Ganondagan and Primes Hill but close to the Townley-Read and Egli density ranges. This suggests that White Springs structures contained significantly greater numbers of nails compared to the earlier sites. However, the upper White Springs density figure is much higher than Townley-Read and Egli. A probable explanation for this is that the White Springs's possible nail density figures incorporate nails from the Euroamerican occupation at the site; the possible hand-wrought nails are highly corroded and impossible to identify precisely. Jordan also notes that the number of nails recovered from Townley-Read and other Hodinöhsö:ni' sites may actually underestimate actual nail use (Jordan 2001:29). Some were probably collected and reused after a site was abandoned, and modern collectors likely removed others with metal detectors. Less of this may have occurred at White Springs because much of the site is on a residential lawn and would not have been easy for artifact collectors to access.

Nail Use in Construction and Structural Maintenance

The earliest known written account of Hodinöhsö:ni' iron nail and hardware use is from an entry in a Dutch Journal. In 1634, Harmen Meyndertsz Van den Bogaert commented that Kanien'kehá:ka and OnΛyoteʔa·ká “houses are constructed and covered with the bark of trees, and are mostly flat above. There were also some interior doors made of split planks furnished with iron hinges. In some houses, we also saw ironwork: iron chains, bolts, harrow teeth, iron hoops, spikes, nails" (Jameson 2009:139; Gehring and Starna 2010:4). Another firsthand account was recorded in 1724 by Jesuit missionary Joseph-Francois Lafitau who worked at the Kahnawake mission from 1712 to 1717 (Fenton and Moore 1977:22). Lafitau's writings indicate that traditional longhouses were still being constructed in Iroquoia during the first quarter of the 18th century. These houses also contained "European-derived features such as gable end-walls strengthened by planks and hung wooden doors with iron bolts" (Jordan 2008:257).

In 1700, Dutch military engineer Willem Wolfgang Römer drew a map that seems to depict two houses from the Snyder-McClure and White Springs sites. The structures appear to be A-frame homes, but Jordan (2008:255) notes that this style was not constructed by either the Hodinöhsö:ni' or Europeans at this time. However, Jordan states that the banding illustrated on the rooftops may actually be an accurate representation of bark roofing. Gerard-Little's (2011:106) analysis of White Springs' post-mold data in conjunction with archaeogeophysical data determined that the houses were "true" multiple-compartment longhouses. A "true" longhouse has a length-to-width ratio of at least 2:1 (Kapches 1984:64). Nails were found at each of the houses and could have been used to secure various types of bark and bark substitute siding such as logs, planks, and other sturdy materials to upright wall posts (Hesse 1975; Jordan 2008:241, 244). Increased iron nail use reduced labor costs in the construction of houses, which was undoubtedly crucial at White Springs (Jordan 2001:1). However, if the main supply of nails was obtained after 1701 due to improved Onöndowa'ga:'-French relations, Jordan (2021, pers. comm.) suggests that their main purpose may have been for the maintenance of structures since the site had already been occupied for over a decade at that point.

Substantially increased nail use at the site also indicates that the houses were not European cabins. Nails were rarely used in their construction because corner-notching secured wall logs into position, and gravity held the roof in place (Jordan 2008:241). This suggests that the White Springs houses were hybrid buildings with "traditional" architectural elements and European hardware. Specific examples of traditional elements at the site include interior hearths, vestibule storage areas, and substantial interior bench support posts (Jordan 2019:49).

Another indicator of hybrid construction is post-mold diameter. By examining post-measurement data from 38 Hodinöhsö:ni' and Oswego sites, Prezzano (1992:259–60) concluded that traditional structures from pre-and post-Columbian sites contained posts between 5–10 cm in diameter; larger diameters are suggestive of intercultural houses (Jordan 2008:239). Intercultural houses also typically contain larger interior weight-bearing support posts and smaller wall posts. Posts are considered a traditional Indigenous construction technique because, like nails, they are unnecessary in Savo-Karelian and Moravian log construction and rarely found in European framed architecture (Jordan 2008:239).

I calculated the mean wall post-mold diameters for each of the White Springs houses. Three are 10 cm or over, and the total mean for all houses is 10.82 cm (see Table 5). Jordan has calculated wall post averages for structures from multiple Hodinöhsö:ni' sites, including Structure 1 (8.60 cm) from the Gayogo̱hó:nǫ' Rogers Farm site (1660–1685 CE), the Trench 4 Structure (9.40 cm) from the Onöndowa'ga:' Ganondagan site (1670–1687), several structures (7.30 cm) from the OnΛyoteʔa·ká Primes Hill (1696–1720 CE) site, and Structure 1 (6.30 cm) from the Onöndowa'ga:' Townley-Read (1715–1754 CE) site. The White Springs houses are the only structures with a mean post-mold diameter over 10 cm, suggesting that they might be intercultural houses. The size of the White Springs central support posts additionally supports this conclusion. All are significantly larger than the wall posts, with the mean equaling 21 cm.

Table 5: White Springs House Post-Mold Diameters

Loci	Smallest Wall Post	Largest Wall Post	Overall Mean Diameter for Wall Posts	Central Support Post Diameters	Mean Diameter for All Posts
House 1	7.00 cm	14.00 cm	9.50 cm	N/A	9.50 cm
House 2 [a]	7.00 cm	14.00 cm	10.00 cm	23.00 cm	11.86 cm
House 3 [a]	7.50 cm	19.00 cm	12.67 cm	20.00 cm by 15.00 cm	13.13 cm
House 4	9.00 cm	15.00 cm	11.00 cm	20.00 cm, 21.00 cm	14.17
Total Mean	7.63 cm	15.50 cm	10.82 cm	21.00 cm	12.17

Data was compiled from Jordan's White Springs Test Unit and Feature Excavation Report (2020).

[a] *These houses contain post-molds with diameter expressed as a range; the mean of each figure was taken before the total mean figures were calculated.*

Domestic Context Iron Density by Locus

Iron artifact densities were calculated for each locus to determine the various types of activities performed across different areas of the site (see Tables 6 and 7). Unmodified and modified artifacts were included in these calculations, but nails were excluded. The Space between House 1 and House 4, Feature 3, Feature 6, and the Ridgetop Minimal Feature Area have the highest density figures. In contrast, the Eastern Slope Disturbed Area, the Palisade, the House 3 Immediate Exterior, and House 2 and have the lowest. Interpretations regarding activity type were made for the loci with higher densities, but this was not possible for the loci with small sample sizes. Densities for the vineyard area were not calculated because all artifacts were surface-collected. The average iron density for all of the domestic contexts is 0.96 items per square meter.

Table 6: Domestic Iron Artifact Density Organized by Locus

Locus	Excavated Area (m^2)	Number of Iron Onöndowa'ga:' Artifacts Recovered [a]	Iron/ m^2
Space Between Houses 1 & 4	2.00	6	3.00
Feature 3 Area	3.14	9	2.87
Feature 6 Area	2.00	4	2.00
Ridgetop Minimal Feature	8.10	15	1.85
House 1 Area	8.75	14	1.60
Feature 2 Area	3.50	3	0.86
Ridgetop Domestic	18.50	13	0.70
Southwest Lawn Domestic	4.60	3	0.65
Northeast Lawn Domestic	13.80	9	0.65
House 3 Area [b]	8.00	5	0.63
House 4 Area	12.00	6	0.50
Northwest Lawn Domestic	6.30	3	0.48
House 2 Area	6.00	2	0.33
House 3 Immediate Exterior	3.00	1	0.33
Palisade Area	9.18	1	0.11
Eastern Slope Disturbed Area	10.06	1	0.10
Northwest Lawn Exterior Artifact Clusters	3.20	0	0.00
Northwest Lawn Town Exterior	8.30	0	0.00
Northeast Lawn Town Exterior	1.40	0	0.00
Southwest Lawn Town Exterior	0.60	0	0.00

Southwest Vineyard Town Exterior	0.00 (Surface-Collection)	1 (excluded)	N/A
Southwest Vineyard Domestic	0.00 (Surface-Collection)	0	N/A
Totals	132.43	95	0.96

[a] *Consisting of tools, implements, and hardware; nails are excluded.*

[b] *The 15 artifacts found in the trench soil were excluded from these calculations because these materials were recovered selectively, the excavated area could not be determined, and it is unclear if they date to the Onöndowa'ga:' component.*

