A Quantitative Dwelling-Scale Approach to the Social Implications of Maize Horticulture in New England

William A. Farley, Amy N. Fox, and M. Gabriel Hrynick

We compare domestic architectural features in New England and the Maritime Peninsula to investigate the relationship between the adoption of horticulture and its relationship to social and settlement change during the Woodland Period. Horticulture was not practiced on the Maritime Peninsula until after European contact, despite cultural and environmental similarity to New England. In New England, horticulture has been implicated in profound social and settlement changes. However, aggregated villages, a unit typically investigated for evidence of social change, have proven elusive in the archaeological record. We compiled and analyzed a dataset of dwelling features instead of relying on identifiable villages. This novel quantitative approach uses dwelling feature shape and size as a proxy for social and settlement change, considering these changes at the scale of the house. We find that, during the Woodland Period, dwelling size was overall slightly larger in New England than on the Maritime Peninsula, but ranges heavily overlapped. After the introduction of horticulture, however, dwellings in New England grew in size overall and assumed bimodally distinct larger and smaller forms, which likely necessitated a restructuring of social and economic behavior. This pattern correlates maize horticulture with changes in social and economic lifestyle in Late Woodland New England.

Keywords: architecture, village, sedentism, horticulture, maize, nonparametric analysis, Native American, New England, Maritime Peninsula, Woodland

Nous comparons des structures d'habitation domestiques de sites archéologiques de la Nouvelle-Angleterre et de la péninsule maritime afin d'explorer les conséquences de l'adoption généralisée de l'horticulture en termes de changements sociaux et de transformation des modes d'établissement en Nouvelle-Angleterre à la période Sylvicole. L'horticulture ne fut pas pratiquée dans la péninsule maritime avant la période du contact européen, malgré de fortes similarités culturelles et environnementales avec la Nouvelle-Angleterre. En Nouvelle-Angleterre, l'horticulture est présentée comme ayant été la source de changements sociaux profonds et d'une transformation des modes d'établissement. Au niveau archéologique cependant les sites de village font défaut, alors qu'ils constituent habituellement un repère pour l'identification et l'étude des changements sociaux; cette situation a provoqué des débats sur l'impact socio-économique de l'horticulture. Nous analysons ici un ensemble de données concernant des structures d'habitation individuelles en faisant fi de l'idée selon laquelle l'étude d'un village bien défini est nécessaire. Cette approche quantitative novatrice nous permet d'aborder la question des changements sociaux et de l'évolution des modes d'établissement à l'échelle de l'habitation, par l'intermédiaire de la forme et des dimensions des structures. Nous observons que durant la période sylvicole la taille des structures d'habitation était en général légèrement plus grande en Nouvelle-Angleterre que dans la péninsule maritime, malgré une fourchette de dimensions comparable pour les deux régions. Les habitations de la Nouvelle-Angleterre voient toutefois leur taille augmenter après l'introduction de l'horticulture, alors que se développe une division bimodale entre de grandes et de petites structures, changements rendus possibles par une probable réorganisation des comportements économiques et sociaux. Cette tendance met en corrélation la culture du maïs avec une transformation des modes de vie économiques et sociaux en Nouvelle-Angleterre durant le sylvicole supérieur.

Mots-clés: architecture, village, sédentarité, horticulture, maïs, analyse non paramétrique, amérindiens, Nouvelle-Angleterre, Péninsule maritime, période Sylvicole

Over much of New England, evidence for domesticated maize (*Zea mays*) appeared on archaeological sites dating only after approximately 1000 BP. Around that same time, major settlement and social organization shifts culminated in the formation of the sedentary villages that Europeans observed at contact. However, the reasons for this change in

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organization, and the creation of these observed villages, are still unidentified in this region, prompting a robust debate about what role maize proliferation might have played (Bragdon 1996; Ceci 1990; Chilton 1999, 2004, 2008; Dewar and McBride 1992; Hart and Lovis 2013; McBride and Dewar 1987). Traditional, accepted models about the social and cultural effects of maize horticultural adoption and practice anticipate that its introduction to a region resulted in increased sedentism, incipient social inequality, expanding population, and a variety of tasks being completed at the same site as opposed to in dispersed locations. In the present study, we evaluate the nature of maize's impact on a culture and an economy at the scale of the individual dwelling, an archaeological feature that is both ubiquitous and free of the many burdensome analytical constraints of the village.

We address this question using a quantitative dwelling-scale approach comparing a region we call "archaeological New England"—which we define as including portions of New York and excluding most of Maine, based upon the geographic spread of maize in the Algonquian homeland—with coeval developments on the Maritime Peninsula, which includes the Gaspé Peninsula, as well as parts of Maine, and the Canadian Maritime Provinces (Figure 1), where maize was not adopted until after European contact. We compare dwelling size and shape because, cross-culturally, these factors tend to correspond to changes in sedentism and social organization. Examples from around the globe show that the adoption of horticulture has specific local effects on house size (Binford 1990; Carleton et al. 2013; Coupland and Banning 1996; Ember 2014; Hassan 1981; McGuire and Schiffer 1983; Robbins 1968; Ryan 2012; Steadman 2015; Warrick 2000; Whiting and Ayres 1968; Wilk and Rathje 1982; Wolff 2008:200–223). The present experimental design tests for correlation between dwelling size and maize horticulture in New England using the Maritime Peninsula as a control for environmental, temporal, cultural, and other variables, allowing us to eliminate their possible effects.

Problem Orientation: The Impact of Maize in Prehistoric New England

Despite recent critiques, an implicitly evolutionary notion of Woodland culture periods (sensu Griffin 1952, 1967; McKern 1939) has retained potency in the archaeology of eastern North America (Chilton 2004; Leonard 1995; McBride and Dewar 1987; Ritchie and Funk 1973; Wiseman 2005). In this formulation, the Woodland period in New England is marked by ceramic vessels, elaborated burials, economic intensification leading to horticulture, population growth, and increasingly sedentary lifeways. Social changes, such as a shift from patrilineal bands to matrilineal tribes, have also been proposed (Bendremer 1999; Chilton 2004; Flannery 2002; Lavin 2013; McBride and Dewar 1987). In New England, these developments are ultimately posited to lead to the establishment of "villages" modeled after Europe's Neolithic (see McBride and Dewar 1987). The criteria offered for a village vary in detail, but they are usually modeled to exhibit at least near-year-round settlement of multiple families in close proximity and represent a broad range of activities (McBride 1984:228–229). In New England and the Maritime Peninsula, the appearance of multiple multi-seasonally occupied, coterminous domestic features would be broadly interpreted to be a "village" by most archaeologists.

