Cattle, Cadaster, & Conflict: Settlement Growth and Social Conflict in Early Colonial New England, 1620-1680

Eric H Wilhelm
ewilhelm@gmu.edu
George Mason University

Abstract

Property rights are secure, and violence over land use can be attenuated when the treatment and delineation of land are consistent, stable, and salient to each party. Land-use stability becomes strained as the area of contested land between two rival parties expands when one party (or group) is perceived as asymmetrically and rapidly accumulating land at another's expense. While relations between Algonquian tribes and English settlers were generally peaceful in the first half of the 17th century, subsequent colonial growth accelerated in the late 17th century and lead to violent conflict. This period of violence culminated in King Philip's War of 1675-1676, the most devastating conflict of early colonial American development. Using probate data covering 56 settlements in New England to measure the growth of farmers as a proxy for colonial territorial growth, I find English settlements that doubled in size were 8% more likely to be damaged or destroyed by an Algonquian tribe. The correlation between settlement growth and conflict also holds after controlling for initial settlement size.

1 Introduction

Social norms and formal rules help define property rights and resolve property conflicts over land use. Historically, these institutions have either been relegated to formal states (Acemoglu & Robinson, 2019; Johnson & Koyama, 2017; and Dinecco & Katz, 2016) or deferred to stateless channels of resolution (Candela & Geloso, 2020). The violence-reducing characteristics of these institutions include: 1) defining property rights over space and time, 2) adjudicating contests over property, and 3) enforcing those resolutions after adjudication. Areas with little to no formal state institutions, such as the early colonial period in North America between European settlers and Algonquian Indians, generally relied on the first characteristic and had few viable alternatives for the latter two.

During the period of rapid colonial expansion in the mid-17th century, the mutually perceived definitions of land use between settlers and Algonquians changed. Rapid colonial population growth and expansion after the arrival of the *Mayflower* made the process of defining and redefining property rights between Algonquian tribes and English settlers costly through peaceful means. The sharp change in relative growth (between the English and Algonquians) expanded the area of contested land and lead to violent conflict.

This paper examines how rapid population growth relates to the likelihood and severity of violent conflict in areas without clearly defined property rights and areas without a mutually-agreed regime to resolve conflict over land. How did colonial expansion in New England confound the treatment of property rights between settlers and Algonquians? Did rapid colonial expansion in New England mitigate or exacerbate conflict? What was the relationship between early colonial expansion and the likelihood of violent conflict with Algonquians?

The type of institution used to address and resolve potential conflict over land impacted the likelihood and severity of violence in colonial North America. In contrast to the English colonial experience in New England, French colonists saw little to no violent conflict with Acadians and Mikmaqs. The rules of collective decision-making for settling land disputes favored consensus and greatly reduced the returns to conflict (Candela & Geloso, 2020). All parties had to come to a collective agreement which eschewed the formation of special interests who could potentially benefit from fighting, thus spilling the external costs of collateral damage onto the rest of the population.

Competing interests over natural resources, such as beaver, constrained the types of institutions that emerged in Canadian North America. European settlements around Hudson Bay had competing interests and varying property rights institutions. Native Americans near Fort Albany and the York Factory faced competition in the beaver fur trade from the French (Carlos & Lewis 1993, 1999, 2001). Hudson Bay Company managers increased the price of furs in those areas which led to more Native Americans entering the market and deplete the beaver population more quickly. Fort Churchill did not face the same level of competition in the supply of beaver pelt. Prices for furs in that

region were more stable, and the beaver population was not depleted as quickly (ibid). Both colonial episodes in French Acadia and the Hudson Bay Company demonstrate how initial settlements, endowments, and incentives impacted the evolution of institutions that helped define property rights and resolve property conflicts. The types of institutions that evolved had varying success at mitigating violent conflict over land and managing natural resources.

This was not the case in early colonial New England which did not have a similar type of consensus-building institution to effectively resolve conflicts over land. Early English colonial development was characterized by an inchoate delineation of land use and rapid colonist population growth at varying proximities to Native American settlements. And English settlements that grew most rapidly in closer proximity to Algonquian settlements were more likely to be subject to conflict.

Recent literature has looked at the relationship between land conflict and contract choice in a modern context. Lee Alston and Bernardo Mueller (2010) analyze how land conflict and initial property endowments impact subsequent contract choice in Brazil. Their research examines the impact of conflict on subsequent contract choice and the type of tenancy arrangement chosen. Similarly, Conning and Robinson (2007) examine how property insecurity impacts the type of agricultural organization selected among competing claimants. They use a model of potential land reform to demonstrate how an agent's expectations of property insecurity, instigated by the likelihood of land reform, are likely to modify their current choice of contract. Both papers measure the impact of property insecurity on subsequent contract choice. This paper examines the relationship in reverse. How does property insecurity combined with an increase in the area of contested land lead to conflict?