Table 7: Iron Artifacts Found in Houses and Other High-Density Loci

Loci with Density Figures (m^2)	Clothing	Tools and Implements	Containers	Food Preparation	Hardware and Fasteners [a]	Gun Parts	Totals
Space Between Houses 1 & 4 (3.00)	1 Buckle	3 Tools	0	1 Knife	1 Screw	0	6
Feature 3 (2.87)	0	5 Tools, 2 Implements	0	1 Knife	0	1	9
Feature 6 (2.00)	0	2 Tools	1	1 Knife	0	0	4
Ridgetop Minimal Feature (1.85)	0	7 Tools	0	2 Knives	3 Fasteners, 1 Hardware	2	15
House 1 (1.60)	0	7 Tools	0	1 Knife, 2 Kettle Hooks	1 Fastener, 3 Hardware	0	14
House 2 (0.33)	0	1 Tool	0	0	1 Fastener	0	2
House 3 (0.63)	0	3 Tools	0	0	2 Fasteners	0	5
House 4 (0.50)	1 Buckle	3 Tools	0	2 Knives	0	0	6
Totals	2	33	1	10	12	3	61

[a] *Calculations exclude nails.*

The features with the highest iron densities are Features 3 and 6. Both are large, multi-level Onöndowa'ga:'-pit features. The upper layer of Feature 3 has been interpreted as a trash midden by Jordan. It contains various materials and artifacts such as fire-altered rock, animal bones, lithics, red stone, shell, white ball clay, beads, etc. Most of the iron objects recovered from this layer are broken tools consistent with a trash midden. Large quantities of charcoal and animal bones along with a single iron knife fragment were excavated from the lower layer, consistent with Jordan's theory that this deposit represents a cooking-related pit.

Feature 6 has two internal layers; the upper is filled with large animal bones, and the lower contains a platform of fire-altered rock. Artifacts from this feature are diverse and consist of glass beads, sheet brass, one brass ring, wampum, and a native-made pipe stem. Recovered iron objects include an awl, a knife blade, a kettle bail poker, and a possible iron crucible fragment. Because lead was not recovered from Feature 6, smithing activities probably did not occur in this locus. Instead, it is more likely that the crucible fragment was discarded here.

The highest iron density locus is the Space Between Houses 1 and 4, presumably an outdoor area during Onöndowa'ga:' times. Recovered iron objects include two awls, a knife blade, a multi-tool, and a screw. Only a few other artifacts were found in this area, including sheet brass, a few glass beads, one shell bead, one Native-made pipestem, and one white ball clay pipe stem. Over 50 bone fragments were found as well. The overall artifact density is low compared to other loci, but the iron density is high. The low artifact density indicates this was not a primary workspace or activity area, but the high iron density and the fragmented animal bones suggest that occasional food preparation or trash dumping may have happened here.

Another high iron density locus is the Ridgetop Minimal Feature Area, which is a possible plaza or outdoor work area where numerous test units found few features. Recovered iron artifacts are mostly tools such as awls, one beamer, one chisel, and two tool fragments. Three strapping pieces, two gun parts, one blade, and one hook represent the rest of the iron from this locus. Other excavated objects include Native-made and European pipe fragments, glass beads, sheet brass, marine shell, thousands of animal bones, etc. This locus also contains the second-highest concentration of lithics, possibly indicating tool resharpening and production (Krohn 2010:4). Due to the enormous quantity of fragmented animal bones and lithic fragments coupled with a high iron density, interpretation as an outdoor work area appears most likely with food preparation, bone grease production, and lithic manufacture activities possibly occurring.

All of the houses have different iron densities. House 1 has the highest (1.60 iron/m^2), followed by House 3 (0.63 iron/m^2), House 4 (0.50 iron/m^2), and House 2 (0.33 iron/m^2). These figures include iron hardware as well as tools and implements. It should be noted that 15 objects were omitted from the House 3 density figure because they were recovered from trench soil. Interestingly, the lithic densities closely mirror the iron density pattern. House 1 (15.31 iron/m^2) has the highest lithic density, while House 2 (1.0 iron/m^2) has the lowest. Houses 4 (7.92 iron/m^2) and 3 (6.13 iron/m^2) also have similar figures.

The differences in the house iron density calculations could be the result of recovery or preservation bias. The sample size for each house is relatively small; the total number of objects is only 27. However, this seems less likely considering that the iron and lithic density patterns are very similar. Krohn (2010:15) suggests that the House 2 residents either engaged in little to no tool use or effectively cleaned the area. Other possibilities include a preference for performing specific tasks in outdoor spaces or unequal access to iron and lithic tools. Of these two possibilities, the latter appears more improbable; all of the houses contained comparable quantities of other artifacts. This indicates that similar activities were performed across all households, such as trading (lead bale seals, beads, wampum), cooking and storing food (kettles, knives), and manufacturing objects for adornment (brass scrap, red stone debris) (Bridges 2019).

The White Springs Lead Assemblage

Assemblage Overview

Four objects in the White Springs lead assemblage definitively date to the Onöndowa'ga:' component; all were excavated from feature contexts. However, 85 additional objects possibly date to the Onöndowa'ga:' component; 16 are located at Cornell University and 69 are housed at the RMSC. The entire assemblage consists of 65 lead shot balls, 15 manufacturing debris fragments, 3 bale seals, 3 ornaments, and 3 lead bars. Most objects (particularly those from RMSC) have questionable provenience, but there is a strong possibility that they date to the Onöndowa'ga:' component since they are similar to lead artifacts excavated from Onöndowa'ga:' graves and middens at the Ganondagan site (1670–1687 CE) (Jordan 2008:166). The Ganondagan objects encompass 127 lead shot balls, 31 manufacturing debris fragments, 1 bale seal, 1 cross ornament, and 1 teardrop-shaped weight (Wray and Graham 1985:51,60).

Table 8 presents all of the White Springs lead artifacts, organized into a table by function. Lead shot constitutes the majority of the assemblage, accounting for 73% of the artifacts. Manufacturing debris represents 17%, while bale seals and ornaments comprise the remaining 10%. Most of these objects were recovered from unknown surface-collection contexts. Only 22% were excavated from domestic contexts; none came from burial contexts.

Table 8: White Springs Modified/Unmodified Lead Artifacts Organized by Function

Functional Category	WS Domestic Contexts	WS Unknown Surface Contexts (RMSC) [a]	WS Mortuary Contexts (RMSC)	Totals
Bale Seals	3	0	0	3
Ornaments	0	3	0	3
Manufacturing Debris	5 Lead Waste, 3 Splashing (1 Metal Detected), 3 Scrap Frags.	3 Splashing, 1 Sheet Lead Frag.	0	15
Lead Shot	3 Excavated, 1 Metal Detected, 1 Surface-Collected	60	0	65
Unutilized Lead	1 Lead Bar	2 Lead Bars	0	3
Totals	20	69	0	89

[a] *Five artifacts were excluded because they could not be located at RMSC, and descriptions were not provided in the museum's database.*

Lead shot was the most essential type of lead object at White Springs. Projectiles were produced by cutting lead bars obtained through trade and melting them over a fire inside an iron ladle or crucible (Sivilich 2016:16). The molten lead was then poured into a two-part single or multiple-cavity mold made of iron or brass. After it cooled, the musket balls were separated from the mold. The casting sprue was cut close to the ball, and any flashing around the mold seam was removed. Manufacturing debris was often created during this process when the molds were overfilled. The presence of manufacturing debris at White Springs suggests that at least some of the musket balls were probably produced on-site, probably by the Onöndowa'ga:' themselves.

Bale seals and ornaments are relatively uncommon at White Springs. Bale seals are a physical product of trade and were used by Europeans to seal and identify packaged goods, typically cloth or clothing. They are made of cast-lead and often stamped with a manufacturer's mark. Their presence at White Springs indicates that the clothing was somewhat valuable to the Onöndowa'ga:'. Similar to iron, only specific fabrics and garments were incorporated into Onöndowa'ga:' culture with the purpose of innovating upon existing adornment traditions (Kane 2014:3). Three possible ornaments represent the last objects in the assemblage. These artifacts are unlikely to be trade items, and are relatively rare at other Hodinöhsö:ni' sites. They were probably manufactured by the Onöndowa'ga:' potentially for adornment purposes.

Unmodified White Springs Lead Artifacts (n=65)

Approximately 73% of the total lead assemblage, 65 objects, are unmodified. This is a significantly higher proportion of modification compared to the iron at the site. Another critical difference between the assemblages is that there are far fewer lead artifacts, more of which were either surface-collected or have unknown provenience. Forty-seven were surface-collected from an unknown location (RMSC), twelve were excavated from plowzone contexts, four came from feature contexts, four were recovered through metal detection, and one was surface-collected from a domestic context. I examine the lead artifacts in three main categories—lead shot, manufacturing debris, unutilized lead, and bale seals. A few are further organized into subcategories.

