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Barriers, Boundaries, and Byways: Water, Mobility, and Society in the Woodland and Colonial Period of the North American Atlantic Coast

Author

Salwen, Stephanie A.

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Barriers, Boundaries, and Byways: Water, Mobility, and Society in the Woodland and Colonial Period of the North American Atlantic Coast.

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requirements for the degree Doctor of Philosophy
in Archaeology

by

Stephanie Anne Salwen

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ABSTRACT OF THE DISSERTATION

Barriers, Boundaries, and Byways:
Water, Mobility, and Society in the Woodland and Colonial Period of the North American Atlantic Coast.

by

Stephanie Anne Salwen
Doctor of Philosophy in Archaeology
University of California, Los Angeles, 2017
Professor Monica L. Smith, Chair

Rivers and streams not only shape the physical geography but can alter cultural perceptions of landscape and influence social organization within and among human communities. Rivers are often perceived as conduits to movement yet waterways have nuanced and at times contradicting characteristics, which people may emphasize differently over space or through time. This study defines four ways in which rivers are incorporated in human mobility patterns: as conduits, obstacles, boundaries, and barriers. These uses reflect the entanglement between humans and moving waterways, suggesting that a waterway's perceived utility is dependent on both the environmental characteristics of the water and the cultural contexts. In this dissertation, I consider the archaeological evidence for these mutable uses through a comparative spatial analysis of site distribution relative to streams within two Atlantic coast river basins, the

James River basin in Virginia and the Saint John River basin that extends through Maine and New Brunswick (Canada). The complex landscapes of inland lakes and rivers have played an active role in the development of native culture in these regions by facilitating navigation, trade, and interaction from prehistory through colonial occupation. Each region provides a different perspective on the human-hydro relationship due to differences in environmental and cultural contexts. Diachronic shifts in site distribution relative to water demonstrate the effects of colonialism on local populations. The project also considers the taphonomic effects of database management on the archaeological record and the implications for extracting usable data from government and CRM datasets for database-driven research.

The dissertation of Stephanie Anne Salwen is approved.

John K. Papadopoulos

Gregson T. Schachner

Min Li

Monica L. Smith, Committee Chair

University of California, Los Angeles

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“Ideas, like large rivers, never have just one source.” (Ley 1944:3). Similarly, completing a dissertation requires the support and contributions of many people and organizations.

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CURRICULUM VITA

Education

2011 M.A., Interdepartmental Program in Archaeology, University of California, Los Angeles

2007 B.A., Anthropology Department, University of Michigan, Ann Arbor

Research Interests

Human-Environment Relationships, Landscapes, Waterways, Mobility, Social Change, Emergence of Political Complexity, Social Networks, Prehistoric Archaeology, Historic Archaeology, North America.

Selected List of Academic Appointments

Teaching Assistant Coordinator, Anthro 495: Teaching Anthro, UCLA

Lecturer, Anthro 118: Artifakes and Aliens: Pseudo-archaeology, UCLA

Teaching Assistant, Life Sci 15: Life, Concepts and Issues, UCLA

Teaching Assistant, SocGen 105B: Race at Bio/Cult. Interface, UCLA

Teaching Assistant, Geog 6: Intro to World Regions, UCLA

Teaching Assistant, Anthro 9: Culture and Society, UCLA

Teaching Assistant, Anthro 8: Intro to Archaeology, UCLA

Selected Research Experience

2014	Field Supervisor, Kerkenes Dag Project, Turkey
2009-2010	Graduate Student Researcher, Channel Islands Lab, UCLA
2005-2008	Investigator, Historic Maritime Research, University of Michigan, Ann Arbor

2006-2008 Field Lab Coordinator, Pecica Archaeological Project, Romania

2006 Field Supervisor/Teaching Assistant, Cultural Landscapes of Douglas Lake Archaeological Research Program, Pellston, Michigan

Selected Fellowships and Awards Received

2014 Steinmetz Travel Research Grant, Cotsen Institute of Archaeology, UCLA

2012-2013 Foreign Language and Area Studies Fellowship, UCLA

2010-2011 Graduate Year Mentor Fellowship, UCLA

2009 National Science Foundation Graduate Research Fellowship, Honorable Mention

2009 Graduate Summer Research Mentorship, UCLA

2008 Dean of Social Sciences Graduate Fellowship, UCLA

Publications

2011 Asphaltum Exchange and the Development of Political Complexity among the Chumash, Southern California, Unpublished MA, Archaeology Department, UCLA, Los Angeles.

2007 Shipwreck Identification and Source Accuracy in the Au Sable Shoals Region, Lake Huron, Unpublished Honors Thesis, Anthropology Department, University of Michigan, Ann Arbor.

CHAPTER 1: INTRODUCTION

Waterways play a broad and varied role in many aspects of human culture. Lakes, streams, rivers, and seas serve as critical sources of subsistence and non-subsistence resources; means of transportation and interaction; natural barriers; distinctive landscape features for wayfinding; and a source of unpredictable hazard. This importance creates a practical and cultural dependence for areal inhabitants, yet water features have nuanced and at times contradicting physical characteristics that affect human behavior even in the modern world. An archaeological perspective on the interface between culture and water can provide distinct insights into cultural adaptations and developments, reflecting the flexibility with which human societies respond to challenges and use the landscape.

Among the many forms of water with which communities interact, rivers are of particular importance. The fluid nature of rivers and streams evoke the notion of movement. While rivers are flowing water that move sediments, they also affect how and where people move in the wider landscape. A river channel may or may not remain stable even as water flows along the course, within which there may be even more nuance to movement with variation in currents.

A waterscape is a picture or view in which an expanse of water is the dominant and focal feature. Although my dissertation draws on many concepts developed within social networks research and landscape archaeology, the centrality of rivers to this research project, both as physical features and as a conceptual basis of cultural landscapes, leads me to consider this project a theoretical *riverscape* analysis.

As significant and recognizable features on the landscape, rivers shape the topography, carving through mountains and plains, carrying sediments, leaves, or debris downstream. Rivers also influence the movement of populations on the landscape. Flowing water may draw organisms to the banks of the channel, as a place to drink and find subsistence. Because rivers are part of the land but are discrete entities that disrupt the terrain, they impact movement across a region, either by altering the cognitive map of space or by creating a feature that needs to be crossed or avoided for movement across a region.

There is a dual resonance here: streams not only embody movement, but they *affect* movement. It is this concept that provides the foundation for my research. The fluid, flowing aspect of rivers--that they are dynamic, rather than stationary features--is essential to understanding not only how communities move through a landscape, but also how they delineate those landscapes. I will analyze how communities incorporate the presence of streams in path-making to shape their mobility patterns and the resulting social networks.

Throughout this dissertation, I shall: a) present archaeological correlates for four common uses of waterways relative to mobility and b) explore how these roles are used to promote distinct social and economic interaction strategies. I will elucidate prehistoric cultural development along a major tributary of the Chesapeake Bay on the Atlantic coast and in the North Atlantic region of Maine and New Brunswick. Whereas these regions provide a unique intersection of environmental systems and human activity, I will explore, in particular how the complex landscape of inland lakes and rivers played an active role in the development of native culture by facilitating navigation, trade, and interaction from prehistory through colonial occupation.

Waterways in Human Culture

Rivers and streams have had a significant role throughout the history of human culture. For one thing, rivers are dangerous. Notwithstanding the direct risks of drowning or destruction from floods, there are indirect risks, such as harboring predators or, where water stagnates, supporting vectors for disease. Rivers also serve as a base for subsistence and non-subsistence resources. For instance, they provide potable water, as well as create an ecological niche for useful flora and fauna. Waterways also indirectly facilitate horticulture within floodplains and agriculture through the use of canals and irrigation. The extent to which rivers as a danger or as a resource base impact culture is well-attested. Far more complex is the impact of waterways on culture, in their capacity as landscape features.

Waterways *as landscape features* have a drastic impact on how communities conceptualize, occupy, and move through the environment. Most studies of water travel emphasize the ways in which water features are conducive to mobility. Populations often exploit waterways in order to access new resources through procurement or trade relations. However, there is a more nuanced relationship between culture and water that cannot be understated. Where water is a conduit, we must consider how seasonal changes water and landscape conditions affect the cost of travel by both terrestrial and riverine routes (Ford 2011). Similarly, the availability and diversity of watercraft may alter the efforts associated with travel or create inequalities among who can travel. Even the premise that travel by water is inherently beneficial must be challenged; a community may have negative associations with waterways. In periods of conflict, large waterways may act as conduits or war paths, benefiting the raiding party but threatening targeted communities. Ethnographic and historic accounts (discussed in chapters 2 and 3) indicate that the dynamism of rivers' flow prompted many groups to identify these features as harboring, or even being, otherworldly spirits prone to caprice and capable of malice. These landscape features affect wayfinding beyond just providing a path along which people travel. As recognizable features, rivers can be used to orient terrestrial travel and delineate geographic space, designating periphery of cultural or political spheres or defining resource zones to promote more peaceful interactions between groups.

While the effects of waterways on society are extensive, water routes do not exclusively determine patterns of interaction. Instead, water features create variation in the landscape that may be used to implement different strategies. They influence the ways in which communities can operate within the environment to respond to periods of social change, which may alter in turn the structure of cultural organization. Rivers and streams can shape the structure of people's movement and interaction in a variety of ways. These may vary through time, for different social, economic and political purposes, and at different geospatial scales. Rivers are a natural starting point to explore the dynamics between communities and the landscape.

As such, I have restricted the scope of this dissertation to consider the effects of flowing water as landscape features, rather than as a resource base or physical danger. This dissertation integrates theoretical ideas about mobility, social interaction and trade, and landscape modeling to address how communities incorporate waterways to actively demarcate and maintain their social networks.

Archaeology of Waterways: Contextualizing and Defining this Research

Waterways, with their implication of movement, are enmeshed with much of human history and archaeological inquiry. They are tied to discussions of human migrations and the origins of watercraft and navigation (Erlandson and Fitzpatrick 2006). Water impacts subsistence, both by providing water-based resources and through the spread of agriculture and irrigation in farming societies (Wittfogel 1956). Water is a key-point in models of emergent complexity and polity expansion where water travel helped the elite to access new resources, establish social relations, and control the movement of people, goods, and ideas (Algaze 2005; Sherman et al. 2010). The loss of water is equally important. It may be tied to theories of collapse (Diamond 2005; Lucero 2002; Tainter 2006) and population dispersal, or linked to the emergence of complexity wherein people restructure economies and labor (Arnold 2001). Water is also important in religious contexts, as evident in the wide distribution of water deities (Håland 2009; Insoll 2009), offerings (Bradley 2000), and the control of water in religion (Lansing et al. 2009; Vaughn 2009). These water features may be symbolically important places with powerful or ancestral associations, but this role is distinct from uses of water in forming social networks and has a different detectability. These cases show that the ability to control access to or travel along water may be leveraged to generate economic or political power to shape interaction spheres and contribute to social stratification.

This research assumes that water is not just a resource but creates conditions to which a community can select a response rather than a force that implicitly determines cultural responses. The project expands upon much of the previous research on water by placing a more explicit focus on the recursive relationship between society and water. I seek to address the relationship between social networking and landscape, by specifically questioning how rivers, a particular type of landscape feature, were employed to construct cultural landscapes that facilitated or limited interactions. I am interested in how these uses change when the broader social organization undergoes transformation, such as the difference between prehistoric and historic uses of waterways.

My research is informed by studies that focus on how river systems influence mobility and subsequent interaction spheres. These studies often focus on the outcomes of water travel and less on the particular routes or how people conceptualize those mobility paths. These aspects of water travel are even less likely to receive due consideration when settlement networks are connected by water because water is often presumed to be the natural, easy, and beneficial route. This persists even though scholars know that the ability to use these routes may be limited, as in the case of access to plank canoes among the Chumash in California (Arnold 2001). Though archaeologists are often focused on trade goods, they less frequently focus on the routes of trade beyond the pragmatic, much less the etic conceptualizations of routes within past landscapes. Ethnographic and historic evidence demonstrate that these corridors can equally facilitate disruptive or malignant interactions.

In this research, I try to identify archaeological evidence of mobility that considers etic and emic perceptions of waterways. The use of a landscape feature is the result of both its physical and cultural components. Hussain and Floss (2016) discuss mobility in the Paleolithic, focusing on the idea that biophysicality creates potential uses – which they call affordances - but that the uses are based on culturally-motivated needs. Their work challenges the idea that a river is implicitly suited to a particular use, providing possibilities rather than dictating particular actions. This dissertation project also draws on studies that explore how cultures adapt their perception and use of a waterway during periods of social or economic transition (Biró 1998; O’Shea 2011). Because this study addresses which potential use a given community will choose to emphasize, this dissertation also incorporates an understanding of how indigenous communities conceptualize spatial information and territories around waterways (Lovis and Donahue 2011). My research contributes to a tradition of settlement aggregation studies, examining how inter-community dynamics relate to environmental features. This helps frame environmental considerations in settlement choice as part of a broader spatial network rather than the localized influence of environmental factors for things such as agriculture or defense (Martindale and Supernant 2009; Maschner and Reedy-Maschner 1998).

Despite the wide-reaching relevance of the intersection between riverine environments, mobility, and interaction spheres, this dissertation is framed in a narrower cultural and environmental scope. In my analysis, I focus on two North American case studies: indigenous communities from the Chesapeake Bay, Virginia and from the Maritime Provinces in Northeastern Canada, both along the Atlantic coast. These cases assess middle-range hunter-gatherer societies within the Eastern Woodland culture that occupied riverine environments.

The two chosen regions also provide differences valuable for a comparative study. Although historical records were kept for each region, the manner in which Native-European contact was made differs. In Virginia, the early and relatively limited presence of 16th century Spanish explorers was quickly followed by English permanent settlements. In contrast, the Northern Atlantic coast experienced more sporadic and limited exchanges, beginning with a small Viking presence and succeeded by off-shore fishing and whaling expeditions by Basque sailors only at the cusp of the 17th century (Bourque and Whitehead 1985); subsequent French and English fishing and whaling settlements were established on the mainland. The comparison of Woodland cultures in two climatic zones will also allow me to consider how water use varied according to both seasonal resource availability and seasonally affected landscapes.

The methods employed in this dissertation blend traditionalist approaches to settlement pattern analysis with advances in hydrological analysis in order to identify how water is implicated in mobility patterns. This project's contribution is in its synthesis of settlement data and environmental contexts to focus on rivers and develop an interpretive framework that shows how water features affect a range of possible uses depending on social or political context, rather than prompting a single intrinsic response. The ability to identify shifting river use may then be evaluated for correlation with periods of environmental, socio-economic, or political disruption. Where these reactions are evident, an analysis may indicate not only how water use changed but which types or degrees of external pressure elicited change in land use.

My research will first identify archaeological correlates for four primary uses of waterways: (1) obstacles to land-based movement, (2) demarcations for geographic boundaries of social groups, (3) physical barriers that separate populations, and (4) conduits that facilitate movement and interaction. Drawing on historical and ethnographic examples from middle-range societies, I generate a series of archaeological correlates for these uses. Because these uses create distinct patterns of movement, I anticipate that each use will leave a specific pattern across multiple lines of evidence, including environmental, historic, ethnographic, and archaeological data. I will perform quantitative and qualitative spatial analyses to look at archaeological data including settlement patterns (both location and type) and the distribution of ceramic styles, trade goods, and raw materials in relation to water-based landscape features such as fords and confluences.

The interpretation of these data is dependent on the relationship between the spatial, material, and environmental data. Geographical Information Systems (GIS) are now a standard tool in evaluating boundaries and movement (Bell and Lock 2000; Hare 2004; Harris 2000; Llobera 2000; Llobera et al. 2011; van Leusen 2002). Determining whether water is an efficient mode of travel depends on the cost of movement by water versus land. To assess the relationship between movement and social interaction relative to surface water systems, I will overlay the cultural data with environmental data using GIS. This analysis and the relationship between data provide the basis for interpreting how communities used water to maintain social and economic strategies for integration and differentiation.

Although water accessibility is now discussed at a global level and the specific details of water pollution and politics have changed, an archaeological investigation of water use can provide insights into current water controversies through several persistent themes:

- Inter-community Conflict: Social groups rely on waterways to differentiate their communities while maintaining cooperative ties that provide security in accessing resources and preventing conflict.
- External Forces: Whether climatological or demographic – namely population increase via incursion or population growth - outside pressures prompt communities to adopt new uses of waterways.
- Cultural Identities: Water use is not purely dependent on biological necessity but incorporated into cultural structures that must also change when water use does.
- Human Ecology: How humans perceive their relationship with the environment influences how they will incorporate the landscape and resources in activities. Modern

> solutions to the water crisis, such as desalination techniques or developing pavement that increase groundwater absorption into aquifers, are ways to maintain cultural practices of "overcoming" nature through technological innovation, rather than acknowledging a recursive relationship between humans and the environment.

While these concepts are discussed more fully in the final chapter, this project illustrates the elasticity of human society in our ability to incorporate water into our lives and speak to modern interests over whether human societies are more resilient to political change or to environmental change.

Organization of this Dissertation

This dissertation is organized into eight chapters across three parts. The first part of this dissertation (Chapters Two through Four) focuses on how to think about waterways. The second part of this dissertation (Chapters Five through Seven) use archaeological correlates for particular uses of waterways to elucidate transformation of social organization in the Eastern Woodlands of the United States. The final part of this dissertation (Chapter Eight) contextualizes these findings into a broader perspective. The concluding pages examine how an understanding of river use can be employed to better understand cultural transformations. It will also consider how we can draw on an archaeological perspective of water use to approach more recent concerns regarding the water crisis in the 21st century.

Chapter Two is a literature review, using ethnographic and archaeological examples of how water has been incorporated to maintain hunter-gatherer's social networks, presenting models of water use amongst confederated groups and chiefdoms. In a brief review of hydrological principles, I discuss how water itself has physical characteristics that put standardizing constraints on how people may interact with or perceive water. As a result of this, I define four major “roles” that waterways have in shaping the mobility of communities across a landscape when maintaining social network structures. Water can be barriers, boundaries, obstacles, or conduits.

Chapter Three elaborates on the major uses of water identified in the previous chapter as they are manifest in the hydrography of North America. This chapter will present the environmental and cultural contexts of social transformation in the Chesapeake region along the Mid-Atlantic Coast and in the Maritimes Provinces of Canada. This introduction to the case studies used in this dissertation will discuss the ecological resources and cultural adaptations during both the prehistoric and early-contact eras of occupation.

Chapter Four describes a methodological framework, concentrating on how concepts from landscape archaeology and social network maintenance relate to the use of particular paths and trails. This chapter explores how GIS have been used to access and interpret both the physical and experiential aspects of an environment through which people travel. Moving water presents a range of additional variables to consider when using GIS.

Chapter Five outlines a method for identifying the four “roles” of waterways in mobility patterns through the archaeological record. I first present a means of evaluating movement through quantifiable aspects of movement, including the direction, intensity (frequency or scale of party), and cost of travel in a particular direction. I then discuss the types of archaeological material and analytic methods used to measure these individual aspects and present expectations for the distinct and predictable archaeological correlates that identify the specific way in which a community was influenced by the water feature.

Chapter Six presents the environmental and archaeological data used to interpret changes in river use from the Woodland Period through the Contact Period occupations of the James River Basin in Virginia. This chapter describes the challenges of environmental and archaeological data collection, presents an analysis of site distribution, and suggests interpretations for this pattern. This discussion considers the extent to which patterns may be a product of human behavior both in the past and in contemporary archaeological practices.

Chapter Seven follows the same structure as chapter six. This chapter presents the data, analysis, and interpretation of site distribution in the Saint John River Basin, which extends from northern Maine in the United States of America and through New Brunswick, Canada.[1] This case study presents a comparative example for both river use in the past and data collection and management in the present.

Chapter Eight concludes the dissertation. I first review how an analysis of social transformation through the lens of waterways can improve our understanding of the cultural sequence and transformations that Eastern Woodland communities underwent during the early contact era. The discussion then turns to whether, based on the physical consistencies of water, researchers can use specific cultures as a means of building a more comparative understanding of the ubiquitous but perhaps repetitious roles that water features play in society. As part of the conclusion, I revisit the question of how an archaeology of water use in the past is relevant to our modern crisis, showing that water is not inherently suited to a given purpose and that cultural

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[1] This river variably identified as the Saint John, St. John, and Saint Jean (in French) and should not to be confused with the Saint Johns (St. Johns) River in the State of Florida.

elasticity allows communities to adapt new ways of using water in their societies. Archaeology lends a long-term view of competing perspectives on, and use of, waterways in societies and how this knowledge may be used to mediate situations of contested water rights and access in the modern world.

CHAPTER 2: WHY STUDY WATER? THE CURRENT WATER CRISIS AND ARCHAEOLOGICAL PERSPECTIVES

Water issues are an increasingly large proportion of our environmental concerns. Water figures into media stories at all scales, from the global perspective to local policies. These stories implicate human health, economics, and cultural identities. While the particular details and scale of the current conflicts may be distinct, the controversies experienced in our lives parallel themes in archaeological case studies that extend back across centuries, with many of the topics in our daily news echoing those in archaeological investigations.

Connected waterways, particularly flowing water, impact mobility and the social interactions which allow communities to live within an ecosystem. Often, however, human interactions with waterways are characterized by conflict: water is a feature whose presence on the landscape must be either yielded to or overcome. A broader geographic perspective spanning a deeper time depth suggests human societies and stream systems are interdependent. Human social networks are co-produced by the physicality of the environment and the ways in which people respond to that environment. However, this dissertation suggests that social interactions and mobility are conditioned by the dynamic presence of water, instead of the human-agentive perspective of paths and trails. Because environmental and cultural processes are both generally predictable and reproducible, understanding the dynamics of this intersection in the past may lend insight to modern human-hydro interactions.

In this chapter, I begin by briefly describing the state of the modern water crises. This is followed by an overview of hydrological principles and the physical characteristics of flowing water. This provides the basis for a discussion regarding the predictability of streams and the ways in which communities, emphasizing hunter-gatherer societies, interact with them. I then discuss some of the challenges of placing moving water within social landscapes. As part of this, I integrate a brief review of social networking with work on trails and paths, which address the physical routes along which social networks are enacted. Synthesizing these perspectives allows me to address the way that waterways shape movement and influence the trajectory of social interactions. I use cross-cultural comparisons from ethnographic and archaeological cases in which water influences movement to illustrate that waterways increase or decrease integration. Finally, I suggest that most cases can be categorized into four heuristic “uses” of a waterway: barriers, boundaries, obstacles, or conduits to movement. I distinguish these roles according to their effect on community movements and subsequent social interactions.

Water Concerns in the Modern World

On-screen images shape our perception of and reactions to the actual state of world affairs. Particularly in Western media coverage, the dramatic coverage of large-scale and frequent flooding events might suggest water is an unpredictable resource simultaneously prone to excess as well as scarcity. It is only in follow-up stories that the contamination and illness posed by receding floodwaters are discussed. Floods are not the antithesis of scarcity but rather another facet of the same crisis: there is a dwindling amount of clean, safe, freshwater left on our planet, only a fraction of which is accessible.[2]

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[2] There are 10.6 million km^3 of freshwater on the planet, but 99% of this is held in aquifers (World Business Council for Sustainable Development 2009:2)

Although there are several methods for evaluating water scarcity, the most widely used is the Falkenmark Water Stress Indicator (Brown and Matlock 2011). This measure defines a country or region as “water stressed” when annual water supplies are less than 1,700 m^3 per capita in a year. Periodic or limited water shortages are expected when water availability falls between 1,700 and 1000 m^3 per person per year. If water falls below this mark, the country faces “water scarcity.” The United Nations Food and Agriculture Organization projects that by 2025, 1.9 billion people will live in areas with an absolute water scarcity and as much as two thirds of the world population may be under “stress” (Alexandratos and Bruinsma 2012).

Water scarcity can result from two physical and economic pressures. Physical scarcity occurs when there are insufficient natural water resources within a region to support demand while economic water scarcity is the product of societal constraints despite sufficient resources. For much of the world, the conditions can be attributed to this latter form of scarcity, in which available water is inaccessible.

Economic scarcity can be caused by competing demands for water from residential or urban use, agriculture, and industrial infrastructures. Agricultural consumption draws on both surface water and aquifers to support both crop irrigation and livestock. There is also a massive demand for industrial uses of water. On a global scale, residential use accounts for 8%, agriculture accounts for 70% of water use, and industry is at 22% and growing. Of course, this breakdown varies between developing nations (82% agriculture, 10% industry, 8% urban) and developed nations (30% agriculture, 59% industry, 11% urban) (World Business Council for Sustainable Development 2009:3).

The cultural implications associated with these competing uses are easiest to see in specific cases. Although competition occurs throughout the world, it is not limited to developing nations or rural contexts, as demonstrated with well-known cases in the United States. Though we may recognize them as major news stories, we might not implicitly recognize them as part of this water scarcity debate. The Great Lakes Compact, signed in 2008 by the eight states that comprise the Great Lakes-St. Lawrence River Basin, and which seeks to manage and protect this waterway, came into existence in part to safeguard against efforts to bottle the water. Among the goals for protecting the St. Lawrence River and Great Lakes is a concern for the preservation of the environment, not just because they support a diverse ecosystem but because the aesthetics of the region itself are a source of tourism revenue and an integral part of the lived experience and identity for those who occupy the region, including the ability to engage in recreational activities on the water.

Amongst the concerns for water, one of the most significant involves water that traverse landscapes, as compared to ponds and lakes. One of the fears is that the increasing water shortage will contribute to conflicts in the absence of a global or regional institution for management of water and trans-boundary waters. There are 263 major rivers that cross or mark international boundaries and the watersheds associated with these waterways account for 60% of the world's surface freshwater (Giordano and Wolf 2002). Of these, 158 rivers are not managed by international legislation, creating opportunity for competing claims. The environmental resources and super-imposed delineation of Nation States have created an opportunity for conflict precisely because water flows from one place to another.

Historically, water issues have contributed to, but have rarely been the actual cause of conflict; cooperation has been more common. Based on a 2011 think-tank initiative report called Blue Peace, which emphasizes cooperation and resolutions focused on need-based rather than rights-based paradigms of water access, many potential conflicts have been avoided. While the most commonly known instance to be resolved by this framework was the series of conflicts between Israel and its Arab neighbors over control of the Jordan-Yarmouk system, that case is one of the few water conflicts that has erupted into physical violence. The Mekong River, a vital resource throughout Southeast Asia, begins in China, one of the most water-stressed nations in the world, yet the Mekong Committee established in 1957 has mediated water use even throughout the destabilization associated with the Vietnam War. The Indus River Commission and Indus Water Treaty have survived two wars between Pakistan and India, though they face continued concerns as Indian farmers draw more heavily from the local aquifers. The success of these institutions is illustrated in contrast with recent threats to water security raising national tensions in the Middle East, as Egypt's government contemplates building a high dam on the Nile and the Syrians consider their own dams (e.g. Bremer 2016; von Lossow 2016).

California's "water wars" are a prime case study for many of the modern concerns about water. The most famous of these was a series of conflicts between the City of Los Angeles and ranchers in the Owens Valley in Eastern California which began over one hundred years ago (Reisner 1993). As the city grew, so did its demand for water. William Mulholland, the chief water engineer of Los Angeles, oversaw construction of an aqueduct, over 320 km long, that brought water from the Owens Valley to the city, the product of both impressive engineering and dirty politics. The diversion of the Owens River led to an agricultural collapse in the valley by 1926. In the 1940s, Los Angeles shifted its demand to the nearby Mono Lake, leading to dramatic decrease in water level and threatening migratory birds that relied on the lake to rest and consume calories to complete their migration. In the 1970s, a second aqueduct was built without completing an environmental impact report, creating further conflict even as the city continued to pump water from aquifers in central California. Only in 2006 did the city re-water the lower Owens River (Sahagun 2006) though groundwater continues to be pumped out faster than the aquifers can naturally recharge their groundwater supply (Knudson 2014).

The politics of California's state's water crisis reflects only a portion of the current challenges. External factors such as climate change have contributed to ongoing drought and historically low snowfalls. The socio-history of "Hollywood" has created an expectation for lush greenery and abundant fountains in the oasis of the rich or famous. Los Angelenos are not unique in their efforts to control and incorporate water in the built landscape. Examples from the past, including the Palace of Versailles, the baths and fountains of Rome, and the water gardens of Petra in Jordan demonstrate that water can provide an aesthetic that both affirms human control of the landscape and the wealth of certain individuals. These examples, however, stand in stark contrast with the necessity for environmental sustainability. Current policy efforts must recognize the reality of water scarcity while acknowledging the ways in which communities identify themselves, particularly where the use of water figures into this identity and the accompanying behaviors. Many cities and organizations in Los Angeles County have begun to turn off fountains, use recycled water to sustain their gardens, and promote xeriscaping with low-water gardens of succulents.

When we discuss water in the 21st century, our perspective assumes unprecedented scales. Though local water politics affect countless communities, we also worry about the absolute presence of water and the implications of depletion for many aspects of society, from basic survival to multi-national industries. In complex societies, humans have increasingly assumed a culture-vs-nature perspective in which we have sought to control nature, as illustrated by the construction of dams, the diversion of rivers, and the creation of numerous lakes and reservoirs. The modern crisis seems driven by two major concerns: (1) the planet will run out of clean water and (2) adapting to a world with water scarcity will entail economic losses and global conflict.

Water as a system can be studied and hypotheses developed to assess to how both environmental and cultural changes will alter the world water configuration. In struggling to address the issues, we find that potential problems and solutions pit many different needs and perspectives on water against each other. In order to consider how people view any particular water resource, one must also understand what forces – environmental, economic, and political – lead them to that perception and subsequent use.

The Hydrological Cycle

The hydrological cycle, also known as the water cycle, is a process by which water moves through and around the earth and its atmosphere as a gas, solid, or liquid. This cycle consists of nine physical processes: evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage (Figure 2.1). As the water cycle is a continuous phenomenon, one can assess the system from any starting point.

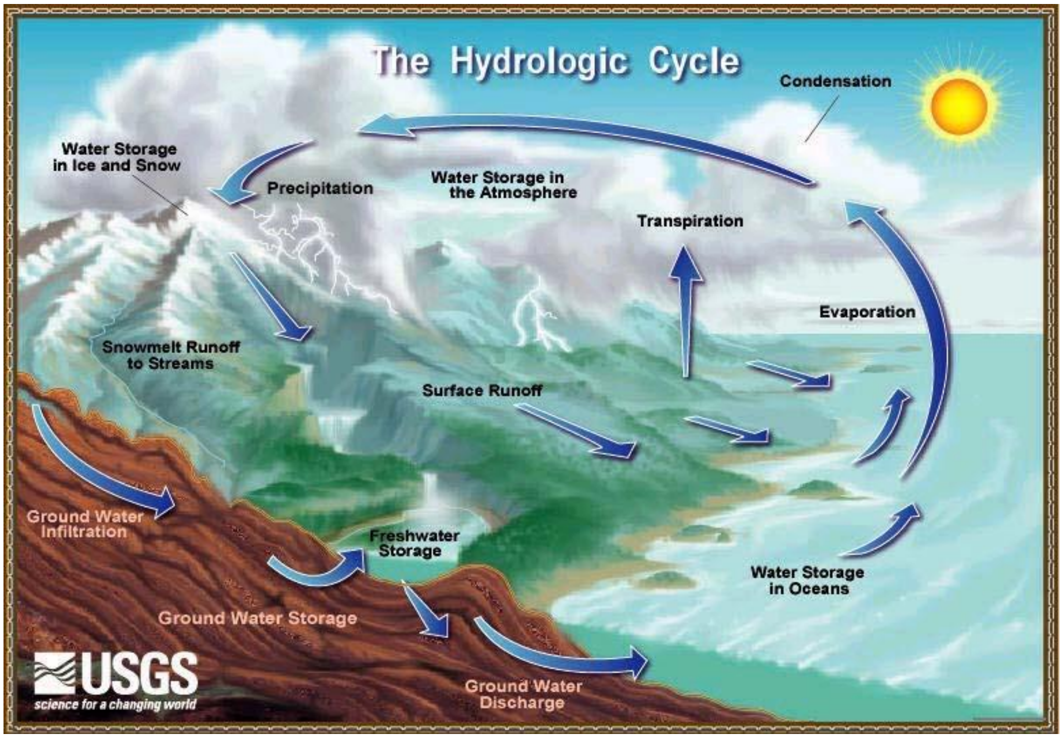

Figure 2.1. The hydrologic cycle (Evans and Perlman 2016).[3]

Evaporation occurs when water enters the atmosphere as vapor, with the rate of evaporation impacted by various environmental factors. Though vegetation reduces soil evaporation, plants undergo *transpiration*, a biological process in which they absorb liquid water to move nutrients and release vapor into the atmosphere. Evapotranspiration refers to the total volume of vapor that enters the atmosphere from evaporation and plant transpiration. As air temperature cools or the air reaches a saturation point, the atmospheric vapor condenses on airborne particles and re-assumes a liquid state, creating dew, fog, and clouds through *condensation. Precipitation* occurs when water molecules bond to a sufficient size that gravity

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[3] https://water.usgs.gov/edu/watercycle.html

forces the particles to fall to the ground, in a liquid or solid state and landing on water or land, where it will evaporate, be absorbed by plants, sink into the soil or flow into streams.