2 Historical Background

After Jamestown was founded in 1607, English emigrants settled in the colonies of Plymouth and Massachusetts Bay. Pilgrims and Puritan settlers left Holland and England to escape religious-conformity restrictions imposed by the state religion of their home country. Disheartened by religious persecution, they wished to preserve their English identity and brought with them their own form of self-governance and legal framework (Winslow, 1646). The attitude of European colonizers towards *terra nullius* ("land with no owners") was varied (Pagden, 2015). English setters' legal justification for a formal expression of property rights was established through agricultural development. The land had to be tilled, sown, harvested, or grazed. Those acts of land improvement, from the English perspective, laid their claim to ownership.

The area of land spanning the coastline of Maine to Long Island Sound included many Algonquian peoples from the Massachusett, settled around Massachusetts Bay, to the Wampanoag, settled around Cape Cod Bay, and the Narragansett, settled in the west of modern day Rhode Island (Washburn,

1989). Over the course of the 17th century, English settlers established various diplomatic, commercial, and religious connections with surrounding tribes, sachems (male leaders), and sunksquaws (female leaders with great authority). Settlers and Natives conversed, intermarried, and formed treaties (Schultz, 1999 and Warren, 2018).

They also exchanged goods and land. As the children and grand-children of England's first "Great Migration" came of age, by 1670 the English population burgeoned to over 60,000 people, almost double the Native New England population (Silverman, 2019). The population boom was not the direct source of conflict; nor was conflict *prior hoc* inevitable. Early interactions between Algonquians and the English (1620-1670) were pacific. What sparked tensions and violent conflict was the rapid rise of English pastures and farms for husbandry - a dramatic increase in the demand for land.

At first, English settlers attempted to purchase land through various exchanges like manufactured goods or wampum, a string of beads used by Algonquian tribes as a form of currency (Brooks, 2018; Schultz, 1999). These trades often took a strategic tone in the greater context of internecine power relations among European powers and rival Algonquian tribes (ibid). The source of conflict resulted from poorly defined property rights - the perceived encroachment or illegitimate purchase of land between English settlers and the Wampanoag, Narragansett, and Nipmuck. More land was contested.

From the perspective of English settlers, an open expanse of land, a significantly depopulated Algonquian territory devastated by disease prior to the arrival of the English (Steckel et. al., 2002), and initial comity with the Wampanoag made the subject of contract choice relatively simple. Under consent and charter from the Crown, most English requests for land were made through purchase (Pagden, 2015 and Roback, 1992). Challenges over occupancy with surrounding Native American tribes were generally met through treaty, gift, or exchange[1]. However, poorly defined property rights, ambiguous land-use arrangements between English settlers and Algonquian tribes, and rapid settlement growth through land-intensive animal husbandry set the stage for one of the most devastating periods of conflict between the English and Algonquians in the Americas.

The Wampanoag, Narragansett, and Nipmuck settled in-land, away from the coastlines, and along well-protected rivers and marshes (Washburn, 1989). Algonquian tribes had a deep knowledge of the terrain and exposed points of attack along coastlines where English colonists predominately settled. Generally, Algonquian forces were mobile and used their knowledge of the land to their advantage while the English typically fought in fixed points of defense near their settlements (Schultz, 1999).

The introduction of livestock, expansion of land-intensive agriculture, and rapid settlement growth characterized early colonial development in New England. Four years after the arrival of the *Mayflower* in 1620, Edward Winslow,

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[1] Since their arrival, English settlers treated native land as *de facto* sovereign territory of American Indians. It would not be until the Treaty of Paris when the Royal Proclamation of 1763 formally ceded *de iure* autonomy to "several Nations or Tribes of Indians".

one of the early Pilgrim Fathers, brought from England "three heifers and a bull, the first of any cattle of that kind in the land" (Anderson, 1994, p. 602). The task of improving the land was met as a general measurement of their prosperity. By 1627, Plymouth Colony had accumulated - either through husbandry or import - up to "fifteen animals, whose muscle power increased agricultural productivity" (Anderson, 1979 & PARP). In order to accommodate this land-intensive form of agriculture, Plymouth began expanding its borders beyond the boundaries of the compact village established at the time of the first Thanksgiving. They traded manufactures and agricultural products with Massasoit, sachem of the Wampanoag and father of Metacomet, in exchange for more land.

The most lethal and politically potent of these manufactured goods were matchlock and flintlock firearms. The proliferation of guns was initially spurred by early colonizers (Silverman, 2016). Colonial governments were late to enforce the arms trade; and even when they began imposing restrictions on the movement of guns, black markets rose. The arms build up - predominantly spurred by Dutch, French, and English arms traders - revolutionized warfare for the Wampanoag. Metacomet, who the English called King Philip, saw the colonies as attempting to drive them off their land. Exacerbating tribal agitation, colonial governments banned the arms trade entirely and began confiscating arms from the Wampanoag (Lepore, 1998 and Silverman, 2016). The confiscation of arms and the perception of conquest came at a time of increased tensions between English colonists and the Wampanoag, Nipmuck, and Narragansett[2].