Lead Shot: Musket Balls (n=42)

There are 42 unmodified musket balls. Twenty-three were fired, thirteen are unfired, and six are "chewed." An additional eight musket balls with catalog numbers could not be located at the RMSC. Four are labeled as either fired or unfired within the database and not described as modified, so they are included in all of the musket ball calculations. Because the database does not indicate whether 6150/168, 6152/168, and 6154/168 were fired or if they have any distinguishing features, they are excluded from the musket ball calculations.

All of the fired musket balls were surface-collected. Nine have an irregular shape possibly caused by either a mid-air collision with a target or through impact by farming equipment more recently. 6284/168 is less ambiguous and has a pitted surface consistent with a tree impact (Sivilich 2016:49). Ten musket balls have an elongated teardrop shape and a singular flat surface. These two distinct characteristics are produced when a projectile ricochets off an object such as a rock or tree (Sivilich 2016:53). Another possibility is that the projectile made contact with a human enemy or prey (Sivilich 2016:57). In this instance, as with most cases, it is nearly impossible to determine the type of object these projectiles collided with. 6170/168, 6178/168, 6182/168, and 6186/168 could not be located at the RMSC and are only cataloged as being fired.

Eleven of the unfired musket balls were surface-collected. Most have sprues, and a few have mold seams. Two unfired musket balls were excavated from the plowzone within the Ridgetop Domestic and Southwest Vineyard loci. WH341.16 has a large casting sprue; the presence of sprues and mold seams provide evidence of lead casting (Bradley 2020:23). WH1446.1 was likely pulled from the barrel after it was jammed. The surface has circular markings and a few indentations that could be from a ramrod (Sivilich 2016:61).

The assemblage also contains six surface-collected "chewed" musket balls, which have been found on a few other Onöndowa'ga:' sites. Witthoft (1951) has interpreted these markings as being caused by human teeth. However, the White Springs musket balls all have fairly deep impressions that could not have been physically made by humans. The most likely culprit is pigs (Sivilich 2016:102). Three musket balls (6278/168, 6279/168, and 6280/168) have deep depressions likely created by pig incisors. 6289/168 is one severely crushed fragment. The size and depth of the markings imply they were made by pig molars (Sivilich 2016:103–104). Pigs typically accidentally ingest musket balls while rooting around the ground for food (Sivilich 2016:102). 6158/168 has shallower dentition marks consistent with young swine dentition impressions (Sivilich 2016:115).

Compared to the others, 6281/168 is small, with very slight detention marks. It is also lighter in color. These characteristics indicate that the musket ball was probably chewed and subsequently ingested by a pig; the gastric stomach acid is what caused the fragment to dissolve partially. Pig remains have been recovered from secure Onöndowa'ga:' contexts (Feature 3) at White Springs suggesting that the musket balls may have been chewed and/or ingested during the Onöndowa'ga:' occupation of the site (Disotell 2021). Because there is no evidence of penning structures and pig bones are relatively scarce, these pigs were likely feral or semi-feral.

Lead Shot: Birdshot (n=3)

Three lead shot fragments can be classified as birdshot, based on their weight, and diameters between 0.15 inches and 0.23 inches (Sivilich 2016:170). Potter and Hanson's (2001) small shot classification chart was used to determine projectile size. The first fragment, WH359.5, was excavated from a feature context within the Ridgetop Domestic locus, and the size is 2. WH1481.1 was surface-collected from the Middle Vineyard. The projectile size is FF, and its surface contains concave dimples and one flat side indicating manufacture by the Rupert Method. This technique was invented in 1665 and allowed for the rapid and efficient production of lead shot (Sivilich 2016:147–148, 170). Molten lead is poured through a colander and into cooled water, which produces a distinctive dimple and apple-shaped projectile (Sivilich 2016:149). The last fragment (WH454.3) was excavated from a feature context within House 4; it has one slight dimple and is size TT. Size 2 birdshot is commonly used for hunting waterfowl, while size TT and FF birdshot are typically used for hunting both waterfowl and smaller thinskinned animals such as squirrels and muskrats.

Manufacturing Debris: Splashing Fragments (n=6)

There are six lead splashing fragments; three were surface-collected, two were excavated from the plowzone, one came from a feature context. WH323.13 is the only fragment with defining features. It was excavated from the plowzone within House 4 and appears to have a molded ridge on one face that could be the negative impression of a circular mold.

Manufacturing Debris: Lead Waste (n=5)

Five lead waste fragments are represented in the assemblage; four were excavated from plowzone contexts and one from a feature. Two fragments do not have any defining features. WH62.12, WH702.12, and WH753.11 have mold seams and raised circular impressions indicating that they were produced from a musket-ball gang mold (Sivilich 2016:19). Two were recovered from the plowzone within House 2 and one from the plowzone above Feature 2.

Manufacturing Debris: Scrap Fragments (n=2)

WH1462.1 represents two scrap fragments that were metal detected from the Southwest Vineyard Town Exterior. One is flat with a rough texture; the other is more globular in shape.

Manufacturing Debris: Sheet Lead (n=1)

6137/168 is a large surface-collected fragment of sheet lead that contains one rivet. Three of the edges are slightly curved; one of the edges is folded onto itself. It appears to be an unutilized scrap fragment.

Unutilized Lead: Lead Bars (n=3)

Two unutilized bars were surface-collected, another was excavated from the plowzone within the Ridgetop Minimal Feature Area. 6138/168 and WH143.9 are rectangular in shape, while 6139/168 is trapezoidal. These bars are commonly found on Onöndowa'ga:' and

Kanien'kehá:ka sites from the mid-17th century (Silverman 2016). They were obtained through trade to cast lead objects. At White Springs, they were likely intended to be melted down and used to manufacture lead balls.

Bale Seals (n=3)

WH196.1 is a definitively identified disk bale seal excavated from the plowzone within House 1. The artifact is a corroded round disk with a rectangular strip near the base. It appears to be a commercial riveted cloth seal that was attached by folding two disks connected by a thin strip around each side of the fabric (Egan 1994). Although these bale seals are typically embossed with markings, the White Springs seal contains no visible surface detailing. This could be because the object is highly corroded. When lead deteriorates, the original surface is not retained. Another possibility is that WH196.1 represents the back of the seal, which may not have had any decoration. There are also two possible bale seal fragments. WH265.23 was recovered from the plowzone within House 4 and could be the back or connecting piece of a bale seal. WH45.5 was excavated from the plowzone above Feature 3. One edge shows a possible break suggesting that it could be one “ear” of a folded bale seal.

Modified White Springs Lead (n=24)

There are 24 modified lead objects, representing approximately 27% of the total White Springs lead assemblage. This is substantially higher than the percentage of modified iron. Another difference between the modified assemblages is object diversity. The modified iron assemblage contains a variety of tools, implements, and structural components recovered from a variety of contexts, while all of the modified lead artifacts are surface-collected musket balls and lead “wheel” ornaments. The projectiles have been modified in four different ways—flattened, cut, melted, and hammered. It should be noted that some of these objects have been modified using several of these methods. The ornaments were likely cast from recycled lead objects.

Lead Shot: Musket Balls (n=20)

Seven musket balls were flattened into fragile pieces of lead less than 13 mm in thickness. 6140/148, 6141/168, 6159/168, and 6172/168 are small and disk-shaped; 6142/168 and 6147/168 have linear indentations on one side. These markings are probably wood grain impressions left on the projectiles after colliding with a wooden object or tree (Sivilich 2016:55). The last flattened lead object, 6144/168, is a possible musket ball. One side of the fragment is round, while the opposite end is cut. The object also has a rough and irregular texture and dark color, indicating that it was partially melted.

The assemblage also contains seven thicker musket balls that have also been flattened. 6171/168 and 6185/168 are round and elongated, while 6184/168 and 6155/168 have a rough texture possibly due to a collision with an object or tree. In contrast, 6181/168 and 6183/168 are flat with an elongated elliptical shape. The last musket ball (6156/168) is more irregular in shape compared to the others.

Four musket balls are missing about 50% of the original projectile and appear cut in half, which was a simple method of potentially increasing the lethality of a musket ball (Witthoft 1951:61; Sivilich 2016:73). 6167/168 and 6285/168 are irregularly shaped and were probably cut after they were fired. This specific type of modification may have been an attempt to reuse a fired projectile. 6288/168 was also cut in half after it was fired. However, this fragment is two musket balls that fused together after they collided mid-air (Sivilich 2016:64). 6286/168 has a similar elongated shape but is unlikely to be two fused projectiles. The object is more abnormally shaped, suggesting that it was partially melted and flattened.