The hydrological cycle continues when precipitation reaches the ground. *Interception* describes disruptions to the flow of water into streams or soil, where water accumulates on plant surfaces or in topographic depressions which delay the rate of absorption or evaporation. Water that reaches the ground via the atmosphere or precipitation moves into the soil through the process of *infiltration* and may be stored, evaporate, be absorbed by plants for transpiration, or contribute to subsurface runoff, depending on the porosity and permeability of the soil. During *percolation*, gravity moves water down through the soil layers. Water in soil layers that include air is called vadose water, while water where soil is saturated is called groundwater; these zones together constitute the water table. Subterranean geological formations that allow water to aggregate in volume are called aquifers. Though humans may draw on this groundwater directly, aquifers also impact surface water: springs occur where the water table reaches the ground surface and groundwater may form the base flow of water in a stream channel during dry periods.

Two phenomena in the cycle are particularly relevant to the spatial distribution of surface water systems. Levels of precipitation that exceed soil absorption contribute to the process of *runoff*, in which water flows downward from the highest topographic points. The total runoff is the cumulative flow of precipitation that falls on the stream channel as well as runoff from land surfaces, subsurface runoff from saturated soil, and groundwater. This surface runoff moves over the topography and surface channels, following a downward trajectory within a given basin and creating streams of different sizes. The portion of runoff that moves on land towards streams is called overland flow, while water moving within channels is called streamflow. Streams continue to flow until there is no water in the channel, due to infiltration and evaporation, or until they flow into a larger body of contained water. This leads to the ninth phenomenon in the hydrological cycle - *storage*. Water is stored in the atmosphere as vapor and underground in aquifers, but on the surface, water is stored in the oceans, lakes, reservoirs, and glaciers.

Stream systems

Although similar cultural conflicts and issues of equity, access, and control unfold across a range of water contexts throughout the hydrological system—including oceans and coasts, lakes and streams, and groundwater and precipitation—this dissertation focuses on flowing surface water. Of all the moisture on the planet, 97% is in the oceans and less than .0002% is in rivers and streams (Gordon et al. 2004:1). Despite representing a minor percentage of the planet's water, cultures around the world have consistently settled, evolved, and even collapsed through their close association with rivers and streams. The extent of this entanglement, particularly flowing water's ability to introduce and alter conditions to which communities respond, makes it necessary to understand rivers as active - almost agentive – entities (e.g. Edgeworth 2014).

From an anthropological perspective, the importance of flowing water is illustrated by the breadth of words used to classify variations in flow. Within American English, a wide vocabulary references different types of flowing water in channels. We may refer to a flowing course of water as a brook, creek, race, stream, or river; regionally we see even greater variation including crick, burn, beck, or kill. These terms relay colloquial distinctions regarding the characteristics of the channel. There is no explicit quantitative basis to these designations, a factor that makes analyses and comparisons of waterways more difficult.

Hydrologists define all moving bodies as a ‘stream’ – a body of water flowing within a channel that may be above or below ground whether water is consistently or only occasionally present. Within the field of hydrology, the sub-field of potamology – the study of surface rivers – provides a systematic way to evaluate water-systems and assess the quantitative aspects of flowing water. A stream’s flow and size create the “agentive” aspect of a river in changing the environment through evaporation, flooding, or freezing, to which the communities need to respond while choosing where, when, and how people can settle or travel.

Rather than approaching an archaeological context as the unique intersection of a particular stream and specific culture, archaeologists can and should draw on interdisciplinary methods to consider the entanglement of anthropological and geophysical processes. Adopting an interdisciplinary perspective on waterways provides a foundation from which different disciplines can draw on a common vocabulary and develop predictions of how people will interact with water.

Anatomy of a catchment

The hydrological properties of a stream are cumulative products of climate, geology, and vegetation of the surrounding area; climate is defined by precipitation rates and temperature, where cold temperatures that lead to freezing will alter the accumulation of flow or lead to frozen ground that prevents absorption. Geology and soil affect absorption, as well as the pattern by which runoff or storage occur, while vegetation generates effects by altering accumulation (snow on branches), evaporation rates of shaded soil, and transpiration depending on how much water they take in and release. Thus, the hydrological cycle is altered by environmental features (the atmosphere, lithosphere, and biosphere), while a river, though a distinct feature on the landscape, is a product of these integrated components in the larger environmental context.

Climatic zones classify the type of weather likely to occur within a region. The most widely used classification, the Köppen-Geiger system, differentiates regions based on the average temperature and precipitation rates (see Figure 2.2). This system allows researchers to anticipate environmental variables for given region and compare across regions. Climatic zones are useful for evaluating regional hydrologic phenomenon, as the precipitation and temperature within each influence rates by which water moves through the water cycle. Regions with colder temperatures and high or moderate precipitation are likely to experience freezing or sub-freezing conditions, during which surface water will freeze, affecting its ability to serve as a barrier, conduit, or obstacle to movement. Zones with moderate temperatures or greater seasonal variation will likely experience annual cyclical changes in the stream systems, as snow or rain increases the stream discharge. Regions with higher temperatures may have lower precipitation and elevated evaporation rates, leading to more intermittent or ephemeral streams. These regions may be prone to drought or flooding, as the soil is less suited to infiltration.

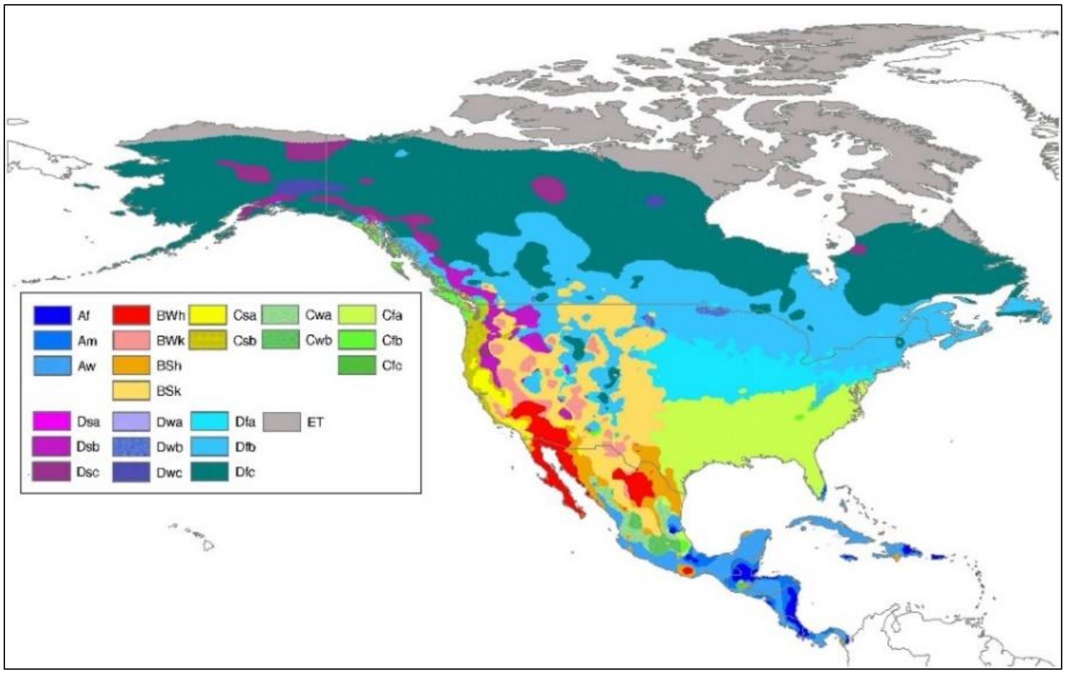

Figure 2.2. Updated Köppen-Geiger climate classification world map (Peel et al. 2007, Fig. 6).

The area that supports a particular water flow, within which the hydrological cycle operates under the influence of the local environmental conditions, is a catchment. For any channel of flowing water, varying conditions and their correlate cycles may create numerous iterations, making catchments multi-scalar and fractal spaces. That catchments can be viewed as having a nested, hierarchical quality is complementary for archaeological investigations of land (or water) use, as it provides a physical context for examining human relations at different social scales.

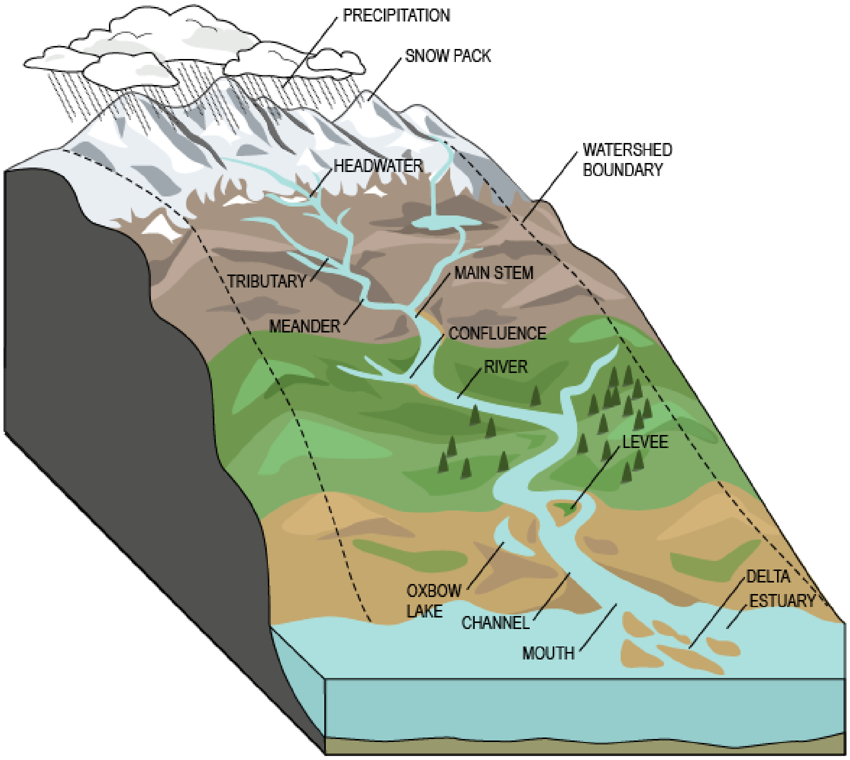

Figure 2.3. Anatomy of a river system.

A catchment refers to the entire area from which water drains into the flow, including subsurface sources of water and precipitation that falls within that zone. The perimeter of each system is called the drainage divide and follows the highest points of elevation along the ridgeline around the flow and between adjacent catchments, though individual points within a basin may attain a higher overall elevation.

Runoff from the drainage divide moves downward, with small flows of water creating channels as they move downward and intersect (see Figure 2.3). The volume and frequency of precipitation, the absorption and erosion rates of the soil, and the type and density of vegetation influence where these channels emerge, creating a network of streams in one of a number of different patterns. Figure 2.4 shows some of the most common patterns, though the density of channels depends on the slope of the land and the substrate (Gordon et al. 2004:60). As water flows down slope, channels intersect at confluences and create larger flows. The primary downstream portion of a flow is called the main stream, while the smaller flows contributing to this main stem are called tributaries.

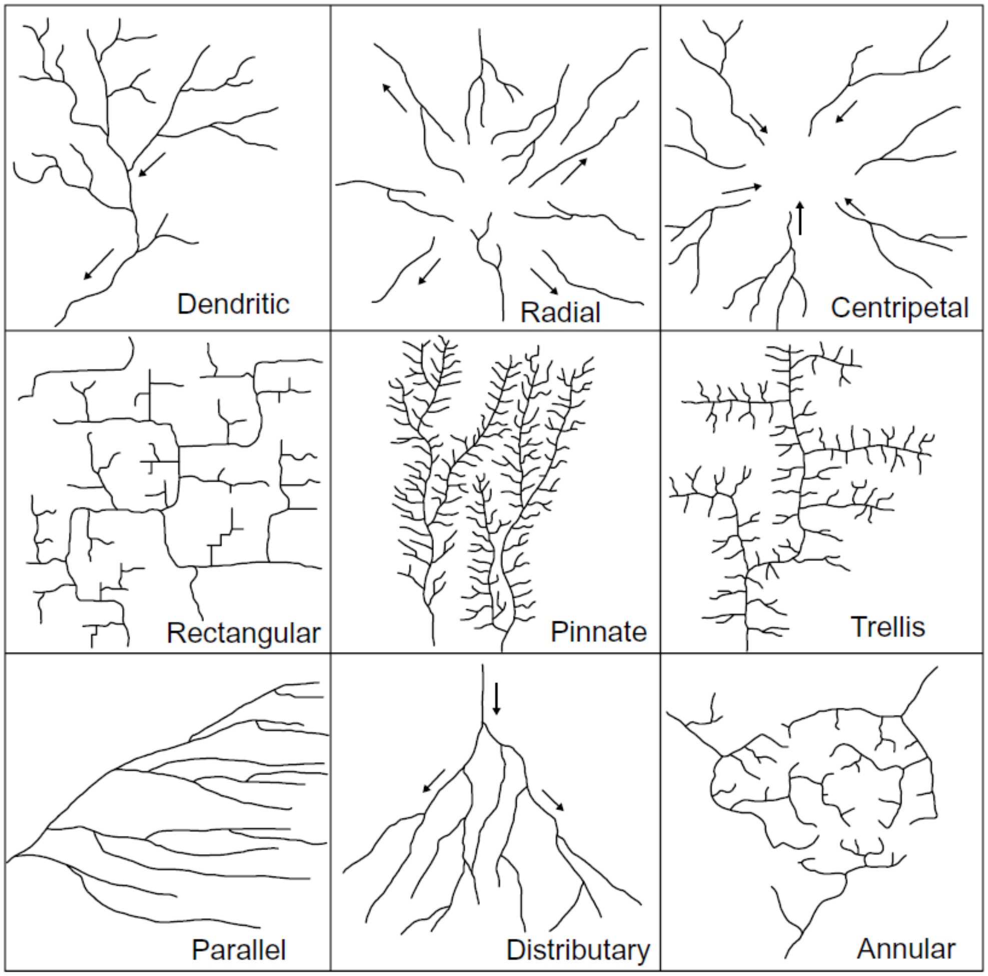

Figure 2.4. Drainage patterns (Gordon et al. 2004, Fig. 4.9).

Different drainage patterns (Figure 2.4) emerge depending on the substrate, as illustrated and explained by Gordon et al. (2004:60): Dendritic patterns occur in areas of relatively uniform geologic structure. Radial patterns are caused by flow from a dome. Centripetal patterns result from flow into a basin; Rectangular patterns occur over bedrock with angular faults. Pinnate patterns occur on fine-grained surfaces. Trellis patterns are produced over alternating bands of hard and soft substrate. Parallel patterns occur where the slope is localized. Distributary patterns are produced by the divergence of a main channel. Annular patterns are produced around a dome or basin with bands of hard and soft substrate.

The interface between the streamflow and the land on either side of the channel are called the banks or bankside. As the flow moves through the land, the combination of substrate and flow may pick up and carry debris that serves to erode the channel's depth or boundaries. The redistribution of sediments in turn may cause parts of the stream to move faster and generate a more substantial erosion effect. This dual erosion and deposition can create bends in the channel, called meanders. These bends may be sharp and frequent or may create long slow meanders with significant land within the curve.

The effect of a river on the land can exceed its immediate banks. In periods of flooding or as a result of external influence, a meander can shift rapidly so that the channel straightens and a bend of the flow will be cut off from the primary course, creating an oxbow lake. Low lands running parallel to the flow, which may become inundated when the streamflow exceeds the banks of the channel, are called the floodplain. Areas where streams flow into a zone in which the land is saturated with water due to soil conditions or a high water table are called wetlands, marshes, or swamps.

Streams may flow into a lake and then continue to flow from that accumulation onwards. Streams may go underground and then re-emerge (though that aspect is outside the scope of this project's purview). Streams continue to flow until either there is not sufficient water to maintain a flow—having evaporated or been absorbed into the soil—or they flow into a basin for water storage, such as a lake or ocean. This confluence is called the mouth of the stream. If the substrate in this location is composed of sediment, the main channel or stem may diverge into smaller flows in a distributary pattern to form a delta or alluvial fan. If the mouth of the river intersects with an ocean, the intersection of a tidal zone and the river create an estuary.

Mechanics of flow

Though calculating aspects of flow is a complex process, hydrology and hydraulics provide a framework to approach the mechanics of streamflow. While the hydrologic properties of each flow are generated by the localized environmental context, they are the product of predictable and measurable processes.

Streams behave differently depending on how they originate. One of the first considerations is how often there is water flowing within a channel Streams can be *perennial*, usually from groundwater, *intermittent*, with water coming from smaller underground sources such as springs or runoff and are more susceptible to absorption or evaporation, and *ephemeral*, when the channel is above the water table and carries water only during and after a rain (Gordon et al. 2004:51). Additional factors that affect a stream's flow are geology, topography, and vegetation. Streams constantly adjust to the climate and geology leading to changes in slope, sediment transportation, and the configuration of its channels, causing subsequent changes in the ecosystem.

Streamflow is affected by several aspects of a catchment, including its physiography, soil and geology, vegetation, and land use within it. The physiography includes size, shape, slope, drainage density and drainage patterns. The size of the catchment determines the peak rate of runoff according to how much water is active within the basin, while the shape of the catchment affects the amount of time it will take for the water to aggregate, leaving more time for water to move into the soil or evaporate. The slope of the basin will affect the degree to which surface water accumulates in depressions and the speed with which runoff, including water in channels, will flow. The drainage pattern will influence the course of the stream, while the drainage density affects the length of streams and the amount of water that moves through a given channel. The soil and geology within the catchment, and the channel in particular, determine the soil intake capacity, the rates of flow or evaporation, and the erosion of drainage patterns. Vegetation in the catchment will impact rates of runoff, infiltration, erosion, soil evaporation and transpiration.

The channel in which a stream moves also has an acute effect on the mechanics of flow. The gradient refers to the downhill slope of the channel; steeper gradients at the headwaters often lead to faster flow while lower gradients at the mouth of the channel contribute to a slower flow. The substrate will determine the stability and shape of a channel which in turn effects the water speed. A narrow, deep channel is often fast flowing while wide shallow channels will cause a slower rate of flow due to the increased friction between the water and channel surface. The texture of this channel, whether smooth or rocky, will further alter the degree of friction. The speed of flow is called its velocity. This value often varies across the channel, with water moving most rapidly in the middle of the channel where friction is lowest and moving more slowly along the banks. A higher velocity in more friable substrates will lead to increased erosion, with rates of water movement capable of sustaining a higher sediment carrying capacity. The amount of water that moves past a certain point within a given amount of time is referred to as the stream discharge. Measured in cubic feet per second, this method of evaluating flow volume is the product of the cross-sectional area of the stream multiplied by the velocity of flow. As stream discharge varies along the course of a stream and through seasonal influences, the water level is called a “stage” and is measured at given points along the flow with a stream gauge.

Streams are ordered to facilitate comparisons and inform predictions about their characteristics. Geographers, geologists, biologists, and hydrologists have created classification systems although no single system has been universally adopted. One of the first was Strahler’s (1957) 12 stage stream order hierarchy. A first level stream is the initial source of a water flow, often from a spring and at higher elevations. As watercourses move downhill, they may join into a single stream, increasing the flow of water in a given channel. When two streams of the same class join, the stream increases by a single order. If two streams of a different order join, the lower order stream is considered to have reached its end and the higher order stream retains its designation number.

Ordering streams is meant to trace flow through a water system and predict a relationship between the size of the contribution area, the channel dimension, and the stream discharge. In Strahler’s system, first through third order streams are typically called headwater streams, and constitute the vast majority of waterways, most frequently occurring in the upper elevations of a watershed. Fourth through sixth order streams are simply referred to as ‘streams’. Seventh order or greater flows of water are considered rivers. As an example, the Mississippi is a 10th order stream while the Amazon is a 12th order stream.

Strahler’s system, perhaps the most widely used, provides a first-approach analysis of streams, but has several flaws in its predictive power. Because many small streams can join the flow without changing the stream’s order number, this method can be misleading in terms of total water flow. Alternative systems to classify streams take into account these increased (or diminished) flows but are computationally more complex (Gordon et al. 2004:61). Even these methods are subject to variation depending on whether a first order stream is defined by permanent flow of water or ability to sustain biotics, the mapping standards of the field surveyor, and the scale of the map used.

Although streams are often identified by flowing water, streams can also be defined by the presence of a channel or streambed. These types of classification more readily incorporate watercourses in which water is no longer flowing due to a number of conditions, including intermittent streams, stream scars when waterways change course, and seasonal freezing episodes where flow is stopped (or at least obscured by surface freezing). These streams may be classified according to characteristics of the channel, such as the streambed substrate, the physical setting, or the sinuosity pattern along the length of the river (Leopold et al. 2012). Rosgen (1985, 1994), Nanson and Croke (1992), Whiting and Bradley (1993), Montgomery and Buffington (1997), and Simon et al. (2007) among others have developed comprehensive approaches that anticipate the size and strength of a waterway, including the amount of sediment or debris it will carry and the organisms likely to be present.

Compressing moving, linear phenomena into geographic narrative

Streams as geographic narrative: ecological phenomena

Streams are part of the permanent landscape, but the flow of water introduces energy and movement to an otherwise relatively static topography. Winds bend and jostle leaves on a tree, temperatures fluctuate, and precipitation may contribute to a changing color palette from verdant springs through umber autumns to hoary winters. Through these changes, the overall structure and shape of the landscape remains consistent, yet streams provide a variety of motion. While the channels themselves create a network that physically integrates regions of land, the streamflow within these channels creates a flow of movement between different geographic areas.

Streams move in many ways. While the flow of water has a general downstream movement, at different places across and along the waterway there are currents, whorls, and eddies with different speeds and directions of flow. Beneath the surface, water may move in invisible undercurrents. This view of flow becomes more complex as water carries sediments, objects like sticks or leaves, or even human artifacts. Over relatively short periods of time, streams may change in character. The mechanics of the streamflow and the influence of surrounding environmental factors can alter them. Variations in the hydrological cycle can affect runoff and streamflow. Higher temperatures that contribute to evaporation or diminished precipitation can reduce the total runoff. High precipitation or the sudden release of intercepted water can create flooding. Freezing and sub-freezing temperatures can prompt streams to become solid, at least on the surface.

Streams do not just move through a landscape, but can alter the landscape itself. Flowing water can wear away stone and soil to shape its own channels, picking up and rolling, suspending or depositing sediments along its course. Dropped sediment, called alluvium, can cause the channels to shift and create meanders as material is alternately eroded and deposited along the channel. Over time, streams often slowly but steadily change course, writhing through the landscape. In most cases, this shift in spatial location occurs through small shifts of erosion and deposition. The frequency and configurations of a meandering channel is topography, substrate, and flow dependent. Importantly, meanders “move” over time as erosion occurs from the faster water velocity outside of a bend and deposition occurs on the slower inner aspect. If there is a dramatic increase in streamflow, as during a snowmelt or excess precipitation, a stream can change course rapidly. If this increased flow erodes a weakness in the banks, the stream may create a new channel and bypass a meander, causing the stream to straighten, change the direction of the flow and create an ox-bow lake. Streams can also flood, cresting the banks of the channel and at least temporarily exceeding their defined boundaries and altering the adjacent land, including potentially flooding settlements.

The dynamics of a stream are intimately tied to the broader ecological narrative. There is tremendous geophysical and biodiversity associated with each of the various stages or components of a stream. A recent series of events in the National Parks captures the interplay between a waterway and its associated floral and faunal inhabitants. The reintroduction of wolves in Yellowstone National Park had dramatic effects on the regional streams and their associated ecosystems (Ripple and Beschta 2012). Prior to the importation of wolves, the major streams in the valley floor of the park followed wide channels prone to erosion and course shifting. Once wolves began hunting deer in the lowlands, the over-grazed plants on the floodplain were able to regenerate. This new vegetation supported songbirds and small mammals, which in turn provided subsistence for predatory birds. The vegetal cover, however, also set roots that diminished runoff and bank erosion, creating stable riverbanks which led to deeper and faster streamflow. These streams were then able to support beavers, who in turn created dams that caused streamflows to create pools or ripples that support a wider range of fish. This case study shows that streams are highly dynamic and co-produce the ecosystems in which they flow.

Although we view landscapes and rivers as the "natural" domain of physical geography, fluvial geomorphology, hydrology, sedimentology and ecology, we need to realize that no river is pristine – our close relationship means that, as Edgeworth (2011) argues, they are "cultural artifacts" whose course and flow are heavily modified in countless ways, both intentional and unintentional. Particularly in modern contexts, we are familiar with hydrological engineering to create dams or channels; however this interference is not restricted to contemporary cultures (Raffles 2002).

Streams as cultural narrative: social network phenomenon

When we talk about people and water, whether in modern or ancient contexts, each interaction is often presented as a conflict in which humans must control or remain vulnerable to the flow of water. Both in popular and academic texts, the discussion of human-nature interactions tends to emphasize the human experience resulting from the exchange. Particularly when talking about rivers, this obscures the nuance of the relationship. The relationship over a wider geographic or temporal scale is better characterized as a series of shifting negotiations with the terrain rather than a series of human activities conducted on it.

Like all societies, hunter-gatherer communities are embedded within their local ecosystems, with social structures and cultural practices intimately linked to the landscape. They must work within these areas to extract resources to meet the metabolic and material requirements to sustain each individual within the group. The intimacy of this relationship, as people depend on the environment even as they impact it, means that many of the qualitative aspects of a community, including oral histories, past events, values, and mythologies, are integrated with how they perceive and thus use the physical landscape.

Streams, as physical landscape features, are distinct in localized contexts yet integrate large areas. This duality is emphasized in the idea of rivers as affordances, as introduced by Hussain and Floss (2016). They present rivers as having affordances – a set of possibilities or options. This is a useful framework as it emphasizes the flexibility with which people approach a moving landscape. In their article, Hussain and Floss discuss the balance between cultural requirements and environmental possibility in the context of Paleolithic Europe. As their research shows, when rivers change they instigate change in response – freezing and flooding impact the affordances. This suggests an entanglement that extends into perceptions and predictions of river behavior, even if the feature itself does not freeze or flood as anticipated. An essential component to the effect of affordances is the concept of heuristics, also introduced by Hussain and Floss (2016). As they describe, heuristics assume communities with their own goals and shared experiences will readily identify short-cuts to decision making. This complements the understanding of landscapes as a waterway creates a recognizable network. While our contemporary heuristics value the affordance of waterways as conduits, it is important to examine whether communities in different social and economic contexts share this heuristic view of a river’s affordance.

In his book, Matt Edgeworth characterizes the human-hydro relationship as one in which we should “focus on rivers as entanglements of natural and cultural forces – almost a kind of wrestle – where water flow is itself an active participant in the transaction” (Edgeworth 2011:22). This suggests that rivers need to be viewed as active phenomena within geophysical and cultural landscapes that intersect in forming the broader landscape narrative, both physically and culturally. The complexity of waterways can either promote or inhibit various cultural behaviors. This relationship is not deterministic and societies may respond in different ways to water systems depending on their cultural conditions, such as their varying social, political, or economic needs. If we focus on how water fits within a smaller scope of the geographic narrative, such as the maintenance of interaction spheres, then it becomes easier to see how rivers fit into a landscape-informed cultural process.

Beyond changing the land and how people can respond, flowing water adds an additional spatial axis to experience (Edgeworth 2011:86-87) – that of directionality. This is substantiated by ethnographic data: the prominence of rivers and streams pervaded fundamental perceptions of space; the Yurok perceive direction in terms of water flow, using words for “up-stream” or “down-stream” rather than East-West or an individual’s left or right (Erikson 1943:270). For this reason, I propose the use of the term ‘riverscape,’ a landscape in which a river is at the focus of one’s view, both practically and—in the case of this research—conceptually.

Social Networks

Social networks—social structures that maintain ties between a set of actors (Evans et al. 2012; Knappett 2011)—are fundamental strategies for ameliorating the risk of environmental unpredictability. The difficulty of provisioning varies regionally, according to the richness of the environment and the homogeneity of resources both in distribution across the landscape and with regard to resource types. In addition to seasonal rounds for food procurement, food processing or storage and intensified resource extraction, the formation and maintenance of intercommunity ties help to reduce risks. Small-scale, acephalous hunting and gathering societies adopt a number of practices in order to mediate the unpredictability of the environment and available subsistence resources. Long-distance interactions help create a buffer against local risk—typically risks in subsistence but also in the form of conflict. This is particularly true in environments which are harsh and have less biodiversity or abundance, or where geographic ranges are constrained (Borck et al. 2015). When resources or territories become limited, communities are more vulnerable to variations in local conditions and often rely on other social groups to mediate food uncertainty (Pearce 2014).

The edges of social networks may emerge due to natural distance and cost of movement or through social choice (White and Surface-Evans 2012). Frontier studies provide a framework for examining regions that are at the limits of, or excluded from, a social network. Parker (2006) describes these divisions between geopolitical and cultural groups. He suggests borders are linear, non-porous divisions between political groups while frontiers are fluid and dynamic due to “interpenetration” from distinct groups (Parker 2006:80). Both divisions consist of multiple types of boundaries, indicating the limit of a social dimension that may be political, geographic, demographic, cultural, or economic. The geographic space in which borders and frontiers exist can become a ‘middle ground’ for unique social processes, including cultural hybridization or the formation of distinct cultural practices (e.g. White 1991). These borderland processes are important because different social dimensions may have different boundaries, which mean that waterways can be used to maintain nested levels of both integration and differentiation.

Rivers and Mobility

The relationships within a social network are maintained through regular interactions. These may be accomplished through the many forms of trade, ceremony, or formation of affinal kinship ties. The maintenance of these relationships often require participants to travel to one another's communities or to a common location (Shepard et al. 2016). Therefore, communities must move both within their primary geographic area and within the regional landscape, such that there are two distinct patterns of mobility occurring simultaneously at different social and spatial scales.

Travel across a landscape must be considered not only at the nodal points where people begin and end movement but along the routes by which they reach those places. Smith (2005, 2007) suggests that a population's territory is better understood as the encompassing maintained routes between essential resource areas rather than as an insular, homogeneously controlled area. In human populations, these key resources include the social relations that provide trade goods or help to mitigate cultural and environmental risks. This shifts analytic focus on the specific routes taken for cultural reasons and across a particular landscape.

What determines where people travel within a specified geographic space? Social landscapes are co-produced by physiography and phenomenology. Geographic and environmental features can influence the movements of people or create an opportunity to control access to resources. Cultural memory or ideology may also influence where people travel, as some locations may be culturally preferred and others proscribed. Additionally, the cultural heuristics likely affect the perceived affordances of geographic features, prompting people to adhere to particular paths or modes of travel.

Recent research focusing on routes in the archaeological record (Snead et al. 2009) develop this cultural aspect of mobility. Archaeologically, trails themselves are often ephemeral; they may be embedded in the cultural traditions even if not inscribed in the physical landscape (Snead et al. 2009). This reiterates that paths are products of, or at least perpetuated by, behavioral choices in a community regardless of whether geographic or cultural influences first motivated the use of a given path.

Although archaeologists are accustomed to thinking of pathways as terrestrial phenomena, waterways provide an essential counterpoint to the transportation narrative. Waterways are implicated in interaction, mobility, and paths to facilitate – or hinder – interaction. One way that rivers influence mobility is in their role as geographic reference points. The intersection of hunter-gatherer practices, ecological variation, and the need for mobility means hunter-gatherers must retain and convey substantial amounts of environmental information. Waterways are distinct landmarks that provide a framework to conceptualize landscapes in the absence of drawn maps. Features like rivers, streams, and coastlines connect tracts of land and can help organize knowledge of space on a large scale. Examples include descriptions from Southern Labrador, where indigenous informants could draw large areas of coastline and drainage basins from memory (Lovis and Donahue 2011).