The constellation of traits that define the Woodland period did not occur synchronously in New England. Accumulated archaeological research is elucidating the interrelationship between these changes, encouraging new analyses of this period that implicate social factors in the development of the Woodland and changes within it (e.g., Chilton 1999; Hart and Lovis 2013; Hart and Means 2002; Leveillee et al. 2006; Taché and Craig 2015; Waller 2000). Furthermore, despite early European settler reports of sedentary horticultural villages along the New England coast, these settlements have not been conclusively identified in the regional prehistoric archaeological record. Because of this paucity of data, there remain considerable questions about what the social and subsistence implications of maize horticulture were in New England.

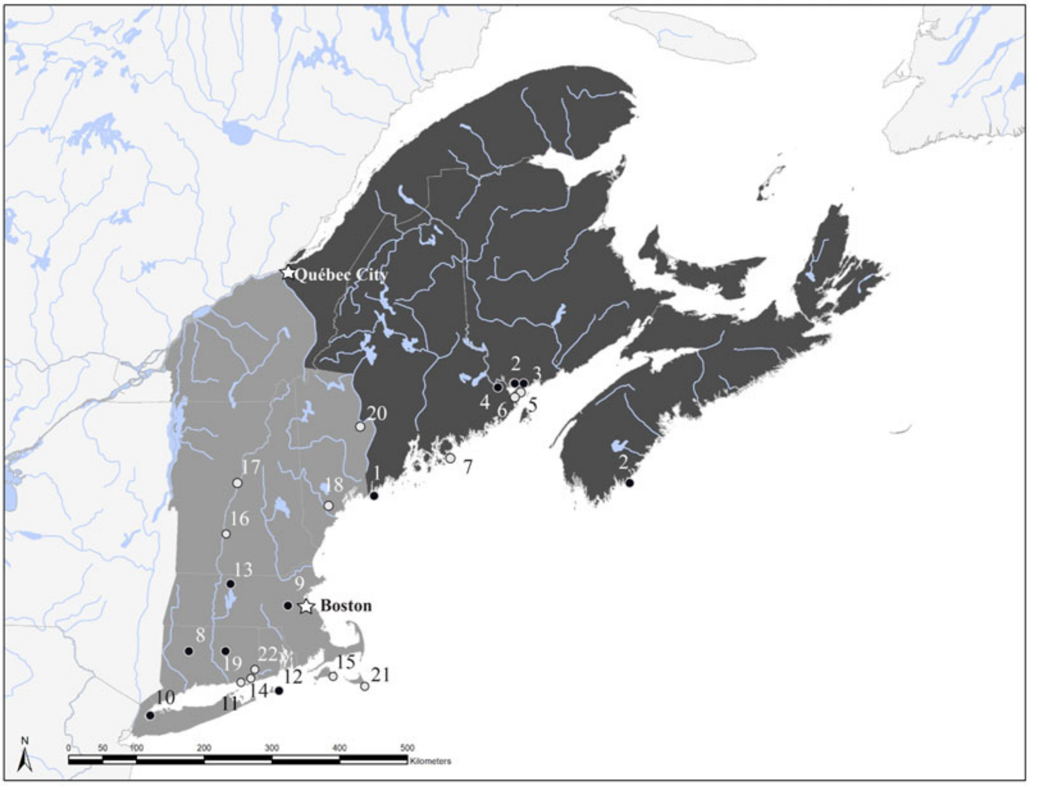

Figure 1. Map of study region discussed in this paper. The New England archaeological region is shown in light gray, and the Maritime Peninsula is shown in dark gray. The dividing line between the regions is the Kennebec River region of Maine, which approximately corresponds to the likely northern expanse of maize horticulture prior to European contact. Dots represent sites included in our analysis and correspond to Table 1. Black dots are sites from before 1000 BP, and gray dots are sites from after 1000 BP. Map prepared by the authors and Noah Fellman.

It is generally accepted that although maize horticulture has a complicated history of domestication (Hart and Lovis 2013), substantive maize horticulture likely proliferated in the lower Connecticut River Valley, arriving from the southwest sometime in the Late Woodland Period (1300–500 BP), around 1000 BP (see Chilton 2004). There is some evidence to suggest that local native people may have been actively cultivating wild or, possibly, semidomesticated varieties of goosefoot (*Chenopodium* spp.; George and Dewar 1999; Gremillion 1993). The earliest recorded example of charred *Chenopodium* dates to the Late Archaic, but it is absent from that period until the Late Woodland period, where it is found alongside maize (*Zea mays)* at several sites in Connecticut (George and Dewar 1999: 125–131). Many Late Woodland sites in New England have yielded preserved maize and other evidence of maize horticulture (e.g., Bendremer 1999:134; Cowie and Peterson 1990; Currie 1994; Hasenstab 1999:148–149; Heckenberger et al. 1992; Lavin 2013:222–223; Petersen and Cowie 2002). Indigenous people in New England maintained a broad-spectrum diet, even after the emergence of horticulture, with maize becoming a true staple crop only after the arrival of European settlers in the seventeenth century (Bragdon 1996; Cronon 2013).

There has been less consensus about the cultural and economic significance of maize in prehistory. The central confounding factor in this debate is that Late Woodland horticultural *villages* have not been confidently identified in prehistoric New England, a phenomenon that has eluded confident explanation. Some scholars, notably Ceci (1982, 1990), have suggested that there simply were no Late Woodland villages.

Table 1. Fully or Nearly Fully Excavated Dwelling Features Considered in This Study, Including Derived Feature Area and Roundness Ratio. The map number indicates site location on Figure 1. Also reported is whether preserved maize macrofossils were found in association with each feature, a phenomenon that only occurred at New England sites after 1000 BP. Dating method, radiocarbon lab number, conventional and calibrated radiocarbon dates, estimated date ranges from artifacts, and citations are also reported.