One musket ball, 6283/168, is more cylindrical than the others. The surface is somewhat irregular; some areas have a pitted appearance. These cylindrical projectiles are called “slugs,” which are commonly manufactured by hammering down a musket ball (Sivilich 2016:83–84). The cylindrical-shaped increased the lethality of the projectile.

The last musket ball has a unique shape. 6157/168 has three flat surfaces and one deep linear depression on the fourth-rounder side, forming a square shape. This mark may have been left by a tool in an attempt to form this rounder side. It has a diameter of 12.52 mm, smaller than most unmodified musket balls. These characteristics suggest that this object could be an unfinished gaming piece (Sivilich 2016:132).

Ornaments (n=3)

Three surface-collected lead “wheel” ornaments (6270/168, 6122/168, 6123/168) are represented in this category. These objects are single lead disks with a smooth surface. The center of one contains a perforation filled with iron fragments indicating that it was made of both lead and iron. A similar but more complete lead wheel ornament (6112/160) was excavated from a burial context at the Townley-Read site (1715–1754 CE); this item is currently located at the RMSC. It is comprised of three lead wheel disks connected by a central iron shaft and may represent the White Springs ornaments’ original form. The exact function of these items is unknown, but it is highly likely that the Onöndowa'ga:' manufactured them by casting the “wheels” from recycled lead objects and connecting them with a salvaged iron fragment.

Manufacturing Debris: Scrap Fragments (n=1)

WH447.8 is a rectangular scrap fragment. All of the sides appear purposely cut. One side is folded upwards. It was excavated from the plowzone within House 4.

White Springs Lead Assemblage Analysis and Interpretations

Domestic Context Lead Density by Locus

The domestic context lead density was calculated by locus to further examine the various activities occurring across the site (see Table 9). Unfortunately, only 22% of the lead artifacts were excavated from domestic contexts. This tiny sample size restricts the conclusions that can be drawn. However, a few tentative judgments can be made. Feature 3 currently contains the highest lead density, and it also happens to have the second-highest iron density. House 4, House 2, and Feature 2 represent other high-density lead loci, while the Ridgetop Domestic, House 1, and the Ridgetop Minimal Feature Area, and area all have the lowest densities.

Table 9: Domestic Lead Artifact Density Organized by Locus

Locus	Excavated Area (m^2)	Number of Lead Artifacts Recovered	Lead/ m^2
Feature 3 Area	3.14	3	0.96
House 4 Area	12.00	5	0.42
House 2 Area	6.00	2	0.33
Feature 2 Area	3.50	1	0.29
Ridgetop Minimal Feature	8.10	1	0.12
House 1 Area	8.75	1	0.11
Ridgetop Domestic	18.50	2	0.11
House 3 Area [a]	8.00	0	0.00
House 3 Immediate Exterior	3.00	0	0.00
Space Between Houses 1 & 4	2.00	0	0.00
Eastern Slope Disturbed Area	10.06	0	0.00
Feature 6 Area	2.00	0	0.00
Northeast Lawn Domestic	13.80	0	0.00

Northwest Lawn Domestic	6.30	0	0.00
NW Lawn Exterior Artifact Clusters	3.20	0	0.00
NW Lawn Town Exterior	8.30	0	0.00
NE Lawn Town Exterior	1.40	0	0.00
Palisade Area	9.18	0	0.00
Southwest Lawn Domestic	4.60	0	0.00
SW Lawn Town Exterior	0.60	0	0.00
SW Vineyard Domestic	0.00 (Surface-Collection)	0 (2 excluded, surface-collection)	N/A
SW Vineyard Town Exterior	0.00 (Surface-Collection)	0 (3 excluded, surface-collection)	N/A
Totals	132.43	15	0.33

[a] *Trench soil was excluded from calculations.*

Feature 3 contains the highest lead density, consisting of three artifacts. These objects include two splashing fragments and one broken bale seal fragment. As previously stated, Feature 3 likely represents a trash midden in the upper layer and cooking related pit in the lower layer. The lead artifacts support this interpretation; both of these objects could logically be found in either layer. However, the bale seal is from a shallower depth of 19.5–31 cmbd, while the manufacturing fragment came from 48–50 cmbd. This suggests that the bale seal was deposited in the trash midden while the splashing fragment was deposited in the cooking pit.

Lead was excavated from Houses 4 (0.42 lead/ m^2), 2 (0.33 lead/ m^2), and 1 (0.11 lead/ m^2). Recovered artifacts include two bale seals, five manufacturing debris fragments (four lead waste, one splashing), and one birdshot projectile. Compared to the iron densities, this distribution pattern is quite different. Houses 1 (1.60 iron/ m^2) and 3 (0.63 iron/ m^2) contained the most iron, while houses 4 (0.50 iron/ m^2) and 2 (0.33 iron/ m^2) had the lowest. These figures appear to indicate that the lead and iron densities are not closely related to one another.

The last high-density locus is Feature 2, which has been interpreted as an Onöndowa'ga:' pit feature used for hide processing and food preparation by Jordan. The soil matrix contained a wide variety of materials such as mammal bones, charcoal, fire-altered rocks, pipe stems, glass beads, etc. A single lead scrap fragment was also recovered from Feature 2 along with a possible iron awl or punch, a fastener, and several nails. The lead fragment is not indicative of food preparation and hide processing but could potentially suggest lead smithing since it was found near a fire. However, this is unlikely considering only one fragment was found. A more plausible explanation is that it was just discarded here.

Lead Smithing at White Springs

The considerable amount of modified lead suggests that it was more easily manipulated by the Onöndowa'ga:' compared to iron. This is certainly related to its very low melting point and its chemical properties. Lead is soft, highly malleable, and ductile. It can be easily cut with iron and chert tools such as knives, celts, and axes without heating. The Onöndowa'ga:' used these implements at White Springs to cut and modify multiple musket balls and to shape the possible gaming piece from bar lead.

The projectiles were manufactured using two techniques—the Rupert method and gang molds. Molds were commonly used to fabricate musket balls, while the Rupert method was utilized to create projectiles of various sizes, such as birdshot. No gang molds or colanders were found, but multiple manufacturing fragments with negative mold impressions and lead bars were recovered. This indicates that molds were present and likely removed after the site was abandoned, possibly by the Onöndowa'ga:' themselves or by European smiths. A possible iron crucible was also excavated from a domestic context, which could have been used to melt the lead for projectile manufacture.

Warfare Tactics and Hunting Practices

The Hodinöhsö:ni' began using guns, powder, and lead shot primarily for military activities (and hunting to a lesser degree) during the 17th century due to their effectiveness (Silverman 2016:53). Compared to arrows, bullets carry roughly six times more kinetic energy and have increased penetrating power (Keener 1999:791; Silverman 2016:28). Not only does this inflict more damage to enemies and animals, but projectiles can pass through tall grasses and thickets without being diverted or dodged. Victims that survived an initial impact also had a high risk of death by infection.

Hodinöhsö:ni' warriors were well equipped with muskets and axes by the 1640s, and Europeans were impressed with their skill in using these weapons (Given 1994). Jesuit Isaac Jogues, who was a captive of the Hodinöhsö:ni' in the 1640s, remarked that war parties had muskets and that "they are skilled in handling them" (JR 24:295). Baron Lahonton, writing from the early 18th century, argued: "the strength of the *Iroquese* lies in engaging with fire-arms in a forrest; for they shoot very dexterously" (Jameson 2009:303). A Dutch source from 1650 claimed that Native Americans "are exceedingly fond of guns, sparring no expense for them; and are so skillful in the use of them that they surpass many Christians" (Jameson 2009:303).

The use of new technologies produced changes in offensive strategies (Keener 1999:802). In one example, documentary sources indicate that the Hodinöhsö:ni' began using hatchets instead of fire to penetrate palisades. This change occurred because gunners could provide better cover to these warriors and more successfully pick off the defending bowman (Keener 1999:791). These tactics were used against the Huron villages of Saint Ignace and Saint Louis in 1649 (JR 34:15, 25–27, 123–125).[7] At White Springs, four modified axe scrapers were recovered

[7] All citations from the Jesuit Relations (Thwaites 1896-1901) are written as JR, followed by the volume and page number.

from the site and could have been used in this way before they were modified.