John Sassamon, a Wampanoag raised by an English family, was a mediator with significant influence in both societies. Harvard educated and a convert to Christianity, he also served as an advisor to Metacomet and was in the best position to ease the rising tensions. It was not until Sassamon was found dead in Assawompset Swamp in the winter of 1676 when conflict erupted. While the nature of Sassamon's death has never been confirmed, three of Metacomet's closest advisors were arrested, tried, and executed by Plymouth colonists for Sassamon's murder later that summer (ibid). Metacomet understood the colonists' summary judgement and execution as a threat. It meant the Wampanoag were a subject people and beholden to a foreign form of justice (Silverman, 2016). King Philip's War had begun.

3   Theoretical Model of Land-Use Conflict

Disagreements over land use can be resolved by jointly defining property rights in which both parties come to a resolution or lead to violent conflict. In a setting with unclear property rights and no mutually-agreed authority (or set of rules) to resolve disagreements over land use, the likelihood of violent conflict increases as the area of contestation - an overlapping geographic area

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[2]The Narragansett remained neutral at the outset of King Philip's War and entered the conflict after peace negotiations with New England militias broke down.

(of uniform natural resource and strategic value) where both parties lay claim over the same plot of land - spreads. Absent formal institutions to resolve land-use disagreements, increases in the area of contestation between Algonquian tribal settlements and colonial English settlements are more likely to be targets of violent conflict.

Potential determinants of overlapping land claims during the period of colonial settlement in 17th century New England include 1) the initial settlement size of colonial towns and villages, 2) the distance between a colonial settlement and a rival, tribal village, and 3) colonial settlement growth. Generally, the area of potentially contested land increases with respect to the initial colonial settlement size, proximity to nearest tribal village, and colonial settlement growth. All else constant, settlement growth increases the area of contested land and the likelihood of conflict such that:

$$logit(p_{conflict}) = \alpha + \beta_1 g + \epsilon_1 \tag{1}$$

where $p_{conflict}$ is a binary variable indicating conflict (1,0). g is settlement growth up until the period of conflict. The functional form is a generalized linear model in which conflict is expressed in terms of the likelihood of conflict:

$$p_{conflict} = \frac{1}{1 + e^{-\alpha - \beta_1 g}} \tag{2}$$

According to this functional form, the growth of colonial settlements increases the potential area of contestation between rivals and increases the likelihood of conflict. Other functional forms incorporating initial settlement size and proximity to tribal villages are also considered.

$$logit(p_{conflict}) = \alpha + \beta_1 g + \beta_2 \chi + \beta_3 \psi + \epsilon \tag{3}$$

where χ is the initial settlement size and ψ is the distance to the nearest tribal settlement. Initial settlement size and subsequent growth may also have interaction effects with respect to the likelihood of conflict. The attacker may deem the defender too large to attack because of an overwhelming imbalance in the size of forces. Subsequent settlement growth rates also rely on a settlement's baseline size. Smaller settlements can grow more quickly compared to settlements that are founded with larger initial populations[3]. In order to account for the interaction effects between initial settlement size and subsequent settlement growth, the last functional form weighs each settlement's growth rate by initial settlement size.

$$logit(p_{conflict}) = \alpha + \beta_{interaction} \frac{g}{\chi} + \epsilon \tag{4}$$

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[3]This also assumes a wide variation in initial settlement sizes across colonial New England settlements.

This last model attempts to measure the relationship between settlement growth and the probability of conflict given a settlement's initial size upon founding.

4   Cross-Settlement Analysis

The models above describe how the geographic distribution and growth of English settlements (defined by a change in settler population, g) increase the area of contested land, break down the possibility of peaceful resolution, and spur violent conflict. In order to measure the determinants of land-use conflict, I examine the relationship between the rate of colonial expansion and the likelihood of conflict at the township level. I first quantify the magnitude of early colonial expansion across all settlements in colonial New England and identify whether that township was damaged or destroyed by rival tribes from 1620-1676. Estimates of the potential determinants of the likelihood of conflict[4] are projected using a generalized linear logistic model. Descriptions of the models, data, and results are below.

A first-best measurement of colonial expansion would be the change in land area of each township over the preceding decades. Growth in settlement area would expand the area of potentially contested land and spur more land-use disagreements between the English and surrounding tribes. Unfortunately, data on cadastral [5] size and development for each township is not readily available at the cross-settlement level (beyond just a handful of early colonial settlements). Instead, I use the growth rate in the population of farmers since the decade of initial founding as a proxy for land growth over the same time period.