The physical characteristics of a river may also impact movement more directly, altering where people can move on the landscape based in part on the effort associated with that movement. Streams disrupt the continuity of the ground surface and create a network of waterways that may in turn connect to other stream systems, with the potential to connect widely disparate parts of the geographic region. As discussed above, streams possess objective characteristics that may be studied empirically and systematically. These variables include, but are not limited to, location relative to other geographic features e.g. stream source or endpoint, channel width and depth, velocity and consistency of flow, stream discharge, slope gradient, ingress and egress potential of the riverbanks, and connectivity with other water features including irregularities like rapids, waterfalls, or portages. Although some of these characteristics may vary annually or even seasonally, the fluctuations are often cyclical and within an anticipated range. A stream suitable for travel in one season may become unsuitable in another, particularly in regions prone to wide climatic swings.

Computer software such as Geographic Information Systems (GIS) have become fundamental tools to suggest probable routes according to the relative transportation costs and "optimal" paths in light of singular criteria such as energy efficiency. Analyses of geophysical attributes in GIS often show that traveling by water is the most "efficient" path, but this is a functionally restrictive perspective unless special care is taken to ensure that the paths are between clearly defined loci. The differential distribution of resource patches on the landscape might encourage movement toward certain areas or along paths that are independent of waterways. Because water routes may or may not relate to the physical distribution of other resources or trade networks, waterways may be used differently for distinct social and economic purposes or at variable times of the year.

Even when restricted to the physical aspects of human interaction with the physical environment, GIS cannot be entirely reliably adjusted for experience. For example, rapids present a navigational challenge for contemporary individuals who rely on boat travel for entertainment and would appear as a disruption in a modern GIS analysis. Taking into account cultural perspectives and experiences, this may not have been a comparable challenge for indigenous communities. For example, a class 3 rapid might appear to require a portage but those more familiar with water travel might not be inconvenienced or might have an alternate technique. Similarly, the distance over which a vessel might be portaged may be culturally informed. In a similar example, Richard White (1995:9) described how indigenous paddlers were able to move upstream in the Columbia River by using eddy currents that may not be recognizable to other individuals, let alone a software algorithm.

The perceived affordance of a stream may not be based solely on physical environmental conditions. The “agentive” power of water to affect the landscape contributes to the perception many cultures have of rivers being, or sheltering, autonomous entities. As a result, communities may not view waterways as exclusively utilitarian and will alter their use of waterways accordingly. These considerations are essential to placing rivers in a culturally-informed landscape narrative.

A single river can be used in different ways, depending on perception and need. What varies across spatial or temporal contexts is how communities perceive and incorporate these streams in their mobility patterns. Stream systems lend themselves to the multi-scalar analysis of social networks because they themselves are multi-scalar, if one considers drainage patterns and nested watershed systems (Ball 2009:104-111). The geophysical aspects of stream systems in the environment are particularly useful for examining social network mobility. Just as streams create networks of varying sizes that separate banks while creating flow across a territory, different forms of trade, exchange, and interaction may necessitate different strategies to engage with the landscape, depending on whether interaction is between adjacent communities or those maintaining ties over greater distances.

Reproducibility and Predictability of River Use

Given the constancy and reproducibility of hydrological processes and the relative consistency of human behavior, one might predict that patterns of hydrosocial relationship (e.g. Linton and Budds 2014) may be similarly reproducible. Mobile communities that encounter flowing water will have a discrete set of ways in which to interact with the stream.

In this context, the two pathways to understanding the dynamic are through historical records or ethnography, and through archaeological evidence. While these sources should be concordant, they can provide complementary perspectives. Archaeological evidence may identify events and behaviors that precede written or oral accounts, those that may have been deemed too trivial or self-evident to warrant inclusion in a more formal record, or indicate actions divergent from reported or perceived behaviors. When addressing issues of water, however, historical or ethnographic sources may describe actions that cannot be preserved in the archaeological record. In addressing the dynamics between humans and water, these accounts are particularly valuable for several reasons. The ability of flowing water to alter the landscape means that physical evidence along the banks of a channel may be obscured or exposed through erosion or flooding. Water itself may preserve artifacts, as in bogs or submerged features, but flowing water more commonly destroys archaeological sites, degrading or displacing artifacts and disrupting contexts. Floods are an exception, where the excess of water may deposit thick sediment layers that preserve the lower strata. Ethnographic records can also provide a broader perspective on human-stream interactions that encompass the experiential aspects of the culture more widely, including physical practices as well as the conceptual perspective of landscapes.

This dissertation initially focuses on hunter-gatherers because of how dependent they are on the landscape, but also because it gives us a valuable insight to the hydrosocial system. I wanted to explore the extent to which these interactions of water and people is recursive and if so, this provides an anthropological expectation that may be applied to people today. Technology provides a greater range of possible behavioral responses, but the fundamental approach of how the water will affect movement may be internally consistent; for example, a more efficient option is selected over a more "costly" one. I also chose hunter-gatherers because the broader scope of the dissertation bridges time periods of cultural contact, that allows me to develop a framework that considers several different cultures' approaches to water and how those approaches may be altered when the same waterway is now part of a very different political, economic, and cultural landscape.

To gain the broadest view of these behaviors without risk of subconscious bias in sample selection, I began this assessment of human-water interactions using ethnographic studies on a global scale. I drew on a standardized database, evaluated the interaction of that community with water specifically with regards to mobility, and then "coded" these interactions according to how the community shaped their movements on the landscape in response to these water features.

A global sample of ethnographic accounts in which human-water interactions impact social networks demonstrate a finite number of functional effects; they integrate or segregate social groups. This dataset was standardized using the World Cultures database by Human Relations Area Files, Inc. (HRAF), an online collection of fully-indexed ethnographic resources on 301 world cultures. [4,5] Drawing on filters, search terms, and an embedded sampling strategy, I queried the database which returned a list of 43 cultures within the cross cultural sample in 6 regions of the world and 19 sub regions (Table 2.1). These examples span a diverse range of environmental contexts, including regions with both dense and scarce waterways, large rivers and small streams, and water flow that may be turgid, placid, or seasonally variable.

Because HRAF includes documents indexed by search word and subject for each paragraph of all documents, HRAF filtered the database to identify 4,510 paragraphs from 453 documents in which at least one of the subject codes and keywords appear. Not all human interaction deals with moving water, nor its implications for travel. I therefore went through each of the passages, a single culture at a time, to infer how waterways were implicated in observed or recorded cultural practices. In some instances, water features were used for subsistence, hygiene, or ritual ceremony and were excluded from further analysis, as were cultures for which documents refer to water features as part of the ecological context. These communities may use water features as a part of their social systems but this survey was limited to information provided by HRAF. For all cultures where water was implicated in travel, I drew conclusions regarding whether moving waterways figure more prominently as a facilitator or hindrance to

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[4] I queried all cultures for the following subject tags: boats, ethnogeography, exchange transactions, maps, navigation, routes, settlement patterns, topography and geology, transportation, waterways improvements, and water transport along with the keywords stream*, river*, water*, and waterway*. I restricted results to cultures relying on hunter-gatherers and primarily hunter-gatherer subsistence strategies. Finally, I used the Standard Cross-Cultural Sample (SCCS) filter, which consists of 186 societies selected by Murdock and White (1969) to represent the greatest degree of cultural diversity and geographic or ecological contexts with a reliable record of the observation's location and time.

[5] I use the names of cultures as they are presented in the HRAF database for the sake of clarity to those who may wish to replicate this study, although in some cases these do not reflect the contemporary identity of these communities.

movement. These examples could be generally classified as falling within four primary categories: water as barrier, boundary, obstacle, or conduit.

By integrating ethnographic and archaeological cases that provide examples for how communities use waterways in social interactions, I suggest that there are a finite number of ways in which communities interact with flowing water when establishing mobility patterns for social networks. Table 2.1 provides a summary of this survey, with the primary uses of a waterway as inferred from the ethnographic documents. Though many cultures use waterways for subsistence as well as an influence on mobility, subsistence is only listed when that was the sole function that could be derived from the accounts. Distinguishing which roles are used in the maintenance of social interaction spheres can highlight the priorities of the community. These "roles" are defined by whether the waterway is being used in a way that brings people into closer interaction with one another or whether it limits interaction. These groups are subsequently divided into four primary roles or uses: conduits, barriers, boundaries, or obstacles.

Four "Roles" of Waterways in Population Mobility: Conduit, Barrier, Boundary, Obstacle

The first role focuses on contexts in which the river system facilitates interaction. These cases show the waterway as a conduit. This is the most frequently anticipated use, however it is in fact far more complex than is typically acknowledged. Where waterways are connected, they provide a means of moving goods, often with greater efficiency, by expanding the range of travel covered or increasing the quantity of materials moved.

The seasonal variations of waterways may affect the efficiency or possible directions of travel. Historic analogs show that water remains a valuable conduit when frozen, as seen around

Lake Ontario, Canada (Ford 2011). The interaction between culture and water in Northern Asia is notable for the impact of freezing winters. Among the Nivikh, a community inhabiting the northern half of Sakhalin Island, the Gilyak - the most water-centric community in the region - were "timid, circumspect and cautious river and coastal navigators” (Innokentii and Bromwich 1855:779). They avoided ocean travel, opting instead for the gentle lower course of the Amur River and its major tributaries for travel and communication with their neighbors. Winter limits boat travel to five months of the year (731) but the use of sleds on the frozen river created an avenue along which the Gilyak covered greater distances (734). Snow and ice made territories like the northern forests accessible and facilitated interaction between communities otherwise inaccessible by boat or obstructive vegetation. Dried stream beds similarly proved useful conduits to movement. Examples fall within this “use” if movement occurs along or on the waterway, using these features to integrate larger areas and facilitate movement across regions and between communities.

In peaceful contexts, waterways may be used to move materials and move people for resource procurement and seasonal cycles, or to aggregate groups. For example, among the Trumai in Brazil and their neighbors, waterways contributed to cultural homogeneity and a “bounded social system” by facilitating intertribal relations for economics, conflict, social organization, ceremony, and myth (Murphy and Quain 1955:10). Similar accounts exist for the Maori (Buck 1952:209).

There is often an assumption that rivers will be used as conduits to movement and that this is universally beneficial, but the increased accessibility may be detrimental to communities living along them. Waterways can be used in aggressive acts. The Tupinamba of present-day Brazil used canoes when confronting their enemies (Thevet and Métraux 1878:193-194).

Evidence for defensive structures in the Pacific Northwest and Alaska (Maschner and Reedy-Maschner 1998; Schaepe 2006) indicate efforts to restrict accessibility of settlements from the water. These structures indicate efforts to limit interactions along water, from which we can infer the same waterways were simultaneously used as conduits for groups with malevolent intent.

The second role, barriers, is a relative designation. A long view of human history shows that no body of water has been an insurmountable barrier to human movement. Hominins migrated to Australia and Southeast Asia approximately 40,000 years ago (Balme 2013), and crossed the Mediterranean to settle Crete (Runnels et al. 2014), navigators of the Pacific colonized islands across thousands of km of open sea (Kirch 2000), and some of the earliest evidence for human occupation in North America comes from skeletal remains found on the Channel Islands, roughly 45 km off the coast of mainland California (Erlandson 2017). Despite these examples, water becomes an effective barrier when the cost of travel becomes prohibitive, rendering mobility infrequent.

Where water is expansive or particularly fast-moving, it can form firm and non-porous divisions that separate people. The ethnographic accounts of the Mbuti state that small streams might be waded through or bridged with fallen trees, but that larger flows were impassable; a cultural anxiety toward water, and the fact that historically they did not possess build boats or bridges, contributed to rivers forming "effective natural boundaries and may well influence migratory tendencies" (Turnbull 1965:164). Other ethnographic and archaeological examples show that in some cases, people tried to reduce connectivity by water and emphasize the use of water as barriers to contact. Alutiiq and Unangan communities of the North Pacific Rim (Maschner and Reedy-Maschner 1998), as well as the Coast Salish of the Fraser River in British Colombia, built defensive structures along the coast and occupied elevated ground that offered greater visibility and reduced accessibility for protection (Martindale and Supernant 2009; Schaepe 2006).

The third role, boundaries, are defined as the geospatial extent of the cultural influence of a community. Waterways may help to create or define a perimeter of varying potential permeability for cultural activities. Boundaries may be associated with ethnicity (e.g. Barth 1998; Lightfoot and Martinez 1995; Stark 1998), but they may also show the extent of geographic, political, demographic, cultural, and economic practices (Parker 2006). A boundary might exist for one dimension without limiting other types of interaction; ritual dimensions often operate on a larger scale than local economic or subsistence practices. The distinction between a boundary and a barrier is one of intensity, as boundaries may be recognizable but "porous"; the ethnographic evidence from the Ainu illustrate this since their concept of territoriality includes an awareness of boundaries despite a lenient enforcement of them.[6] These boundaries result in movement diverted from or minimized beyond a certain area.

As recognizable features on the landscape, cultures can incorporate waterways as reference points that delineate territorial boundaries without requiring active markers, particularly in light of extensive indigenous landscape knowledge (Lovis and Donahue 2011). This is likely to be a later use, since it is associated with a degree of territoriality uncommon in highly mobile hunter-gatherer societies – the use of fixed or marked boundaries is generally limited to sedentary, agricultural contexts, and the emergence of large polities. For example, as

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[6] The Ainu of Japan in East Asia, on the Island of Sakhalin, maintained peaceful relations with their neighbors, with a mutual dependence on shared natural resources. (Ohnuki-Tierney 1974: 73). Although communities "owned" the land and water near their settlements and use of this area by outsiders required permission from the chief, this was rarely enforced as adjacent communities were often composed of kin upon whom they might depend for future aid (Ohnuki-Tierney 1974:73).

the regional population of Maori in New Zealand increased, communities minimized conflict by establishing circumscribed boundaries marked by rivers and streams (Buck 1952:380). Boundaries may also be conceived of as creating a spatial distinction from either shore of the waterway (Flannery 2009 [1976]) or as segmenting water features, ensuring equitable access to the river banks (Graesch 2006).

The fourth role, obstacles, consist of those cases where people must either circumvent or cross waterways. Depending on the type of commodity being moved, the available technology, and the spatial distribution of resource areas and trade partners, watercourses may not be the most efficient route. If water is perceived as an obstacle, movement is often channeled toward locations where the breadth, depth, or rate of flow of water diminishes, creating natural fords. Examples of this include the Canela in Brazil whose primary means of travel through the forest was via trails parallel to streams that guided movement toward natural fords (Crocker 1990:64) and the Andaman Islanders in South Asia who relied on an extensive network of trails and took circuitous routes to find detours around swamps and smaller creeks (Man 1932:47).

The term “obstacles” is relative, as the environmental conditions, cultural skills, or technological solutions can alter a waterway from being a barrier, as illustrated by Mbuti’s lack of boat and bridge technology, to an obstacle. Even then, the term obstacle is used broadly to include conditions where they are inconveniences. The Nambicuara in the Brazilian Amazon would cross streams by swimming, felling a tree, or constructing palm-stem rafts (Levi-Strauss 1948:365). Even so, the technological “solution” may only be effective under certain conditions. Small lakes and streams may allow individuals to wade or swim across the feature without finding a ford, but this may not be an effective strategy for other cultural needs or in some riverine conditions.

Alternatively, the use of water as an obstacle can be an intentional countermeasure against perceived threats from those using water as a conduit. The Miskito and Sumu who live on the eastern coasts of Nicaragua and Honduras abandoned their traditional territory during the period of European incursion in favor of interior settlements that can be reached only by crossing water features – which suggests an effort to increase isolation through a defensive position – though it is difficult to distinguish from the historic and archaeological records whether this community selected this new territory or was pushed into the area (Helms 1971:43).

The four uses of waterways characterized above are not mutually exclusive; some naturally occur together. One example of this is the context of non-peaceful conduits. Hostile parties may use water as a conduit, and as a result, these routes become a liability for the communities under attack, prompting other communities to respond by building defensive structures and settlement patterns to remove themselves from the water and use them as an added level of defense; this is illustrated by the Barama River Carib whose settlements were set km back form the river to access virgin hunting territory and as a security measure from threats along the river (Gillin 1936:31). In another example, communities may move different commodities along different distribution networks, so that some resources are procured or distributed along waterways while others are moved perpendicular to these features. These uses may be employed simultaneously at different scales of movement. A river may be a local boundary while providing a conduit for occasional regional aggregations. Distinguishing these uses addresses anthropological questions about how landscapes inform the creation of networks as well as culture historical questions of how communities used water to transform social and economic relations.

Communities assess their social interactions and consciously emphasize whichever use of the water system will best achieve these social needs. Ethnographic cases show that engaging with waterways is not only a utilitarian decision based on energy expenditure, resource acquisition, and environmental determinism; rather, there is cultural awareness of how to incorporate water in the practical and spiritual aspects of daily life. That the Ainu considered rivers to be “living creatures” who were shown respect by maintaining silence while traveling rivers highlights the nuanced perspective with which a community views waterways and challenges the idea that rivers are primarily a utilitarian advantage (Batchelor 1927:387). Similar autonomy is assigned to rivers by the Maori in New Zealand. The Whanganui, a local Maori tribe, fought for and recently won legal “personhood” status for the Whanagnui River, known as Te Awa Tupua to the local Maori, based on its importance as an ancestor (Hutchison 2014; Williams 2017). As noted by a local politician, the much-touted novelty of this solution to tension over control and conservation is a western construct that legally reifies established Maori knowledge of the river’s personality (Borrows 2017). This suggests the European perspective on waterways is also mutable, with implications for river conservation and management more broadly.

While recognizing the relativistic limits to the designation of conduit, border, barrier or obstacle, human behavior is similarly nuanced and complex. The heuristic acceptance of these distinctions still moves our understanding of the interplay between waterways, culture and social transformation forward.

Table 2.1. Ethnographic summary of the "role" of waterways in social network mobility

Region	Sub-Region	Country	Culture	Water Feature	Cultural Response
Africa	Central Africa	Congo	Mbuti	Rivers	Barrier
	Southern Africa	Botswana	San	Stream/spring	Subsistence, Hygiene
Asia	East Asia	Japan	Ainu	Coast, Straits, River	Year-Round Conduit
	North Asia	Russia	Nenets	Rivers	Year-Round Conduit
		Sakhalin Island	Gilyak/Nivkh	Coast, Rivers	Year-Round Conduit
	South Asia	Andaman Islands	Andaman Islanders	Ocean Coasts	Obstacle
		Sri Lanka	Vedda	Rivers, Coast	Subsistence, Hygiene
	Southeast Asia	Malaysia	Semang	Rivers, Streams	Conduits, Boundaries
Carib. & Mid.America	Central Mexico	Honduras/Nicaragua	Miskito/Sumu	Rivers, Deltas	Conduit, Barrier
	Carib	Guyana	Barama River Carib	Rivers	Conduit, Barrier
North America	Arctic and Subarctic	USA/Russia	Aleut	Coast	Conduit
		Canada	Copper Inuit	Coast, Streams	Subsistence
		USA	Ingalik	Rivers	Conduit, Boundary
		Canada	Innu	Rivers, Lakes	Seasonal Conduit
		Canada	Kaska	Rivers, Lakes	Seasonal Conduit
		Canada/USA	Ojibwa	Rivers, Lakes	Conduits. Barriers
	Southwest Basin	USA	Chiricahua Apache	Rivers	Obstacle
		USA	Northern Paiute	Rivers	Subsistence
	Plains and Plateau	USA	Comanche	Rivers	Subsistence, Ecology
		USA	Gros Ventre	Rivers	Subsistence, Obstacle
		USA	Klamath/Modoc	Rivers, Lakes	Obstacle
		USA	Omaha	Rivers	Obstacle
		USA	Pawnee	Rivers	Subsistence, Ritual
	Northwest Coast and California	Canada	Nuxalk	Rivers, Streams	Conduits
		USA	Pomo	Rivers, Lakes, Coast	Obstacle
		USA	Yokut	Rivers	Seasonal Conduit
		USA	Yurok	Rivers	Year-Round Conduit
	Eastern Woodlands	USA	Creek	Rivers	Conduits, Barriers
		Canada	Mi'kmak	Rivers, Lakes, Coast	Conduits

Region	Sub-Region	Country	Culture	Water Feature	Cultural Response
Oceania	Australia	Australia	Aranda	Springs	Subsistence
		Australia	Tiwi	Springs	Subsistence
	Melanesia	Papua New Guinea	Manus	Lagoons, Rivers	Conduit
	New Zealand	New Zealand	Maori	Rivers, Coast	Conduit, Boundaries
South America	Amazon and Orinoco	Brazil	Mundurucu	Rivers	Post-contact Conduit
		Brazil	Nambicuara	Streams	Obstacle
		Bolivia	Siriono	Rivers, Streams	Obstacle
		Brazil	Trumai	Rivers	Conduits
		Venezuela/Guyana	Warao	Rivers, Lakes, Delta	Conduit, Barrier
	Eastern South America	Brazil	Canela	Streams	Obstacle, Barrier
		Brazil	Tupinamba	Rivers	Conduit
		Brazil	Xokleng	Rivers, Streams	Obstacle
	Southern South America	Argentina	Abipon	Rivers	Obstacle
		Argentina/Chile	Tehuelche	Rivers	Obstacle
			Yaghan	Rivers, Coast	Conduit

CHAPTER 3: WATERWAYS AND CULTURE IN NORTH AMERICA

The journalist Charles Kuralt reflected on his experiences traveling across the United States, saying: “I started out thinking of America as highways and state lines. As I got to know it better, I began to think of it as rivers…America is a great story, and there is a river on every page of it” (Kuralt 1991:159,166). Waterways – the rivers, streams, and interconnected lakes through which water flows – define and create the landscape in which humans act while simultaneosuly remaining entangled in the social, political, economic, and ideological narratives of people’s lives. While scholars have sought to explain cultural events and evolutions of society with a range of intellectual frameworks, including power, economics, behavioral or cultural ecology, population migration, and cultural coalescence or resistance, a theoetical perspecitve centered on rivers integrates these social processes. The intimate and co-produced relationships between humans and flowing waterways suggests that riverscapes are a useful framework for studying cultural tranformations and examining the agentive *choices* in land use that communities perceived or enacted, leading to different strategies in land use, mobility, and social or political organization.

In this chapter, I demonstrate that riverscapes, which are closely entwined in our historical narratives, are a singular feature that can be used to understand pre- and post-Colonial social systems, particularly where there are different strategies or responses to the same landscape features. I first explore the hydrology of North America. I briefly discuss how these systems have been tied to political, economic, and ideological aspects of North American human societies over time. I include ethnographic and archaeological cases from North America, which show that indigenous communities have adopted diverse strategies, using waterways as barriers, boundaries, obstacles and conduits. Lastly, I discuss the cultural and ecological background for portions of the Chesapeake Bay in the Middle Atlantic region and the Saint John River Basin in the Atlantic Northeast, the two regions selected as case studies in this dissertation.

Hydrology of North America

North America's rivers are extensive and diverse. Each one embodies its own logistical traits: some are turgid white water while others flow in placid but persistent channels that wind through floodplains. The thousands of streams that carve the land vary in intensity and scale. The continent's size is sufficient to span distinct geologic, topographic and climatic zones. Though the particular characteristics of a given streamflow will vary based on localized conditions, the broader regional factors help to produce rivers and regions with discrete hydrological characters.

North America has six principal catchments, areas within which all water drains to a common source, defined by the highest topographic ridgelines (United States Geological Survey [USGS] 2013). These continental divides form the perimeters of the macro-scale watershed basins through which water flows from the continental landmass to the oceans. The Great Continental Divide, the most prominent division, extends from the Bering Sea to the Strait of Magellan and separates watersheds that drain to the Pacific Ocean from those that flow into the Arctic or Atlantic Oceans. The other five major hydrological divides are the Laurentian, Arctic, St. Lawrence, Eastern, and Great Basin. The intersection of the hydrological divides is called a triple point, as water from that locus contributes to three different oceans. Triple Divide Peak in Glacier Montana, considered the hydrological apex of North America, marks the convergence of the Great Divide and the Laurentian Divide. Other triple points in North America include Snow

Dome on the Columbia Icefield between Alberta and British Columbia, Canada, Hill of Three Waters in Minnesota, and an unnamed peak in Pennsylvania. Of the major watersheds, the Great Basin Divide forms a self-contained, or endoheric, basin while the others are exoheric basins that supply water to major rivers that drain to the ocean along the continents long and irregular coastline, particularly the major "indentations" of the coast, the biggest of which are the Gulf of Mexico, the Hudson Bay, the Gulf of St. Lawrence, and the Gulf of California. Figure 3.1 shows the six continental basins of the contiguous United States of America, with black lines along the continental divides. Within each of these basins, the major river basins within that catchment are distinguished with different shades of a color family.

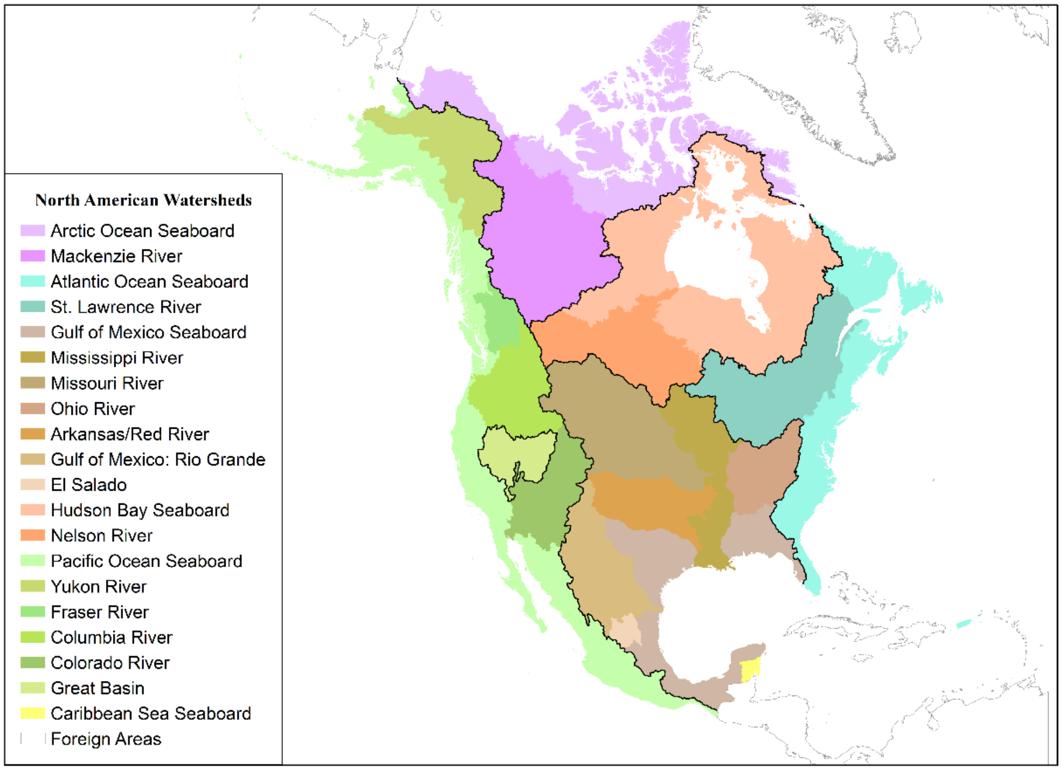

Figure 3.1. Major river basins of North America.
Produced from North American Watershed data available from the Commission for Environmental Cooperation [CEC] (cec.org) with black lines added to denote Continental Divides.

In the United States, the federal government designates catchments in a scalar system using the Hydrologic Unit Code (HUC). This system uses 2, 4, 6, 8, 10, and 12-digit numbers to reference catchments, with the number of digits indicative of its hierarchical level. The U.S. Water Resources Council has designated eighteen major basins in the contiguous United States for environmental monitoring (USGS 2013). This system allows for a comparative study of water quality and catchment conditions. The boundaries of the 18 continental regional 2-digit units (Figure 3.2), formerly referred to as level 1 or regional basins, are based in part on major river drainages, such as for the Missouri River, but may also consolidate a number of rivers, as in the South Atlantic. This system shows the importance of emic perspectives in water; there are hydrological bases to these perimeters but they are also influenced by contemporary socio-cultural and ecological zones.

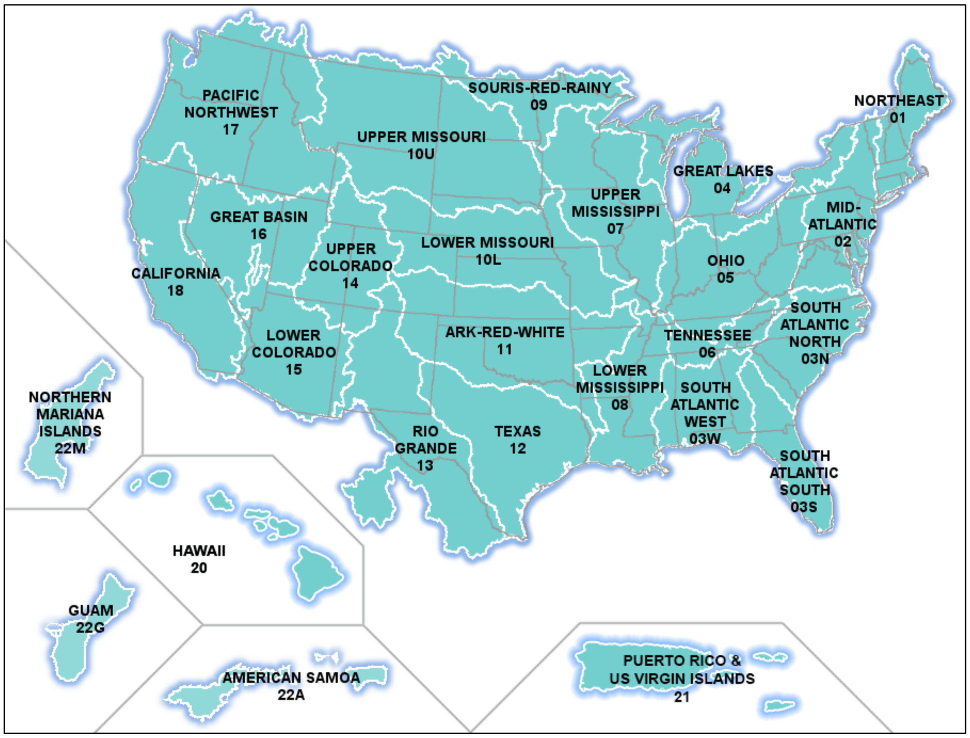

Figure 3.2. National Hydrography Dataset Regional Units
(United States Environmental Protection Agency 2017).

Table 3.1. Hierarchical hydrological units of North America (USGS 2013, Figure 3:31).

Hydrological Unit Name	Historical Name	Historical Tier	Average Size (square miles)	Approximate number of hydrologic units
2 digit	Region	1	177,560	21 (actual)
4 digit	Subregion	2	16,800	222
6 digit	Basin	3	10,596	370
8 digit	Subbasin	4	700	2270
10 digit	Watershed	5	227 (40,000-250,000 acres)	20,000
12 digit	Subwatershed	6	40 (10,000-40,000 acres)	100,000
14 digit	(none)	(none)	Open	Open
16 digit	(none)	(none)	Open	Open

It is impossible to count the number of streams in the United States but Figure 3.3 identifies more than 250,000 individual channels. These streamflows reflect their surrounding topography, geology, and climate. This image shows the location of these streams; each stream’s Strahler order number (see Chapter 2) is indicated by the thickness of the line. The colors indicate specific basins according to the confluence with each ocean or bay. Though the map is valuable in showing the location and density of streams, and the size of different basins that carve the continent, it is not a fully functional hydrographic model; the image does not relate information regarding volume or even presence of flowing water. Particularly in regions with higher temperatures and lower precipitation, these “streams” are likely to represent channels with intermittent or ephemeral stream flow.