As other tribes and colonial outposts obtained more firearms in the 1660s and increased their defenses, the Hodinöhsö:ni' responded by utilizing indirect assault tactics on fortified areas to decrease casualties. Indirect strategies can be characterized as engagements that do not attempt to infiltrate the enemy's perimeter. Specific strategies included the siege, subterfuge, encirclement, raiding, the ambush of reinforcements or garrisons outside of the fortification walls, disruption of supply lines, and the destruction of unprotected outbuildings, crops, and settlements (Keener 1999:796, 800).

Ambushes were a preferred tactic of the Hodinöhsö:ni', and they became even deadlier with the use of guns and axes. Small parties of warriors would position themselves in areas where the enemy was most vulnerable, such as river straits or curves in the road (Silverman 2016:28). Cliffs, trees, and swamps could also provide cover and block the retreat of their targets. Once the warriors were in position, they would rush the enemy in one or two bursts attacking with clubs, tomahawks, and axes. Gunners would also occasionally load their weapons with small shot (or grapeshot) at close range of three meters or less (Silverman 2016:29). This covered a large area with multiple projectiles and could potentially kill more than one person despite the fact that accuracy and kinetic energy were both sacrificed.

Guns were also used in individual and group hunts to primarily hunt deer (Silverman 2016:28). Dutch lawyer Adriaen van der Donck remarked in the 1640s that "deer are hunted and killed in great numbers in the coastal areas and riverbanks. They used to catch deer only in traps or shoot them with arrows; now they also use guns" (Gehring and Starna 2010:99). The Hodinöhsö:ni' incorporated guns into their arsenal because a musket ball was more likely to incapacitate a deer or large animal instantly compared to an arrow, which might require chasing a wounded animal for long distances. The slow rate of reloading a rifle was not an issue because the hunter would only have one opportunity to fire at an animal before it ran away. Deer were hunted using the same warfare ambush technique of lying-in wait and firing at close range. However, documentary sources do not indicate whether guns were used in ceremonial deer drives where hundreds, and sometimes thousands of people, would use fire and noise to lead deer into a narrow enclosure or stream where hunters would kill them.

At White Springs, white-tailed deer by far represent the majority of the excavated mammal bones. The age distribution from House 3 and Feature 3 is indicative of a prime-dominated hunting strategy, which is marked by an increased proportion of prime adults relative to juveniles and older animals (Stiner 1990:309; Disotell 2021). Todd and Hoffman (1987) associate this pattern with selective ambush hunting, a well-documented strategy used by the Onöndowa'ga:'. This type of controlled selection was likely facilitated by long-range weapons such as bows and guns in addition to cooperative ambush strategies (Stiner 1990:317).

Five musket balls were modified at White Springs to increase the projectile's lethality, signifying their use in hunting or warfare. This represents approximately 8% of all musket balls. However, an additional 19 fired projectiles may have also been used in similar ways. Nine likely collided with a mid-air target while ten possibly ricocheted off enemies, animals, or objects, meaning that up to 37% of all musket balls could have been used in combat or hunting. The presence of numerous fired projectiles within the site suggests they were used for attacking and defending the settlement. Frequent attacks by the French and their Indigenous allies occurred from 1691–1701, while the Mihtohseeniakis (Miamis) and Anishinabes (Ottawas) attacked the Onöndowa'ga:' "almost yearly" during 1703–1708 (Haan 1976:157; Aquila 1983:44–45; Havard 2001:64; Jordan 2001:53; Keener 1998:146).

Domestic Context Nail, Iron, and Lead Density Analysis

The nail, iron, and lead density figures are combined in Table 10. The purpose of this table is to determine the accuracy of the possible nail densities and whether lead and iron use is related across the site. To better visualize the data, each density figure was assigned a specific color. Green represents a high density, gray a medium density, and red a low density. The parameters for each color were determined by significant breaks within the data. For positively identified nails, green represents 2.0–3.0, while gray is 1.0–1.99, and red is 0–1.98 nails/m^2. For all possible nails, green is 5.0–29.13, gray is 1.0–4.9, and red is 0–0.99 nails/m^2. For iron, green represents 2.0–3.50, while gray signifies 0.86–1.99, and red is 0–0.85 iron/m^2. And for lead, green is 0.43–0.96, gray is 0.29–0.42, and red is 0–0.41 lead/m^2. The table is organized by the positively identified nail column; the highest densities are at the top and the lowest at the bottom.

Table 10: Color-Coded Nail, Iron, and Lead Density Figures

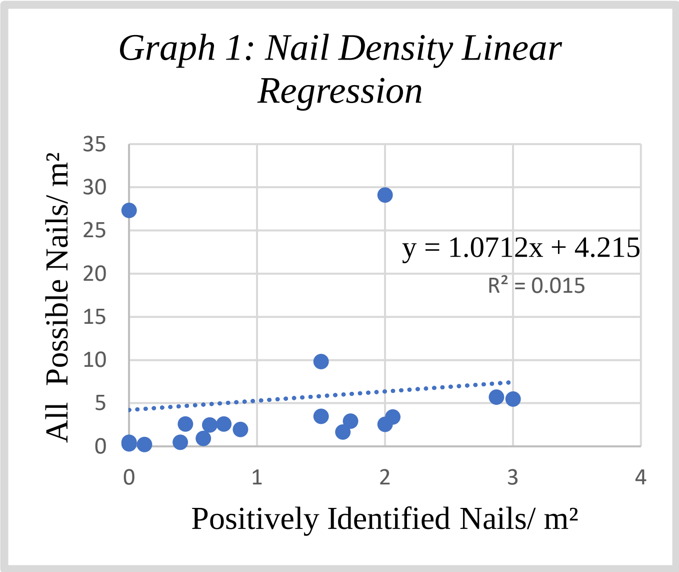
Locus	Nails/ m^2 (Positively Identified)	Nails/ m^2 (All Possible Nails)	Iron Tools/ m^2	Lead/ m^2
Space Between Houses 1 and 4	3.00	5.50	3.00	0.00
Feature 3 Area [a]	2.87	5.73	2.87	0.96
House 1 Area	2.06	3.43	1.60	0.11
House 3 Area	2.00	29.13	0.63	0.00
Feature 2 Area	2.00	2.57	0.86	0.29
Ridgetop Domestic	1.73	2.92	0.70	0.11
Southwest Lawn Town Exterior [a]	1.67	1.67	0.00	0.00
House 2 Area	1.50	9.83	0.33	0.33
House 4 Area	1.50	3.50	0.50	0.42
Southwest Lawn Domestic	0.87	1.96	0.65	0.00

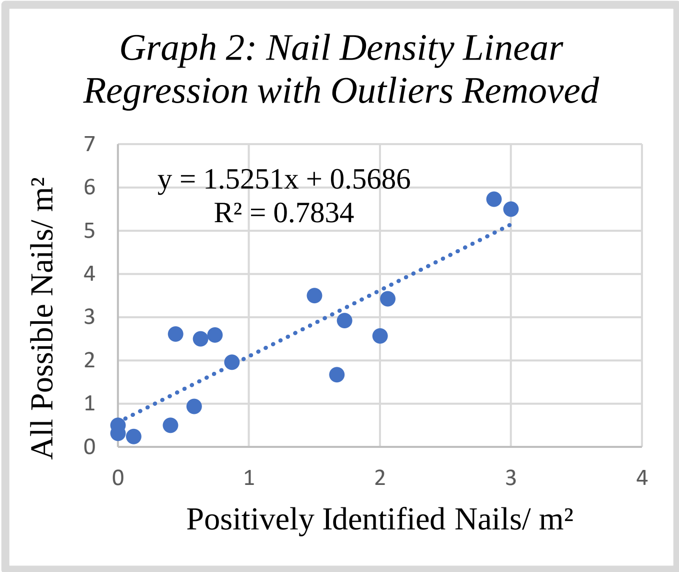
Ridgetop Minimal Feature [a]	0.74	2.59	1.85	0.12
NW Lawn Exterior Artifact Clusters	0.63	2.50	0.00	0.00
Northeast Lawn Domestic	0.58	0.94	0.65	0.00
Palisade Area	0.44	2.61	0.11	0.00
Eastern Slope Disturbed Area	0.40	0.50	0.10	0.00
Northwest Lawn Town Exterior	0.12	0.24	0.00	0.00
House 3 Immediate Exterior	0.00	27.33	0.33	0.00
Northwest Lawn Domestic [a]	0.00	0.32	0.48	0.00
Feature 6 Area	0.00	0.50	2.0	0.00
Northeast Lawn Town Exterior	0.00	0.00	0.00	0.00
Southwest Vineyard Domestic [b]	N/A	N/A	N/A	N/A
Southwest Vineyard Town Exterior [b]	N/A	N/A	N/A	N/A

[a] *These loci contain barbed wire.*

[b] *These loci are excluded from any calculations derived from this table due to surface-collection.*

Table 8 indicates that there is validity to the possible nail densities; twelve out of twenty loci are within the same color category as the positively identified nails. Because the result changes if the parameters for the color categories are altered, a statistical linear regression model was created (see Graph 1). Linear regression illustrates the relationship between two variables by fitting a linear equation to the observed data. The calculated correlation coefficient of all nail densities is 0.12, which indicates a very weak positive correlation. However, three loci densities are significant outliers. The House 3 (29.13 nails/m^2) and the House 3 Immediate Exterior (27.33 nails/m^2) densities are approximately five times higher than Feature 3 (5.73 nails/m^2), the fourth-highest figure. The third outlier figure, House 2 (9.83 nails/m^2), is almost two times higher. This is probably the result of poor nail preservation; the two highest densities were most affected because these loci contained a larger quantity of possible hand-wrought nails. Once the outliers were removed (see Graph 2), the correlation coefficient substantially increased to 0.88, indicating a strong positive correlation.