4.1   Data

The data for farmer population comes from a sample of colonial New England probate records from 1620 to 1675 (Main, Main & Lindert, 2013). The universe covers all deceased individuals - including landowners and landless tenants - in southern New England over this time period. The probate data also includes categories for each individual's occupation, value of real property, wealth [6], debt, age, and sample weight by age group [7].

The size of a township cadaster is a *stock* measurement of land; the number of deceased individuals reported in the probate is a *flow* measurement of the colonial population. To account for this discrepancy, I aggregated the farmer

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[4]Conflict is defined as whether a colonial settlement was damaged or destroyed.

[5]The formal surveying and public assignment of cadasters do not begin historically until later in the 17th century. A "cadaster" in this context is simply a publicly salient delineation of property.

[6]Wealth measurements include real property as well as other types of capital.

[7]The weight equals the inverse of the probability of selection for a deceased individual of a certain age group reported in the sample. For example, a deceased individual is more likely to be older than younger. The probability of a sample probate listing an older person is higher than a younger person.

population[8] by decade. Annualized growth rates have many gaps, were too variable, carried too much noise, and did not reasonably represent changes in the stock of colonized land[9]. The model assigns one decennial growth rate to each township. The decennial growth rates were computed using a straight-line approach[10].

I also consider the measurement of farmer population to be more economically representative of land growth relative to real estate value. Seventeenth century frontier farming in the American Colonies can be characterized as a factor minimizing production function between land (capital) and labor: $F(K, N) = min[K, N]$. This type of production function treats land (K) and labor (N) as complements. It assumes that a given acre of land did not yield more output (or be anymore productive) after substituting production towards more labor. Given that assumption, any increase in agricultural production would need to be met with a one-to-one increase in *both* factors.

Figure B1 in Appendix A highlights in red or yellow each of the townships that were damaged or destroyed during King Philip's War. The source for township damage comes from a collection of accounts from the war. Figure B2 includes other areas of conflict in colonial New England 30 years before and after King Philip's War. For this analysis, I assigned a binary variable of 1 to any township that was either damaged or destroyed in the 17th century. Although Figure B1 distinguishes between destroyed and damaged towns, the relative magnitude of destruction is unknown. I consider any sign of war-related property damage as sufficient for indicating conflict. Figure B4 is a magnified map showing tribal settlements in yellow and "Indian praying towns" (Christian missions) in black.

4.2 Results

Table 1 shows the estimates and standard errors for models (1) through (4). The dependent variable of interest is a binary indicator of a colonial township being damaged or destroyed by an Algonquian tribe. A *LOGIT* model accounts for this binary relationship and bounds the predicted values to between zero and one. All of the models presented in Table 1 are a logistic regression measuring the relationship between the population growth rate with the likelihood of the township being damaged or destroyed. Rewriting equation (2) in Section 3 with the parameters from column (1) of Table 1, the relationship between settlement growth and the likelihood of conflict in terms of probability can be

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[8]Each record represents a deceased individual. The farmer population of a given township equals the sum of the sample weights across all individuals listed as a farmer, artisan-farmer, or laborer. See: Occupational codes listed in the probate codebook.

[9]Aggregating probate records by decade also suffers from fewer observations and less variation.

[10]

$$Decennial\ Growth = \frac{1670\ to\ 1676\ Pop - First\ Settlement\ Decade\ Pop}{First\ Settlement\ Decade\ Pop} * \frac{100}{Number\ of\ Decades}$$

$$(5)$$

expressed as:

$$P(TownDamaged_i) = \frac{1}{1 + e^{2.49 - 0.065 * GrowthRate_i}} \tag{6}$$

According to baseline model (1), a settlement that doubled in size (or a 100% growth rate) over the period from its initial settlement date to 1670-1676 was 8.1%[11] more likely to be damaged or destroyed in the 17th century[12]. Model (2) includes the initial settlement size as a separate explanatory variable. Initial settlement size has a slight positive relationship with the likelihood conflict but is not statistically significant. Settlement growth remains positively correlated with the probability of conflict and has a similar magnitude as the baseline model. Model (3) adds a binary variable indicating whether a rival tribal settlement is within 20 miles of an English settlement. While proximity to nearest tribal settlement has the strongest relationship with the likelihood of conflict, the coefficient is completely cancelled out by the model's constant, making the odds of conflict close to 50%[13]. The coefficient for settlement growth is also similar to the previous two baseline models.