Figure 1 Map Number	Site Name and Feature Designator	Area (m^2)	Roundness Ratio	Preserved Maize Macrofossils Recovered	Dating Method[a]	Radiocarbon Lab #	Conventional ^{14}C Age (BP) or Estimated Age Range from Artifacts (BP)[b]	2σ cal BP[c]	Citation[d]
					Maritime Peninsula				
1	Moshier Island Structure 1	3.14	1.00	No	Radiocarbon Date	GX-6882	4225 ± 150	5288–4416	Yesner 1984:66
1	Moshier Island Structure 2	3.14	1.00	No	Radiocarbon Date	Beta 6406	2210 ± 320	3004–1421	Yesner 1984:58
2	AlDf-30 Feature 2	6.59	0.93	No	Radiocarbon Date	Beta 341499	1410 ± 30	1360–1285	Betts et al. 2017:24; Hrynick and Betts 2014:99
3	Teacher's Cove Feature 2	5.51	0.96	No	Radiocarbon Date	S-609	1635 ± 60[e]	1232–857	Davis 1978:32
3	Teacher's Cove Feature 3	5.93	0.96	No	Radiocarbon Date	S-609	1635 ± 60[e]	1232–857	Davis 1978:32
3	Teacher's Cove Feature 4	4.14	0.55	No	Radiocarbon Date	S-609	1635 ± 60[e]	1232–857	Davis 1978:32
3	Teacher's Cove Feature 5	3.43	0.83	No	Radiocarbon Date	S-609	1635 ± 60[e]	1232–857	Davis 1978:32
3	Teacher's Cove Feature 1	5.89	0.83	No	Radiocarbon Date	S-608	1170 ± 100	1289–926	Davis 1978:16
2	AlDf-30 Feature 1	5.89	0.83	No	Radiocarbon Date	Beta 341498	1380 ± 30	1344–1270	Betts et al. 2017:24; Hrynick and Betts 2014:99
4	Sandy Point Feature 2	6.48	0.76	No	Radiocarbon Date	S-2185	1320 ± 90	1693–1295	Canadian Archaeological Radiocarbon Database 2018; see Lavoie 1972
5	Minister's Island Feature 1	6.91	0.55	No	Radiocarbon Date and Seriation Typology	GSC-1674	1060 ± 40[f]	1059–922	Sanger 1987:106
5	Minister's Island Feature 3	4.40	0.71	No	Radiocarbon Date	Beta 346114	910 ± 30	917–746	Hrynick and Black 2016:33; See Sanger 1987
6	AlDf-24	8.24	0.86	No	Radiocarbon Date	Beta 286106	660 ± 40	677–553	Betts et al. 2017:24; Hrynick et al. 2012:9
7	Flye Point-2	9.55	0.84	No	Radiocarbon Date	Beta 5919 Beta 6333	420 ± 60 490 ± 90	539–315 660–316	Cox 1983:90

Table 1. Continued.

Figure 1 Map Number	Site Name and Feature Designator	Area (m^2)	Roundness Ratio	Preserved Maize Macrofossils Recovered	Dating Method[a]	Radiocarbon Lab #	Conventional ^{14}C Age (BP) or Estimated Age Range from Artifacts (BP)[b]	2σ cal BP[c]	Citation[d]
					New England				
8	Kirby Brook Site Structure 1	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 2	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 3	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 4	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 5	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 6	7.07	1.00	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 7	7.85	0.63	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 8	7.85	0.63	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 9	7.85	0.63	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 10	7.85	0.63	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 11	11.78	0.60	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
8	Kirby Brook Site Structure 12	11.78	0.60	No	Seriation Typology		3800–2700		Lavin 2013:132–133; Swigart 1974:28–31
9	Oak Knoll Site	0.59	0.75	No	Seriation Typology		3400–2200		Johnson 2012:10–13
10	Morris Estate Club Site	5.72	1.00	No	Seriation Typology		3400–2200		Juli and Lavin 1996; Kaser 1978:38
11	Timothy Stevens Site	19.63	1.00	No	Radiocarbon Date		reported radiocarbon dates 2740 and 2460 BP	2821 and 2644	Lavin 2013:132
12	RI 1428	21.20	0.33	No	Seriation Typology		3400–2200		Tveskov 1992; Tveskov 1997:347
13	Wills Hill Site	8.98	0.53	No	Seriation Typology		2200–1300		Heckenberger et al 1992:134; Thomas 1979:106

14	Military Academy Site	63.19	0.61	Yes	Seriation Typology		970BP ± 110 720BP ± 60	1173–681 762–554	Lavin 2013:183 (note no laboratory information reported)
15	Cunnningham Site	22.05	1.00	No	Seriation Typology	Y-1652	800 ± 80	916–570	Juli and Lavin 1996; Ritchie 1969:88–124
16	Skitchewaug Site Housepit 1	17.66	0.90	Yes	Radiocarbon Date and Seriation Typology	Beta 29831	730BP ± 60	781–558	Hasenstab 1999:148–149; Heckenberger et al. 1992
16	Skitchewaug Site Housepit 2	17.66	0.90	Yes	Radiocarbon Date and Seriation Typology	Beta 29831	730BP ± 60	781–558	Hasenstab 1999:148–149; Heckenberger et al. 1992
17	Orange County Longhouse	98.13	0.20	Yes	Dating Method Not Provided		1000–500		Haviland and Power 1994:138; Skinas 1993:6–7; Wiseman 2005:211
18	Early Fall Site	14.18	1.00	Yes	Radiocarbon Date		670BP ± 70	725–538	Heckenberger et al 1992; Cowie and Petersen 1990:214 (note no laboratory information reported)
19	Griswold Point Site Structure 1	26.30	0.75	No	Radiocarbon Date	Beta 13976 Beta 15993	510 ± 110 780 ± 110	673–315 925–553	Juli and Lavin 1996
19	Griswold Point Site Structure 2	16.49	0.76	No	Radiocarbon Date	Beta 13976 Beta 15993	510 ± 110 780 ± 110	673–315 925–553	Juli and Lavin 1996
20	Norridgewock Site	98.13	0.20	Yes	Seriation Typology		500–300		Hasenstab 1999:148–149; Cowie et al. 1995
21	The Coffin Farm Complex 1 Site	117.75	0.67	Yes	Historic Documentation		291		Rainey 2010:46
22	Monhantic Fort	25.12	0.50	Yes	Historic Documentation		280		Benard 2005:31

[a]Reported method used to date features. These dates have all been previously published. Some features were dated using radiocarbon dates, some by seriation typologies of diagnostic artifacts such as lithics or ceramics, some by a combination of the two, and others were dated using historic documentation. Note that, in some cases, only partial information was provided by previous researchers regarding radiocarbon dates.
[b]Conventional radiocarbon age (± 1σ error) reported in radiocarbon years before AD 1950 (BP). All radiocarbon dates were previously published, and none were newly taken for the analysis in this paper. Non-radiocarbon dates in this column are derived from seriation typologies of diagnostic artifacts such as lithics or ceramics found in feature contexts or from historic documents.
[c]Calibrated with OxCal version 4.3 (Ramsey 2009) using IntCal13 calibration curve from Reimer et al. 2013.
[d]Reference to original publication of each feature. Page numbers indicate the specific reference to radiocarbon dates.
[e]This radiocarbon date was approximated by using the Marine13 curve (Reimer et al. 2013) with a localized marine reservoir correction of 160 ± 60 BP from St. Andrews, New Brunswick (McNeely et al. 2006) in order to make the shell date commensurate with charcoal and terrestrial bone dates.
[f]We interpret this feature (following Sanger 1987) as Middle Woodland based on this radiocarbon date and the association with dentate motif ceramics (see Petersen and Sanger 1993).