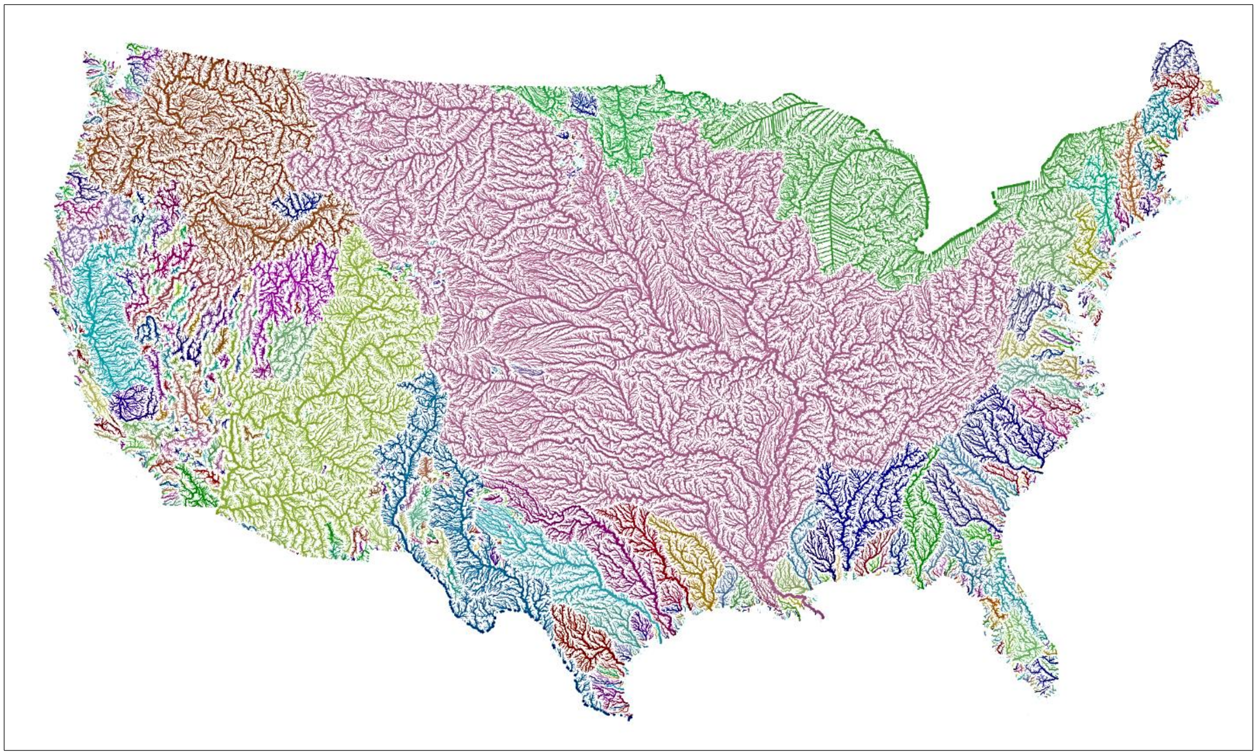

Figure 3.3. River basins of the United States (Szucs 2016)[7]

Streams and their hydrological characteristics vary by region due to the effects of geologic formations and climatic zones. Particularly in the northern regions of the continent, many of the lakes and major rivers are attributed to receding glaciers that occurred approximately 10,000 years ago (Benke and Cushing 2005). As these ice masses contracted, they left scars on the landscape building moraines and eskers, and gouging basins. Glacial melt water flooded these basins, following geological contours and creating freshwater lakes and rivers, including the Great Lakes. The Great Lakes Basin constitutes the world's largest surface system for freshwater, due to the volume of water in storage among the connected lakes, including the five inland seas that flow into the St. Lawrence Seaway. A series of small discrete basins

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[7] Digital Map Print available at: https://www.etsy.com/shop/GrasshopperGeography.

continues along the Atlantic seaboard. On the northern Atlantic coast, the combination of mountainous topography and higher precipitation create an abundance of first order streams, which move quickly downhill in a series of separate drainage basins. Basins along the southern Atlantic coast show a lower density of first order streams, consistent with the flat topography, in which channels quickly aggregate to the lowest point and form larger channels.

Historic, Ethnographic, and Archaeological Riverine Cultures of North America

Rivers have been implicated in the mobility of humans in North America for millennia. Native Americans relied on rivers for subsistence, the first farming communities spread along floodplains, drainages and river valleys became corridors for trade and integrated political, economic, and cultural identities. European explorers used rivers as routes for incursion into new territories, determining the course of cultural collisions and determining the distribution of colonial issues of geopolitics, conflict, restructured economy, and disease. Other explorers sought a Northwest Passage, a northern corridor for water travel between the Atlantic and Pacific Oceans. Later, industrial economies in cities across the United States blossomed through trade made possible by steamships and canals. This section establishes a case for the continuous entanglement of rivers and mobility in the political and economic narratives of North America.

This section illustrates the continuous entanglement of rivers in political and economic narratives in North America. A range of archaeological and historical examples show that there are similar concerns when dealing with water and mobility that are not limited to native practices or colonization; they are persistent across human-hydro experiences. These examples show that a framework to compare strategies for river use, both across indigenous communities and between indigenous and colonial societies, provides a viable method for understanding culturally-driven landscape archaeology without reverting to environmental determinism.

The extent to which water may influence our choices is often greater than we realize. Historical events and decisions exemplify this effect and illustrates the ways that technology and economies affect land use, even as the effect can sometimes be exerted in reverse. The concern for water access led to the Enlarged Homestead Act of 1909, which increased the number of acres granted per homestead to 320 acres, to account for dryland farming as settlers moved westward into non-irrigable lands (Bradsher 2012). The extent to which a region's hydrology shapes a population's evaluation of political and economic systems, particularly toward social networks, is encapsulated in the contentious debate over whether industrial cities would build canals or railroads (Scientific American 1858a, 1858b). Eastern cities, like Buffalo, still feel the effect of decisions to prioritize water travel; such a debate is irrelevant in the American West.

Drawing on ethnographic data discussed in the previous chapter, the examples of rivers in social networks and mobility by North American hunter-gatherers demonstrate the same four primary ways in which water affects mobility: as barriers, boundaries, obstacles or conduits. They are presented regionally, to maintain uniformity for each region's environmental contexts.

In the arctic and subarctic, water is essential for travel, even when it is frozen. The Aleut relied on water for almost all resources and travel, both peaceful and militaristic (Lantis 1984:166). As a result, villages were set near fresh water on land accessible to two bodies of water for easy escape and on exposed beaches for the kayaks to land, with an elevated observatory to seek game, returning hunters, or enemies (Jochelson 1925:23; Lantis 1970). After the Russian arrival and intertribal warfare ceased, villages moved to river mouths to take advantage of fish spawning (Collins 1945:21).

The expansive Plains and Plateau region is characterized by open plains and a few larger rivers. Ethnographic accounts note that the Gros Ventre communities settled along woodland tributaries in the winter and coalesced in the summer (Beierle 2012:3) when, if a large river must be crossed, people would convert hide lodges into temporary boats (Flannery 1953:67). The Omaha employed this same practice (Dorsey 1896:281). The Klamath Lake and Modoc Indians occupied the water-rich drainage basin of the Klamath, Tule, and Rhett Lakes, with territory bounded by the watershed basins rather than a particular channel (Barrett 1910:240). Despite this riverine environment, waterways were implicated in mobility primarily when boats were needed to cross rivers or lakes to reach seasonal habitation sites (Spier 1930), suggesting they were obstacles.

The standard cross-cultural sample in HRAF identifies four cultures to represent the cultural and ecological variability of the Northwest Coast and California: the Nuxalk in British Columbia, the Pomo in Northern California, the Yokuts in Central California, and the Yurok in Northwestern California. Prior to European contact, indigenous communities in British Columbia were connected through waterways and trails that facilitated the exchange of grease, fish, meat and furs as well as ceremonial practices (Solomonian 2011:7). These trails were primarily across the interior plateau or extended inland along small rivers rather than the ocean coastline, resulting in cooperative systems along fjords rather than the coastline (McIlwraith 1948:22). At the time of European contact, the Nuxalk Bella Coola relocated their villages from up-river inlets to the mouth of the Bella Coola River (Kennedy and Bouchard 1990:323), which became a primary corridor for transportation and communication (Solomonian 2011:4).

The Pomo, whose ancestral lands encompassed the coastal region of northern California, relocated seasonally between the coast and interior valleys. There are few rivers in this region, so most people would swim or ford rivers as necessary but might use tule or balsa canoes to traverse the lakes and lagoons during the seasonal migration or raft to off-shore seal and mussel outcrops (Barrett 1910:163-164). The Yokut relied on waterways to integrate regional trade routes. The east-west trade routes between the coast and interior zones consistently follow waterways from the coastline to the Great Basin (Arkush 1993:623). Seasonal conditions influenced trade between the Yokuts and Western Mono: high water levels in the spring connected sloughs and allowed larger parties to travel by boat, allowing communities to strengthen affinal ties and develop shared cultural practices (Gayton 1946:258). Among the Yurok, rivers were again a main conduit for commerce, interaction, and intermarriage with the Karok on the upper Klamath River or the Hupa along the Trinity River. These relations contrast with the Yurok's limited interaction with the Tolowa, who lived a comparable distance away up the coast rather than along a river precluded relations (Erickson 1943; Kroeber 1925:184).[8] Though Kroeber claimed the Yurok and Karok did not have territorial boundaries (Kroeber 1925:255), Hester (2011) indicates they maintained boundaries between resource procurement zones for acorn harvesting or whaling.

The Eastern Woodlands of North America supported cultures from the humid south to the harsh northern climates. In the south, the Creek People lived along major rivers, their tributaries, and an intricate trail network which connected permanent nucleated villages along the waterways in the 18th century and earlier (Sattler 2009:3; Walker 2004:383). Using dugout canoes for travel and disposable bark canoes and hide rafts for ferrying, fording, and one-way trips (Walker

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[8] Because the rivers were difficult to cross, the Yurok mandated that anyone able to do so must provide free ferriage regardless of interpersonal strife or an individual's ability to reciprocate – refusing ferriage could result in a "fine" of prestige goods (Kroeber 1925:35).

2004:377), the Creek used natural features to create protective palisades along rivers (Swanton 1928:438), though in peaceful times, unprotected settlements spread along creeks (Walker 2004:379). To the north, the Mi’kmaq in the region of the St. Lawrence River and Gaspe Peninsula, used the network of lakes, rivers, and coastline for subsistence (Prins 1996:24) as well as for trade within the tribe and in raids against others (Prins 1996:110). Their reliance on water “highways” is evident in canoe variations (Prins 1996:31), techniques to navigate in fog or ice (Wallis and Wallis 1955:54), at night (Speck 1922:119), or with temporary maps (Bock 1978), and through the homogeneity of Mi’kmaq culture (Wallis and Wallis 1955:18-19). In the late 16th century, the diffusion of ceramic style was facilitated by the use of *shallops*, Basque sailing ships, which shaped the economy and territorial organization along the rivers (Prins 1996:92).

Case Studies: Framework and Regional Background

Historical, archaeological, and ethnographic examples show that a framework to compare strategies for river use, both across indigenous communities and between indigenous and colonial societies, provides a viable method for understanding culturally-driven landscape archaeology without reverting to environmental determinism. Across different environmental contexts, communities adopted different practices for engaging with the environment. These decisions are not based solely on the environmental conditions but the political and economic aims of each community. On a macro scale and even locally, different communities adopt different strategies for incoporating flowing water into their mobility practices. It is in this variation of use that we can start to adress how the entanglement of culture and rivers leads these landscape features to help frame the narrative of human choice and cultural transformation.

Comparative Framework

This research adopts a comparative framework to address whether shifts in social networks are connected to landscape mobility. My dissertation examines how communities use rivers to structure their geographic and social organization, particularly during periods of change. For this reason, I am particularly interested in the different strategies of river use that communities employed during the Late Woodland and how these strategies changed or varied during the early colonial period, when European presence altered the economic and social landscapes. Adopting a comparative framework allows me to assess a range of variables, both cultural and environmental, that may demonstrate how communities incorporate rivers as they construct and maintain interaction spheres.

This study consists of a diachronic analysis of two different regions: portions of the Chesapeake Bay in the Middle Atlantic and the Saint John River Basin in the Northern Atlantic (Figure 3.4). The geographic and temporal contexts allow for many potential comparisons (Table 3.2): land use variation among indigenous communities within and between each region; how indigenous practices were impacted by colonial presence; how indigenous communities utilized waterways compared to colonialists; and whether Europeans used North American waterways differently depending on whether the engaged in seasonal resource procurement, exchange, and proselytizing or maintained a permanent presence. The communities in both of these regions belong to the Algonquian language group, one of largest and most widespread native language groups prominent along Atlantic Coast and St. Lawrence River into the Great Lakes region and whose cultural practices are considered to have been a part of the Eastern Woodlands Culture complex (Trigger and Sturtevant 1978). Though they are both situated along the Atlantic coast, the regions are considered part of different ecological and climatological zones. These regions are marked by sufficient environmental and cultural differences to consider how river use reflects conscious decision making while retaining enough similarities to assure any differences are meaningful.

Table 3.2. Comparative temporal and spatial areas of study.

James River Basin Woodland Period	Saint John River Basin Ceramic Period
James River Basin Contact Period	Saint John River Basin Contact Period

The first axis of comparative analysis is temporal. In a given region, there may be synchronic variation in landscape use relative to different interaction spheres such as the acquisition or distribution of various economies/materials. Communities occupying the same landscape may also use water systems differently, particularly where water travel by one community poses a threat to another community. A diachronic assessment reflects changes in land use that are implicated in periods of intra- and inter-community political and economic transformations.

This study considers variations in river use that may be implicated in the structure of social and economic networks which shifted during the transition between defined periods of culture history. Both case studies are Eastern Woodlands Cultures. This encompasses communities living within an area that extended from contemporary eastern Canada just below the subarctic zone down to the southeastern United States (Trigger and Sturtevant 1978). The one oft-cited departure from this cultural/regional association is the emergence of the

Mississippian culture, which was characterized by monumental complexes and intensive agriculture that developed out of the Eastern Agricultural Complex (Blitz 2010; Pauketat 2007).

Communities across the eastern woodlands share enough similarities through cultural processes, technological innovation, and interaction spheres that they may be discussed with the same broader chronological terms. Of these phases, the Woodland Period refers to the chronological period that lasted from roughly 1000 BC to the early 17th century and was characterized by similar developments in subsistence practices and technology throughout the eastern portion of the North American continent (Trigger and Sturtevant 1978). This period is divided into three sub-periods, characterized by shifts in subsistence practices such as the adoption of horticulture or technological innovations such as ceramics or the bow and arrow. The periods are differentiated by prevalence of use, rather than the first appearance of, new practices. The specific dates of transition and variations in style or resource exist within localized areas or communities but the general designations of Early, Middle, and Late Woodland cultures remains a valuable framework for understanding social evolutions.

The Early Woodland (1200-500 BC) is characterized by many trends that began in the Archaic Period. Communities relied on a mobile, seasonal subsistence strategy of foraging, fishing, and hunting for bear, deer, and other small game while coastal community subsistence relied on salt marshes, lakes, and waterways (Emerson and Fortier 1986; Fiedel 2001; Rick et al. 2017; Yarnell and Black 1985). The most significant difference between the Archaic and Early Woodland Period is the prevalence of ceramics, though the types of ceramic, date of acquisition, style, and connection to sedentism and horticulture varies widely by region. As there is evidence for mobile Archaic Period communities using pottery (Skibo et al. 2016), the Early Woodland is defined by a preponderance of ceramics and its application for cooking (Taché and Craig 2015) permanent (or at least semi-permanent) settlements, and more elaborate burial practices rather than the presence of any particular trait.

During this period, the Adena Culture can be identified, a mortuary complex of built mounds in single and multiple burials. This complex is considered part of the Meadowood interaction sphere, which included cultures occupying lands from the Great Lakes, St. Lawrence region, the Far Northeastern United States and the Atlantic region. This exchange network, an expansion of interactions that began from diffusion or migration during the preceding Archaic Period, continued into the Middle Woodland.

The Middle Woodland (500 BC-AD 300) was a period of homogenization in cultural practices, resulting from exchange networks and possibly even population migrations (Dent 1995; Gallivan 2011). The Meadowood system extended from New York and Ontario and seemingly served as a social network system, primarily for aggrandizing populations and the distribution of prestige goods including Onondaga thinned bifaces and Birdstones (Taché 2011a, 2011b). Taché's research shows that the distribution of materials follows waterways and that there is a pattern of primary and secondary distribution along major water routes and secondary tributaries and streams. Additionally, she found that aggregation sites, defined by the largest quantity of Meadowood materials along with a diverse assemblage of regionally-sourced chert, were most commonly found at river confluences, suggesting these locations were accessible for aggregation and served as opportunities for trade fairs, public secondary burials, and cooperative fishing endeavors. This shows a reliance on waterways for an economic and cultural social network beyond the reliance on riverine environments for seasonal subsistence and sedentism.

The Late Woodland Period (AD 300-1600) marked a shift from long-distance regional interactions to politically defined groups in more spatially circumscribed areas (Baugh and

Ericson 2013; Schroeder 2004). This was associated with diminished monumental complexes and reduced interregional trade and travel and increased diversification. Increased settlement sizes were supported by an expansion of horticulture and the introduction of bow and arrow technology, used for hunting and in inter-community conflict. The latter portion of this period is sometimes referred to as the late Late Woodland, a division that acknowledges the predominance of maize-based agriculture and larger villages. The reliance on agriculture in the late Late Woodland created greater subsistence risk (through crop yield unpredictability) and reduced mobility, likely encouraging a different type of social network for political integration (Braun and Plog 1982; Howey and O'Shea 2006). Many of the larger groups identified by colonialists, including the Iroquoian and Algonquin confederacies likely emerged, at least in part, through these conditions.

The Late Woodland Period ends with the introduction of European culture and materials, designated as the proto-historic or historic period depending on the way European cultures or materials were introduced to indigenous communities. This phase marks a significant transition that dramatically altered the landscape, both physically and culturally. Though a detailed discussion of colonialism and its effects is beyond the scope of this dissertation, the fact that my analysis bridges the pre-contact and historic periods makes it necessary to acknowledge the principle effects at a global scale.

My interest in the agentive use of landscape provides the tie to considering colonialism, its effects on indigenous social structures, and how communities perceive affordances of rivers. The contrast between indigenous and colonial human ecology has been of persevering interest (e.g. Cronon 2003 [1983]; Kemp et al. 2005). This project assumes a similar approach in considering how perceptions of landscape and motives for land use affect recognition of river affordances. The arrival of colonists and European explorers also provides a context to also consider how communities engage with physical geography in the absence of prior landscape knowledge (Rockman and Steele 2003). While most assessments attribute the disruption of indigenous systems to illness, geopolitics, and economic opportunities (e.g. Silliman 2004; White 1991), rivers were the primary routes into the geographic and cultural landscape along which the effects of colonialism were distributed. An analysis that spans this chronological transition can address how cultures with different backgrounds, aims, and limitations, may use – or compete to use – rivers.

The second axis for comparison is regional. A comparison of mobility patterns between cultures living in the Middle Atlantic and Northeast captures a number of environmental variables that produce distinct riverine contexts.

The physiography of the two regions is different. In Virginia, mountains along the western boundary of the state reduce in slope through the piedmont and into the coastal plain that is intersected with numerous rivers. The gentle gradient of the landscape affects the flow, allowing water to aggregate in moderately-sized tributaries that support the larger rivers which supply the Chesapeake Bay. Maine and New Brunswick are characterized by rugged mountains and heavy vegetation abutting a jagged coastline with rivers cutting through the interior. The differences in physical landscape between the regions, including topography and vegetal cover, not only alter the network of streams but affect the feasibility of overland travel. Finally, the Mid-Atlantic and Northeast, located at different latitudes, fall into different climatic zones. The northern zones typically experience greater precipitation, particularly in the form of snowfall, which produces variable rates of stream discharge during snow melts. The colder climate creates conditions in which streams can freeze, though this is dependent on additionally variables, including the velocity of streamflow.

A regional comparison also includes different cultural histories. Although both of the case studies are part of the Eastern Woodland culture, there are significant differences in the social structures that emerged within each area. To some extent, these distinctions may be partially attributed to the ecological conditions. In Virginia, the milder climate allowed communities to aggregate and support larger populations, in part through the adoption of horticulture, and later agriculture, along the abundant rivers and tributaries. In contrast, the harsh northern climate left insufficient frost-free days, precluding crops for subsistence, except in the lowest portions of Maine outside of this study area. The contrasts in cultural trajectories extend into the historic period, as the process of colonization occurred differently in each region.

Figure 3.4. Major river basins of the Eastern Continental Drainage.
Adapted from the Watersheds, North America Atlas (CEC 2006) to highlight the Eastern Watershed and, within it, the James River Basin in Virginia and the Saint John River Basin, spanning the international border between Maine and New Brunswick (in gray), within the Eastern Watershed.

Case Study 1: James River Basin, Virginia

Researchers consider the Chesapeake region and the archaeology conducted therein to be a part of the Middle Atlantic (Brush 1986; Carbone 1976; Dent 1995; Gallivan 2011, 2016; Potter 1994). The Middle Atlantic can be difficult to define, as there are cultural and ecological similarities to both the Atlantic Northeast and the Southeast. Within this larger zone, the Chesapeake region was characterized by a landscape integrated within the societal processes and identity of resident communities, whose network of polities came into contact with Europeans in the early 17th century. In his extensive review of archaeology of Native societies across the Chesapeake, Gallivan (2011) notes such an undertaking "requires accepting an area with artificial and permeable limits and internal diversity" (Gallivan 2011:285). The studies he highlights depict communities characterized by fluctuating affiliations, migration, and interactions that complicate efforts to define the region, whether on cultural or geographic parameters.

Environmental Setting

The physiographic conditions of the Middle Atlantic, as we know it today, are largely attributed to the end of the Pleistocene and environmental changes resulting from milder climate, including warmer temperatures that contributed to glacial melt and rising sea levels (Brush 1986; Carbone 1976; Dent 1995; Gallivan 2016). These worldwide changes contributed to the formation of the defining feature of the region; the Chesapeake Bay is the largest estuary in

North America. The Chesapeake Bay formed as the Susquehanna River Valley flooded, attaining its current configuration of estuaries 3500 years ago (Dent 1995:83-84). To the north, the Susquehanna River contributes a significant flow of water while the southern end of the bay is subject to tidal variations from the Atlantic Ocean. Across the 322 km between these points, the water sources create a gradient brackish water; with the tributaries included, there are 18,804 km of shoreline (CBP, accessed May 19, 2017).

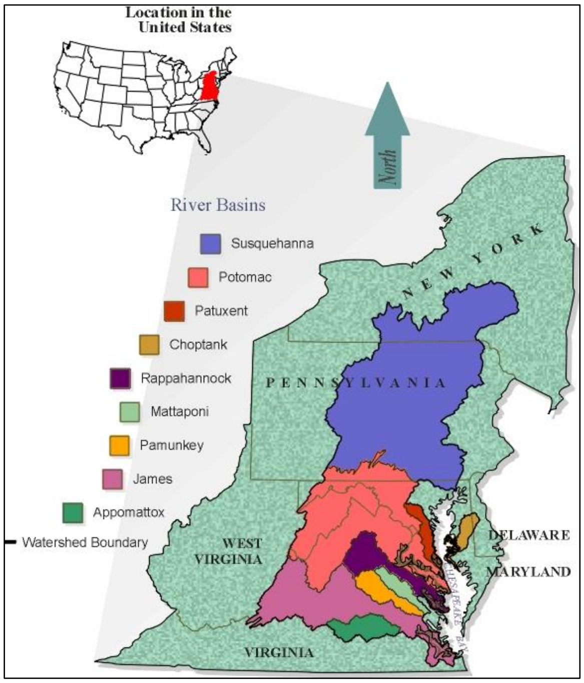
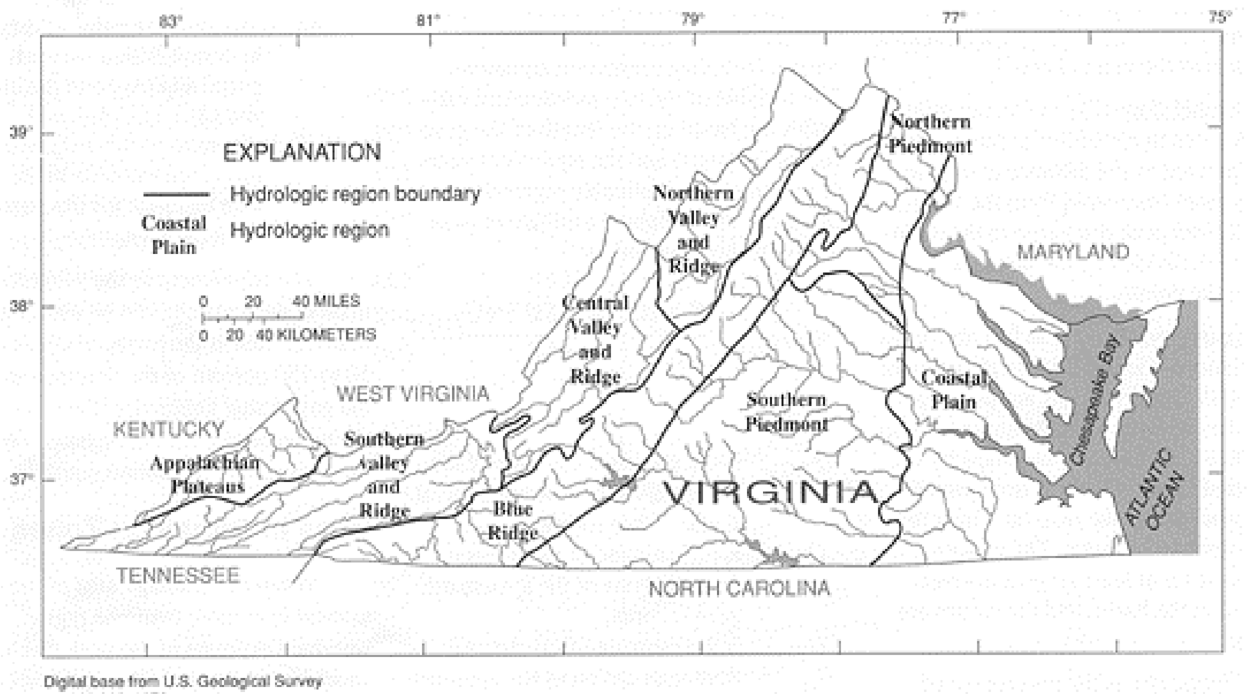


Figure 3.5. Location of Chesapeake Bay watershed and major river basins (Phillips and Caughron 1997, Fig.1).

The Chesapeake Bay falls primarily within a humid subtropical zone, characterized by hot and humid summers and cold to mild winters. This climate and rich environment support a dense and abundant population of flora and fauna, with several thousand species represented, including the occasional presence of larger marine mammals near to, or even within, the bay.

The Chesapeake Bay reflects the ecosystems of a much larger area (Figure 3.5). The drainage basin for the Chesapeake Bay is 165,759 square km, extending across six states – New York, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia as well as the entire District of Columbia (Chesapeake Bay Program [CBP] 2012). This watershed collects water from 150 major rivers and streams with more than 100,000 small tributaries that contribute to the surrounding wetlands (CBP 2012). The Chesapeake Bay Watershed can be divided into smaller catchments as each of the primary tributaries has its own river basin. The largest rivers that feed into the bay with large mouths are, from north to south: The Susquehanna River, Patapsco, Chester, Choptank, Patuxent, Nanticoke, Potomac, Rappahannock, York, and James. These rivers connect the bay to the region’s interior, forming a complex and resource rich landscape across the several distinct physiographic regions.



Digital base from U.S. Geological Survey 1:2,000,000, 1970

Figure 3.6. Physiographic and hydrologic zones of Virginia (Mason Jr. and Fuste 2001, Fig. 1).

Virginia is comprised of five physiographic zones that characterize the topography (Figure 3.6). At the western boundary of the state, the southern portion of the state is a portion of the Appalachian Plateau. To the east, the Ridge and Valley zone runs north to south through the state. This region historically supported grasslands, large mammals such as elk or bison, mast forests and non-subsistence materials including fine-grained lithic sources (Gallivan 2003:13-15). The next major zone is the Blue Ridge Mountains, with elevations from 300 to 760 m above sea level. This region is characterized by heavy forests and lithic quarries (Gallivan 2003:15; Hantman and Klein 1992) but also copper (Hantman 1990; Potter 2006) and soapstone deposits (Klein 1997), both of which held spiritual and prestige value for exchange in the later prehistoric and early colonial periods (Gallivan 2003:15). The Piedmont, between the Blue Ridge Mountains and the Coastal Plain, is a region of gentler foothills rich with fauna such as deer, soil suited for agriculture, and dendritic rivers in which anadromous fish spawn (Gallivan 2003:15). The Fall Line marks a geological divide between harder stone in the piedmont and softer sediments in the Coastal Plain characterized by waterfalls and rapids. The Coastal Plain is an estuarine environment with rivers and wetlands supporting fish, shellfish, and plants as well as migratory birds and small mammals, with highly productive soil for agriculture along the rivers.

This study focuses on the James River, the largest river basin entirely within the state of Virginia (Figure 3.7). It is the southern-most major river that contributes to the Chesapeake Bay and drains over 6 million acres (26,164 km^2) (Gallivan 2003:13). Flowing 540 km, it is the longest river in Virginia and crosscuts five physiographic zones (Smock et al. 2005:77) over which its characteristics change significantly. At its headwaters in the Ridge and Valley, the river is less than 90 m across while through the Piedmont it widens to 152 m and after the Fall Line, spreads to as much as 8 km across (Gallivan 2003:13). These changes in breadth may be attributed to changes in the gradient of the channels, allowing the flow to widen and slow. The main stem of the James River begins at the confluence of the Jackson and Cowpasture Rivers in the Valley and Ridge region as a 5th order stream with fast-moving and cool water forming a riffle-run-pool flow pattern (Smock et al. 2005:77-78). Across the piedmont, the gradient is diminished by half, leading to less well-developed riffles, though this region has been heavily modified by impoundments (Smock et al. 2005:78). The James River Fall Line extends over 15 km dropping an average of 2 m per km and creating Class I-IV white water rapids, beyond which the river becomes a meandering, 7th order tidal river, with numerous islands and oxbow lakes, which drains into the Chesapeake Bay (Smock et al. 2005:78-79).

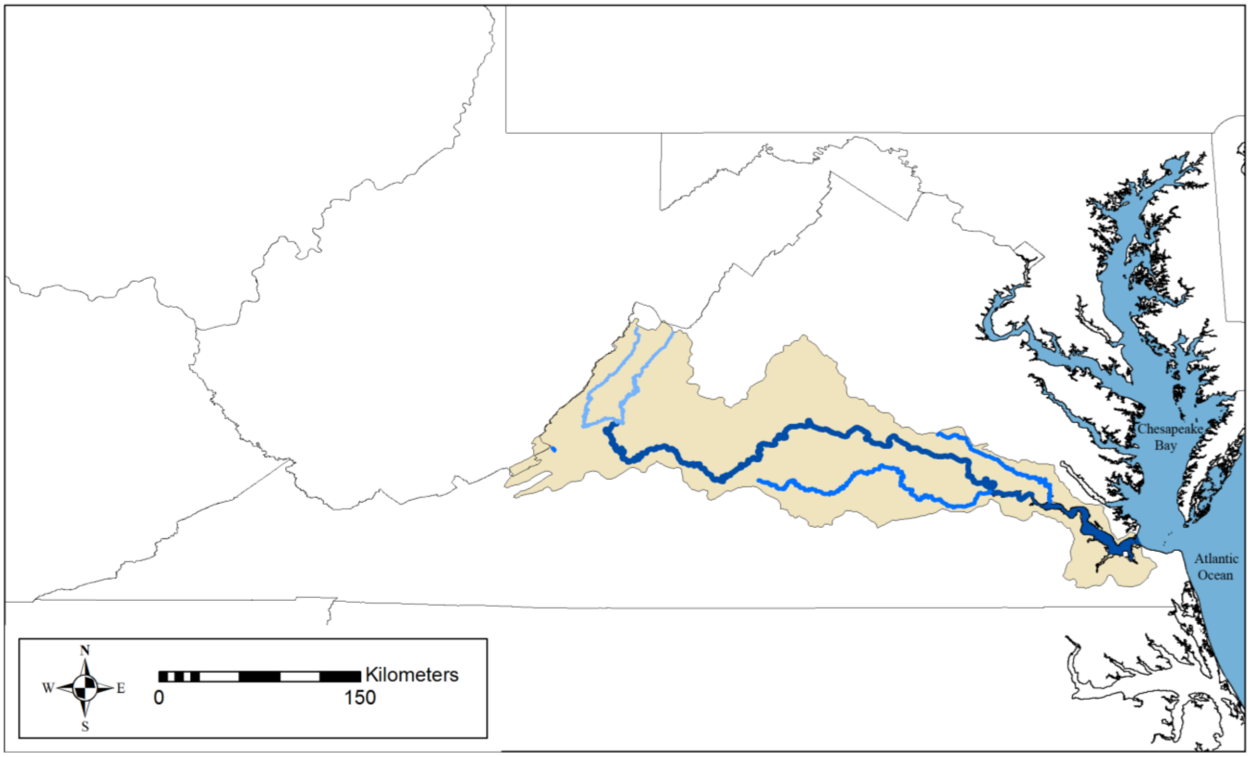


Figure 3.7. James River and major tributaries.
The James River is shown in dark blue.