Table 1 Results

	Settlement Attacked			
	(1)	(2)	(3)	(4)
Settlement Growth	0.065*	0.073*	0.060	0.139***
	(0.037)	(0.040)	(0.052)	(0.030)
Initial Settlement Pop		0.014	−0.004	
		(0.026)	(0.033)	
Within 20MI of Tribal Settlement			3.615***	
			(1.096)	
Constant	−2.486***	−2.721***	−3.616***	−2.406***
	(0.559)	(0.729)	(1.074)	(0.156)
Observations	56	56	56	56

*p<0.1; **p<0.05; ***p<0.01

Model (4) weights settlement growth by initial settlement size at the decade of its founding. The constant parameter is similar to models (1) and (2). Given a settlement's initial size at founding, settlements that doubled in size were roughly 9% more likely to be damaged or destroyed by rival tribes. Models (2) and (4) suggest that settlements with a large presence at founding *and*

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[11] $\frac{1}{1+e^{2.49-0.065}}$

[12] Townships with higher growth rates *decrease* the denominator which *increases* the probability of a town being damaged or destroyed.

[13] $\frac{1}{1+e^{-3.616+3.615}}$

which subsequently grew more quickly were more likely to share contestable land with rival tribes and lead to conflict.

5 Plymouth Settlement Analysis

The cross-settlement analysis suffers from an absence of data on the growth of land in English settlements measured in surface area. In order to corroborate the magnitude of the growth rates observed in the cross-settlement analysis (which relied on the population of farmers who entered probate), I also looked at archaeological data on livestock and pasture size over the same time period for Plymouth township to compare how growth in the number (and type) of livestock reconciles with the proxy variables used in the macro analysis. Using United States Department of Agriculture (USDA) guidance on pasture size capacity, I imputed the total number of pasture acres required to accommodate the number of livestock reported in the archaeological site.

5.1 Plymouth Archaeological Rediscovery Project

Craig Chartier and other members of the Plymouth Archaeological Rediscovery Project used faunal analysis to catalogue and substantiate the number of cattle reported in select probate records across three sites within Plymouth township (PARP). The faunal results reported in Figure C6 show the total stock of cattle for each decade. Ratios of other types of livestock relative to each cow were also confirmed in the archaeological analysis. I applied those ratios to the total stock of cattle to derive the total number of livestock for each decade. The total number of livestock and decennial growth rate in the number of livestock are reported in the last two columns of the lower table in Figure C6.

5.2 Pasture Size

Using the USDA formula, I then imputed the pasture size required to accommodate the livestock from Figure C6. The USDA formula is adapted for small-scale farm use and mixed operations including foraging and crop rotation (NRCS, USDA). These assumptions are more relevant for 17th century agriculture and colonial English farming methods. I scaled down the average size of each animal[14] as well as reduced the utilization rate and average yield per acre to reflect a level of farm productivity that is closer to subsistence. Settlement growth, in this analysis, is entirely driven by the growth in cattle reported from archaeological evidence and the ratios of livestock weight.

The total number of acres required to house each type of livestock are reported by decade in Figure C7. The assumptions I made for average livestock weight, utilization rate, grazing days per year, and average yield per acre are listed on the top left. The pasture size imputations reported in Figure C7 are constructed using the USDA formula and total livestock figures reported in

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[14]Assuming scrawnier 17th century livestock

Figure C6. The decennial growth rate in pasture size for Plymouth township is reported in column 7 of Figure C7. The highlighted records in Figure C7 compare the decennial growth rates of the micro analysis to the growth in farmer population and real estate value reported for Plymouth derived from the probate records used in the cross-settlement analysis. The growth rates show a similar pattern: a rapid expansion in 1630-1640, moderate growth in 1650-1660, followed by a decline resulting from King Philip's War in the later part of the 1670's.

6   Conclusion

Many factors contributed to Algonquian-English conflict from the Pequot War in the 1630's to the onset of King Philip's War in the 1670's: colonial expansion, disparate treatment of property, the proliferation of guns, inter-colonial and inter-tribal rivalries, and the failure of diplomacy. But the absence of shared property enforcement rules or institutions did not inevitably lead to conflict. The enforcement of peaceful resolutions to property rights disagreements became more difficult as the area of contested land between Algonquian tribes and English settlers expanded.

Colonial growth in New England was rapid and geographically heterogenous in the early to mid 17th century. From 1620 to 1680, over 500 English townships were founded, and townships growth ranged from a doubling in size to an increase by a factor of 40. Threats, such as weapons confiscation and perceived loss of land, drove the Wampanoag and other Algonquian tribes to violence. After accounting for proximity to the nearest surrounding Algonquian tribal settlement, townships that grew more rapidly during the early stages of colonization were more likely to be attacked, raided, damaged, or destroyed.

While initial colonial settlement size and proximity to rival tribal settlements contributed to the expansion of contested land, the strongest predictor of early colonial conflict was the growth of English settlements. A colonial settlement's proximity to a nearby tribal settlement made conflict 50% more likely. Settlements that doubled in size were 8.1% more likely to be attacked. Settings with weak property rights institutions, like 17th century colonial New England, made the expansion of contested land more likely to lead to violent conflict rather than a peaceful resolution to land-use disagreements.