This is consistent with some views of the Woodland that downplay the socioeconomic impact of maize. These models suggest that maize may simply have been treated as another more-or-less predictable botanical resource of comparable import to wild plants (see Bendremer 1999; Bragdon 1996; Chilton 2008) with Late Woodland people in New England continuing to be broad-spectrum foragers to the degree that they were effectively "mobile farmers" (Chilton 1999). Scholars have noted the continued relevance of such "wild" plant and animal species at archaeological sites both before and after the appearance of maize, as well as related domesticates such as beans and squash, and they have surmised that horticulture did not have the massive impact on subsistence, settlement, and social hierarchy that it did in regions to the west and south (Bendremer 1999; Chilton 1999, 2008; McBride 1984; McBride and Dewar 1987).

Other scholars have suggested that the absence of prehistoric horticultural villages is an archaeological illusion, likely due to sampling bias, low archaeological visibility (e.g., Petersen and Cowie 2002:268), or sites' destruction when Euro-American towns and cities were built (Hasenstab 1999:140–142). Bendremer (1999:143) argues that "large, essentially non-horticultural, sedentary villages of logistically organized foragers were established in the lower Connecticut River valley and coastal region by the late Middle Woodland period" (also McBride 1984). He goes on to argue that this may represent regional variation, in which inland peoples were more likely to aggregate, whereas coastal peoples remained largely mobile to exploit shellfish. Bragdon (1996) viewed similar regional variation in the Late Woodland not as indicative of separate populations but of the same groups of people practicing seasonal relocation to maintain the use of long-standing traditions of hunting and gathering alongside newly available horticultural resources.

Leveillee and colleagues (2006) propose an intermediate hypothesis—a "dispersed" model for New England villages within which the activities of village life might be spread over a larger area than that which previous models appreciated, while at the same time retaining village sociality:

> [T]he social landscape included collective communities, each characterized by a series of cooperative households within dispersed villages…characterized by domestic dwellings where nuclear and extended families lived and carried out activities primarily in support of their own household [Leveillee et al. 2006:85]

While more research is required at the landscape level to better evaluate this model, Leveillee and colleagues offer two Late Woodland sites as potential central places: RI-110 on Point Judith Pond, Rhode Island; and RI-2280 on Quonchontaug Pond (see Waller 2000). They envision these sites and surrounding landscapes as likely corresponding to a dispersed village model, characterized by a variety of feature types and represented activities, plausibly associated with a political community consisting of core aggregations surrounded by residential "hamlets."

A Comparative Approach Using Dwelling Features

Unlike villages, domestic architectural features are fairly prevalent in the archaeological record starting around 3400 BP during the Terminal Archaic in New England, and around 3000 BP at the beginning of the Woodland on the Maritime Peninsula. Although archaeologists have long been interested in Indigenous architecture in the greater Northeast (e.g., Matthew 1884; Sturtevant 1975), the landscape and "village" levels of settlement have received more archaeological and ethnographic attention in New England. (Notable exceptions are included in a 1984 issue of *Man in the Northeast*, which focused on New England households, both historic and prehistoric [Kerber 1988; Luedtke 1988; Thorbahn 1988].) Throughout the Northeast, prehistoric dwelling construction is inferred via direct-historic analogy (Sanger 2010). On the Maritime Peninsula and in New England, early European accounts described small, oval, bark- or hide-covered wigwams with bent poles, fairly straight sides, and smoke holes (e.g., Heath 1986: 28–29; Le Clercq 1910:100–101; Sturtevant 1975; Thwaites 1898:40–41; Wood 1865:105–106; Wroth 1970:139; see Glick 2013).

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Here, we use the term "dwelling feature" to impart and subsume the excavators' and our own inferences of features that represent past dwellings and correspond to the ethnographic accounts described above. Combined, these inferences are based on shape, minimum size, and activities represented within the features. In the Northeast, the categories of dwelling or house feature have developed inferentially and iteratively such that they must be treated as polythetic sets (sensu Clarke 1978:35–37). Accordingly, our analyses check reported features for defined dwelling attributes described elsewhere (e.g., Glick 2013; Hrynick 2018; Sanger 2010) while excluding suites of attributes for other structures such as sweathouses (e.g., Hrynick and Betts 2014) or storage pits (e.g., Black and Whitehead 1988). Figure 2 provides an example of an archaeologically investigated dwelling feature from the site of Monhantic Fort in Mashantucket, Connecticut. This feature is included in the statistical analyses of this paper and is presented here as one example of how the houses in our dataset were originally interpreted as such. The Monhantic Fort feature was identified by several diagnostic archaeological signatures. As Figure 2 reveals, the archaeological block contained many post molds. Archaeologists isolated an ovoid pattern of posts within the palimpsest. That proposed feature was further delineated by the presence of an internal hearth and external storage pits as well as artifact concentrations that were strongly grouped on the interior and exterior of the house feature suggesting a dwelling wall, including an abrupt increase in the concentration of ceramics found on the inside of the inferred house (see Benard 2005:27–40).

Dwelling features are a valuable scale of analysis because changes to their size and shape through time suggest shifts in settlement and subsistence strategies. Such changes are often similar to those that would be implicated in Woodland villages. Cross-culturally, dwellings tend to covary in form and size with changes in mobility, kinship, gender dynamics, and cosmology (Binford 1990; Hrynick and Betts 2017; Robbins 1968; Steadman 2015). In addition, dwelling features are more accessible proxies than whole villages for identifying changes in these factors due to their size and structural simplicity. Dwelling features are particularly comparable because they are ubiquitous and spatially bounded. Establishing the contemporaneity of dwelling features at a single site or in a dispersed area is difficult due to problems of archaeological scale, especially given the presently available radiocarbon inventory for New England (Dewar and McBride 1992:227–252).