Cultural Context of the Study Area

The diversity and abundance or resources within the local ecosystem have supported a long history of cultural occupation and development, though it can be difficult to determine how the environmental parameters of the region are implicated in the cultural transformations in the area. Climate is considered to be consistent, as has vegetation and fauna since 1000 to 800 BC, with small changes and most big shifts attributable to human intervention rather than global climatic trends (Carbone 1976; Gallivan 2016; Stewart 1993). Even where changes are credited to human activities, there has been some debate over the extent to which the environmental contexts facilitated the emergence of chiefdoms. While some argue that there is no ready correlation between the environment and increasing complexity in the area (Custer 1994:347), others argue that the riverine landscape was instrumental in the social structures that culminated in the 16th century riverine chiefdoms (Gallivan 2016). The centuries following 1500 BC were characterized by less radical environmental change than preceding 10,000 years yet culture change occurred more quickly; the social transformations and environmental constraints (and opportunities) are, as Martin Gallivan's extensive research shows, better explained as product of social or historical context (Gallivan 2003:19, 2016).

Indigenous communities have occupied the Chesapeake Bay region continuously for over 10,000 years. Archaeologists divide these millennia into several time periods, characterized by the prevailing modes of subsistence, or the innovation and adoption of technology or cultural patterns. The Paleo-Indian Period marks the first settlement of the area. The Late Archaic Period is characterized by intensified hunting and foraging of estuarine resources and the emergence of a soapstone exchange system, which while rare (Blanton 2003), may have served as a model for the subsequent adoption of ceramics and regional interaction (Shaffer 2008). The Late Archaic period ended with the transition to the Woodland Period, which can be generally divided into the Early, Middle, and Late Woodland Periods. These are periods of relative continuity, each period is differentiated by the relative abundance of certain resources or technological innovations, rather than their presence or absence. Though this study focuses on the latter half of the Middle Woodland, the Late Woodland, and the Contact Period, the social and political processes evident during this time show continuity with traits or systems that emerged in earlier periods of occupation, including continued reliance on regional exchange networks.

Middle Woodland (500 BC to AD 900)

The Middle Woodland Period (500 BC to AD 900) was a period of intensifying interactions and long-distance social networks reflected in an archaeological record of settlement data, ceremonial centers, and a robust corpus of ceramic technology (Gallivan 2011:289). This period has been deemed one of "technological homogenization" (Dent 1995:235) due to the rapid spread and pervasive use of shell-tempered Mockley ceramics throughout the coastal Chesapeake (Blanton 1992:74-76; Custer 1989:276-277; Potter 1994). This pottery, made in the latter portion of the Middle Woodland (AD 200 to AD 800 or 900) is coarse, thick, and shell-tempered with three classes of surface treatment: Cord-Marked, Net-Impressed, and Plain in simple, conical jar forms with direct rims, wide mouths and semi-conical or rounded bottoms (Potter 1994:64-66). These ware occupations are associated with various points, including Selby Bay points, Fox Creek points, and Nomini points (Potter 1994:66-68).

The Mockley phase, as a spatially and temporally distinct material period, is defined by the presence of Mockley ceramics, which are prevalent in components of late Middle Woodland Periods throughout the lower Potomac River Basin and across the Virginia-Maryland piedmont (Potter 1994:103). The White Oak Point (44WM119) is a comparative seasonal shellfish-site of late Mockley phase with components from 2000 BC to AD 1700; with 4 components between AD 700-900, the transition of the Middle to Late Woodland, and suggests camping for the purpose of oyster collection (Potter 1994:104). In the brackish water zone of the outer Coastal Plain, a Mockley phase component at Loyola Retreat (18CH58) shows Mockley Cord-Marked and Net-Impressed ceramics. Small and intermediate sized sites with assemblages including Mockley ceramics and Fox Creek-Selby Bay points located along the freshwater tributaries of the Potomac through the inner coastal plain (Johnson 1991, Potter 1994), are likely associated with the fishing and processing of anadromous fish (Gardner 1982:60).

Laurie Steponaitis's (1986) regional survey of the southeastern Patuxent River basin in southern Maryland is critical to contextualizing the effect of the Mockley phase, not just as sites and distribution, but in characterizing a major shift in settlement and thus likely social structures. Her work, examining settlement patterns from the Late Archaic through the Late Woodland Periods found that the Mockley phase marked a significant change in patterns. She evaluated archaeological assemblages for artifact functionality, diversity, density, and distribution. Her work showed an increase in the intensity which lowland areas were used relative to the interior regions and that the total number of artifacts in assemblages increased but greater differences emerged between interior and coastal assemblages. She also found that the Mockley occupation components were much larger in riverine and estuarine contexts and noted the appearance of large, special function sites. She interpreted these collective changes as a shift from residential mobility to increasing logistical resource procurement. This may be attributable to a combination of environmental changes and shifting social ties, with an increase in interregional exchange reflecting stronger alliance networks. For the purposes of my dissertation, this shows an increase in movement, regardless of whether that social mobility was undertaken as part of intensified trade or community migrations.

The adoption of Mockley ceramics coincides with an increase in number of sites and a shift in settlement location to the outer coastal plain with a greater reliance on estuary resources (Gallivan 2011). These sites increase in intensity as well as number, consisting of multi-hectare shell middens (Dent 1995:240-241), and large burials and deep storage pits indicative of near sedentary occupation (Gallivan 2011). Throughout the beginning of the Middle Woodland, hunter-gatherer groups lived in a seasonal cycle, moving between small interior camps and intermediate-sized sites in riverine and wetland environs, similar to the pattern in the Early Woodland, though with a prioritization of estuarine resources. In the later portion of the Middle Woodland, there is evidence of larger shell midden sites, such as Boathouse Pond (AD 550), which served as gathering places for several centuries (Gallivan 2011:290).

Though most prevalent in the coastal plain, sites with a Mockley component also occur sporadically away from the waterways and in interior physiographic zones. The survey and excavation at the Karell site (44FX944) shows a small Mockley component, including ceramics and a Selby Bay point in the interior uplands, in areas away from the Potomac (Johnson 1991) though the small size of the assemblage suggests this was a temporary camp used by hunter-gatherers from residential bases along the Potomac (Potter 1994:107). Similarly, Mockley components are used to trace evidence of task-specific activities beyond the Great Falls and into the Virginia-Maryland Piedmont and the Blue Ridge province, likely associated with lithic procurement, particularly rhyolite (Stewart 1987). This is substantiated by small base camps and lithic processing detritus, such as at three camps in the Monocacy River valley and additional Mockley components throughout the valley. This evidence for direct procurement may have co-occurred with broader trade of rhyolite banks in a more extensive trade-network, attested by the extent of non-local lithic distribution (Potter 1994:108; Stewart 1987).

Whether Mockley ceramics were carried by migration or trade is unclear. The proliferation of Mockley ceramics appears to coincide with the initial arrival and spread of Algonquian-speaking populations into the Chesapeake (Herbert 2008:273-274). An argument for pure replacement is complicated by the coexistence of Mockley ceramics with local wares, which may suggest distinct populations overlapped in territory (Gallivan 2011). The population increase in the region, if not total replacement, can likely be attributed to this migration, as substantiated by linguistic evidence of Proto-Algonquian terms (Gallivan 2011:291).

The prominence of interaction and exchange networks is illustrated by the Delmarva Adena Phenomenon. The Adena culture noted above as part of the Woodland Culture is evident on the Delmarva Peninsula from 500 BC to AD 1 (Gallivan 2011:290). Sites on the Delmarva Peninsula contained trade objects associated with this Midwest exchange, including distinctive tubular beads and copper and most of these Delmarva Adena sites are mortuary complexes with secondary burials and cremations consistent with Adena practices (Gallivan 2011). These examples argue for either a sporadic, ritual exchange between the Ohio Valley and the Chesapeake (Custer 1989:262) or a migration of those with a lineage tie to Adena.

The second major exchange network of the region is evident in the distribution of Abbott zoned-incised pottery - Abbott ceramics altered with combinations of incision lines (Gallivan 2011). These ceramics are found in substantial numbers in deposits at Abbott Farm in New

Jersey as well as from at least six coastal Virginia sites. Stewart (1998) suggests these locations mark ceremonial feasting activities at aggregation sites for the exploitation of seasonal anadromous fish runs. The presence of Abbott zoned-incised ceramics at the Maycock Point site on the James River dating from AD 200-900 may indicate long-distance trade with groups in the Delaware Valley up to 400 km to the north (Gallivan 2011).

There is also settlement data that supports the argument of an Algonquian incursion during the late Middle Woodland. The Island Field site (Custer et al. 1990), with several hundred burials dating from AD 410 to 1180, contained ceramics, grave good assemblages, and mortuary patterns associated with the Kipp Island phase of the Point Peninsula Complex (AD 500-800) that is traditionally centered in New York and Ontario (Gallivan 2011:292). Sites in the Potomac River inner coastal plain also show evidence of Kipp Island traditions, connecting Chesapeake communities to the people and practices of communities located further north at the end of the Middle Woodland; the mortuary complexes at the Ramp 3 site among others may even have served as “route markers” for Algonquian people migrating south during the Middle Woodland (Gallivan 2011).

Migration is an increasingly convincing explanation for the appearance of Mockley ceramics and subsequent ceremonial centers, earthworks, and chiefly linages rather than gradualist arguments supported by more nuanced models of movement, ethnohistoric analysis, and archaeological research (Dent 2005) adding to studies of culture change in pre-contact Eastern Woodlands (Nassaney and Sassaman 1995). One could argue that for my research, the distinction between migration and trade is less important than an understanding that while pots are not people, nor can pots move independently, so the distribution of cultural practices or material culture reflects movement and interaction.

Late Woodland Period (AD 900 to 1500/1600)

While the Middle Woodland phase can be characterized by the movement of people and goods through migration and interaction spheres, research in the Late Woodland Period shows a transition to permanent towns, a reliance on early horticulture and then agriculture, and the emergence of chiefdoms (Emerson et al. 2000). These changes affected social issues such as boundaries, conflict management, and community formation. Though contemporaneous with the emergence of complex, hierarchical civilizations in the Midwestern river valleys, the politically and socially complex organization in the Chesapeake appears to have emerged as an independent development in several of the major tributary basins (Gallivan 2011).

The forms of Late Woodland communities vary across the region, although there are some common characteristics. The settlement patterns for this period typically show scattered farmsteads with garden plots and oyster-gathering sites for meat that could be stored or traded (Potter 1994:115). These farmsteads are part of a two-tier pattern with larger villages surrounded by hamlets and foraging camps, though villages increased in size and frequency along the Patuxent River (Steponaitis 1986).

Subsistence in the Late Woodland focused on estuarine and riverine resources (Hutchinson 2002) as well as a reliance on deer, exploitation of which intensified to the western and northern edges of the Chesapeake Bay, particularly for the procurement and trade of hides (Lapham 2004). Though there was no horticulture before AD 1100, in the latter portion of the Late Woodland Period maize was adopted in regions that were not part of the pre-Maize Eastern Agricultural Complex (Gallivan 2011), apparently as a resource for aggregation and ritual rather than subsistence (VanDerwarker and Idol 2008), promoting social ties among communities that were already largely sedentary.

Diagnostic artifacts of the Middle Woodland, such as Mockley ceramics, were modified to create new and distinctive ware types. The characteristic pottery throughout the coastal plain is Townsend ware, a shell-tempered pottery of small to large wide-mouthed jars, direct rims, conoidal bodies, and rounded or semiconical bases whose origin is not satisfactorily agreed upon (Potter 1994:77). Though the most prevalent form of this pottery, Rappahannock Fabric-Impressed, was used from AD 900 to the early 1600s and cannot be used to date components, other decorative motifs can be used to identify Late Woodland 1 components (Egloff and Potter 1982:107-9; Potter 1994:77).

During the late Late Woodland, a number of communities consolidated within multi-community polities, though some chiefdoms eclipsed other in their geographic scale and political authority. The most well-known of these, in large part due to the record of John Smith from his explorations in 1608, is the Powhatan Confederacy, a paramountcy that expanded dramatically under the leadership of its eponymous chief, Powhatan, during the late 16th century and early 17th century.

Within the cultural context of late Late Woodland occupations in the James River Basin, the Powhatan Confederacy was organized in a system consistent with the generalized character of this system. At the top is the paramount chief, here called the *mamanatowick.* In the James River Basin, a man named Powhatan (also known as Wahunsenacawh) held this position from the late 16th century to just before his death in 1618 (Potter 1994:14). This position was at the apex of a social and political hierarchical structure. At the top level was the *mamanatowick*, his brothers and matrilineal relatives, seven priests, a number of warrior advisors called *cronocces*, and shamans. The next level consisted of district chiefs. These leaders, called *werowances* (males) or *weoansquas* (females) maintained the larger communities and, with their families, administered the larger villages that paid tribute to the paramount chief. Smaller hamlets were led by lesser *werowances*. The lowest tiers of this system consisted of commoners and war captives (Potter 1994:16).

This paramountcy, under Powhatan, was consolidated during the late Late Woodland Period through a combination of inheritance and conquest. Powhatan (AD 1545-1618) ruled from the village of Werowocomoco on the north shore of the York River (Gallivan 2007). Wahunsenacawh inherited leadership over six tribes: the Powhatan, Arrohateck, Appamattuck, Pamunkey, Mattaponi, and Kiskiak. A number of other local communities were incorporated into the paramountcy throughout the late 17th century. This aggregation of communities into a confederacy served as a means of support, alliances, and geographic buffer during the early Colonial era. Notably, the Chickahominy retained autonomy from the Powhatan Confederacy. No *werowance* was installed and instead, the chiefdom was led by a council of eight men, called *munguys.*

The Powhatan Confederacy, which dominated the tidewater lands around the James River and York River, diminished in power with distance from this central point. Helen Rountree (1992) noted the authority was diminished along what she called the “ethnic fringe” which consisted of chiefdoms that were influenced, but not controlled by, the Powhatan chiefdom. These communities include those groups living near the Rappahannock River, the Wicocomocos, Chicacoans, and Matchotics of the Potomac, and the Accomacs and Occohannocks who occupied the Virginia Eastern Shore (Potter 1994:19). Two groups on the right bank of the lower Potomac appear to have been excluded from the Powhatan influence: the Patawomekes who sought to remain independent and the Tauxenents who were influenced by the Conoy chiefdom, the large polity north of the Potomac (Potter 1994:19).

Across the Potomac resided additional Algonquian-speaking groups in tidewater of modern Maryland. With the exception of the Patuxent, they collectively formed a chiefdom called the Conoy, a name given by Iroquoian-speaking enemies (Cissna 1986:88-89; Potter 1994:19). The extent of this area also first recorded by Europeans in a Jesuit letter of 1639 that described smaller "kingdoms" with the paramount chief, called the *tayac* (rather than the *mamanatowick)*, encompassing a much wider area potentially as far as the mouth of the Potomac to Washing ton DC and the Falls, possibly on both sides of the river (Potter 1994:19). Under this tayac were indigenous groups of the Conoys, including the Nacotchtanks, Piscataway, Pamunkeys, Naanjemoys, Potapacos, Yaocomacos, and possibly the Tauxenents to some extent (Potter 1994:19). The Piscataways were the largest and most powerful of these groups, the title of tayac was passed down within this community and the geographic location of this territory served as a point for centralized authority (Potter 1994:19; Steponaitis 1986:32-33).

Contact Period (AD 1606 to 1750)

In 1607, English colonists arrived in the Chesapeake Bay and observed the political systems and polities built during the 17th century. The English colonists were not the first Europeans to arrive in the region – Spanish explorers had visited and mapped the area in the mid-16th century – but they were the first to remain. Although one could argue that the Spanish presence established a proto-historic period, the arrival of the English Colonists marked an abrupt end to the Late Woodland Period and the beginning of the early Colonial Period. This period is often characterized as a collision of different cultures and world views. Many researchers have sought to explain this change within a global context (e.g. Hall and Chase-Dunn 1999), discussing issues of “contact” (Gosden 2004; Loomba 2015; Silliman 2005; White 1991) and the mediation of different world views (e.g. Gleach 1997).

At the turn of the 17th century, European nations competed on a number of issues. European exploration was driven by many practical motives, including increasing overpopulation, disease, competition for new commercial enterprise, and even a spiritual competition among religious entities to increase their roster of souls saved and tithes collected. These conditions promoted early nationalism and assertiveness, particularly as England faced increasing threats from the Spanish.

In this climate, the London Virginia Company financed the first permanent European settlement in North America at Fort James. The primary objective of these early colonists was to locate gold. The colonists failed to find gold. They also failed in their early attempts at local agriculture. The first years of the Fort James settlement are often called “the starving time” as many colonists died from hunger, disease, and local conflict (Blanton 2000).

Local tribes provided subsistence in the early years but conflict rapidly escalated between the English and the Powhatans. The colonists saw economic opportunity in the resources of the region and quickly began exploiting the wildlife for furs, trading where possible and extending their presence along the rivers. One analysis suggests that the Europeans violated indigenous gift-exchange rules, contributing to hostilities (Mallios 2006), but control over land and resources are often credited as the primary cause of conflict.

Case Study 2: St John River, Maine and New Brunswick

A large portion of the Northeastern United States and the Southeastern provinces of Canada form the ancestral territory of the Wabanaki people. The Native word “wabanaki” can be generally translated as land of first light or dawnland (Prins and McBride 2007). This word is used to describe the territory and people, as they occupy the northern and eastern lands that the sun first touches on the continent. This area extends from the Gaspe Peninsula on the southern side of the St. Lawrence River, south to the Canadian Maritime Provinces (Prince Edward Isle, Nova Scotia and New Brunswick) and Quebec and to the west through most of Northern New England to the Merrimack River, in New Hampshire. The Wabanaki Confederacy, initially formed in the 18th century, united five major cultures in an alliance to resist mounting pressures of European presence. In contrast to the robusticity of historical record, archaeological research of this region is made challenging by the rugged terrain, heavy vegetation, and seasonal weather.

Environmental Context

The physiography of Northern New England and the Maritimes is characterized by mountains, dense forests, and a jagged coastline. The terrain was formed during the Holocene transition; retreating glaciers carved basins and deposited moraines and eskers while glacial melt and rising sea levels drowned much of the region, creating bays, inlets and islands from river valleys and hilltops.

The State of Maine and the Maritimes fall within the Northern New England physiographic province, while most of this region is comprised of three physiographic zones.

The mountain zone is dominated by elevations averaging 150-450 m of relief, as well as eskers, lakes, and the headwaters for many of the region's waterways. The interior is part of the New England Upland zone, characterized by rolling hills and rounded valleys with numerous lakes and streams. The Seaboard Lowlands form the coastal zone, much of which was inundated by glacial melts, and is characterized by sandy beaches, salt marshes, creeks, bays, cliffs and islands. The region experiences a continental climate with warm, humid summer conditions and four distinct seasons, though proximity to the shore mitigates the harsh winters along the coast.

The Saint John River is the longest river in the region, flowing 637 km and draining 55,110 km^2 (Cunjak and Newbury 2005). The river originates in Maine, flowing northeast into Quebec, Canada before curving to the southeast, where it flows through New Brunswick and into the Bay of Fundy. Along this course, the river moves through three physiographic zones and drops 481 m though it is a fairly shallow gradient in the main channel, averaging 1.3m/km in the headwaters and .3m/km in the river valley (Cunjak and Newbury 2005). The main channel is supplied by many substantial tributaries, including the Kennebecasis, Nashwaak, Tobique, Allagash, Aroostook, and Madawaska Rivers (Figure 3.8).

Over 1/3 of the catchment draws from the forested hills and lakes of northern Maine in the Upper Basin, which ends at Grand Falls, New Brunswick. This feature is a natural barrier to diadromous fish moving upstream (Cunjak and Newbury 2005). The middle basin extends from Grand Falls to Mactaquac Dam. This segment of the river flows through the sedimentary plains of a wide glacial valley. Pre-impoundment, the river was a small channel within the valley, however damming has altered the channel; eleven dams, including 3 on the main stem of the river have created hydroelectric storage reservoirs that cover much more of the valley bottom today (Cunjak and Newbury 2005). The lower basin extending from Mactaquac Dam to the sea is tidal, though a series of bays, an inland delta, several lakes and two bedrock sills limit the exchange of salt water flowing from the Bay of Fundy.

The climate of this region is considered humid continental but much or the region does undergo freezing temperature. The temperatures in the estuarine zones are often warmer than in the uplands, where temperatures range between -9.4 degrees Celsius in January and 19 degrees Celsius in July (Cunjak and Newbury 2005). Precipitation falls evenly throughout the year but at different rates in each zone, accumulating 140 cm in the lower reaches but only 90 cm in the upper basin, which lies beyond the effects of the maritime conditions (Cunjak and Newbury 2005). Much of this precipitation is stored in snow and ice, particularly as the highest stages of the river are prone to icing and even ice-jams that blockade the flow, which creates variable runoff in the early spring months. Through most of the river basin, these conditions create a New England/Acadian Forest terrestrial ecoregion. Vegetation in the upland is primarily black spruce, balsam fir, trembling aspen, and white birch. In the river valley, the trees are predominantly white spruce, white pine, red maple, yellow birch, beech, and red oak (Cunjak and Newbury 2005).

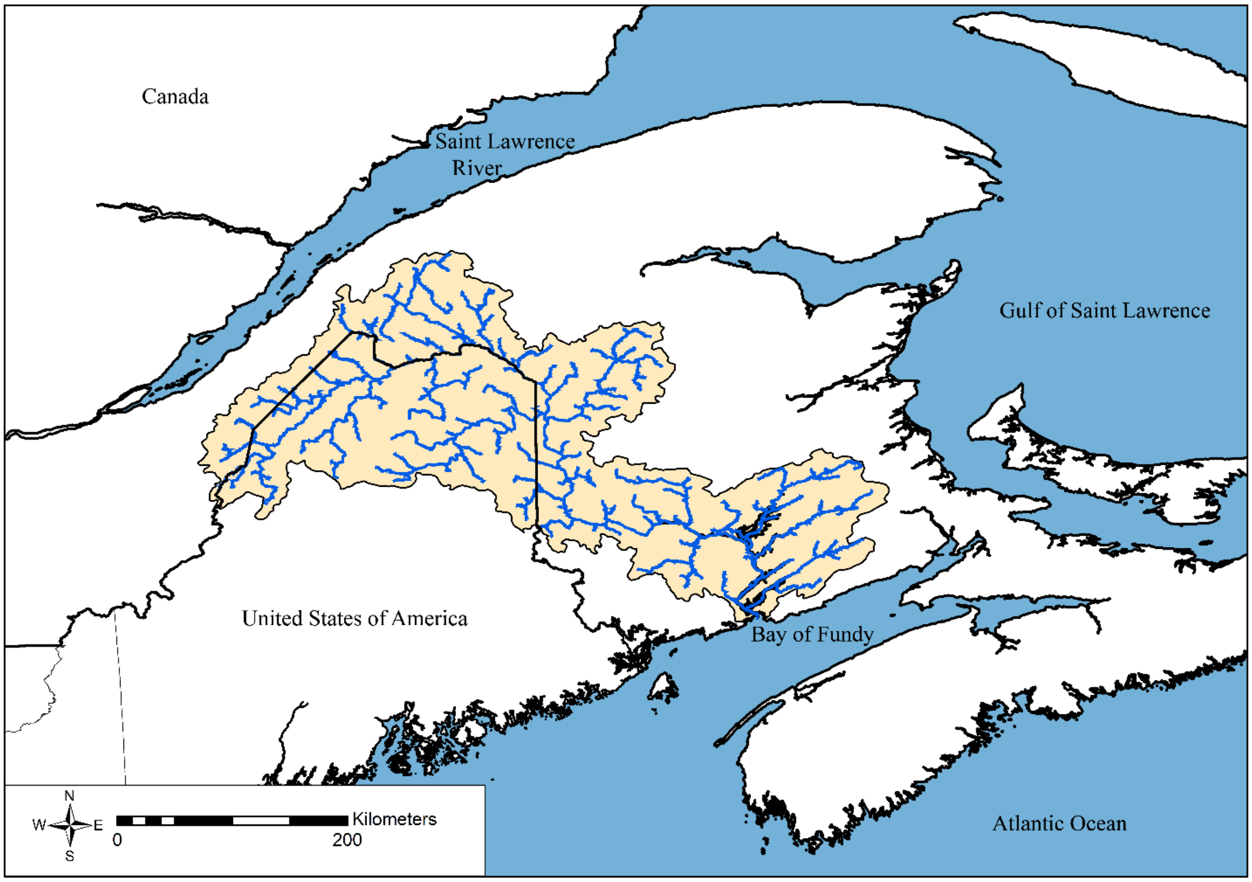


Figure 3.8. Saint John River Basin with major rivers and tributaries. The Saint John River forms the central vein through this network from northern Maine to the Bay of Fundy.

Cultural Context

Although the inhabitants of these lands can be collectively identified as the Wabanaki, which formed a confederacy in the periods just prior to and during the Colonial Era, there are five major groups who occupied this large territory (Prins and McBride 2007). Based on linguistic and cultural practices, these can preliminarily be more generally distinguished as the Western Wabanaki and the Eastern Wabanaki. This division characterizes some variation in settlement and subsistence strategies. Situated to the more southern and western portions of the territory, the Western Wabanaki lived between the Kennebec and Merrimac Rivers, in ecological and climatic zones that were sufficiently mild as to allow them to grow maize, beans, and squash in addition to hunting, fishing, and foraging and establish semi-sedentary villages. The Eastern Wabanaki, living throughout the woodlands and coastal zones from the Kennebec River Valley east to Newfoundland, were fully depending on fishing, foraging, and hunting in migratory bands.

Variances in Community Naming and Identification

Though the historical details of naming a community is important, it is both theoretically and historically a complicated practice that I do not discuss here. As this dissertation draws on ethnohistorical data, the idea of community identification however requires some consideration. Naming can also give an insight to a national distinction in the type of colonialism and colonial, or at least landscape, outlook of Europeans. Early French colonial documents identify three major culture groups, largely based on linguistic patterns: 1) Souriquois bands, known as the Mi’kmaq after 1600, who lived in the coastal and interior region just south of the St. Lawrence River, from Newfoundland west to the Saint John River Valley; 2) The Etchemin foragers who lived in the woodlands between the Kennebec River and the Saint John River Valley; and 3) the Armouchiquois who lived to the southwest of the Etchemin and who grew corn east of the Kennebec River. This group included a number of smaller ethnic groups, including the Abenakis who lived in the Kennebec to Merrimac. While the former are considered part of the Eastern Wabanaki, the Abenaki are considered Western Wabanaki. Alternatively, the English distinguished communities by geographic location – namely the river or bay where they lived

(Prins and McBride 2007:2). This practices explains how the identification of Western and Eastern Etchemin came to include communities in the 1600s such as the “Pemaquids,” “Penobscots,” “Machias,” “Passamaquoddies” and “St. John’s Indians” (Prins and McBride 2007:2). The European groups glossed over, or remained unaware of, differences and made categorizations of communities based on their imperfect understandings of local conditions; indigenous groups were themselves often divided in different ways especially over the long course of time.

The Indigenous communities themselves identified important cultural and regional distinctions within these large groupings (Figure 3.9). The ethnic and territorial boundaries between these groups and subdivisions shifted over the centuries. The Wabanaki Confederacy consisted of five tribes, some of which were organized in even smaller divisions: The *Mi’kmaq* (Souriqouis according to the French) organized themselves into three divisions, each of which consisted of several districts. These divisions are considered ethnic groups in the tradition of Barth (1969, 1998), since the communities shared linguistic and cultural practices but did not have a formalized system of political allegiance (Bock 1978). To the west of the Mi’kmaq, the French encountered a community that they named the Etchemin. This community likewise consisted of at least two geographically distinguished subdivisions. The Eastern Etchemin are known as two communities – the Passamaquoddy and the Maliseet. Both communities were characterized by small, familial hunting bands living east of the Narraguagus River. The Western Etchemin, who lived along the Penobscot River and on the Mount Desert Island off the coast of what is today the state of Maine, integrated with refugees from the west to form a tribe known today as the Penobscot. The final group to discuss as part of the Wabanaki people is the Abenaki. While Abenaki is a language group, this term is also used to designate both and Eastern and

Western Abenaki communities. Particularly in the Protohistoric and Contact Periods, the changes and challenges accompanying the demographic collapse led to resistance, coalescence, and relocation that in turn restructured the ethnic and territorial configuration of the indigenous people and their identities.

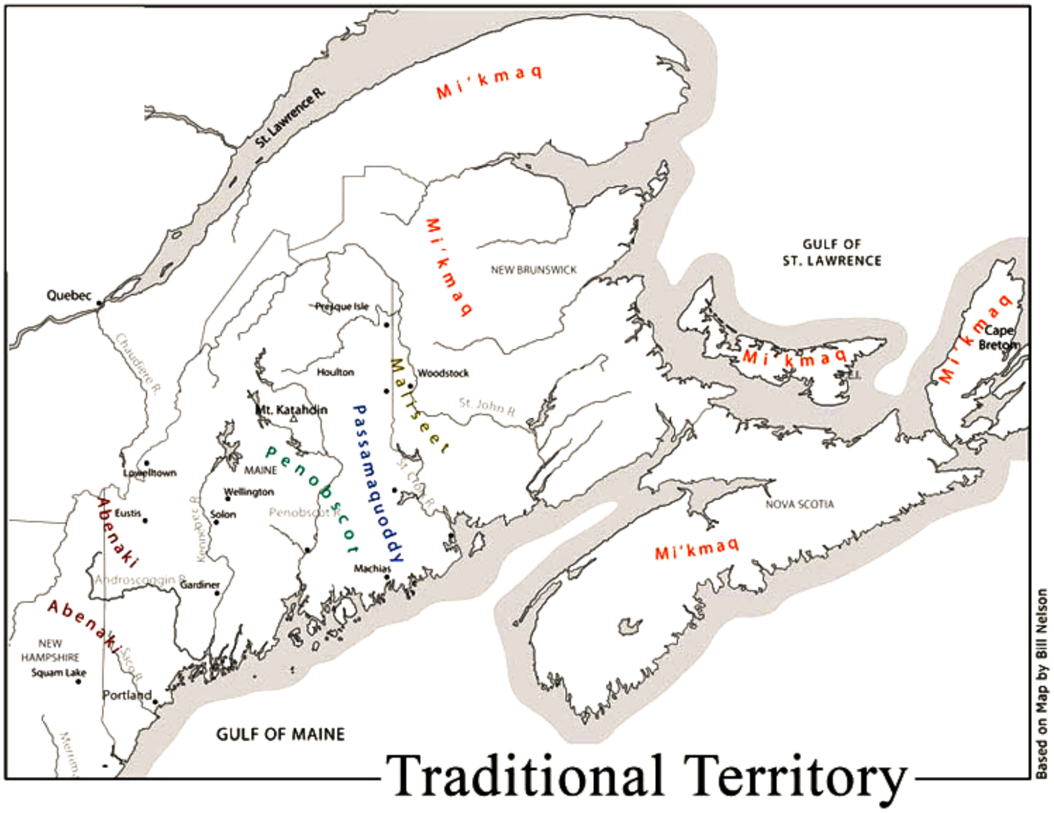


Figure 3.9. Traditional territories of the Wabanaki communities (Abbe Museum).