Declarations

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- Data and materials referenced in this paper will be made available upon request
- SAS, R, and Excel workbooks used to prepare the analysis are also available upon request

Appendix A   Historical Accounts

A.1   English & Algonquian Interactions Prior to King Philip's War

A summary of secondary sources categorizing the types of interactions among Algonquian tribes and English settlers.

Type of Interaction	Time Period	Algonquian People\Tribes	English People\Settlements	Summary of Findings	Source
Trade	1500s-1600s	Narragansett	European Traders	Trading, fishing, exploring, Narragansett prized European manufactured goods. Europeans demanded furs, wampum - shifting Narragansett production from commercial hunting to crafting. Beaver population depleted. Rise of wealthy Narragansett wealthy "middlemen".	Schultz, 1999
Land Use	1627	Wampanoag	Gov. William Bradford, Plymouth Colony	English colonists desired additional farmland farther away from close-knit Plymouth settlement. A second grand of land was made to every resident of Plymouth to satisfy their desire for more land.	Schultz, 1999
Politics & Diplomacy	1622	Massasoit, Pokanoket	Plymouth Colony	Negotiated peace treaty (era of peace) guaranteeing English colonists' security. New ally for Wampanoag contra Narragansett.	Schultz, 1999
Land Use	1651	Pocasset (Nonaquaket)	Richard Morris, RI	English colonists graze cattle on salt marsh grasses confined by water on both sides in a peninsula harvested by the Pocasset. Early test of diplomatic rhetoric, writing, and English legal discourse.	Brooks, 2018
Land Use & Trade	1651	Weetamoo, Squa-Sachem of Pocasset	Portsmouth (Plymouth)	Portsmouth settlers relied on planting in fields. Weetamoo (Namumpum) held the role of "cultivator of diplomacy" working with other tribes and English settlers teaching cultivation methods.	Brooks, 2018
Land Use; Legal Chicanery	1651	Wamsutta & Weetamoo of Pocasset	Plymouth	English men "were somewhat uncomfortable in dealing with women in land transactions". English settlers strongly enforced *coverture*, the legal principle that all of a woman's property is transferred to her husband upon marriage, to limit the number of negotiating parties.	Brooks, 2018
Politics & Diplomacy	1662	Pokanoket	Colony of Rhode Island (RI)	Death of Ousamequin, Massasoit "great sachem" of Pokanoket. End of peaceful English-Indian relations in New England	Schultz, 1999

| Type of Interaction	Time Period	Algonquian People\Tribes	English People\Settlements	Summary of Findings	Source
Politics, Diplomacy & Trade	1675	Narragansett	Roger Williams (RI)	Establish commercial and military relations with Narragansett (involved in sporadic conflict with Wampanoag)	Schultz, 1999
Disease	1600-1675	New England Native Tribes	European colonists	Southern New England's native population declined from 90,000 in 1600 to 10,750 in 1675. Massachusett tribe warriors declined from 3,000 to 300.	Schultz, 1999
Legal Chicanery	1676	New England Native Tribes	Francis Jennings, Plymouth	Attempts to secure land from New England natives in a legal manner. Fraudulent methods: Impose absurd amount of fines to forfeit lands in lieu of payment; allow livestock to ruin native crops; threats of violence; induce drunkenness so a native would sign a deed he was unable to understand.	Schultz, 1999
Trade & Demographics	1670	Wampanoag	New England settlements	Children and grand-children of the English "Great Migration" came of age and started looking for their own land to establish farms. Increased demand for New England beef and pork to feed enslaved people in burgeoning sugar plantations of the Caribbean. Colonist population reached 60,000 (about double the total number of Natives).	Silverman, 2019
Trade & Land Use	1650s	Narragansett	Dutch & Colonies of MA, CT, RI	Relative price of land shot up relative to wampum after the Dutch "flooded the with low-quality beads. Narragansett's most valuable asset was land." Colony of RI made an agreement to share land use to preempt large purchases by MA investors, particularly the Atherton Company "with malign intentions."	Warren, 2018
Politics & Diplomacy	1660-1662	Narragansett	New England Colonies	The restoration of the English monarchy in 1660 forced all New England colonies to renegotiate the terms and status of their settlements. RI was the first colony to recognize the new monarchy with the hopes of receiving sign-off on their charter. CT received an extremely favorable charter that included nearly all of Narragansett land agitating the neighboring colony of RI.	Warren, 2018
Conflict	June 8, 1675	Wampanoag	Plymouth	Three of King Philip's men were executed by Plymouth colony for the murder of the prominent Christian Indian, John Sassamon.	Warren, 2018