The Maritime Peninsula provides a close culturally related (i.e., Algonquian; Snow 1978) and environmentally similar hunter-gatherer case to control for other factors that could instigate changes in New England dwelling feature size. The Maritime Peninsula exhibits many Woodland traits also seen in New England in the last 3,400 years, including increases in burial ceremonialism, an increased reliance on shellfish as a food resource, decreasing mobility, and new technologies such as ceramics, bows, and watercraft (e.g., Betts et al. 2017; Black 2002; Bourque 1971; Bourque and Cox 1981; Leonard 1995; Petersen and Sanger 1993; Turnbull 1976). The notable and essential exception for this study is that while there is some evidence for the occasional gardening of groundnut (*Apios americana*; Leonard 1995) as well as the influence of traded domesticates or the occasional gourd (*Cucurbita* spp.; Petersen and Cowie 2002), all evidence suggests that domesticated plant species did not contribute substantively to diet on the Maritime Peninsula. People on the Maritime Peninsula did not adopt maize horticulture in any substantial way until after European colonization, despite an environment that would have permitted it (Leonard 1995). The Maritime Peninsula also provides a small but reasonably high-resolution dataset of dwelling features spanning the Middle and Late Woodland periods (Hrynick 2018; Hrynick and Black 2016; Hrynick et al. 2012; Sanger 2010). As in New England, survey bias and issues of archaeological visibility have resulted in a Woodland period architectural dataset that is primarily coastal (Sanger 2010).

Methods

The authors compiled a database of dwelling features from New England and the Maritime

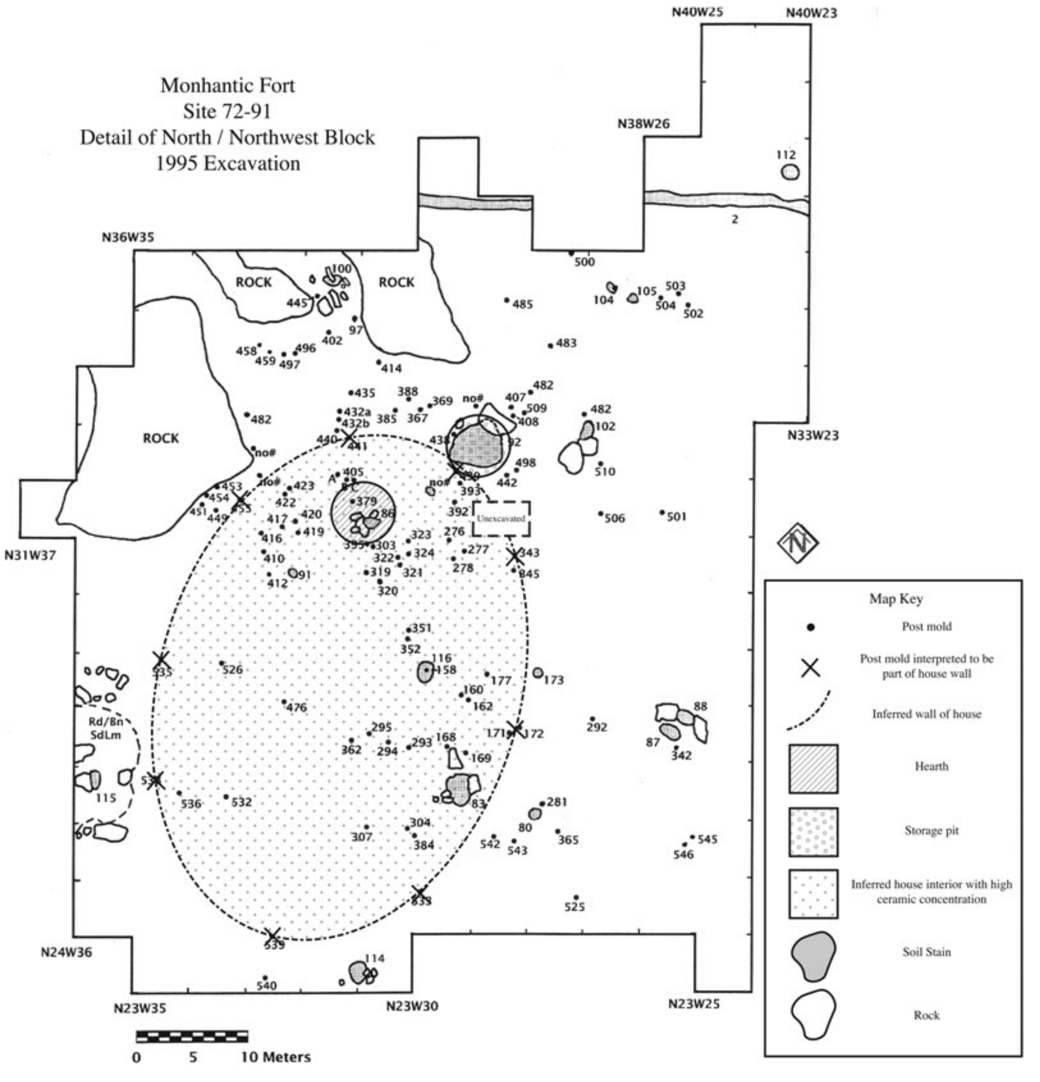

Figure 2. Plan drawing of an excavated domestic feature from the site of Monhantic Fort (CT 72–91) in Mashantucket, Connecticut. The dashed line represents the boundary of the house interpreted from post molds, internal and external features, and artifact concentrations. Numbers on plan drawing reference original feature numbers. Plan map is adapted from one provided by the Mashantucket Pequot Museum and Research Center, Akeia Benard, and Kevin McBride. Additions to map made by authors.

Peninsula consisting of previously reported structures from published sources, "grey" literature, and original excavations (Table 1). These dwelling features were then sorted by date of occupation and region. In many cases, researchers provided associated uncalibrated radiocarbon dates, which we calibrated. For features without radiocarbon dates, we calculated the date of occupation using diagnostic projectile points, ceramic vessels or, in some cases, historical records. To make the data as comparable as possible, we relied exclusively on archaeological findings, excluding ethnohistorical sources that describe Indigenous houses in the contact period (see Glick 2013). The addition of these sources would have skewed our analysis toward the latter periods and introduced a series of potential biases.

In order to approximately represent the widespread appearance of maize on sites in New

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England, the dwelling features were then categorized by date, splitting the dataset at 1000 BP. Prehorticultural period dwellings form the majority of the dataset and are thus used as the control group against which to compare dwelling features constructed after horticulture appears in New England. Because published information on dwelling feature size is unstandardized over 50 years of archaeological practice, both size variables have been derived strictly from two measures of dwelling diameter alone: length and width.