A strong positive correlation between the nail density figures indicates that many of the possible nails are likely to be hand-wrought. This implies that more nails were being used at White Springs than the positively identified nail figures initially suggested. However, some of the non-outlier figures are unlikely to be entirely accurate. Barbed wire was found in several loci—the Ridgetop Minimal Feature area, the Southwest Lawn Town Exterior, the Northwest Lawn Domestic, and Feature 3. Because broken and corroded wire fragments often appear similar to nails, these numbers are likely somewhat overinflated. Euroamerican fence posts with highly corroded nails were found in House 1, House 3, the Ridgetop Minimal Feature Area, the Ridgetop Domestic locus, and the Eastern Slope Disturbed Area, which could also affect the accuracy of the nail density figures.

Table 10 also implies that the iron and lead densities are moderately correlated. Thirteen out of twenty loci from the iron and lead columns are within the same color category. This result stayed consistent after a linear regression model was calculated for the iron and lead figures. The correlation coefficient is 0.46, suggesting a moderate positive correlation between the iron and lead densities. This means that the distribution of lead and iron across the site could be related.

Concluding Remarks

Applying a Practice-Based Approach to the White Springs Assemblage

Analysis of the White Springs assemblage demonstrates that the Onöndowa'ga:' obtained iron and lead from colonial traders and transformed select objects into more "traditional" forms. Although these objects were not necessarily new, they were created during a specific moment in time by a unique individual. Because it is impossible to replicate something in the exact same way, this essentially makes them original. The creation of such an object can be thought of as both traditional and innovative with the application of a practice-based approach.

The struggle to reconcile the seemingly contradictory concepts of tradition and innovation has long plagued the field of Indigenous archaeology (O'Brien 2010). Deviations from established and static "traditional" practices have historically been recognized as evidence of acculturation and inauthenticity, which continue to undermine claims of federal recognition in the United States today. This belief is so pervasive that in the context of colonization, many archaeologists remain fixated on stationary elements of indigenous cultures even while attempting to provide evidence of Indigenous survival and Native identity (Law-Pezzarossi 2014). However, in actuality, this instead promotes themes of cultural loss and gradual decline. New practices, which inevitably occur, are regarded as a "corruption of a previously 'pure' Indian identity" (Law-Pezzarossi 2014:356; Silliman 2009). This ultimately results in the marginalization and erasure of Indigenous peoples who are considered "inauthentic."

Practice theory instead views tradition as constantly renegotiated through performance and as requiring both agency and memory, which allows for a more generational approach to tradition (Pauketat 2001:2). By viewing tradition as dynamic, this allows for the simultaneous existence of local variants and regional homogeneity. A practice-based approach also highlights that tradition and innovation are more closely intertwined than they initially appear. Innovations can only occur with the continued enactment of a tradition and can only be defined by actually referencing a tradition. A tradition also provides constraints that directly affect the range of new practices and possible innovations. These constraints can change as a tradition continues to be repeated over time.

The White Springs iron assemblage clearly demonstrates that the concepts of tradition and innovation are two sides of the same coin. Many of the modified objects were manufactured in reference to traditional Indigenous forms and created from a European material. Gun barrels and axe blades were transformed into scrapers, an implement fragment was manufactured into a beamer, a sword was crafted into a harpoon, and iron rods, spikes, and kettle bails were modified into awls, chisels, and punches. The majority of these modifications were not novel, equivalent object forms had long existed before the introduction of European trade goods. Iron and lead were also known materials at this time; they had already become a part of Onöndowa'ga:' culture in modified and unmodified forms. In Roger's (1990:106) classification system, iron use would be generally classified as *maintenance* because the "native program of artifact usage continues largely intact." However, the transformation of one object into another can still be considered innovative at the individual scale since a unique item was always being produced.

With a "dynamic-tradition position," traditions and patterns can still be named and interpreted (Pauketat 2001:5–6). They may also correlate to demographic shifts, movements, social disturbances, and hardships. In the case of White Springs, multiple lead musket balls were modified in a new and original way to increase lethality. This represents an "abrupt shift" in the composition of the lead assemblage and can be classified as *transformation* using Rogers' (1990:109) classification system. Considering that these fired projectiles were found within the actual settlement and the Onöndowa'ga:' political and economic situation was damaged due to multiple conflicts with Europeans and western Indigenous enemies during this time, this new innovative practice may have been a response to these difficult circumstances.

Conclusion

The usefulness of iron and lead artifacts in ascertaining valuable information about the past is not typically recognized in archaeological scholarship. Part of this is due to the fact that these objects are often challenging to identify as a result of extreme fragmentation and corrosion. However, issues of identification can be significantly mitigated by referencing museum collections and by taking digital radiographs. Many museum collections are comprised of reasonably complete objects and offer a comparison point for damaged artifacts, while radiographs penetrate corrosion products and elucidate surface characteristics and the overall shape of an object.

There is also a misconception that iron and lead were only utilized to manufacture mundane objects such as nails, hardware, and projectiles that provide little insight into past cultural practices. The White Springs iron and lead assemblages clearly refute this belief; they are comprised of a variety of tools, hardware components, fasteners, cooking implements, clothing items, recreational objects, containers, ornaments, and projectiles, which reveal information regarding Onöndowa'ga:' construction techniques, warfare tactics, and hunting practices. An analysis of these artifacts in conjunction with nail, iron, and lead density calculations also allowed for the identification of the various activities performed across the site, including tool manufacture, food preparation, and lead smithing.

An investigation of White Springs iron and lead use additionally created the opportunity to challenge the pervasive and problematic model of acculturation, which continues to permeate the field of Indigenous archaeology and studies of colonialism and cultural entanglement. This model argues that Indigenous peoples collectively experienced cultural decline and dependence on “superior” European trade goods. The White Springs assemblage provides evidence to the contrary. Trade items and traditional objects were simultaneously utilized at the site. Iron implements also failed to replace stone tools; the two technologies were concurrently used from 1688 to at least 1754 (Krohn 2010:65).

Although the Onöndowa'ga:' accepted certain European objects, this is evidence of active selection and agency, not decline. They had clear preferences regarding European technologies and made conscious selections when presented with an array of items. The White Springs iron and lead assemblages demonstrate that specific objects such as lead projectiles, kettles, awls, and axes were essential to daily life, while others were not. The residents of White Springs rejected items that have been recovered from other Hodinöhsö:ni' sites, including horse hardware, iron hoes, scythes, iron needles, fish hooks, iron projectile points, and silverware (Williams-Shuker 2005:262). Rogers (1990:108) argues that items are rejected because they do not fit into “the current cultural logic.”

The persistence of the acculturation model can be predominantly traced to a singular deep-rooted assumption: the concepts of tradition and innovation are fundamentally opposed. When the two are viewed as separate, any divergence from established and static “traditional” practices is recognized as a sign of cultural loss and inauthenticity. An analysis of Indigenous object use and modification can effectively reconcile these seemingly contradictory concepts with the application of practice-based approach. In the particular case of White Springs, construction techniques and modified objects were especially well-suited for this type of study because they synchronously contained aspects of “traditional” Indigenous culture and elements of innovation. Although tradition and innovation appear to be irreparably conflicted, a practice-based approach views these concepts as intertwined and inseparable. Traditions supply constraints that influence possible innovations, while innovations are created in reference to traditions. This allows for the simultaneous existence of conventional cultural traditions and new innovations. Therefore, new practices can be thought of as both traditional and innovative.