Appendix B   Figures

Fig. B1 Towns Damaged or Destroyed

Source: American History Online

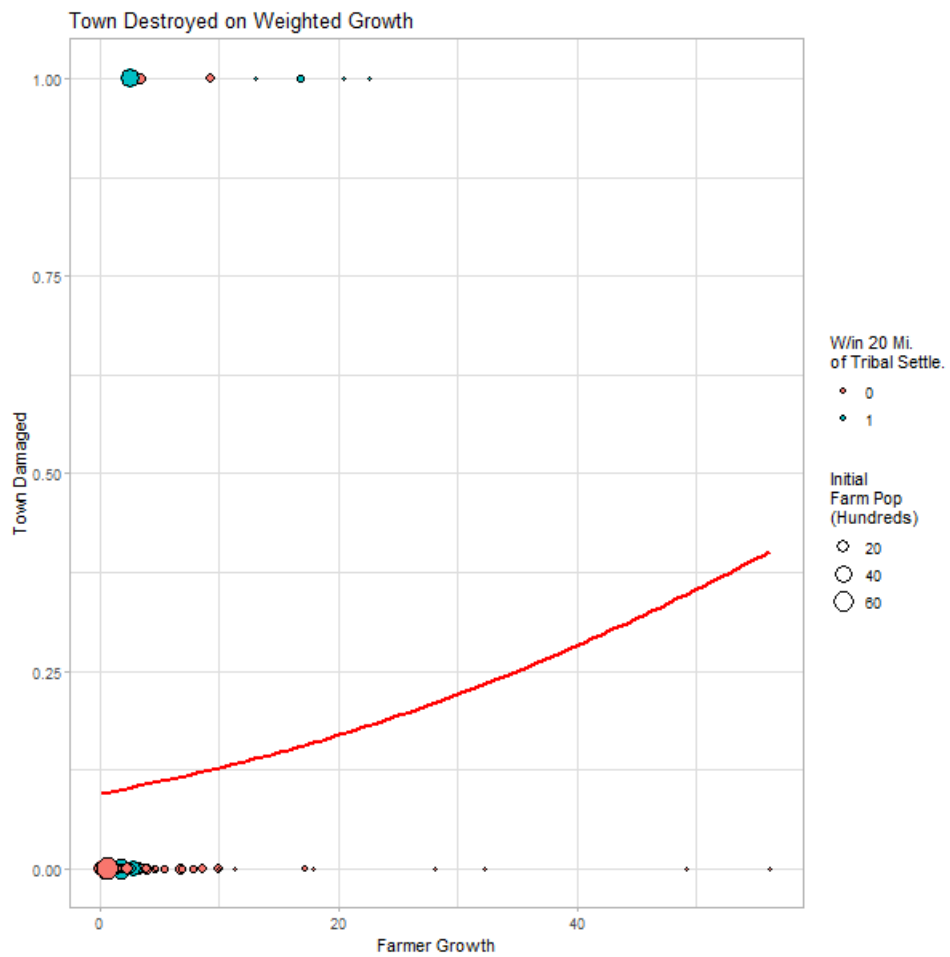**Fig. B2** Washburn Areas of Conflict
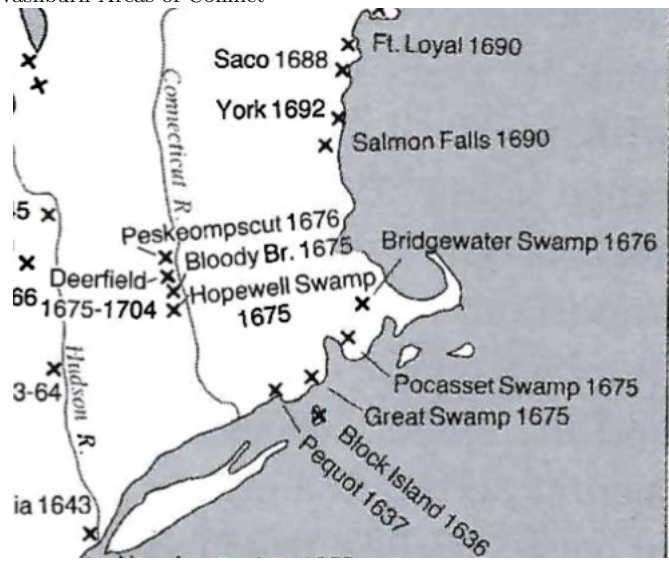
Source: Washburn, Vol. 4