Next, the authors measured dwelling feature area and roundness by treating each dwelling feature shape as though it were an ellipse, using its length and width to calculate the semimajor and semiminor axes, respectively. Our assumption of elliptical shape thus calibrates all published literature, rendering our results comparable across the region. We calculated dwelling feature area by multiplying both radii together, then by π (Table 1). However, this measure does not accommodate the possibility of rounded rectangle-like houses with parallel sides. Consequently, it underrepresents nonelliptical dwellings at a scale exponential to increasing house area, a noted source of possible error.

In order to study shape, the authors created a "roundness ratio" by dividing the dwelling features' semiminor axis by their semimajor axis. The closer the ratio is to 1.0, the more circular the feature, and the closer the ratio is to 0.0, the more elongated. These two dependent variables are subject to nonparametric (Table 2) statistical tests versus the independent variable of categorical time.

Results

Before 1000 BP, the range of dwelling feature sizes in New England and on the Maritime Peninsula overlapped, but New England dwelling feature size was more variable. Overall, dwelling features in New England were larger (Mann-Whitney rank sum, $p = 0.0003197$) and size was more varied (Kruskal-Wallis $\chi^2 = 13.122$, $p = 0.0002918$). Dwelling feature size on the Maritime Peninsula was consistently smaller and more uniform.

Figure 3 shows the results of a quartile analysis of dwelling size that compares the earlier and later temporal periods. This analysis navigates differing sample sizes between both the two temporal groups and two geographic regions. To begin, the assemblage of prehorticultural dwelling features is divided into quartiles and represented with a box-and-whisker plot with an interquartile range (IQR) calibrated to customary 1.5 IQR in order to determine outliers.

On the Maritime Peninsula, all dwelling feature areas fall within the designated 1.5 IQR with no outliers. In New England, two large dwelling features (Timothy Stevens, 19.63 m^2; RI 1428, 21.20 m^2) are considered outliers. The quartile analysis continues by plotting the location of dwelling feature areas atop this model, visualizing their relationship to the control group in order to determine which houses are within the established range and which would count as outliers.

On the Maritime Peninsula, there are only three dwelling features that date after 1000 BP at the time maize is present in New England. None of these were associated with recovered macrobotanical evidence of maize. This differs from the New England dataset, in which eight of the 11 post-1000 BP dwellings had evidence of maize macrobotanicals. Two of the Maritime Peninsula dwelling features are larger than any of those before this period (Figure 3: AlDf-24, 8.24 m^2; Flye Point-2,9.55 m^2). The size distribution here demonstrates a weak trend of increasing dwelling feature size into the Late Woodland period in both the Maritimes and in New England, although more excavation of whole dwelling features is needed to rigorously parse this phenomenon. Based on presently available data, a slight dwelling feature size increase in the Late Woodland period in the Maritime Peninsula was not correlated to the advent of horticulture, but rather occurred independently of it. Moreover, although we do not formally consider the ethnohistoric record here, we note that ethnographic accounts of dwellings on the Maritime Peninsula suggest that the average size of postcontact dwellings was consistent with prehistoric features dating back to 1000 BP (see Hrynick and Black 2016).

In New England, seven of the 11 dwelling feature sizes cluster around the two outliers from the period before the adoption of horticulture (Figure 3: Early Fall Site,14.18 m^2; Griswold Point

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Table 2. Summary of Prehorticultural Dwelling Shapes Shapiro-Wilk Test of Normality.

	New England $n = 17$	Maritime Peninsula $n = 11$
Dwelling Area	W = 0.7826 $p = 0.001183$	W = 0.85848 $p = 0.05503$
Dwelling Roundness	W = 0.80318 $p = 0.002244$	W = 0.84753 $p = 0.03962$

Before the introduction of horticulture to New England, neither dwelling area nor roundness values are normally distributed in this region ($\alpha = 0.05$), regulating the present analysis. Maritime Peninsula dwelling feature area values show weak unimodal distribution in comparison, although not to a truly convincing degree.

Site Structure 1, 26.30 m^2; and 2, 16.49 m^2; Skitchewaug 1, 17.66 m^2,and 2,17.66 m^2; Cunningham Site, 22.05 m^2; Mohantic Fort, 25.12 m^2). The remaining four (Figure 3: Military Academy Site, 63.19 m^2; Norridgewock Site, 98.13 m^2; Orange County Longhouse, 98.13 m^2; The Coffin Farm Complex Site 1,117.75 m^2) are extreme outliers in this model. All dwelling features during this time are larger than any that were built in the Maritime Peninsula during the Woodland period. After 1000 BP, size ranges no longer overlapped between the two regions, even as they became larger on the Maritime Peninsula. Thus, a bimodal distribution of dwelling feature size emerges in New England with two distinct size-groups of dwellings: those that most closely resemble the largest of the dwelling features before the advent of horticulture and those that were much larger.

Dwelling feature shape is uncorrelated with region overall. As can be observed in Figure 4, it may appear that dwelling features in the Maritime Peninsula were consistently rounder, but this is not a statistically significant observation,

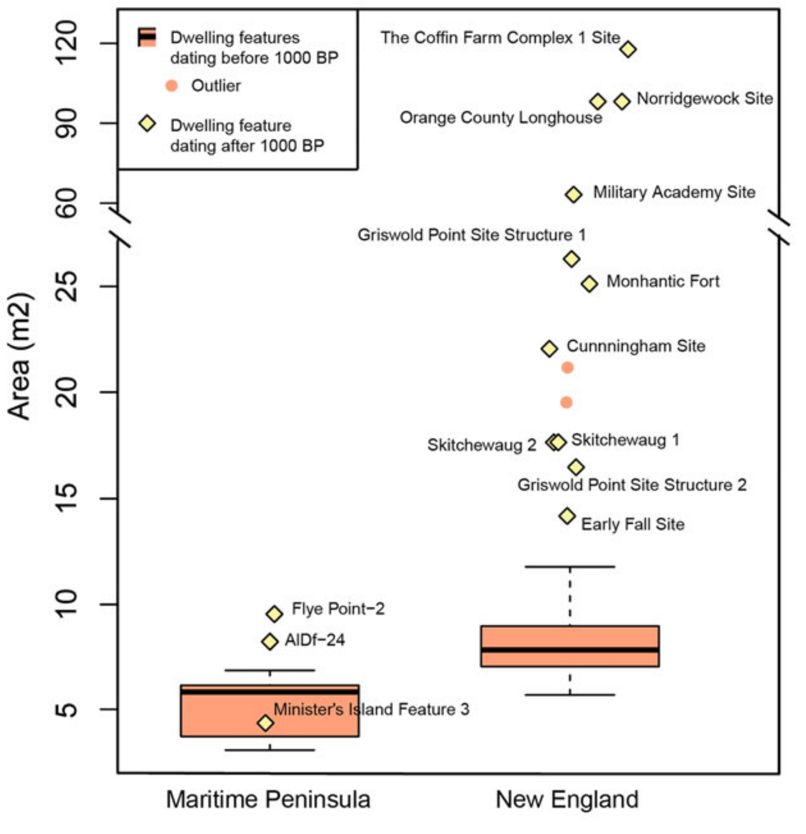

Figure 3. Sorted by region, dwelling features dating after the advent of horticulture in New England are plotted in comparison to area quartile ranges of dwelling features dating before it.