Woodland Period Occupations

The early Early Woodland occupation in this region shows a strong influence of population migrations and extensive regional networks, including the Meadowood Interaction Sphere (McEachen 1996, Taché 2011a). Habitation and burial sites that include Meadowood trade goods suggest that this region had closer ties to the Great Lakes region than did other New England communities. Sites at St. Croix, Nova Scotia and Mud Lake Stream, in New Brunswick (Deal 1986; Deal et al. 1991), and Jemseg (Blair 2004) in Nova Scotia show Meadowood ties by 2500 BP. McEachen (1996) suggest these similarities are attributed to population movements that carried the characteristic trade goods and ritual ideology, as seen in the Maritimes settlement pattern of habitation on major river terraces and mortuary sites near residential sites or on the coast. The importance of rivers for this period is shown not only by the site location, which allowed the residents to rely on fishing, but by the broader trend of Meadowood materials distributed along riverine contexts (Taché 2011b).

Archaeologists have identified a distinct mortuary practice that emerges during the late Early Woodland Period. The Northeastern Middlesex Tradition is interpreted as an eastern manifestation of the Ohio Valley Adena traditions (Rutherford 1990; Turnbull 1976). These Middlesex burials appear similar to Adena mortuary practices but are blended with those of the Meadowood cultural system. In the Maritime Peninsula, Middlesex sites are found along St. Lawrence River drainage, eastern coast of New Brunswick and south central Nova Scotia, where they tend to be found in clusters (Abel and Fuerst 1999). Despite similarities to the Ohio Valley assemblages, the traditional pecked and polished adzes are replaced with chipped or ground blades and projectile points are square rather than lobate (Deal 2002).

The Northeastern Middlesex Tradition practices suggest a continued interaction with river systems. The diffusion of these traditions follow the waterways as they did in the early Early Woodland. However, the Meadowood cultural system relied on coastal burials while most Middlesex burials appear along major rivers. The Champlain drainage in Vermont appears to have been an important part of Adena network that extended along the southeastern Great lakes and Hudson, Ohio, and St. Lawrence Rivers (Heckenberger et al. 1990), with notable sites at Swanton and Orwell (Deal 2002).

Contact Period

The Protohistoric Period (AD 1500-1600) typically describes the period of sustained contact between Europeans and the Indigenous communities living on the Maritime Peninsula and in the Northeastern United States. Archaeological evidence suggests that the first Europeans to make contact with Aboriginal communities were Norse explorers in AD 1000. Excavations at the L'Anse aux Meadows site in northern Newfoundland confirm this presence (Ingstad and Ingstad 2000) but contact appears to have been sporadic and geographically limited and so likely did not significantly impact traditional indigenous practices.

Among European documents, the biological abundance of the region was first publicly documented after John Cabot's voyage in 1497 (Heymans 2003; Nuffield 1996; Pope 1997). The French and Portuguese both explored the area in the early 16th century: the Portuguese explorer Gaspar de Corte Real passed through the Strait of Belle Isle and abducted 50 men and women in 1501 (Heymans 2003) while the French moved about Newfoundland. Jacques Cartier observed the St. Lawrence River (Nuffield 1996). It is unclear, with the exception of the Portuguese kidnapping, whether these interactions included inter-personal contact. Additionally, there is evidence that the Basque fishermen had known about and exploited the rich fishing grounds of the Labrador Sea during the early 1400s. While Loring (1992) suggests these fishing ventures occurred subsequent to Cabot's exploration, Kurlansky (1998) suggests that the Basque may have operated in the North Atlantic without contact since their method of fishing and processing did not require the ships to land.

The flow of contact between European fisherman and indigenous groups accelerated through the early 16th century. Although early techniques for fishing and "wet" processing were conducted on boats with only occasional landings for water or hunting, the increasing volume of fishing and the evolving "dry" fish processing techniques on land led to increased cultural contact (Kurlansky 1998). The Portuguese established a brief settlement at Fagundes Colony on Cape Breton in 1525 (Figueirô et al. 2007). In the mid- to late 1500's, Basque whaling voyages established a seasonal site at Red Bay to render and barrel whale oil at Saddle Island (Tuck and Grenier 1981).

The fur trade was fully established by the 1560s, with significant implications for the various Indigenous communities. To take advantage of the economic opportunities, the Mi'kmaq traders who traditionally wintered on the coast inverted their seasonal mobility cycle to that they could harvest thicker pelts from the interior during the winter and spring yet be present on the coast during the summer trading season (Bourque and Whitehead 1985).

The Mi'kmaq assumed a position of power as middlemen and traded European goods along the coast for furs with other tribes (while also raiding) and centralized these goods for exchange with Europeans. The Mi'kmaq adopted a type of canoe with sails called a Shallop and by mid-16th century used a Portuguese-Basque pidgin in the Gulf of St. Lawrence (Bourque and Whitehead 1985). These changes also affected the social structure and territoriality of different tribes. The desire to obtain furs and the introduction of trapping technology increased pressure for defined hunting territories (Leacock 1954). As the Mi'kmaq increasingly controlled coasts and rivers, the Maliseet were pushed into the interior regions (Bourque and Whitehead 1985).

There are few single-component protohistoric sites in the Maritimes region, since the indigenous communities maintained occupation in late-woodland sites or integrated with European forts and outposts. Burnt Bone Beach on Gaspereau Lake represents one example of such a site, with a small quantity of trade beads and copper clothing decoration but distinctive sites of period (for indigenous communities) are burial sites (Deal 2002). These sites reflect the Copper Kettle Burial Tradition (1500-late 1600s) associated mostly with Mi’kmaq on coastal Maritimes. Though they are primarily distributed in New Brunswick, Nova Scotia, and Prince Edward Island, there are a few in Maine, Northern New England, and New York. Despite European exploration of Saint John River in the 17th century, the upper reaches of the river basins remained largely unpopulated into the 1800s, when the timber industry led to expanded colonization (Wilson 2005). Though these activities are past the chronological period of interest in this investigation, the period is likely to have impacted modern ecological comparisons.

CHAPTER 4: ARCHAEOLOGY OF LANDSCAPES, MOBILITY, GIS, AND WATERWAYS

Landscapes have long been a central consideration in archaeological research (Ashmore and Knapp 1999; David and Thomas 2016; Kvamme 2003; Tilley 1994). Over time, scholars began to consider a broader range of variables that affect the land and human activities. These views moved from a deterministic, physical system to a culturally informed idea of "scapes" (Appadurai 1990:296). Landscape may refer to a geophysical environment or how that environment is conceptualized by people and shaped by, or incorporated into, human activities. The geophysical aspects of an environment have quantitative variables such as topography and climate that affect people living in ecosystem. Because physical features can be perceived in many different ways by different people even at the same time, cultural perceptions create qualitative values that influence human behavior (Tilley 1994, 2016; but see also Hussain and Floss 2016). How people move through space is a product of both the physical and conceptual landscapes (Snead et al. 2009; White and Surface-Evans 2012) influencing patterns of mobility and the social structures they develop and maintain through the resultant interactions (Gjesfjeld 2015; Knappett 2013).

This chapter establishes a methodology for assessing how people employ waterways to shape landscape knowledge, adopt patterns of mobility, and maintain interaction networks. I first discuss the components that constitute a landscape – both physical and cultural – within which people establish paths. This includes a discussion of spatial conceptualization and information-recording about the environment. I review how Geographic Information System (GIS) technology facilitates the analysis of spatial information and its evolving role in landscape archaeology. Building on this, I discuss how I conceptualize and quantify mobility as a means of determining the structure of movement in this dissertation. The previously defined four uses of waterway – barriers, boundaries, obstacles, and conduits – each influence the pattern of movement differently, generating distinct but replicated patterns within the archaeological record. Through the distribution of artifacts and settlements, integrating archaeological analysis with environmental data allows me to anticipate archaeological and environmental correlates for the four primary uses of flowing water in mobility related to interaction spheres.

Physical Aspects of the Natural World

In a single panoramic view, the natural world contains immense variety and activity. One might imagine wind rustling the leaves of trees, lush from a recent rain. Plants along a riverbank provide refuge for fish, reptiles, and amphibians. Small animals may smell a predator and dive into underground burrows. The sky may meet the horizon of dense forest or mountain ridge. Six months later, this panorama may look the same or seasonal changes may render it drastically altered. Move the view by 200 km and the physical geography may change drastically, from mountains to the seashore to the desert. From one image, we see that the physical world is active, mutable across different timelines, and diverse within and between loci.

An ecosystem undergoes change on several temporal scales and with varying degrees of predictability. Annually, seasons may alter the environment; these changes are common and predictable in a year. On a decadal scale, the physical environment may be altered by catastrophic events. Fires, floods, droughts, or tornados are relatively common but unpredictable while high-magnitude temblors or sinkholes are also unpredictable but often rarer. On the largest scale relevant to anthropologists, environments may change over centuries. Rivers may change course and impact the landscape through erosion, or temperature and precipitation within a region may change enough that entirely different ecological niches emerge, impacting or leading to entirely different species populations (Blois et al. 2013). This time period exceeds the life of any one individual but can fall within the collective memory of a community, thus suggesting that communities may have the knowledge of events and a system of response despite a lack of first-hand experience (Whallon et al. 2011).

Because humans live within environments and adapt or respond to them, it is essential to understand the overlapping and interacting systems that constitute the physical world. In the terminology of geophysical sciences, these systems are identified as the atmosphere, lithosphere, hydrosphere, and biosphere (Skinner et al. 2011)[9]. The atmosphere consists of the layer of gases that surround the planet. The lithosphere is the outer portion of the earth's crust, both at the macro-scale of topographic features and the micro-scale of different sediment types. The hydrosphere is all the water on the planet including within the crust (groundwater, wells, and aquifers); on the earth's surface as oceans, lakes, and rivers; and in the air as humidity, clouds, or precipitation. The biosphere refers to all living organisms on the planet, including prokaryotic and eukaryotic species. These spheres, which can be more easily quantified and evaluated for distinct variables, intersect to create an ecosystem in which people live.

The atmosphere, as an aspect of the environment, is rarely explicitly incorporated into archaeological studies. Studies of climate change rely on ice-cores to assess the ratio of oxygen

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[9] The term geosphere has conflicting definitions. In a narrower definition, it refers to all the solid parts of the earth, of which the lithosphere is a sub-section of only the outer layers of the earth including the crustal rocks and upper mantle. In a wider definition, it is the collective name for the lithosphere, atmosphere, and hydrosphere (including the cryosphere – the frozen water of the planet).

isotopes, as an indicator of temperature among other environmental conditions, as well as ratios of carbon isotopes for radiocarbon dating. The atmosphere, however, also includes climatic variations, including air temperature.

The lithosphere data on surface contours has evolved from early maps that demarcated only significant landforms as points in undifferentiated space to topographic maps to contemporary digital elevation models (DEMS) that show detailed elevation changes and slope. Elevation models will vary slightly depending on the data sources used to produce them; topography information may be collected for elevation models from topographic maps and aerial photogrammetry, airborne laser altimetry (LiDAR), and ground survey with differential GPS (DGPS) (Rayburg et al. 2009). These data collection techniques create variability in coverage and precision but the differences are minimal unless used for fine-grained analysis. Lithospheric data also includes geological formations and soil types.

The hydrosphere, discussed in greater length in chapter 2, includes all of the water on our planet, in all physical states throughout the hydrologic cycle. In archaeological analyses, an assessment of this aspect is often concentrated on identifying areas of sufficient precipitation for agriculture or the locations of water sources, including coastlines and stream networks.

The biosphere includes all living organisms. There are many ways to quantify this but for a study on mobility, the key variables are resource abundance, diversity, and distribution.

These individual datasets that taken together characterize individual spheres can be manipulated and integrated to identify specific interactions within systems or between two or more spheres in an ecosystem. The particular intersections create the processes such as climate that affect people living within an environment; they determine where people can live and impact the risk associated with food predictability, which in turn affects the structural organization and inter-community network of a society (Gjesfjeld 2015; Pearce 2014). For example, the intersection of the lithosphere and atmosphere at higher latitudes or elevation are suited to particular species in the biosphere or may affect the degree of evaporation from rivers, producing variable precipitation in the hydrosphere. Each of these may affect human mobility, as the slope of terrain, the presence of rivers, type of precipitation, and the density of vegetation all impact the effective travel across a given region. To understand the intersection of systems, the processes they produce, and the cultural adaptations people develop as a response to these conditions, we must evaluate the influencing factors and analyze the relationships between them.

Mapping and Geographic Information Systems

As a discipline, archaeology has long focused on spatiality (Gupta and Means 2015). Archaeological interpretations rely on understanding the geospatial relationship between artifacts and human actions. The ability to thoroughly assess and interpret spatial relationships, however, has been hindered by the analytical tools available until relatively recently.

Geospatial data have long been recorded, manipulated, and displayed in paper maps that reflected the maker's (or intended consumer's) prioritization of environmental features (e.g. coastline or rivers) and human activities (such as town locations). When limited to a physical page, these maps are confined by space to display only some information, all of which must be at a single compatible scale (Connolly and Lake 2006). There are examples of scholars integrating different types of spatial data for analysis using early maps - notably epidemiologists seeking to identify the source of a cholera outbreak in London in 1854 (Brody et al. 2000). The term "geographic information system" was first used by Roger Tomlinson who created a computerized, interactive database for the Canada Land Inventory that included the ability to overlay, digitize and quantify information for a 1968 publication on forestry management (Mott 2014). His efforts were the first to unify data storage, editing, and overlay through computerization.

Geographic Information System (GIS) refers to the hardware, software, geographic data and human resources that collectively store, compile, manipulate, and display spatial information (Aldenderfer and Maschner 1996; Ebert 2004; Mott 2014). These programs allow the user to integrate multiple types of spatially-referenced information and facilitate analysis of the relationship between objects or variables. A GIS is a system built from several component parts: the hardware, software, data, and specific methodologies used to address each research question. Arguably, the most important variable is the user. A GIS analysis will always generate some form of map or relational analysis; the product is user-defined. The results reflect the user's choices based on the specific question or product, the data they incorporate, the methods used to evaluate or integrate the data, and the stylistic choices in producing a final product. I provide an overview of each of the component parts of a GIS.

1. <u>Hardware</u> is a fundamental component, as the digitization and automated integration of information is a defining characteristic of GIS that separates this process from earlier phases of cartographic or spatial analysis. With the proliferation of web-based GIS, the effect of hardware has a diminished impact on the final GIS product. Computers with high capacity for rapid processing and memory are widely available for personal consumer use and many GIS applications can be run from these personal devices; some complex GIS projects may require more intensive computing power.

2. Software is available in a range of applications. GIS software is available as both Desktop GIS and WebGIS systems (Fu and Sun 2011). Various applications are available both as open source software and in commercial and proprietary formats. The software varies in a few ways, including their compatibility with the computer's primary operating system, the organizational structure of the storage database, and the types of analysis or calculations that can be run through the program. Perhaps the most well-known commercial system, and the one used in this research project, is ArcGIS by Environmental Systems Research Institute (ESRI). This company has released an expansion called ArcHydro (Maidment 2002) to facilitate hydrology-based studies.

3. Data in GIS can come from any source or type so long as there is an aspect that can be referenced to a coordinate system. These data typically have a descriptive attribute, for example, as vegetation type, and they must have locational component. This means that both quantitative and qualitative data can be layered, vertical, or overlapping so long as some aspect of the information can be tied to a geographical point. Within ArcGIS, the spatial database supports two formats. Raster data is represented in a grid or cell structure of individual pixels, each containing it specific qualities or values. This type of data is used to convey continuous data, such as digital elevation models that convey topography, where adjacent cells can be used to indicate gradients of information. Because this type of data covers a greater area, each cell is relatively large and is best suited to analysis at larger scales. Vector data refers to defined features, represented as points, lines, or

polygons, which often depict environmental or human-produced features, including rivers or towns.

4. Methods are an important aspect of GIS. GIS applications are capable of integrating and displaying information, but various types of information must be measured against a common datum point, to ensure fidelity of the spatial relationship. Within the software itself there are a range of analytical tools to calculate spatial relationships. This may include, for example, a suite of "tools" to calculate distance between two points, including Euclidean distance, cost distance, proximity of two points or nearness of points to other features, such as streams or lakes. The use of one versus another of these calculations can produce different characterizations of the data.

5. Users are the most influential factor in producing a GIS. The user decides what hardware and software to use, will determine what data is relevant (and reliable), and what methods can or should be used to assess the relationships between the variables of their choosing and, in generating the final map, how to interpret and depict the results (e.g. Connolly and Lake 2006).

Tara Mott (2014) distinguishes six major phases in the development of GIS from the 1960s to the present. These include the adoption of automated computer overlays, innovation in software and graphic user interfaces, the advancement and broader accessibility of Global Positioning Systems (GPS) that allowed easier collection of more accurate spatial reference data, expansion of imagery resources to include new methods and declassified material, adoption of standards to promote shareable data across operating systems, and the emergence and proliferation of the internet which made these programs accessible to many more users. Thinking about these developments illustrates how the GIS has evolved as a field and how scholars have adapted the use of GIS to new applications and conceptual questions.

Evolving applications of GIS in Archaeology

In the last 30 years, the innovation and application of Geographic Information Systems (GIS) has arguably been the most valuable technological advancement for archaeological research. The computerized integration of many types of data allow archaeologists to systematically address the relationship or correlation between behaviors and real-world information. GIS also facilitates analysis at a wider geographic scope than previously possible, which allows archaeologists to more easily conduct regional and landscape-based analyses. In many ways, GIS provided a technological advancement that facilitated and expanded the settlement studies and regional analyses present in archaeology.

GIS applications in archaeology typically fall within three main applications: for visualization through map-making, as part of data management, and as an analytical tool. The least intensive use of GIS, requiring relatively low expertise, is for map-making. Because GIS programs allow the user to integrate a variety of different types of data and emphasize values associated with particular features, GIS allows the user to produce specialized maps. The second use, as a data management system, is particularly prevalent among cultural resource management efforts, as a means of recording and managing archaeological sites for their location, as well as additional data about a site and or region. This is valuable not only for maintaining information about known sites but in assessing how these sites might be affected by new infrastructure and in establishing efficient surveys to identify new sites. Finally, the most intensive applications of GIS focus on analysis of the spatial relationships as part of theory building and hypothesis testing. GIS provides a means of understanding the world by integrating a broad variety of information from which the user can formulate many different means of viewing environments, analyzing relationships, and interpreting landscapes.

Shifts in the theoretical framework of how archaeologists approach the human-environment relationship have had a significant effect on the application and perceived utility of GIS analysis. Though GIS emerged in landscape management in the 1960s and 1970s (Tomlinson 1987), these methods were not applied to archaeological studies. Through the 1960s and 1970s, archaeologists increasingly focus on regional surveys and settlement systems, though these efforts were done by hand rather than computerized. Analyses sought to define catchment areas for a given group, based on the researcher's calculation of the caloric needs of a community using equations such as Euclidean distance to determine the extent to which individuals might travel to obtain resources.

In the late 1980s and 1990s, systems-focused researchers began to address these questions using GIS applications, more easily integrating a range of environmental variables. In the later 1990s, these applications drew increasing criticism. From a methodological sense, the reliance on known sites to identify relevant environmental variables created bias in subsequent surveys toward the identification of sites that fell within the same pattern. From a theoretical perspective, the early predictive models for site location or catchment boundaries unduly prioritized environmental factors. The resulting interpretations were thus predicated on the assumption that humans operate within an ecosystem as purely rational biological organisms.

Some scholars criticized that this was environmentally deterministic and indifferent to human agency (e.g. Fisher 1998; Gaffney and Van Leusen 1995; Mehrer and Wescott 2006). Predictive modeling was a tautological approach that could locate the same types of sites that were already known but would exclude other site types within the settlement pattern.

The theoretical framework that emerged in opposition to the ecological systems approach placed human experience in the foreground of research questions and analysis. This post-processualist view incorporated a human-driven perspective toward geophysical features. Scholars such as Tilley (1994) posited that the "objective' environment cannot be used to interpret human behaviors because lived experiences and knowledge affect each individual's perception of the natural world and that an individual's or communities' actions are more dependent on their conceptualizations of the environment than any quantifiable variable. This perspective raised concerns over the limitations of GIS projects, including whether it imposed a modern, Western conceptualization of space onto past communities. The discussions also questioned whether GIS studies lent analytical value if researchers cannot discern the cultural rationale behind behaviors that created spatial relationships.

Current Methods: Experiencing Physical Landscapes, Quantifying Cultural Landscapes

As a discipline, archaeologists have generally accepted that processual and post-processual frameworks each offer some valuable perspectives on landscape theory. Current theoretical questions and the methods used to examine them increasingly consider the lived experiences of people within the confines of a physical reality (David and Thomas 2016; Rockman and Steele 2003). Integrating environmental features and ethnographic or cultural landscapes can reveal balances between environmental determinism, adaptation, and culture (Fleming 2006). These integrations of culture and environment are called social landscapes and GIS has been increasingly applied to these theory-based questions.

Experiencing Physical Landscapes

Well attested in ethnographic accounts is the importance of spatial cognition among historic communities. Among indigenous communities, spatial knowledge is collected, organized, and interpreted to conceptualize and inform their own land use, such as for navigation across the landscape. Indigenous communities maintain and share spatial information about where resources are located, when they will be available, and the ideal routes for accessing them.

My analysis draws on the theoretical framework for spatial interpretation laid out by Hussain and Floss (2016). Their article seeks to interpret the role of Upper Paleolithic Rivers within the sociocultural structures and spatial organizations of Pleistocene hunter-gatherer communities. They explain how a single landscape feature, like a river, which is embedded in the larger environment, may have an unduly large effect on behaviors. They build their argument on two interacting principles: integration of *heuristics* that allow one to make rapid and reasonable decisions based on a smaller portion of information and *affordances* that suggest an environment actively shapes the inhabitant's behavior by creating particular opportunities for use, without compelling a given use.

Hussain and Floss (2016) note that the use of heuristics and affordances can be used to integrate ecophysical features and perceptions of them, though this is only viable when used in socio-culturally informed contexts to understand the community's shared cultural heuristics.

Some landscapes features, notable for their easy recognition or asymmetry on the landscape, are readily recognized which provide a heuristic for coordination of social information. They term these locations a *focality*– notable landscape features, suited for cognitive heuristics which integrate geophysical affordances with sociocultural considerations.

The concept of affordances and how a particular landscape feature – or focality – may promote or inhibit particular behaviors, is particularly relevant to the study of mobility (Hussain and Floss 2016). Landscape navigation is often dependent on notable landmarks. In hunter-gatherer societies, permanent navigational markers were rarely necessary, often restricted to places where an individual may lose the path, as when crossing a field, in places where the topography and vegetation are repetitive or homogenous, or where snow can obscure landmarks (Lovis and Donahue 2011; Tilley 1994). Instead, people relied heavily on distinct landmarks. Rivers are valuable for this use, as they are significant physical features whose characteristics allows them to become important cultural landmarks. In ethnographic interviews, a detailed knowledge of river systems often emerges as a primary structure by which individuals organize geo-spatial information across a region (Lovis and Donahue 2011).

Mobility as a focus of research has, itself, emerged within the new theoretical framework of social landscape. The spatial scale of computerized GIS and the ability to harness many types of continuous information across that area has facilitated studies of mobility by considering more sites and the spaces between them. Researchers address not just the places of habitation or resource procurement but the spaces between these loci. This perspective shows an increasing awareness in the terrain through which people travel and the perceptions or priorities that may inform which particular path is taken, and that the path itself may become meaningful (Snead et al. 2009). Even in these cases, however, the focus remains on people who move, rather than a landscape that moves.

What, then, determines where paths through a landscape will emerge and how can scholars identify and interpret the rationale behind their placement? Geographical Information Systems (GIS) are now a standard tool in evaluating boundaries and movement (Bell and Lock 2000; Hare 2004; Harris 2000; Kvamme 2003; Llobera 2000; van Leusen 2002). Many efforts to address paths with GIS have relied on the geophysical space and the acknowledgement of humans as biological organisms. Attempts to identify trails (or probable trails) have been built on the assumption that humans operate as rational agents motivated primarily by efforts to minimize caloric expenditure. Most of these studies, however, remain focused on terrestrial agentive movement. Determining whether water is an efficient mode of travel would seem to depend on the coast of movement by water versus land (e.g. Supernant 2017).

Within GIS applications, potential terrestrial trails can be identified by calculating the Least Cost Path – the line that connects two points with the lowest investment of energy. Using raster data, this type of analysis combines various geophysical datasets, such as topography and vegetative cover. Each cell is assigned a value associated with the "friction" or amount of caloric energy needed to move through it. The algorithm then compares all of the adjacent cells and calculates the path between two points that accumulates the lowest amount of friction over the distance.

Because people do not engage with their environment as purely biological entities, least cost path analyses raise two concerns, both of which draw on sociocultural considerations. The first problem emerges with the human capacity to innovate technology that changes how they interact with the environment. This not only alters their efforts in travel but also introduces challenges for the researcher who seeks to estimate and quantify energy expenditure. The second problem is one of landscape perspective. Individuals living within a community may observe physical characteristics in an environment that are not preserved through time, either physically or in cultural awareness. Land use is dependent on cultural information, heuristics, memory, or priories to which the GIS user may not have access but which alter the decision on where communities travel or establish boundaries.

The amount of energy expended along a particular route is not only dependent on the eco-spatial features but in the manner in which one travels. ArcGIS programs have been extended to allow the user to compare transportation costs when walking or with a wheeled cart or horse, which alter the amount of time and energy. This offers a culturally-adapted evaluation of time and energy, with calculations of time and calorie cost derived from observing comparable costs in modern individuals.

Water transportation costs remain particularly difficult to model because comparable data is difficult to obtain. The amount of energy associated with water is not only dependent on the particular river, as each waterway has different water volume and flow velocity. A particular river may have markedly different friction costs depending on whether one is moving with or against the current. The river's characteristics will also change throughout the year, an observation that the inhabitant can use to determine when a path is not viable. Additionally, it is difficult to replicate the skill set of paddlers in the archaeological past, who were likely to be more physically and technically familiar with the demands of paddling watercraft. These individuals may perceive sub-currents and variations across the breadth of a stream that can be used to minimize effort.

Another problem with calculating travel costs via water is in assessing the accuracy of analogous experimental data. Unlike walking, those who rely on boats likely employ different boats, paddles, techniques, and greater physical experience – both in terms of physical fitness and the ability to read the water and currents that vary in a single stream. It is very hard to create an experimental data reference base for water travel, unlike walking which can more easily be changed to time and calories. Similarly, waterfalls and rapids that pose a limit to contemporary river navigability may have had a lesser effect for communities familiar with portaging their watercraft around obstacles or overland between waterways.

Attempts to address the energy associated with waterways as travel corridors or paths include studies of indigenous paddlers, though the boat technology and waters vary significantly by region, and the incorporation of ethnohistoric accounts. In 2001, Chumash descendants paddled a traditional plank canoe from the California Mainland to Santa Cruz Island, crossing the Santa Barbara Channel, recreating the traditional voyages of their ancestors who occupied the Channel Islands. This undertaking takes a full day of paddling which gives some insight into the time and effort of maritime travel, however the participants do not have the same lifestyles as their ancestors and new paddlers are switched in over the course of the trip. Ethnographic accounts, such as Fleischman's (1984) account of the Warao illustrate observations from communities that regularly employ these more traditional modes of mobility:

> "Distance was difficult to measure with accuracy, so the following method was used: a distance between two log posts at the Guayo Mission was paced off and the boat was timed at average running speed (the one used for long distance; not full bore) from one post to the other. This was done going in two directions and the directions were averaged. The reason for averaging was because of the great variation of the river flow. The boat was not only affected by varying current speeds on different rivers, it was also affected by tidal flow which moves either against, or with the current. The prevailing wind, which was generally from the

> Northeast, likewise affected the speed. During a trip, any or all of the factors would influence boat speed and were not easily measured without specialized equipment. At medium speed, then, and disregarding the other factors affecting speed and headway, the canoe averaged 765 feet per minute. This number will be used to compute mileage between villages. At this speed, it takes 6.89 minutes to cover one mile of waterway, which rounded off to seven minutes a mile" (Fleischman 1984).

These examples, however, are within contemporary contexts. Ethno-historic accounts provide additional insight. When Jesuit missionaries came to North America to proselytize, they relied on indigenous guides for transportation between villages, recording notes about the routes, the duration, and their perception of the effort associated with trips between villages (Little 1987).

The accuracy of Least Cost paths remains tied to experiences of a landscape. People in ancient communities and today prioritize different interactions with the environment and different skills to fulfill their "outdoors" activities. These different expectations and practical skills alter one's perception of and ability to respond to address environmental conditions. This is particularly true of rivers, which by their nature are prone to change. Rivers fluctuate on a daily, seasonal, annual and millennial scale, as well as with small oscillations that are not visible in an archaeological way but might contribute to the perception of the river at a given time. For example, rapids or a waterfall are notable challenges to contemporary navigation but would not necessarily have been a commensurate challenge for those individuals accustomed to dealing with them. As an example, Holyoke and Hrynick (2015) discuss the role of portages (locations in which canoes are carried over land) in the procurement of lithic resources in New Brunswick. This study demonstrates the frequency of portages and distances around obstacles that canoes could be carried, while a GIS analysis of waterway connectivity might deem these areas inaccessible or unnavigable. The ability to portage is also dependent on a knowledge of local terrain and the construction of the boats themselves, which may have a shallower draft making them more suited to riverine navigation but may also be too wide or heavy to portage.

The nature of rivers as landscape features make them significant focalities that are readily incorporated into cultural consciousness. Distinctive as a landform in nature and as a heuristic for integrating space over distance, they are often seen as features that have affordances toward conduits (Hussain and Floss 2016:1172). Their affordance as landmarks, however, make then equally able to designate a cultural boundary. Negotiating use of resources may involve defined boundaries; waterways provide visibly distinct and recognizable points by which to define a boundary. Because these must be mutually recognized between communities demonstrates the potential porosity and collaborative, if not cooperative, demarcation of boundaries. Additionally, the indigenous knowledge of landscapes may allow physical aspects such as promontories, bends, or changes in flow to indicate boundaries along waterways.

The movement within a river, either in its course or its character, affects the possible uses to which it can be put. Water can have different affordances depending upon whether the flow is fast or slow, the channels are wide or narrow, the depth shallow or deep, and the surface frozen or not each. Freezing in particular alters the friction of travel along rivers, as the solid surface more readily facilitates travel across the surface and may allow travel along the tree-free corridor without the limitations of boat size or availability.

Quantifying cultural landscapes

As archaeologists have developed a more holistic understanding of landscapes and how to incorporate environmental and cultural considerations into analyses, flowing water is a relatively recent addition to these issues. Water features warrant a particular discussion for how they are incorporated into GIS and cultural landscapes.

How does quantitative value relate to qualitative perception in order to blend different types of descriptive data? In their study of quantifying culturally defined landscapes, Cătălin Popa and Daniel Knitter (2016) introduce a method for linking environment to landscape, using fuzzy logic to describe two geomorphometric datasets for slope and saturation and formed into 3 overlapping categories that create four qualitative categories of landscape: flat wet, steep dry, flat dry, and gradual moist. These were then successfully corroborated by archaeological data in Turkey and Syria, though data from Serbia was deemed inconclusive.

As an environmental feature, rivers have presented additional challenges to the real-world environmental data. From a contemporary standpoint, incorporating environmental information about streams can be difficult. Flowing water may not appear on maps at smallest scales. Depending on who is conducting the survey, the definition of a stream may depend on different characteristics. The stream may or may not be flowing during the time of year that the region was surveyed, particularly if it is an intermittent stream. The gradient of the channel and velocity of the flow must also be considered. This will mean that the calculated cost of traveling one direction versus another will not be equal.

Recent studies (Howey 2007, 2011; Howey and Burg 2017; Whitley and Hicks 2003) show the importance of incorporating slope with multiple criteria, including walking speed and vegetation. In applications to water travel, walking speed may be equated with transportation technologies and vegetation may be replaced with water direction and flow. Flow accumulation, which incorporates hydrological data to determine the direction and speed of water flow is used to determine location of streams but could be used to calculate water travel costs. Waterways are assumed to reduce the friction associated with travel, promoting the mobility of populations and materials but additional factors affect the surface friction, and thus cost of movement, including wind, currents, flow, and technological innovation (Arnold 2007). The rate of flow may vary seasonally; rivers freeze in winter, swell to rapids in the spring thaw, or become too shallow to navigate in summers.

Meghan Howey's (2007, 2011) research models the successful application of GIS and water travel in a forested, interior woodlands landscape within the Great Lakes region. She calculated travel costs based on topography, vegetative cover, and the location of waterways in relation to monumental earthworks, showing inter-tribal monuments were most widely accessible by water. These works illustrate probable trails through both least cost and multi-circuit calculations. While Howey considers the use of waterways in defining large-scale integration, alternative uses of water for local territory boundaries is understudied.