REFERENCES

Aid, Toney

2004 "Long-Stemmed Spuds." Central States Archaeological Journal, Vol. 51, no. No. 4. Central States Archaeological Societies, Inc.

Alexander, Rani T.

1998 Afterword: Toward an Archaeological Theory of Culture Contact. In *Studies in Culture Contact: Interaction, Culture Change, and Archaeology*, edited by James G. Cusick, 476-495. Center for Archaeological Investigations, Occasional Paper No. 25. Carbondale: Southern Illinois University.

Aquila, Richard

1983 *The Iroquois Restoration*. Detroit: Wayne University Press.

Bakker, Peter

1991 "A Basque etymology for the Amerindian tribal name *Iroquois*." *Anuario del Seminario de Filología Vasca* (ASJU Geh). 14(2): 1119–1124.

Birch, Jennifer, Sturt W. Manning, Samantha Sanft, and Megan A. Conger

2020 "Refined Radiocarbon Chronologies for Northern Iroquoian Site Sequences: Implications for Coalescence, Conflict, and the Reception of European Goods." *American Antiquity*, vol. 86, no. 1, 2020, pp. 218–218., doi:10.1017/aaq.2020.106.

Bradley, James W.

1980 "Ironwork in Onondaga, 1550-1650." In Nancy Bonvillain, ed., *Studies on Iroquoian Culture*, 109-17. Occasional Publications in Northeastern Anthropology No. 6. Rindge, N.H.: Department of Anthropology, Franklin Pierce College.

2005 *Evolution of the Onondaga Iroquois: Accommodating Change, 1500-1655*. Syracuse, NY.: Syracuse University Press.

2020 *Onondaga and Empire: An Iroquoian People in an Imperial Era*.
New York State Education Department, New York State Museum Bulletin No 514.

Brain, Jeffrey P.

1979 *Tunica Treasure. Papers of the Peabody Museum 78. Cambridge*, MA: Peabody Museum of Archaeology and Ethnology, Harvard University (tDAR id: 117857).

Bridges, Dusti C.

2019 The White Springs Palisade: Maybe? May 2019, PowerPoint Presentation, Cornell University, Ithaca, NY.

Disotell, Samuel R.

2021 *Faunal Analysis of White Springs: A 17th–18th Century Seneca Town in Upstate New York.* Master's Thesis, Cornell University.

Egan, Geoff

1994 *Lead Cloth Seals and Related Items in the British Museum*. Department of Medieval and Later Antiquities, British Museum, occasional paper 93. London: Brit. Mus.

Fenton, William N., and Elizabeth L. Moore, eds.

1977 *Customs of the American Indians Compared with the Customs of Primitive Times*, by Joseph-Francois Lafitau. Vol. 2. Publications of the Champlain Society 49. Toronto: Champlain Society.

Gehring, Charles T., and William A. Starna, eds.

2010 *A Description of New Netherland*. By Adriaen van der Donck. Translated by Diederik Willem Goedhuys, University of Nebraska Press. Originally published in 1655.

Gerard-Little, Peregrine A.

2011 *Understanding the Built Environment at the Seneca Iroquois White Springs Site (1688-1715): Incorporation of Small-Scale, Multi-Instrument Archaeogeophysical Survey.* Master's Thesis, Cornell University.

Haan, Richard

1976 *The Covenant Chain: Iroquois Diplomacy on the Niagara Frontier, 1697-1730.* Doctoral dissertation, University of California, Santa Barbara. Ann Arbor, Mich.; University Microfilms.

Hamilton, T.M.

1976 *Firearms on the Frontier: Guns at Fort Michilimackinac 1715-1781*. Reports in Mackinac History and Archaeology, No. 5. Mackinac Island State Park Commission, Williamston.

Havard, Gilles

2001 *The Great Peace of Montreal of 1701*. Translated by Phyliss Aronoff and Howard Scott. Montreal: McGill-Queen's University Press.

Hesse, Franklin J.

1975 "The Egli and Lord Sites: The Historic Component–'Unadilla' 1753-1778". *The Bulletin: New York State Archaeological Association* 63: 14-31.

Houghton, Frederick

1912 "The Seneca Nation from 1655 to 1687." *Bulletin of the Buffalo Society of Natural Sciences*, X, no. 2, 1912, pp. 363–476.

1922 “The Traditional Origin and the Naming of the Seneca Nation.” *American Anthropologist*, vol. 24, no. 1, pp. 31–43., doi:10.1525/aa.1922.24.1.02a00040.

Jameson, John Franklin, ed.

2009 *Narratives of New Netherland, 1609-1664*. Charles Scribner’s Sons, New York. Originally published in 1909.

Jordan, Kurt A.

2001 “Smiths and Senecas: Iron Tool Production and Use at the Townley-Read Site, ca. A.D. 1715-1754.” Report submitted to the Early American Industries Association in fulfillment of 1999 John S. Watson Grant.

2004 “Field Methods for Exploring a Dispersed Village: Lessons from the Eighteenth Century Seneca Townley-Read Site.” *Annual Meeting of the New York State Archaeological Association*.

2008 *The Seneca Restoration 1715-1754*. Gainesville, FL.: University of Florida Press.

2018 “From Nucleated Villages to Dispersed Settlements Transformations in Seneca Haudenosaunee (Iroquois) Community Structure, circa AD 1669-1779.” In *the Archaeology of Villages in Eastern North America*, edited by Jennifer Birch and Victor D. Thompson, University of Florida Press, pp. 174–191.

2019 “Neither Contact nor Colonial: Seneca Iroquois Local Political Economies, 1670-1754.” In *Indigenous Persistence in the Colonized Americas: Material and Documentary Perspectives on Entanglement*. Edited by Heather Law Pezzarossi and Russell N. Sheptak, University of New Mexico Press, pp. 39–56.

2020 “White Springs Test Unit and Feature Excavation Report.” Unpublished raw data.

Kane, Maeve

2014 “Covered with Such a Cappe: The Archaeology of Seneca Clothing, 1615-1820.” *Ethnohistory*, vol. 61, no. 1, pp. 1–25., doi:10.1215/00141801-2376060.

Kapches, Mima C.

1984 “Cabins on Ontario Iroquois Sites.” *North American Archaeologist* 5: 63-71.

Keener, Craig S.

1998 *An Ethnohistoric Perspective on Iroquois Warfare during the Second Half of the Seventeenth Century (A.D. 1649-1701)*. Doctoral dissertation, Ohio State University. Ann Arbor, Mich.; University Microfilms.

1999 “An Ethnohistorical Analysis of Iroquois Assault Tactics used Against Fortified Settlements of the Northeast in the Seventeenth Century.” *Ethnohistory*, Vol. 46, No. 4, Warfare and Violence in Ethnohistorical Perspective, pp. 777-807.

Konrad, Victor

1981 "An Iroquois Frontier: The North Shore of Lake Ontario during the Late Seventeenth Century." *Journal of Historical Geography* 7:129-44.

Krohn, Matthew R.

2010 *Innovation and Identity in Seneca Iroquois Lithic Debitage: Analysis of Stone Tools from the White Springs and Townley-Read Sites, circa 1688-1754.* Master's Thesis, Cornell University.

Kuhn, Robert D., David B. Guldenzopf, Pamela E. Sugihara, and Mary Schwarz

1986 "The Jackson-Everson Site (NYSM 1213)." In Robert D. Kuhn and Dean R. Snow, eds., *The Mohawk Valley Project: 1983 Jackson-Everson Excavations,* 7-33. Albany Institute for Northeast Anthropology, State University of New York.

Law-Pezzarossi, Heather

2014 "Assembling Indigeneity: Rethinking Innovation, Tradition and Indigenous Materiality in a 19th-Century Native Toolkit." *Journal of Social Archaeology*, vol. 14, no. 3, 2014, pp. 340–360., doi:10.1177/1469605314536975.

Loewen, Brad

2016 "Intertwined Enigmas: Basques and Saint Lawrence Iroquoians in the Sixteenth Century." In *Contact in the 16th Century: Networks among Fishers, Foragers, and Farmers*, edited by Brad Loewen and Claude Chapdelaine, Mercury Series Archaeology Paper, 176. Canadian Museum of History and the University of Ottawa. Gatineau, QC and Ottawa, ON.

McIlwain, Charles Howard, ed.

1915 *An Abridgement of the Indian Affairs Contained in Four Folio Volumes, Transacted in the Colony of New York, From the Year 1678 to the Year 1751*. By Peter Wraxall. Cambridge, Mass.: Harvard University Press.