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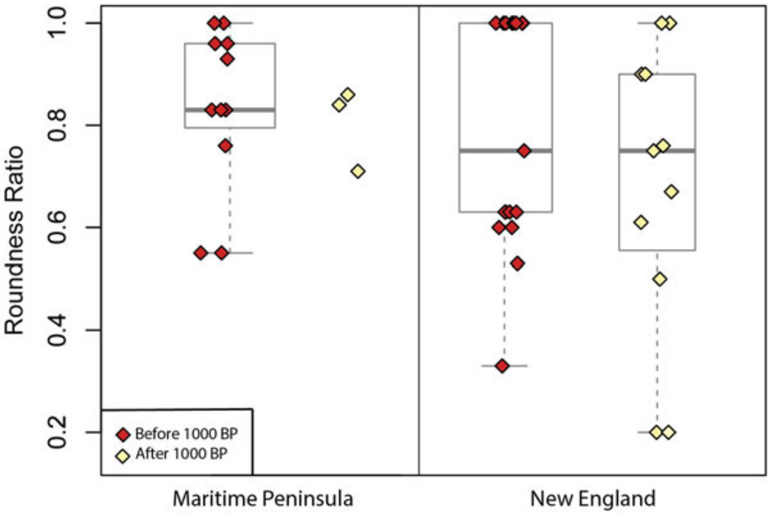

Figure 4. Distribution of dwelling feature circularity by study region and temporal category, including a box plot of each dataset's quartile ranges when possible. As the dwelling's roundness ratio approaches 1, overall roundness increases. A dwelling with a ratio of 1 would be shaped like a circle. Dwelling features understood to be longhouses would have a low roundness ratio.

and it may be attributed to an overall smaller sample size than in New England (Kruskal-Wallis $\chi^2 = 0.3696$, $p = 0.5432$).

However, in New England, dwelling feature shape and size vary allometrically, with the four large dwellings among the most elongated (Figure 5). After the introduction of horticulture in New England, two of the four large dwelling features observed above have the lowest roundness ratios overall, being five times as long as they are wide and distinctly longhouse shaped (Figure 5: Orange County Longhouse and Norridgewock Site). The other two of the four largest dwelling features have roundness ratios below 0.7, making them among the most elongated of the total assemblage. Taken together, these four large dwellings are the size outliers defined above, and they are consistently more elongated than the other dwellings. The size and shape of dwellings covaried according to architectural and functional concerns: as dwelling size increased, the shape of the circular dwellings lengthened. This allometric relationship between shape and size of larger dwellings does not represent merely a larger version of a smaller phenomenon; it would have required a restructuring of interior space. It may have been based on architectural and structural needs, functional needs, or both, but the result is the same: a more fixed tradition of size and shape in the Maritime Peninsula than in New England.

Discussion

In New England, the two categories (large and small) of dwelling features we have parsed in our analysis act as a proxy for two significant modes of spatial organization and thus mobility. That the larger dwellings only occur after the adoption of horticulture indicates a correlative relationship but not necessarily a causal one. Results of this change in dwelling size include a marked difference in the scope of social and task potential associated with the act of practicing horticulture both within the dwelling and across the changed New England regional landscape.

The proliferation of maize horticulture in New England around 1000 BP coincides with increasing variability in dwelling size and shape in that region: some dwellings become larger and longer, while others remain smaller and rounder. These changes suggest, minimally, socioeconomic shifts coincident with the proliferation of maize. While the implications of these shifts in house shape and size require further examination, they are suggestive of some specific changes when considered

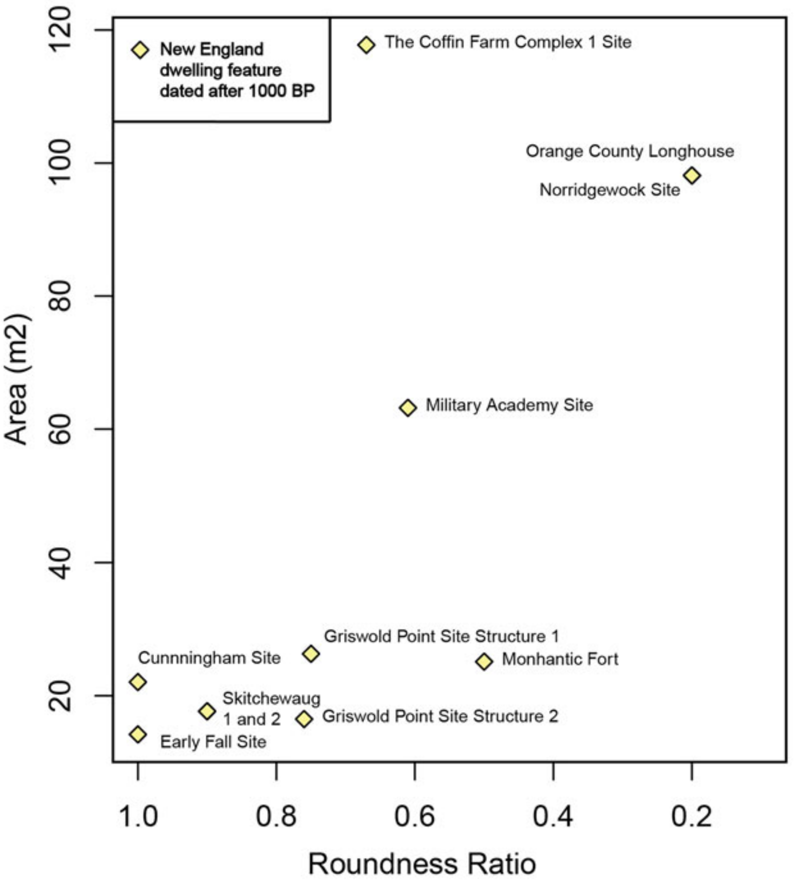

Figure 5. Area and roundness are compared for New England dwelling features dating after 1000 BP.

in light of local context and cross-cultural studies of domestic architecture. In contrast, dwelling features on the Maritime Peninsula do not display an increasing range of variability at any point during our study window and were, by contrast, less prone to variations in form overall. In a region where horticultural practice was not adopted until after the arrival of Europeans, traditions associated with dwelling building were continuous.