Although individual communities and waterways have particular traits, characters, or practices, the progression in theories of landscape and methodological practices allows scholars to characterize predictable patterns in human-hydro interactions. As the study of trails has shifted our perspective from land and travel to meaningful landscapes and paths, waterways and the movement of water also can be analyzed as essential means of travel. In practice, many other practical and cultural constraints may prompt people to use water for other purposes. Advances in GIS allow scholars to being assessing these variations, particularly as they can readily be adapted to analyze changes in water flow or cultural pressures (e.g. Gustas and Supernant 2017). By altering the values associated with river features, scholars can look at the range of conditions under which water travel would be beneficial, as has been done with other efforts to quantify the experiential aspects of environments.

CHAPTER 5: MOBILITY AND MODELING ARCHAEOLOGICAL PATTERNS OF RIVER USE

Because the physical, predictable characteristics of waterways afford a finite number of ways for people to interact with water features, I have defined four categories of use which influence interaction: barriers, boundaries, obstacles, and conduits. Distinguishing these uses in the archaeological record provides a foundation for understanding how populations used waterways in order to shape social organization and social networks. Each use influences the pattern of movement differently, generating distinct but recurrent patterns within the archaeological record. Although the broader cultural contexts may make one or another function of water "necessary" it is important to note that the water feature itself does not necessitate any given use. The use of a given waterway which people chose to emphasize at a particular time in history is likely to reflect social structures rather than an ecological imperative inherent to the waterway.

In this chapter, I lay out the methodological steps and interpretive framework taken to address the relationship between waterways, the structure of movement, and the archaeological record. To understand how communities interacted with water in shaping their social networks, I integrate the cultural data indicative of structure of movement with environmental data to see how water features relate to patterns of mobility. First, I implement a method to characterize and quantify movement of people and goods. Next, I identify patterns of movement that characterize distinct uses of water features. I then associate these expectations of movement from the four uses of waterways with a model to identify archaeological correlates that reflect this structure through the distribution of settlement data and material culture. In the analysis phase, a GIS analysis compares the structure of movement with environmental characteristics in order to assess how people used water features to reinforce the structure of movement and facilitate or delimit interactions among communities.

Conceptualizing Mobility and Quantifying Movement

One commonly discussed aspect of the hunter-gatherer lifestyle is the mobility of these groups. Within small-scale, acephalous societies, people move for many reasons ranging from the pragmatic to the aesthetic. People move both as individuals and as part of a community. The sex, age, or particular skillset (e.g. as a hunter or ritual specialist) of a traveler likely affects the frequency, direction, or distance that the individual moves. Although anthropologically and ethnographically informative, motive and demographics are often difficult to distinguish using the material record (though see Ruff and Larsen 2014; Stock and Macintosh 2016 for examples of osteological studies and Makarewicz and Sealy 2015 or Fornander et al. 2015 for examples of isotopic studies). Because movement, regardless of motivation, often results in the same behavior – people leaving a distribution of sites and materials on the landscape – analyses of mobility, including the work in this dissertation, are typically conducted at the scale of a community or population.

The theoretical understanding of mobility in archaeology has become increasingly nuanced. The four category system of sedentism, semi-sedentism, semi-nomadism and nomadism, based on the frequency with which the entire community relocates (Murdock 1967) is now recognized as simplistic (Barnard 1998; Fitzhugh and Habu 2002; Kelly 1983, 2013). Historically, the classification has implicitly equated mobility with subsistence practices, yet evidence for semi-sedentary hunter-gatherer societies, particularly along the coast (Yesner et al. 1980), such as on the Channel Islands of Southern California (Arnold 2001; Rick et al. 2005) and the Pacific Northwest (Ames 1994) discredit the idea that hunter-gatherers must inherently be mobile for subsistence or that subsistence drives mobility. Many scholars now discuss mobility as a continuum, with many motivational axes and spatio-temporal scales at which a community may move (Leary 2014; Wendrich and Barnard 2008; Whallon 2006). Finally, these categories conflate the ideas of movement and mobility, obscuring movement prevalent in “sedentary” societies, such as daily travel between residence and activity centers (Erickson 2009) or movement undertaken within state-level communities (Alcock et al. 2012; Gibson 2007; Ogburn 2004; Snead et al. 2009).

Mobility and movement are related but distinct terms used throughout this dissertation. Movement refers to the physical action of relocating between particular points in space. Mobility, though traditionally defined as the ability or proclivity toward movement, is defined here as a theoretical construct reflecting the cumulative effect of movements that create patterns on the landscape. Binford’s (1980) ethno-archaeological study on hunter-gatherer settlement systems illustrates this distinction: in a forager strategy, individuals move in a smaller area but engage in community-level mobility throughout the year, while in a collector strategy, individuals undertake significant movement while the settlement remains largely immobile during the year. Although Binford’s work has faced criticism for its approach to hunter-gatherer subsistence strategies, it is a valuable foundation for how patterns of mobility alter the archaeological site profile.

Drawing a distinction between mobility and movement provides a foundation from which to evaluate the archaeological traces of physical movement in a particular direction or intensity.

By addressing movement, itself as a product of discrete dimensions, I can differentiate the environmental and cultural considerations that affect movement, illustrating how communities respond to these factors in creating and maintaining their social networks.

Movement itself cannot be measured. As an action, the participant negotiates several smaller variables, including who is moving, where, when, why, and with what possessions. In this sense, movement, particularly regional patterns of movement, are the sum of specific dimensions of movement. To address this, I heuristically distinguish three aspects of movement that I contend are most relevant to community interaction and can be identified archaeologically: 1) the cardinal *direction* of movement from one location to another, 2) the *intensity* of movement, based on both the temporal frequency and the scale of people engaged in the interaction, and 3) the *cost* of this movement based on time and energy expended.

I chose these dimensions because each has archaeological proxies by which they can be assessed. Further, evaluating movement as a product of several dimensions provides a finer scale resolution on movement that can be used to differentiate the ways in which people used a focality, such as a stream or even a confluence. The particular pattern in the dimensions of movement in relationship to a waterway indicative the use of that waterway as a barrier, boundary, obstacle, or conduit.

Dimensions of Movement

The first dimension, *direction*, refers to the trajectory between a point of origin and a destination. It affects where and how people are moving on the landscape and with whom they are likely to interact. These travels may reflect shifting home ranges (Shepard et al. 2016), seasonal migrations between residential sites common among hunter-gatherers (Lieberman et al. 1993), or between a settlement and resource procurement area (Blair 2010). This dimension is evaluated with cardinal directions.

The second dimension, *intensity*, refers to the relative strength of a connection between two locations or communities. The overall strength of this connection serves as a proxy for how impactful the movement is likely to be to the social structure of either population. Three different variables contribute to the cumulative intensity of a connection. *Participatory intensity* refers to the number of people who engage in interactions or mobile activities. Binford's (1980, 1982) research provided a foundation that characterized the material correlates to the scale of annual movement by distinguishing community-wide migrations from contexts in which individuals collect resources to provision a central location. The number of participants is important when movement enables interactions between individuals from separate groups. The presence of a few individuals has a smaller impact on the social organization of either community while the addition of larger groups of newcomers can prompt social responses that lead groups to integrate (e.g. Birch 2012; Howey and O'Shea 2006; Kowalewski 2006), more firmly establish their distinctions (e.g. Stone 2003), or fission into new groups (Bandy 2004). *Temporal intensity* is based on the frequency of interactions. Infrequent interaction will not have the same influence on cultural practices and the development of formal responses to interaction that we would anticipate in response to frequent interaction. It can be difficult to distinguish temporal intensity. Susan Blair's (2010) study on lithic procurement illustrates the difficulty of evaluating frequency of movement, examining whether lithic resources were procured frequently or sporadically in larger volume. *Organizational intensity* describes the social organization and demography of the interacting parties, as this will affect the goals and effects of interacting with groups whose participants may differently influence social, political, or economic systems.

While these nuances in interaction may be visible while observing a dynamic population, retrospective analysis of archaeological material often obscures these distinct cultural processes and creates equifinality in the material assemblage. To adjust for this, I collapse these variations of interaction into a single dimension of intensity.

The third dimension, *cost*, refers to the energy and effort associated with movement. This aspect of movement plays a more complicated part of this analysis, as it is calculated by incorporating direction and intensity of movement. Using GIS software, the effort associated with travel from one point to another in Least Cost Paths can be used to determine whether the routes people use are maximizing the temporal or caloric efficiency of travel. If movement in intensity of direction is inconsistent with this least cost, it indicates cultural priorities that challenge the “rational actor” expectation of landscape use.

While each component of movement may be evaluated independently, the relationship between these dimensions align in different configurations, indicative of the waterway being used as a barrier, boundary, obstacle or conduit.

Table 5.1. Patterns in dimensions of movement relative to affordances of waterways

	Direction	Intensity	Cost
Barrier	Parallel; diminished relative to interior	None to Very Low across	Very High
Boundary	Parallel, diminished relative to interior	Low	Neutral
Obstacle	Across	High at crossings; Low in general	Variable
Conduit	Paralell, intensified near water	High	Very Low

Archaeology of Movement

As people's movements create their cultural and physical interaction sphere, these behaviors leave material traces that are preserved in the archaeological record. Archaeologists have used material culture in a number of ways in order to see movement, interactions, and networks. These analyses, based on settlement systems, ceramics, lithics, metals, and subsistence resources, provide evidence of movement including exchange networks and social boundaries.

We can see archaeological traces of mobility by shifting our perspective of methods that are already standard in the discipline. The first studies of settlement patterns address mobility, in that these regional analyses acknowledge that a single cultural system incorporates a number of places between which a community would move. As people move, they leave behind a distribution of objects that are given away, broken, or lost so that any study of the distribution of objects can, in the conceptual background of that analysis, speak to the structure of mobility (e.g. Hayden 1997; Hayden and Schulting 1997; Shepard et al. 2016). These studies create a broader picture of where and how people are traveling across the landscape and with whom they are interacting. Though these studies often assume an economic perspective focused on trade, exchange and access to resources, they are a reflection of mobility.

In order to understand the relationship between water and movement, I established two objectives: 1) assess the patterns along which people moved in order to maintain cultural interactions, and 2) characterize the landscape as it relates to mobility. To accomplish the first objective, I use archaeological data on settlement patterns and site distribution, artifact distribution, and ethnographic and historic data in order to contextualize it. To accomplish the second objective, I use environmental data encompassing the physical and climatological characteristics of the waterway and surrounding landscape.

Objective One: Characterizing the Evidence of Movement

Archaeological data include spatial data on settlement systems and artifacts including metal, ceramic, and lithic data. In some contexts, additional lines of evidence such as metals or food resources might also be suitable for analysis.

Settlement Data

Settlement patterns tell us where people chose to live on the landscape and the points that would be connected as people moved between them. The settlement system includes non-residential sites, such as those associated with subsistence activities, temporary camps and look-outs, monuments, and way-finding markers. Settlements often have constraints on their location many of which are related to water, including population size, proximity to resources, defensibility, and the risk of flooding. These variables have less of an influence on cultural constructions such as short-term camp sites or monuments. The extent to which one variable is prioritized in the decision-making of where habitation sites are established speaks to the priorities of a community, be it for defensive location or access to resources (e.g. Jones 2010; Maschner and Reedy-Maschner 1998).

Based on ethnography of hunter-gatherers, (e.g. Lovis and Donahue 2011), paths were embedded in cultural knowledge and rarely actualized on the landscape. Exceptions emerge where the landscapes are repetitive and an individual is likely to lose a path, as when moving through a large clearing. In these cases, there might be “sites’ in the form of monuments or markers, however these features might have been impermanent, as with charred marks on trees or a particular formation that no longer exists. Even where the marker does exist, they may not be recognizable as such. Relatively recently have archaeologists focused on the more mundane function of rock art, that it may communicate information along waterways and mark territory (Bradley 2000; Norder 2003; Norder and Carroll 2011). In some cases, the routes themselves become visible, though travel on smaller or more infrequent paths or by water is less likely to generate permanent traces.

Settlement patterns include measurable variables such as the location and types of sites. Whether settlements aggregate speaks to intensity or frequency. Settlement size reflects permanence or seasonality. The size of the settlement might reflect cost of movement, depending on whether the sites appear to be campsites along waterways, habitation sites, or aggregation locales accessible by multiple water ways, since these indicate the permanence of a site and the importance of waterways for aggregation rather than resource procurement. Cost is based on the distance and terrain between settlements and from site to river.

Material Culture Evidence

Archaeologists learn about people's patterns of movement by using artifacts. People often carry objects with them, yet through trade, destruction or loss, these artifacts are often fall from use and enter the archaeological record. This creates a distribution of material objects that reflect the movement of people or, at least, their possessions across space (Schiffer 1972). If the origin of the object is known, its final location can indicate direction of movement while the abundance or homogeneity of artifacts can indicate the intensity of movement and inter-community interactions. Artifacts, whether ceramic, stone, or metal, can be linked to specific raw material sources and their routes can be traced through communities and landscapes. Archaeologists can also use production and decorations techniques to identify production locations.

Each material class can be used to assess the direction and intensity of movement. The breadth of this discussion is presented as illustrative examples. The application of these techniques would vary depending on which materials were recovered according to the specific questions of the researcher. Despite the numerous analyses possible, any individual study may not require all materials nor all forms of analysis. In my own analyses presented in chapter 5, I demonstrate the applicability of this model for interpreting waterway use while employing only one or two methods for each material type.

Ceramic

Ceramics are particularly valuable for analyses because they are often one of the most prevalent artifact types in the archaeological record. Ceramics are durable and are preserved well in many contexts in which other kinds of material culture preserve less well. Ceramics are also unique in that many steps in the production process are reflected in the finished product from raw material selection to forming, firing, and decorative choices making each of these steps accessible to the researcher. Because vessels break, variations in production can capture shifts in cultural practice over shorter intervals of times.

Ceramics can be used to assess the magnitude of movement and interaction based on their density and homogeneity, indicating shared production knowledge, trade, or aggregation. In the absence of readily identified boundary marks on the landscape, archaeologists have sought to identify boundaries based on the distribution of artifact types and stylistic attributes (e.g. Gosselain 2000; Parkinson 2006; Stark 1998; Stark et al. 2000). Homogeneity in assemblages suggests greater integration and relaxed boundaries while stylistic differences are associated with defined boundaries or limited interaction. Integrating these material boundaries with GIS analysis may suggest physical features, such as waterways, that did serve to visibly denote these cultural edges.

Ceramics can be evaluated for homogeneity using variables from several stages of the production and utilization sequence. Beginning with the procurement of marls and clays, ceramics may in some cases be differentiated according to where the producer acquired raw materials. The fabric of the shreds can vary according to the temper or tradition or construction and this can be identified using various compositional analyses including petrography or x-ray diffraction in scanning electron microscopy. These same techniques can be used to identify variations in firing intensity or glazing. Finally, the decorative styles can be used to determine how widely particular ceramics were moved and the extent to which producers might share an ideology (c.f. Rice 2015 [1987]).

Lithics

Lithic analyses allow archaeologists to view mobility patterns and technological innovations through a long time depth. This is because stone tool technology often appears early among cultural innovations and the material is naturally resilient, lending to greater preservation in the archaeological record. Lithic analysis can be used to identify the direction of movement on several spatial scales. The distribution of stone tool styles has been used to identify many major human migrations, including the peopling of North America. The procurement of stone from particular source areas has been used to identify planning and mobility patterns as early as with Neanderthals. For example, Katalin Biró (1998) analyzed the presence of six types of stone, using the frequency and diversity of raw material in assemblages to identify cultural groups, their geographic extent and interaction networks along the Danube, Tisza and Koros rivers in Neolithic Hungary.

With advances in sourcing, archaeologists are able to trace the direction of movement and identify interaction networks based on resource procurement. Identifying the presence and frequency of lithic sources within assemblages, particularly relative to nearby sites, can provide insight to the directions and intensity of movement. While there are numerous studies that seek to differentiate stone material sources through archaeometric studies (e.g. Eerkens et al. 2007; Shackley 2008), scholars have long relied on their regional expertise to draw classifications between visually “distinct” lithic sources (Cackler et al. 1999; Howey and O’Shea 2006), though this approach may yield inaccurate classifications (Luedtke 1979; Milne et al. 2009). The relative abundance of a given lithic source or processing style or system may speak to the magnitude of movement between procurement locale (whether from outcrop or trade) and use.

Exotic, Prestige, or Uncommon Material

An analysis of spatial distribution could be applied to a number of other material types that best reflect regional assemblages. Studies of metal ores frequently rely on provenance studies to identify the source of materials against the production of materials or distribution of completed artifacts. Similarly, bitumen appears in archaeological assemblages in a range of artifact types (Salwen 2011). While the use of bitumen material within cultural assemblages remains understudied and inconsistently recorded, studies have sought to geochemically identify the source of this material, which typically indicates longer-distance trade. The incorporation of less common resources would add a valuable perspective as exotic, circumscribed, or prestige materials are likely to follow a different distribution structure.

Maritime Technology

Transportation technology has a significant impact on how communities interact with the landscape and with one another. In the ethnographic case study of the Mbuti in the Ituri Forest of Zaire, the absence of complex bridge-building prevented them from moving easily across rivers. The use of boats or carts alter the cost of travel and encourage travel along routes suitable to the technology, prompting a community or a particular traveler, to utilize rivers or terrestrial paths respectively depending on the destination or perhaps the material being moved. Transportation technology may impact the magnitude of movement, by facilitating faster or safer travel for a larger or more diverse demographic and may enable people to access entirely new resources and forming new interaction networks or strengthening existing social ties.

Boats have received extensive consideration for this influence. Jeanne Arnold has written extensively on the impact of the plank canoe in the emergence of regional complexity in the California Channel Islands (Arnold 2001, 2007; Arnold and Bernard 2005). Kenneth Ames (2002) argues that boats help move and process larger amounts of resources even across small distances, enabling storage and intensification of production. Susan Blair (2010) questions whether lithic procurement in the Canadian Maritime Provinces was embedded in seasonal rounds and consistent with catchment sizes. She finds that assemblages showed a persistently high proportion of materials from distant sources even as catchment sizes shrank with territoriality. This suggests sources were accessed less frequently but with bulk procurement that allowed time and energy to be directed elsewhere – illustrating why frequency and intensity of travel may be difficult to differentiate. These examples demonstrate how important technology can be in understanding the cost and magnitude of travel.

Ethnographic and Historic Data

Ethnographic and historical data, written descriptions of communities either recording observations about a culture or events in the past, often yield descriptions of people's behaviors and the cultural contexts that rationalized those actions. These data must be considered with caution because ethnographic examples are analogous to archaeological contexts, and both ethnographies and histories may be biased to reflect the content and perspective of the author. As discussed in Chapter Two and noted in the previous section of this chapter discussing intensity as a dimension of movement, ethnographic and historic resources may also serve to verify practices which are not visible or wholly distinct in the archaeological record. Despite these considerations, these textual accounts provide important insight into human activities. In evaluating the magnitude of movement, ethnographic or historic accounts may note how frequently communities move. Ethnographic and historic accounts may also provide information about the cost of travel. This information may be overt, as in accounts that relate how long a canoe trip would take depending on the direction of travel and amount of supplies carried. The information may also be indirect, where accounts discuss the seasons in which travel occurred, and how snow, heat or vegetation would affect mobility.

Objective Two: Characterizing the Environment

Environment can have a strong influence on human mobility, creating physiological variations in the landscape that make particular routes more or less cost effective. This cost of travel can in turn affect magnitude of travel, because when the cost of travel is diminished a particular route is likely to see more frequent travel or by a larger number of people. Understanding the environment in which people live allows us to determine whether people's behaviors vary from a purely environmental approach and therefore highlight culturally-informed behaviors.

Archaeologists often assume that waterways are primarily a conduit in trail systems. If this is true, water features should typically reflect the least cost-path and archaeological evidence which would correlate with such use. If an analysis of the landscape shows alternate viable trails, the analysis would indicate when the waterway is the ideal corridor, obstructs a path, or halts movement. This analysis occurs on two levels: an environmental perspective would determine whether water does provide an ideal route. When integrated with the analysis of people's movements, the study will focus on those contexts in which people elected to use waterways differently than the “environmentally rational,” defined as being the energetically cost-effective choice. This leads to a more nuanced understanding of people’s mobility with regards to water.

Because the environmental information is integrated with people’s patterns of movement, my analysis of the environment can be restricted to the variables that influence the direction and cost of movement. For this study, the relevant environmental features consist of the topography, vegetation, and climatological factors that influence the landscape – such as snowfall or freezing temperatures - which in turn impact the dimensions of movement.

Testable variables that reflect direction include physical data such as the direction of water flow or currents, the connectivity of water features, and archaeological data including the distribution of resource areas and styles compared to the region of origin. Topographic data can show natural crossings, confluences, portages, or rapids that would facilitate or hinder travel, depending on which modes of travel are used. Whether a stream is navigable will affect the direction and cost of movement. Navigability depends on the depth of the water, rate of flow, and interconnectedness, which may vary seasonal and with available transportation technology.

Seasonal temperature fluctuations allow for the possibility of water freezing or drying up which might prompt people to use these features differently throughout the year. The flow characteristics (and predictability of said flow), on a spectrum from frozen to fully dried up, affects the cost of travel along water routes or the ability to cross it. Ford (2011) notes that frozen water routes change the physical network, providing shortcuts in littoral contexts or allowing people to follow frozen routes. The frozen route allows the traveler to reduce surface friction and diminishes the potential limitations caused by a boat’s carrying capacity. Individuals can walk alongside a sledge in contrast to traveling within the boat when water is in a liquid state.

Table 5.2: Quantifiable variables relative to dimensions of movement.

Type of Data		Dimensions of Movement Direction	 Intensity	 Cost
Environmental	→	Direction of water flow Natural fords Interconnectedness	Rate of flow Interconnectedness Seasonality	Rate of flow Direction of flow Interconnectedness Depth
Material Culture	→	Raw material source Stylistic source Distribution drop-off	Style homogeneity vs. heterogeneity Frequency of exotic goods	Raw Material Source Material Type and Form
Settlement	→	Location of site Site Types	Location of site Site size	Proximity to water
Technology	→	Type of Technology (Boats or Terrestrial)	Differential access to innovations	Type of technology (Boats or Terrestrial)

Anticipated Archaeological Correlates

The previously defined four uses of waterways - barriers, boundaries, obstacles, and conduits - each influence the pattern of movement differently, generating distinct but replicated patterns within the archaeological record. Table 5.2 lists testable variables from four types of data that can be used to assess dimensions of movement. I overlay cultural data with environmental data through GIS to assess the relationship between movement and social interaction relative to surface water systems.

The movement around a barrier is defined by a general absence of movement across water, though movement may be directed to the waterline, a high cost of movement across the water, and low to no intensity of movement across the water, with evidence of interaction also extremely low in proximity to these water features.

Where water is expansive or particularly fast-moving, it can form firm and non-porous divisions that separate people. Water depth does not have the same power to indicate a potential barrier because once individuals employ boats or swimming, activity is restricted to the water surface regardless of depth. The breadth of the water surface is a more complex indicator, as some distances across open water may become dangerous, as shown in the ethnographic accounts of the Great Lakes (e.g. Ford 2011) or the travel from the Channel Islands to the California Mainland before the plank canoe (Arnold and Bernard 2005), however, people will adjust to this by following coastlines to maximize both safety, resource procurement, and interpersonal interactions along the extended route. Environmental indicators of barriers may also include surface currents and winds or topographic features including points of ingress or egress and proximity of the water feature to a desired resource.

For boundaries, we would expect to see signatures in the archaeological record that correlate with particular river features. Archaeologists have inferred cultural boundaries based on the distribution of artifact types and stylistic attributes, particularly where they diminish in homogeneity or frequency (Croucher and Wynne-Jones 2006; Skibo 2013; Stark 1998). Homogeneity in assemblages suggests greater integration and relaxed boundaries while strong stylistic differences are associated with defined boundaries and limited interaction. Boundaries should be associated with diminished occupation and fewer or different cultural materials near physically distinct “landmarks” such as confluences, promontories, or meanders as well as subtle markers like stone or tree formations.

Waterways function as a boundary where an individual could likely cross the feature but it provides a recognizable focality to differentiate economic, cultural, political, or subsistence areas. The direction of movement will resemble that of a barrier, with movement along the waterway possible but more heavily concentrated within the area for which water forms a perimeter. The direction may be less focused toward water features with a commensurate decrease in intensity and frequency of travel evidenced by fewer sites or artifacts toward the waterway. The cost of travel to or along a waterway would be neutral, as this use is primarily a cultural rather than physical designation.

Waterways are considered an obstacle when a community's routinized movement is perpendicular to a water feature and requires accommodation through the redirection of a route or with technological innovation. This definition excludes cases where a small stream could be traversed via a log, stones, or by wading. The direction of travel should be perpendicular to the water feature, while concentrating the magnitude of this movement toward loci with features that facilitate water-crossing, such as locations where the stream is narrow or where the rate of flow slows significantly. The cost of traveling along water would reflect a higher cost, either through lack of transportation technology or indirect routes between points.

In general, when water is a conduit, the pattern is one in which there is a low cost of movements in the same direction as waterways and stronger degrees of interaction, suggesting a higher intensity of movement. This is likely to be manifest in the distribution of sites near waterways, procurement of resources accessible by water, and shared material culture within regions accessible by water. The intensity of this connection will be strongest in directions consistent with water networks. Conduits, however, may counter-intuitively be identified through an absence of settlements and shared archaeological practices. As shown in the ethnographic accounts, waterways can be conducive to travel for hostile groups, who conduct raids along waterways.

The concept of conduits introduces one final type of artifact class: landmarks and pictographs. John Norder's (2003) work on pictographs along rivers in Ontario demonstrate how this type of artifact lends insights into river-based mobility. His research sought to classify and test hypotheses on pictograph locations, particularly as they relate to worldly function rather than cosmology. His findings suggest the pictographs can be classified for four types of single or multi-use configurations used in information exchange and trail-making. Notably, he suggests a number of these pictographs are most highly accessible when approached from a canoe, particularly those used by medicine men. This study is useful in anticipating archaeological correlates of movement as it illustrates the primacy of water-travel, at least in some aspects of culture and information access, both among past communities and for contemporary research.

Table 5.3. Archaeological Correlates for Affordances of Waterways in Mobility Patterns.

		The Role of the Waterway as Landscape Features			
		Obstacle	Barrier	Boundary	Conduit
Classifications of Data	Environmental	Expansive or fast moving water; difficult access to water	Physical: Expansive or fast-moving waters Social: No regularities anticipated	Across Water: No regularities Along Water: Land features or hydrological changes visible from the water	Navigable; may freeze or dry up seasonally
	Material Culture	Raw material and styles distinct on sides of a feature, greater similarity at possible crossings	Strong distinctions in raw materials or styles coincident with waterways	Distinctions in raw materials or styles coincident with water ways or landmarks	Raw materials accessible by water; styles/traits shared along water routes or between water-connected sites
	Settlement	Sites at natural crossings	Sites with greater viewshed but less accessibility to water	Cultural markers, cemeteries or settlements along water, particularly at confluences	Accessible to water; at confluences or portages; contiguous settlements
	Technological	Ferries and bridges	Defensive structures	Not applicable	Direct evidence for resources only available by boat

CHAPTER 6: DATA AND ANALYSIS FOR RIVER USE IN A MID-ATLANTIC RIVER BASIN: THE JAMES RIVER OF VIRGINIA

The United States’ Commonwealth of Virginia consists of a diverse natural environment within which complex social systems have evolved for centuries. The richness of this ecological and cultural context make it a valuable case study through which to examine how waterways were used to structure community systems and interactions across the landscape throughout the Woodland Period and early Contact Period occupations. The data in this chapter describe the archaeological site distributions and the physiographic zones through which the James River Basin extends. The cultural transitions and reorganizations that characterize the transitions between prehistoric and historic periods suggest that the occupants of the region adopted distinct systems of land use shaped by exploiting different affordances offered by waterways.

The James River Basin is appropriate for such an analysis both for environmental and cultural reasons. As this dissertation concentrates on surface water systems and their impact on mobility, it was important to identify a region that had enough water sources that communities were not dependent on a single common stream for subsistence, hygiene, and/or travel. Additionally, the change in water flow from the Piedmont to the Coastal Plain allowed me to examine a single waterway under different flow characteristics. The history of the region reflects occupation by a number of culturally independent groups who, over time, shifted their reliance on a social, political, and economic system defined by long-distance trade with the continental interior to one win which localized communities aggregated in political (but not necessarily cultural) affiliations, most notably during the coalescence of the Powhatan confederacy. Because this dissertation is interested in how communities perceived different heuristic affordances of waterways during different periods of sociopolitical organization or regional interaction, this region of study considers interactions from the estuary of the Chesapeake Bay, across physiographic zones, into the headwaters of this major river.

This chapter presents environmental and archaeological settlement data used to analyze how streams were used by communities to structure social networks and interactions. After reviewing the contextual background for the environmental and cultural history of the region, I describe the data sets used to address land use during the Woodland and Contact Periods. For the latter period, data include both indigenous and colonial sites. Using a Geographic Information System, archaeological sites are analyzed against the surface water system. These analyses include mapping proximity of sites to water, as well as comparing the occurrence of sites along different stream orders such as the James River, its tributaries, and the smaller headwaters, or whether the stream flow is seasonal. The chapter closes with a discussion of how these analyses may indicate shifting heuristics and perceptions of a stream's role in promoting or delimiting interactions between communities and over time.

Objectives

The premise of this dissertation is that people's use of land reflect, in part, shifting perceptions of waterways' affordances across periods of cultural transitions. Broadly, this assessment is considered through a rubric that evaluates changing use of rivers in a localized context by considering how these landscape features are used for social networking and mobility in the prehistoric and early historic period and then comparing these diachronic changes.

To what extent are rivers used to integrate or differentiate communities within a social network? The theoretical basis of this inquiry draws on concepts of social networks and the formation of cultural landscapes, particularly as related to the movement of communities along particular paths across the physical terrain (see chapter 4). These issues are addressed from a methodological approach which incorporates regional settlement data and site distribution with geographic information software (GIS) to assess the spatial relationship between archaeological sites and hydrological features.

Data

The investigation of the stated inquiry is dependent on characterizing the relationship between cultural systems and environmental features. These datasets, both environmental and archaeological, are described below. The foregrounding of environmental data is not meant to suggest an ecologically deterministic perspective, but rather characterizes the environmental configurations in conjunction with which communities, whether indigenous or colonial, enacted a range of culturally-informed land use strategies.

Environmental Data

To best assess how surface water systems create affordances of use to local communities and which uses are employed in the community’s land use, it is essential to characterize the physical dimensions of the region. Because surface water systems, as part of the hydrologic cycle, are heavily influenced by a number of variables in the environment, the quantitative assessment of the physical environment is one of two central objectives underpinning GIS analyses.

The Commonwealth of Virginia, located in the Middle Atlantic region of the continental United States of America, extends 755 km from west to east and 323 km north to south, with a total area of 110,784 square km, of which 8236.5 square km are water (Virginia Department of Conservation and Recreation, Division of Natural Heritage 2016). Of this area, 1,157 square km constitute territorial water extending into the Atlantic; 4,478 square km are coastal waters; and 2,865 square km are inland water, consisting of lakes, reservoirs, rivers and streams (United States Census Bureau, [USCB] 2012, Table 358). By contemporary political divisions, Virginia is bordered by the State of Maryland and Washington, DC to the north and east, by the Atlantic Ocean to the east, the State of North Carolina to the south, the State of Tennessee to the southwest, Kentucky to the west and West Virginia to the north and west. While this information locates the study area for contemporary recognition, the physical features within this region define the landscape and its entanglement with human occupancy.

Based primarily on geological formations, Virginia can be divided into 6 physiographic zones. Listed west to east, these zones are the Appalachian Plateau, Ridge and Valley, Blue Ridge Mountains, Piedmont, Coastal Plain, and the Chesapeake Bay. Each of these zones, which are largely defined by the geology of the region, also represent variations in topography, climate, vegetation, and water flow. These variables constitute the types of data collected for this GIS, as these types of landscape data that affect settlement accessibility via water travel. These data were aggregated from a range of online sources, in those maintained or produced by open-source databases, private individuals, universities, and government agencies. Unlike topography, the other variables of environment but especially water are susceptible to changes over time. I attempt to address the challenges of assessing historic conditions with GIS in association with each type of data.