Moorehead, Warren King, Arthur C. Parker, Edward H. Williams

1917 *Stone Ornaments Used by Indians in the United States and Canada: Being a Description of Certain Charm Stones, Gorgets, Tubes, Bird Stones and Problematical Forms*. Andover Press. Andover: Massachusetts.

Moutner, Amanda K.

2013 *Understanding Landscape Modification at White Springs Manor, Geneva, New York: An Archaeological and Historical Study.* Master's Thesis, Cornell University.

Navias, Robert A.

1995 "Iroquois Lanceolate Projectile Points." *The Bulletin: Journal of the New York State*

Archaeological Association 109:28-33.

NYCD. See O'Callaghan, E.B., ed. 1969 [1853-1887].

O'Brien, J.M.

2010 *Firsting and Lasting: Writing Indians Out of Existence in New England*. Minneapolis: University of Minnesota Press.

O'Callaghan, E.B., ed.

1969 [1853-1887] *Documents Relative to the Colonial History of the State of New York*. 15 vols. New York, A.M.S. Press.

Pauketat, Timothy

2001 "A New Tradition in Archaeology." In: Pauketat T (ed.) *The Archaeology of Traditions: Agency and History Before and After Columbus*. Gainesville: University of Florida Press, pp. 1–16

Perino, Gregory

1964 "The Grove Spud." *Central States Archaeological Journal*, Vol. 1, pp.4–6.

Potter, Gail Debuse, and James A. Hanson

2001 "Shot Sizes—What Do They Mean?" *Museum of the Fur Trade Quarterly,* 7–13.

Poulton, Dana R.

1991 Report of the 1991 Archeological Investigations of the Bead Hill Site, City of Scarborough, Ontario. Unpublished Report on file with Ontario Service Center, Parks Canada, Cornwall, Ontario.

Prezzano, Susan Carol

1992 *Longhouse, Village, and Palisade: Community Patterns at the Iroquois Southern Door*. Doctoral dissertation, State University of New York at Binghamton. Ann Arbor, Michigan: University Microfilms.

Rapp, George R.

2002 *Archaeomineralogy*. Germany, Springer-Verlag Berlin Heidelberg.

Reinprecht, Ladislav

2016 *Wood Deterioration, Protection and Maintenance*. John Wiley & Sons, Ltd. West Sussex, United Kingdom.

Richter, Daniel K.

1992 *The Ordeal of the Longhouse.* Chapel Hill: University of North Carolina Press.

Rogers, Daniel J.

1990 *Objects of Change: The Archaeology and History of Arikara Contact with Europeans*. Washington, D.C.: Smithsonian Institution Press.

Rumrill, Donald A.

1985 "An Interpretation and Analysis of the Seventeenth Century Mohawk Nation: Its Chronology and Movements." *The Bulletin and Journal for New York State*, no. 90, pp. 1–40.

Ryan, Beth, and Adam G. Dewbury

2010 The Eugene Frost Collection: Artifacts from the Seneca Iroquois Dann Site, circa 1655-1675. Report on file with Division of Rare and Manuscript Collections, Cornell University Library, Ithaca, N.Y.

Sempowski, Martha L., and Lorraine P. Saunders

2001a *Dutch Hollow and Factory Hollow the Advent of Dutch Trade Among the Seneca Part One*. Rochester Museum and Science Center Research Records No. 24. Rochester, NY.: Rochester Museum and Science Center.

2001b *Dutch Hollow and Factory Hollow the Advent of Dutch Trade Among the Seneca Part Two*. Rochester Museum and Science Center Research Records No. 24. Rochester, NY.: Rochester Museum and Science Center.

Serneels, Vincent and Sébastien Perret

2003 "Quantification of Smithing Activities Based on the Investigation of Slag and Other Material Remains." Proceedings of the International Conference, Milano, September 24-26, 2003, Archaeometallurgy in Europe, p. 469-478.

Shannon, Timothy

2016 "Iroquoia." In *the Oxford Handbook of American Indian History*, edited by Frederick E. Hoxie, Oxford University Press.

Silliman, Stephen W.

2009 "Change and Continuity, Practice and Memory. Native American Persistence in Colonial New England." *American Antiquity* 74(2): 211–230.

Silverman, David J.

2016 *Thundersticks: Firearms and the Violent Transformation of Native America*. The Belknap Press of Harvard University Press, 2016.

Snow, Dean R.

1994 *The Iroquois*. Cambridge, Mass.: Blackwell.

1995 *Mohawk Valley Archaeology: The Sites*. Maton Museum of Anthropology, Pennsylvania State University, University Park.

Stine, Roy S.

2000 “Finding the Forge: Geographic Visualization in Archaeology.” *Historical Archaeology* 34(4): 61–73.

Stiner, Mary C.

1990 “The Use of Mortality Patterns in Archaeological Studies of Hominid Predatory Adaptations.” *Journal of Anthropological Archaeology*, vol. 9, no. 4, pp. 305–351, doi:10.1016/0278-4165(90)90010-b.

Stone, Lyle M.

1974 *Fort Michilimackinac, 1715–1781: An Archaeological Perspective on the Revolutionary Frontier*. Vol. 2, Publications of the Museum, Michigan State University, East Lansing, Michigan.

Thwaites, R., ed.

1896-1901 *The Jesuit Relations and Allied Documents: Travels and Explorations of The Jesuit Missionaries,* In *New France, 1610-1791*. 73 vols. Cleveland, OH: Barrow Brothers Company.

Todd, Lawrence C., and Jack L. Hofman

1987 “Bison Mandibles from the Horner and Finley Sites.” *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G.C Frison and L.C. Todd, pp. 493–539., doi:10.1016/b978-0-12-268566-8.50026-9.

Trigger, Bruce

1990 *The Huron: Farmers of the North*. 2nd ed. Fort Worth, TX.: Harcourt Brace Jovanovich College Publishers.

University of Michigan Museum of Anthropological Archaeology

2020 “UM Museum of Anthropological Archaeology Image Database.” *UM Museum of Anthropological Archaeology*, quod.lib.umich.edu/a/anthro1ic?page=index.

Whitney, William D.

1914 *The Century Dictionary and Cyclopedia with a New Atlas of the World: A Work of General Reference in All Departments of Knowledge*. Edited by Benjamin E. Smith, Revised and Enlarged ed., vol. 9. New York, NY: The Century Company.

Williams, Kayanesenh Paul.

2018 *Kayanerenkó:Wa: The Great Law of Peace*. University of Manitoba Press.

Williams, Kayenesenh Paul, Kenneth Atsenhaienton Deer, Agnes F. Williams, and Iakoiane Wakerahkats:teh Louise McDonald

2019 “Practicing Peace for Climate Justice: Haudenosaunee Knowledge in a Global Context.”

Panel Event, Cornell University, Ithaca.

Williams-Shuker, Kimberley L.

2005 *Cayuga Iroquois Households and Gender Relations During the Contact Period: An Investigation of the Rogers Farm Site, 1660s-1680s*. Doctoral dissertation, University of Pittsburgh.

Witthoft, John

1951 “The Chewed Bullet.” *Pennsylvania Archaeologist Bulletin of the Society for Pennsylvania Archaeology*, vol. 21, no. 3-4, 1951, pp. 60–61.

Wray, Charles F.

1983 “Seneca Glass Trade Beads c. A.D.1550-1820”. In Charles F. Hayes III, ed., Proceedings of the 1982 Glass Trade Bead Conference, 41-49. Rochester Museum and Science Center Research Records No. 16. Rochester, N.Y.: Rochester Museum and Science Center.

1985 “The Volume of Dutch Trade Goods Received by the Seneca Iroquois, 1600-1687 A.D.” *Bulletin Koninklijke Nederlanse Oudheidkundige Bond* 84(2-3):100-112.

Wray, Charles F., Martha L. Sempowski, Lorraine P. Saunders, and Gian Carlo Cervone

1987 *The Adams and Culbertson Sites*. Vol. 1, Rochester Museum and Science Center

1991 *Tram and Cameron: Two Early Contact Era Seneca Sites*. Vol. 2, Rochester Museum and Science Center.

Wray, Charles F., and Harry L. Schoff

1953 “A Preliminary Report on the Seneca Sequence in Western New York,” 1550-1687. *Pennsylvania Archeologist* 23: 53-60.

Wray, Charles F. and Robert J. Graham

1985 “The Boughton Hill Site, Victor, New York.” *The Iroquoian*, vol. 10.