Changes in the shapes and sizes of individual houses tend to correlate to changes in social and economic strategies. The changes we have identified have the potential to address open questions about the effects of maize on socioeconomic life in New England and the nature of village aggregation in that region. Cross-cultural ethnographic evidence provides some avenues to explore this specific regional context. In general, large and elongated houses are associated with socioeconomic factors consistent with horticultural villages, whereas small, oval structures tend to be associated with high mobility (Ember 2014; Robbins 1968; Whiting and Ayers 1968). When compared to oval house forms, elongated houses require more work and material to manufacture, but they require less maintenance than oval structures do (McGuire and Schiffer 1983; Ryan 2012:185–186). As a result, change from small oval structures to big, longer ones is usually, but not universally, associated with increasing sedentism. Moreover, large structures permit either multiple indoor tasks to be conducted concurrently, or for multiple people to be devoted to a single task at once. The latter scenario would occur annually during a short and intensive maize harvest as may have come to be practiced in New England.

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These internal differences extend into the larger regional social landscape surrounding the dwelling as well (Coupland and Banning 1996:2–3; Groover 2004; Ingold 1993; O'Sullivan and Nicholl 2011; Wilk and Rathje 1982). Importantly here, dwelling size affects people's tacit knowledge of the dwelling space in singular ways relative to their own experience, movement patterns, and social memory (Butler 2011:71). Architectural variability—such as between large and small houses—may also correlate to social inequality (McGuire and Schiffer 1983:282), but it can be difficult to distinguish from task-specific features without careful consideration of associated artifact assemblages. It is notable that there are examples of complex hunter-gatherer cultures sometimes building very large houses meant for extended families (see Ames 1996), but houses of that type do not appear on the Maritime Peninsula. The presence of these houses in areas without agriculture implies that, at least in some cases, house growth can occur due to economic intensification and labor needs associated with, for instance, large-scale fishing enterprises (Ames 1996:145; Coupland 1996:129).

The architecture of Iroquoian longhouses in New York and Ontario has been well documented. Studies from this region reveal intriguing parallels and contrasts to the New England and Maritime Peninsula datasets presented here. Warrick (1996:13–14) posits that "the adoption of corn horticulture by Middle Woodland people in Ontario and New York State about AD 700 did not appreciably alter the organization of households or communities." Instead, it appears that house sizes grew gradually over time, with very large longhouses emerging in the region centuries after the adoption of maize agriculture.

Although two of the house features described herein (Orange County Longhouse and Norridgewock) are shaped like Iroquoian longhouses, they seem to share little resemblance otherwise. Typical contemporary Iroquoian longhouses had undivided interiors, storage pits at one end, and several internal hearths arranged along the center of the house (Warrick 1996:11). The houses at Orange County and Norridgewock also lacked internal divisions. Beyond this, though, they bear little resemblance. Orange County had only one internal hearth, but Norridgewock had none. Orange County had no internal storage pits, while Norridgewock had three, which were spread throughout the house (Cowie et al 1995:30–31; Haviland and Power 1994:138; Skinas 1993:6–7). Haviland and Power (1994:138) state that "on the basis of their unusual length…these [Orange County and Norridgewock] may have been longhouses….However, these features are quite unlike the remains of Iroquoian longhouses known elsewhere in the Northeast." Warrick (1996:12) argues that the presence of multiple internal hearths is evidence of larger family households in Late Woodland and contact-period Iroquoian longhouses. The smaller number of internal hearths at Norridgewock and Orange County could imply that household family size remained low at these sites despite the overall increase of house area. There is no direct evidence at these sites that the houses were used to store large amounts of horticultural product, although evidence of maize was found at both.

A variety of possible interpretations could explain the shifts outlined above, including increasing political complexity, increasing social or economic stratification, changes in systems of kinship, and/or the emergence of true year-round sedentism, at least in some localities. The diversity of dwelling size and intrasite variability may be most consistent with a dispersed village model, in which large structures represent places of intensive, year-round activity and habitation, versus smaller structures, which may correspond to specific seasonal tasks associated with, for instance, maize harvesting or processing (Leveillee et al. 2006:82–83). Others have argued that the Late Woodland period in New England saw the emergence of an economic seasonal round (see Bragdon 1996). A pattern within the data that may support either the dispersed village or seasonal round theories is that, despite the bimodal distribution of house sizes in post-maize New England, no site includes both large and small houses. It is possible that the sites within the dataset, being arbitrarily bounded in space, are capturing only portions of a dispersed village or part of a seasonal round where only large or small houses appear.

On the Maritime Peninsula, a case has been made for increasing sedentism and year-round occupation at some sites despite the lack of maize horticulture prior to European settlement (Betts et al. 2017; Black 2002; Nash and Stewart 1990). This trend suggests that maize was not the only social and economic driver of sedentism. The absence of dwelling growth and dwelling-size bifurcation in the Maritimes strengthens the assertion that maize horticulture played an important role in these processes in New England.

Conclusion

The proliferation of maize horticulture in New England occurred contemporaneously with quantifiable changes in architectural size and shape. This pattern contrasts with a lack of change in the dwelling features of the nonhorticultural Maritime Peninsula, suggesting that horticulture may have played a part in driving the substantial social changes archaeologists associate with village formation in New England, such as increased sedentism, year-round occupation, and diversification of task-specific structures.

More broadly, this research emphasizes the utility of examining dwelling features, a ubiquitous and comparable feature class that is more easily accessed archaeologically than villages. Moreover, comparing dwelling features to similar ones on different, coterminous sites as we have in this study avoids the issues of archaeological scale that have historically plagued attempts to study entire villages.

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Data Availability Statement. An expanded dataset that includes partially excavated structures from these regions can be found online on tDAR at https://core.tdar.org/collection/69178/a-quantitative-dwelling-scale-approach-to-the-social-implications-of-maize-horticulture-in-new-england (tDAR id: 447016; doi:10.6067/XCV8447016).

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