Fig. B3 Logistic Regression Model
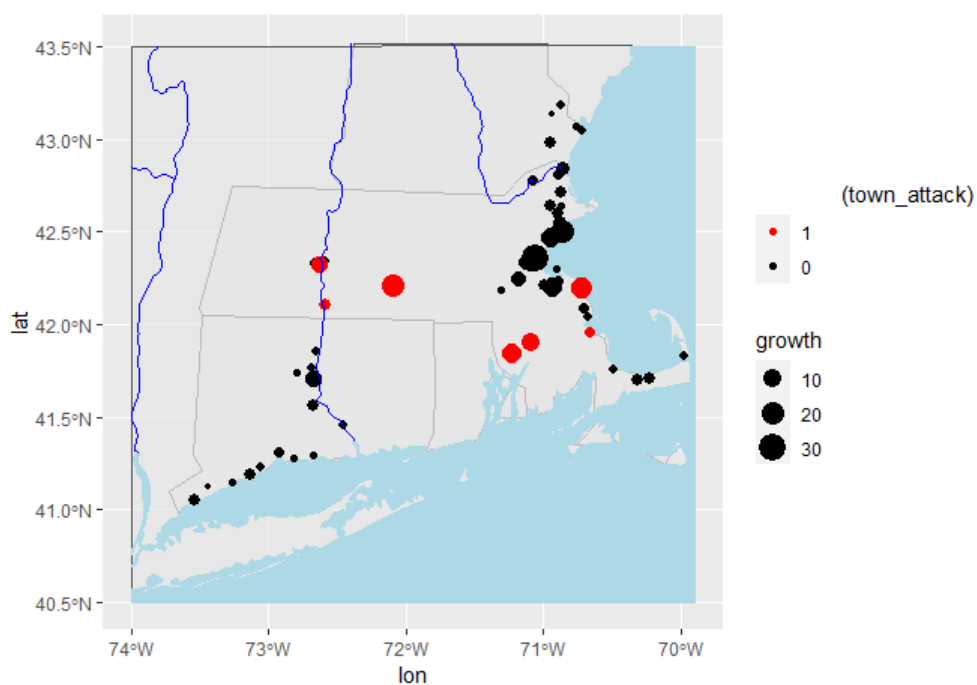

Town Destroyed on Weighted Growth

Corresponds to Model (5) in Table 1. Growth rates are weighted by initial population.

Fig. B4 Hassanamesit and mission communities, with Missitekw, Cambridge, Boston

Source: Brooks, Lisa. *Our Beloved Kin.* 2018.

Fig. B5 Probate & Conflict Map

Appendix C Plymouth Settlement Pasture Growth Tabulations

Fig. C6 Faunal Statistics in Plymouth Colony

Cattle from Probate Records of Plymouth Colony

Decade	Under 1 yo	1 yo - 4 yo	+4 yo	Total	Growth Rate Total	Growth Rate of 1-4
1620	3	7	3	13		
1630	7	15	9	31	138.5%	114.3%
1640	46	51	69	166	435.5%	240.0%
1650	61	111	96	268	61.4%	117.6%
1660	105	178	171	454	69.4%	60.4%
1670	67	185	4	256	-43.6%	3.9%
1680	24	40	54	118	-53.9%	-78.4%

Ratios of Cow:Pig:Sheep:Goat

Decade	Cow	Pig	Sheep	Goat	Cow	Pig	Sheep	Goat	Total Livestock	Growth Rate
1620	1	1.2	7.4	2.396	13	15.6	96.2	31.148	156	
1630	1	0.7	3.9	1.2	31	21.7	120.9	37.2	211	35.2%
1640	1	0.2	0.4	0.004	166	33.2	66.4	0.664	266	26.3%
1650	1	0.1	0.3	0.009	268	26.8	80.4	2.412	378	41.8%
1660	1	0.2	0.3	0	454	90.8	136.2	0	681	80.3%
1670	1	0.8	0.4	0.004	256	204.8	102.4	1.024	564	-17.1%
1680	1	0.6	0.3	0	118	70.8	35.4	0	224	-60.3%

Fig. C7 Pasture Growth Rates in Plymouth Colony

Average Animal Weight

	Cow	Pig	Sheep	Goat
	1,000	130	250	200

Utilization Rate: 3%

Grazing Days: 300
Average Yield per acre: 5,000

Decade	Acres for Cows	Acres for Pigs	Acres for Sheep	Acres for Goats	Total Acres of Pasture	Decade-Over-Decade Pasture Growth Rate	Plymouth Value of Real Estate			
							Total Accumulated Real Estate (Unweighted)	Total Accumulated Real Estate (Weighted)	Decade-Over-Decade Growth Rate (Unweighted)	Decade-Over-Decade Growth Rate (Weighted)
1620	23	4	43	11	82		£ 303	£ 2,107		
1630	56	5	54	13	129	57.8%	£ 1,343	£ 6,440	342.9%	205.6%
1640	299	8	30	0	337	161.7%	£ 1,932	£ 30,212	43.8%	369.1%
1650	482	6	36	1	526	56.1%	£ 2,471	£ 32,398	27.9%	7.2%
1660	817	21	61	0	900	71.1%	£ 2,619	£ 33,554	6.0%	3.6%
1670	461	48	46	0	555	-38.3%				
1680	212	17	16	0	245	-55.9%				

Sources: Plymouth Archaeological Rediscovery Project & USDA

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