A Digital Elevation Models (DEM) is the most commonly used source of digital data used to show the contours of the earth’s surface. This information is presented as a cell-based raster representation of continuous surface data. Within the United States, the U.S. Geological Survey’s National Elevation Dataset (NED) is traditionally the primary source for elevation information and consists of data from a range of sources processed to a common database. DEMs were originally made to correspond with contour topographic quadrants, with large scale maps corresponding to 7.5 minute and 15 minute maps, intermediate maps measured on 30 minutes, and small scale maps based on 1 degree. While the 7.5 minute models are equal to 10-m resolution, new techniques of mapping have generated DEMs with 5- and 1- m resolution for some portions of the United States. The accuracy of elevation models is dependent on the resolution of the data, which is a product of the distance between sample points along a south-north profile and the east-west spacing between profiles.

The accuracy of DEMs is important when considering hydrological characteristics such as flow. Because DEMs rely on algorithms to generate topography between data points, the accuracy of these models is affected by data collection methods, including resolution and precision of surface sampling, as well as data processing. Errors at a particular point, either as recorded or extrapolated, may create false “peaks” (a high point surrounded by lower elevations) or “sinks” (a depression or pit surrounded by higher elevation). The frequency of sinks is likely to be greater in coarse-grained DEMs or where the relief value is recorded as an integer. Though these characteristics may occur naturally on the landscape, they should be at least evaluated for whether they indicate a false elevation. Where DEMs are integrated with flow analysis, the program assumes that water can flow into a cell from any adjacent cell but will only flow out through a single cell. As such, sinks in particular should be removed from the data wherever possible, as they create a depression that will halt flow across adjacent cells; peaks will re-route flow through an adjacent cell with lower elevation. Peaks and sinks can be removed using tools within the hydrology toolset of ArcGIS. These DEM files are often incorporated in hydrologic data, discussed below.

As hydrological data becomes increasingly important to a range of GIS applications, these data have become more widely available as downloadable packages. Prior to this proliferation, hydrologic data could be extrapolated by each individual user, relying on DEMs to project stream networks that are highly dependent on the data and processing of each user. As the nuances and extensive impacts of the human-hydro interaction are more widely understood as reflecting changes within an entire catchment area, the need to standardize and incorporate hydrologic data has led to the aggregation and distribution of this information by governmental agencies, non-governmental groups and even individuals; these efforts produce a few common datasets that lead to greater analytic consistency.

The US government maintains and provides the most up to date and detailed datasets for surface water in the United States. The National Hydrography Dataset (NHD), which represents the drainage networks and related water flow features, and the Watershed Boundary Dataset (WBD) depicts the catchment or drainage areas for these flow networks in eight nested levels (to a 16-digit hydrologic unit) in many parts of the country. These datasets were more recently integrated with the National Elevation Dataset (NED) to produce a new hydrographic dataset called NHDPlus, which expands on the earlier dataset to include greater hydrographic details, including stream level, stream order, and permanence of flow within the channel. This newer dataset adds additional distinctions, including where water channels are canals or other artificial constructs and provides point and line information to designate dams/weirs, rapids, rocks, stream gauges with associated records of stream level, other attributes that are likely to affect flow or navigability.

Understanding the long-term temporal variability of river channels is dependent on historical analysis. Robert Grabowski and Angela Gurnell (2016) note two types of historical information that can be used to identify channel shifts: the first is channel width, drainage and navigations surveys, flood events and general observations on the riverine context as evidenced in stream scars or historic maps; the second type source of information on river courses come from documents dependent on river processes, such as flood damage or land disputes associated with channel migration. Though this information emerged in the 16th century during colonial exploration, the practicality of these documents are restricted to the 17th century (particularly the later half) as this is when population growth, capitalism, and new data-collection methods increased the need for, and ability to produce, spatial information used to exert political control over colonial territories and manage economic undertakings (Grabowski and Gurnell 2016: 56-58). Although there is some evidence that ongoing sea level change has affected the water courses in the James River Basin, it is difficult to discern how much of the relatively minor changes are attributed to fluvial processes and tidal impacts versus inaccuracies in historic mapping (Gallivan 2003; Potter 1994). Historic maps suggest that the channels within the James River Basin have remained largely consistent through the upper and middle portions of the river basin but sedimentation of the Coastal Plain is more susceptible to channel erosion.

The final variable included in this analysis is climatic conditions, including precipitation and temperatures. Climates are characterized by the range of temperatures and precipitation in a region. The extent to which these vary annually constitute seasons. The seasonal changes often are designated by a particular range of temperatures and volume of precipitation. In areas with extreme seasonal variability, the effect of these conditions on water in particular, e.g. droughts and unseasonable freezes, can have a significant effect on the adaptations of communities. As discussed in chapters three and four, such seasonal changes, especially relative to water features, may affect both the pressures that contribute to hunter-gatherer communities engaging in mobility and the efforts associated with undertaking movements. Seasonal changes may affect resource distribution, prompting communities to move around the landscape and even aggregate for communal or cooperative resource procurement or exchange activities.

Temperature and precipitation data are included as they can significantly alter the landscape in ways that alter the relative cost of land versus water travel. One facet of this is through the effect on land cover: springtime precipitation and snowmelt may lead to heavy mud, early summer is often associated with nascent vegetation, and winter snow accumulation may hinder movement or, if substantial, allow people to move on the snowpack to access regions that are otherwise inaccessible via terrestrial routes. The climatic conditions may also create variation in the waterways themselves. Precipitation reintroduces water to a catchment and so the rate at which this water falls can influence the runoff and volume of water within stream channels, though this relationship is a complicated calculation (Fisher 2009; Vieux 2001). Where precipitation rates are consistent throughout the year, streams will remain largely constant.

Sub-freezing temperatures have two effects on mobility. First, when temperatures fall below freezing, precipitation may undergo interception as snow accumulation. While some snowfall can hinder travel, sufficient accumulation can make it easier to travel across snow than through vegetation, making land travel easier. Second, a frozen water surface dramatically alters the energetic costs of travel. As Ben Ford (2011) notes, frozen water changes the friction of surface travel, equalizing costs in either direction without consideration of currents and allowing people to shorten path distances in littoral contexts by traveling in chords across the edges of water rather than traveling the full perimeter or by more easily crossing frozen channels. Frozen surfaces are dependent on temperatures falling, and remaining, below freezing.

Moving water once again introduces particular considerations, as the volume and velocity with which water moves affects whether the waterway will freeze entirely across, a more complicated process than the freezing of lakes. When temperatures rise, snow melt can create flood pulses. This increase in flow may make some streams and sloughs more navigable but increased stream discharge may also create dangerous rapids. As a result of precipitation and temperature fluctuations, some streams are only navigable seasonally, being too dry or too dangerous at other times of the year. There is evidence of changes in recent centuries, including shorter annual periods in which rivers are frozen (Magnuson et al. 2000) and well-attested intervals of irregular climate in the past centuries, including droughts and cooling periods (Cronin et al. 2010), however these considerations are excluded from this analysis. These conditions can be difficult to incorporate in a GIS for human activities, as the impact of these physical changes are dependent on emic and etic perspectives. Based on the continuity of ecological niches, I assume sufficient persistence of climatic conditions to warrant the use of modern climate conditions for the analyses in this chapter, though future studies would take into account short-term fluctuations such as the Little Ice Age.

Archaeological Data

In order to address how affordances of waterways (as conduits, obstacles, boundaries, or barriers) were perceived by different communities, at different scales of interaction, and at different periods of time under shifting cultural and economic pressures, I have concentrated my analyses of archaeological material on settlement data.

A detailed discussion on the limitations and benefits of settlement data, particularly related to data collection and survey, can be found in Chapter Five. This discussion can be summarized in a few points that directly relate to the use of site distribution as datasets. There are some drawbacks to a regional approach, as it precludes a detailed assessment of intra-site information including precise occupation dates or seasonality. A coarse-grained study allows me to concentrate on a larger geographic range, encompassing a variety of waterways and across cultural interaction spheres in a way that would not be possible through an analysis of a single cultural group or a few archaeological sites.

For this analysis, settlement data come from published data maintained by the Virginia Department of Historic Resources (DHR). The dataset was derived from the archaeological component of the DHR’s Virginia Cultural Resources Information Systems (V-CRIS), which is a digital platform for data sharing. This database contains information on individual properties, sites, and historic districts, supplementing an internal mapping system and geographic information with additional details and reports for many of the sites. These kinds of data are collected through individual contributions, academic research, and Cultural Resource Management (CRM) firms. Entries are then reviewed by the V-CRIS administration. The system is interactive, allowing the user to search using a number of parameters including site name or number, occupation period, drainage basin, or cultural affiliation among others. Importantly, it is constantly updated with new sites.

Results of a given search within V-CRIS may be evaluated within the program or exported as a Microsoft Excel spreadsheet. These data consist of 27 columns that relate several types of information. The first type is descriptive data about the site, including the trinomial ID, site name, site category (funerary, industry, or domestic), site type (camps, artifact scatters, farmsteads, etc.), periods of occupation, cultures affiliated with those occupations, and an assessment of the site's present condition and threats of destruction. The second type of data is locational, including the jurisdiction, association with incorporated towns, and the USGS quadrant, river drainage, and physiographic province in which it is located, as well as the site class specifying whether the site is terrestrial or submerged. Finally, each site is associated with preliminary investigative information, including the project's file number, the name of the investigator and organization who reported the site, the date of the survey, and the phase and method of survey, including a true/false indication of whether specimens were collected and whether additional specimens were not collected. These last columns are complementary and help indicate the extent of the observed assemblage.

One of the most common problems in using databases is that data entry can have variability invisible to the spreadsheet user. In these cases, some patterns may be known artifacts of program or policy changes in the database management, while other variations are dependent on how information was entered. It may be possible to untangle these patterns if is there is someone who can serve as an "archaeologist" of the database itself and explicate the history of decision-making through different iterations. A robust database, such as V-CRIS, may include access to original sources both through attached files or library review numbers that allow the user to pursue further investigation. Because these sites and associated collections include survey and excavation projects undertaken over several decades, the research goals and methodologies by which this information was originally obtained and recorded varies accordingly. An initial exploration of the program indicated some issues that warranted consideration in generating the dataset for this study. I discuss these issues and the steps taken to address them below.

After applying for and receiving access to the V-CRIS database, I ran a number of queries to gain familiarity with the system. Like many databases, the user guide suggests using as few fields and restrictions as possible, as each field is exclusionary rather than supplementary; the query results will only provide sites that meet all the designated criteria. Of these exploratory queries, one search proved particularly useful in identifying issues and variances that required further consideration. This search considered two inquiry fields: drainage in which the site is located and cultural affiliation. A search for “James” drainage basin with “Native American” cultural affiliation returned 1703 archaeological sites in a query run in late April 2017.

The ability to search by drainage basin is valuable but subject to a range of challenges. As Lovis and Donahue (2011) noted, these physical catchments provide meaningful boundaries for ecological processes and are therefore may similarly influence cultural actions and territories. In the V-CRIS system, the program will auto-supply possible search terms. As of April 2017, the Drainages field could be completed using either “James River” or “James,” with the latter yielding results inclusive of the former. In the above query, the term “James River” was associated with 1398 results, while “James” was tied to only 304 results. This association may be an ineffective query for a number of reasons: it is unclear what geographic parameters define each term or whether this differentiation is a product of data entry, the database does not require that affiliated drainage systems be identified, and an unknown number of sites within the area may not be searchable by that trait. Finally, the multi-scalar nature of drainage basins can introduce error; for example, a site located within the HUC8 catchment of the Chickahominy River or Appomattox River are technically within the HUC6 area of the James River but may not be recorded as such.

To ameliorate the risk of sites' exclusion due to data entry variance, the preliminary dataset was generated with the assistance of Jolene Smith, the Archaeological Inventory and V-CRIS Accounts manager, who queried the archaeological database for sites within the geographic parameters of a GIS polygon of the James River Basin. Catchment boundaries are determined by the ridgelines surrounding a waterway, so these boundaries can vary slightly depending on the elevation models used and the guidelines for catchment designation used. Using a feature layer of the North American Atlas Basin Watersheds data, produced by an international consortium of governmental and conservation agencies at a 1:10,000,000 scale, I identified the James River Basin and created a new polygon in ArcMap by clipping the boundaries of the catchment of the James River, as designated by the Commission for Environmental Cooperation, which formed the geographic parameters of the new search. A query of this area in the V-CRIS database, run by Ms. Smith, identified sites within my geographic area of interest, regardless of whether the investigator reported the affiliated drainage basin. This search identified 12,695 site entries and generated a three column spreadsheet with the DHR ID number and the decimal degree xy coordinates for all sites within the provided area. This data table is the "coordinates table" and did not include any descriptive information for the sites.

Integrating Site Description and Coordinates

Because the coordinates table provided by the V-CRIS office did not include detailed site information. I created a second table, the “descriptive table,” retrieving site information from V-CRIS for all sites within my search area. Virginia uses the Smithsonian trinomial system (State number-county abbreviation-site number) to designate sites. I determined which counties were represented in the primary table. Some of counties fall entirely within the search area but many of the county boundaries only partially overlap with the boundaries of the James River drainage basin. Using the V-CRIS data viewer page, I ran a search using the DHR ID field to access a list of all sites in a county; this was done by entering only the state and county portions of the ID. For example, a search for DHR ID: 44AB returned a list of all sites recorded in Albemarle County. I exported these results to a spreadsheet and repeated this process for all 59 counties represented by sites in the primary table. One county, 44ZZ, for which there were 8 sites in the primary table had no results in V-CRIS and an additional 51 entries in the primary table listed the site ID as either “null” or was blank and could not be searched. Each county’s sites were added to generate this “descriptive table” with 22,538 sites.

Using Microsoft Office Access to create a relational database, I linked the coordinate table and the descriptive table, using the DHR ID as a key. I then created a query to link all the sites that fit my spatial criteria. The resulting dataset includes detailed site information for all sites within the James River Basin. This table contains 12,640 sites, as those entries without a DHR ID from the coordinate table could not be associated with entries in the descriptive table. The resulting table was named the “James River Basin table.”

Description of the Data

The James River Basin datasheet generated for this project contains 12,640 sites. The spreadsheet is organized with one site per row; attributes and descriptions of the site are populated in columns. The “DHR_ID” column contains the unique trinomial ID of the site as assigned by the State of Virginia Archaeology Repository. This ID can be used to locate additional archived materials relevant to the site, such as reports and specimens. The “x” column and “y” column contain geographic coordinates of the physical location of the site. These columns contain sensitive information that is restricted to registered professional archaeologists.

Table 6.1. Columns and descriptions of data within V-CRIS archaeological database.

Column	A	B	C	D	E	F	G
Column Heading	DHR ID	Other DHR ID(s)	Site Name	Jurisdiction(s)	Site Category	Site Types	Time Periods
Description	Site ID code	If sites have 2 IDs	Given Name	County site is located in	Classifies activities	Site function	Temporal occupation

H	I	J	K	L	M	N
Evaluation Status	Incorporated Towns	USGS Quads	Project Review File Number	Organization	Investigator Name	Survey Date
Whether state may assess site	If sites affiliated with a town	Name of USGS topo quadrant	Project Identification number	Agency that reported site	Individual who led project	Date site was found or reported

O	P	Q	R	S	T	U
Survey Event Type	DHR Library Report Number	Cultural Affiliations	Drainages	Land Uses	Physiographic Provinces	Site Conditions
Survey intensity (phase 1, 2, or 3)	Project records number	Culture associated with occupation	River Catchment in which site is located	Activities on landscape at time of site ID	Physical region in which site is located	Estimate of site integrity, preservation

V	W	X	Y	Z
Site Threats	Survey Strategies	Site Class	Specimens Collected	Specimens Not Collected
Modes of possible site destruction	Techniques used to investigate site	Whether site is terrestrial or submerged	True/False record of artifact collection	True/False record of artifact collection

The “site name” column contains a descriptive name assigned to the site, if available. Only 2,596 out of 12,695 sites are assigned a site name. The “jurisdiction” column contains the county in which the site is located. Some sites are located in multiple counties and have more than one county listed in the “jurisdiction” column. The “site category” column contains classification information about the type of sites: domestic, industry/processing/extraction, or religion. The “site type” column contains a qualitative, descriptive assessment of site use. These terms are an elaboration on the previous column, describing industry/processing/extraction sites as “agricultural field” or “lithic scatter” but includes even broader terms such as “camp” or “artifact scatter.”

The “time period” column contains a description of the temporal occupation of the site. The broader chronology is divided into a number of distinct phases associated with calendric dates. Within a single column, all occupations present at the site are listed. More inclusive descriptors such as “pre-contact,” “historic,” or “indeterminate” are also used and may appear alone, as the sole descriptor of the pre-contact or historic occupations, or in association with a series of specific occupation periods.

The dataset also includes information on the site’s archaeological history. The “USGS quads” column indicates which USGS quadrant topographic map the site would fall within. The “project review file number” column contains the record number associated with the site’s identification and inclusion in the database. The “organization” column indicates which archaeological organization, whether governmental, university, or commercial, reported the sites, though most sites report an “unknown” organization/DSS legacy, meaning it was entered without an affiliated organization under the previous database system. The “investigator name” column reports the individual who led the project from which the site was identified and reported. The “survey date” column indicates when these sites were recorded and entered into the DHR, or its antecedents’ database. The “survey event type” column reports the type of survey through which the site was identified, such as “survey: phase 1” or “survey: phase 2.” In CRM work, these designations characterize the degree of work undertaken in an area. A phase 1 survey consists of surface reconnaissance, a phase 2 survey will include sub-surface test pits, and a phase 3 project will consist of excavations. This is done only where significant sites are indicated in the earlier projects and where the site is subject to damage from new construction. Of the original 12,695 sites, 9,646 sites were assessed and reported only through phase 1 reconnaissance work, representing 76% of the entire sample.

The “cultural affiliation column” provides a generalized assessment of which cultural groups are associated with occupations at the site, with possible affiliations limited to African American, Euro-American, Native American, Indeterminate, or a combination of these groups. Native American only sites formed the largest of these groups with 4,650 sites. This is in contrast to the low number of sites, N=322, with a combination of “Euro-American and Native American” affiliations reported.

The “drainages” column identify in which river’s catchment area the site is located. Of the 12,695 sites reported within the area equal to the HUC 6 James River Basin, 233 sites were attributed to a different drainage basin and 8,777 sites had no drainage basin listed. Of the 12,695 sites, only 29% (3,685 entries) were marked as “James” or “James River” drainages. The “land uses” column indicates the current uses of the area where a site is identified, with implications for site discovery, recognition, and preservation. The “physiographic provinces” column reports which major physiographic zone in which the sites were identified, whether the Coastal Plain, Piedmont, or Ridge and Valley. Although this information can be ascertained by plotting the sites, the dataset reports the physiographic province for only 3,803 sites of which 2,025 sites are within the Coastal Plain.

The “site condition” column reports the extent of damage the site has sustained, if this is known. The descriptions include: “0-24% of site destroyed,” “25-49% of site destroyed,”“50-74% of site destroyed,” “75-99% of site destroyed,” or additional categories that may accompany these including “site totally destroyed,” “unknown portion of site destroyed,” “surface deposits,” “subsurface integrity,” and similar descriptors. The next column, “site threats” contains descriptions of the types of threat to the integrity of the sites, including neglect, vandalism, public utility expansion, erosion, demolition, deterioration, development in varying combinations, however 10,743 sites (84.6% of the dataset) left this information unmarked. The “site survey” column contains descriptive information regarding how the various techniques by which the site has been observed or recorded. These include historical map projections, informants, observation, metal detection, surface testing, subsurface testing, and other remote sensing. Although many sites include multiple observation or survey methods, 5,040 sites of the original 12,640 (about 40%) have undergone at least some subsurface testing. The next column, “site class,” specifies whether the sites are terrestrial or submerged and whether it is in open air or a cave/rockshelter; 12,345 sites are considered terrestrial, open air. The final two columns are labeled “specimens collected” and “specimens not collected.” Each of these columns contain either true or false and indicate whether materials were collected but also whether some observed materials were left *in situ*.

Preparation of the Data

The James River Basin datasheet described above requires preparation in order to produce data useful to addressing the aims of this study: a comparison of site accessibility to water prior to and after the introduction of colonial presence and shared use of river networks. As such, my primary goal in preparing the data is to identify sites that have time-period occupations as Early Woodland, Middle Woodland, Late Woodland, and/or Contact Period.

First, I established the sites that are candidates for my study. I ran a relational query between all the decimal digit locational data for sites within the James River Basin and all sites within counties that geographically overlap with the James River Basin. I produced a spreadsheet with locational and descriptive information for sites in the established geographic area. This information includes the columns described above. This spreadsheet allowed me to integrate the geographical location and description of sites. A total of 59 sites lacked site ID and/or data in geographical location and site description columns. These sites were eliminated, leaving a total of 12,640 sites in the prepared spreadsheet.

This aggregation of sites was then filtered to identify sites relevant for a comparison of pre-contact and contact-era site locations. I concentrated on first winnowing the sample according to occupation periods. I sought to identify those sites within the James River Basin occupied during the Middle and Late Woodland Periods and during the early phases of the Contact Period. Archaeologists commonly narrow their research through the lens of a specific occupation period, defined by notable trends in cultural practices rather than a given interval of time. These periods are then equated to a calendric period although the specific dates at which a given area adopts new technology or practices will vary by region.

Though period affiliation is an important initial variable on which many archaeological studies are defined, the trait is prone to a variety of biases and errors, particularly in databases. The well-documented challenges of assigning an occupation date, whether relative or absolute, to a cultural site is further complicated when the data is incorporated into, or being extracted from, a large database. This variation may first emerge in data acquisition. Archaeometric methods to discern a calendrical date for a site component are expensive and associated with additional concerns on depositional and contamination processes. In some regions, archaeologists can rely on diagnostic, and ideally short-lived, technologies to attribute a site's occupation to a cultural period, though in other regions, communities show persistence in artifact style or rely on organic materials unlikely to be preserved. As noted above, nearly three-quarters of the sites in the James River area are known only through surface information. The material and methods of dating are very limited.

Even where site occupation components can be dated to a relative period, large databases often reflect immense variance in both data collection and data entry. A database such as V-CRIS incorporates sites identified and dated using a variety of survey and excavation techniques. State databases such as V-CRIS are likely to incorporate extensive contributions from CRM projects, which are often limited to phase 1 reconnaissance in which surveyors rely on surface finds, noting a presence/absence of archaeological sites in a strategy that does not require data collection or interpretation regarding occupation dates beyond "pre-contact" or "historic." Even if a diagnostic artifact is observed, the recognition and recording of that data varies with the field recorder.

In the V-CRIS database, sites can be associated with multiple occupation periods, each of which is associated with calendric dates. Additionally, some sites were designated with a more generic Woodland (1200 BC-AD 1606) code, while a large number of sites' time periods are listed as "Indeterminate," "Pre-Contact," or "Prehistoric." A few sites were listed as having a "Protohistoric" occupation, and although this term appears broad it can only refer to a relatively narrow time period between or overlapping with the late Late Woodland and early Contact Periods.

I identified the sites that were potentially occupied during the Woodland and Contact Periods. In the original spreadsheet, each period identifier is separated by a comma within the same cell. I used the Text to Columns feature in Excel to separate the string of period labels into separate cells. The original spreadsheet contains up to 16 unique period identifiers in a single cell. In the prepared spreadsheet, each row (a single site) contains 16 period columns (period1, period2, etc.) with a single period identifier in each cell. I then used the Custom Sort feature in Filter mode to arrange the rows (sites) in batches of similar values.

Probabilistic Conversion of Time Period Data

Many time-period identifications in the original James River Basin spreadsheet are represented in ways not useful to the aims of this study. I developed a time period classification scheme in order to assign probable time periods to sites in the study area.

First, I identified the sites that could not be dated. I removed 1104 sites (11.45% of the total sites) for which no occupation age could be discerned from the column describing time period. I excluded 112 sites with "Indeterminate" in the period column and 992 sites with blank cells in the period column, which were relabeled as "Undefined."

Second, I identified sites with known occupation periods outside the time periods of interest to this study. I removed all sites that specified occupations preceding or post-dating the Woodland or Contact Period. Of the 11,536 sites remaining in the prepared dataset, this process allowed me to exclude 4,615 sites (36.5% of the original sample). These sites fall into one of three categories: (1) Prehistoric Known sites where all designated occupations fall in the Paleo-Indian and/or Archaic periods (n=571); (2) Historic Known sites where all components fall in the Colony to Nation period or later (N=3,973); (3) Bracket sites recorded as having a Paleo-Indian and/or Archaic component and a specified historic component later than the Contact Period—but no recorded Woodland or Contact Periods (N=71).

Third, I clarified vaguely-defined periods. In the original spreadsheet, some sites contained vague period identifiers such as "indeterminate," "historic/unknown," "prehistoric and historic," or "pre-contact" in addition to list of specific periods. For my time period classification scheme, I consider these sites as having an "unknown" or "indeterminate" date within the specified periods. If the specific periods is outside the time span relevant to my study, I excluded the site from the sample and included the site in the Historic Known, Pre-Contact Known, or Bracket categories. However, if the site was labeled as pre-contact or prehistoric and *did not* include a specific pre-Contact Period, it was left in the sample at this stage even if specific historic periods were listed.

Table 6.2. Example of probabilistic occupation period designation.

DHR ID	Site Name	Time Period	Dataset Label
44BA0321	Back Creek Housesite (*sic)*	Historic/Unknown, Antebellum Period (1830-1860), Civil War (1861-1865), Reconstruction and Growth (1866-1916)	Historic Known
44NE0164	Porters Ridge 3	Historic/Unknown, Middle Archaic Period (6500-3001 BC.)	Pre-Contact Known

Of the remaining 6,921 sites that *might* have a woodland or Contact Period occupation, I removed sites identified as unknown historic or unknown pre-Contact Period *and* lacking any further precision. First, I removed all sites that are tagged with “historic/unknown” (N=692). Next, I removed all sites tagged with an undefined pre-Contact Period (prehistoric and historic), with a “pre-contact” designation that may or may not also have a known historic component post-dating the Contact Period (N=249).The number of sites that I excluded in this step does not reflect the total number of sites for which any of these terms were used; based on the rule in step one, the sites that had a generic label and specific time periods were considered “known.” These sites represent only those for which no additional or meaningful identifying information was listed under time period.

Time Period Classification Rules for Study

The above actions removed all sites without pre-contact or Contact Period occupations, including those for which the occupation period cannot be readily discerned from the dataset. This process can be described with an initial set of rules:

1. Sites for which all occupation periods are specified but post-date the Contact Period are “Historic Known”
2. Sites labeled as indeterminate or historic with no pre-contact occupation (in generic or specific terms), where accompanied by specific historic periods are “Historic Known.”
3. Sites labeled as “historic/unknown” with no pre-contact occupation are “Historic Unknown.”
4. Sites where the only time period is listed as indeterminate are classified as “Indeterminate”
5. Sites for which no occupation periods are listed are classified as “Undefined”

Having removed all the sites for which there was no relevant occupation period, I amended the process to evaluate and identify occupations, rather than sites that were relevant to my study. At this stage, I encountered the most significant invisible discrepancy in the database. I noted that 3,320 sites had all seven pre-contact occupation periods listed. Finding it improbable that several thousand sites were continuously occupied for at least 16,000 years, I consulted the database manager who reported that a previous system update had created a software malfunction and sites that were meant to be listed as “pre-contact” instead produced a list of all pre-contact occupation periods.

Based on the nature of the dataset, a more extensive set of rules were implemented to identify sites with relevant pre-contact occupations.

6. Sites for which all listed occupation periods are specified but pre-date the Early Woodland Period are “Pre-Contact Known”

7. Sites labeled as indeterminate or prehistoric, if accompanied by specific pre-Contact Periods are “Pre-Contact Known”
8. Sites that specify occupation periods prior to and subsequent to, but not during the Woodland and Contact Period are called “Bracket”

An awareness of the system error that mislabeled the pre-Contact Periods required further decision-making with regards to identifying both Contact Period and Woodland Period occupations within sites. The following rules were implemented to exclude undifferentiated pre-Contact Period sites and to identify and classify those sites with probable Woodland Period and Contact Period sites:

9. Sites with broad identifications as ‘pre-contact” or “prehistoric/historic” and no additional pre-Contact Period identifications were labeled “Pre-contact Unknown.”
10. Sites for which all seven pre-contact occupations are listed were considered “Pre-contact Unknown,” so long as the sites did not include a specified Contact Period component.
11. Sites for which all seven pre-contact occupations are listed that also included a specified Contact Period component were duplicated. One copy of the site information was listed as “Pre-contact Unknown” and a second copy of the site information was labeled as “Contact Period.”
12. Any site for which the Contact Period was listed was also labeled as “Contact Period.”
13. Any site for which the Protohistoric period was listed was labeled as “Protohistoric,” duplicated where this label co-occurred at sites with a Contact Period and/or potential Woodland Period occupation.

The first decision was how to evaluate and include Contact Period sites. It is possible the program experienced a comparable glitch for sites in the historic period. However, rather than re-label sites with all historic occupations as “historic unknown,” I assumed these designations were accurate reflections of the occupation. This decision was based on several factors: the entire historic period represents 411 years rather than 1,606; these periods are more readily recognizable and identifiable as the artifacts are more similar to modern material culture; and the pattern of human habitation since the 17th century has been one of increasing sedentism with more permanence and increasingly dense population. These considerations led me to assume that a site could well remain continuously occupied since 1607 and therefore all sites that listed a Contact Period occupation were considered accurate designations. A total of 1,370 sites included a Contact Period occupation.

The final phase of data processing was to identify Woodland Period occupations. While just over three thousand sites listed all seven pre-Contact Periods and were labeled as “pre-contact unknown,” sites for which only six of the possible pre-contact occupations were listed were not excluded with rule ten. The majority of these remaining sites listed Early Archaic, Middle Archaic, Late Archaic, Early Woodland, Middle Woodland, and Late Woodland. As the previously discussed system error auto-replaced a broad term with all possible periods, it is possible these sites represented a less precise “Archaic” and/or “Woodland” designation rather than a multi-component site. This was substantiated by a separate pattern; several sites had four tags: “Early Woodland,” “Middle Woodland,” “Late Woodland,” and an inclusive tag for “Woodland.” Given the vagaries of the time period affiliation in the database, any site with an Early, Middle, or Late Woodland component were coded as “Woodland Undifferentiated.”

In order to gain finer resolution, if possible, I also evaluated sites for which only two Woodland sub-periods were listed. If only one or two of these periods were listed, I assumed the identifications reflected distinct occupation periods. Several steps were taken to label these occupations. First, the site information was included in the "Woodland Undifferentiated" table, producing a comprehensive list of all sites with a Woodland occupation. Second, the site information was duplicated and incorporated into separate spreadsheets, each representing a single period of Woodland occupation, though many of these sites also appear in the Contact Period table.

This process allowed me to exclude sites for which there was no relevant occupation, while generating separate tables for five occupation periods: Contact (AD 1607-1750), Woodland Undifferentiated (1200 BC-AD 1606), Protohistoric (no calendric dates), Late Woodland (AD 1000-1606), and Middle Woodland (AD 300-999). This produced a series of tables to compare temporal patterns in occupation even where the continued use meant these occupations are components of a multiple occupation site.

I ran a pivot table to see how many sites were represented and how many of those sites had multiple occupation components. When the table was filtered to show only Woodland Inclusive and/or Contact Period components, several sites showed between 3 and 12 components. Several DHR IDs appeared in the James River table multiple times because the IDs had multiple xy coordinates associated with them. I created a new column that combined the site ID with the period ID as assigned in the previous steps (e.g. "44AB0060 Woodland Inclusive") and removed duplicates, so that for each site there was only one entry per time period. The sites and occupation periods appeared in the frequencies shown in Table 6.1. The increased total is a reflection of sites being duplicated in multiple categories due to a shift from differentiating

Contact Period and Woodland occupation components rather than classifying sites as a single entity where there were multiple or continuous habitation periods.

Table 6.3. Occupation categories and occurrence frequencies within sample.

Time Period	Count of Period Occurrence
Undefined	971
Indeterminate	112
Historic Known	3838
Historic Unknown	681
Pre-Contact Known	555
Bracket	65
Pre-Contact Unknown	3489
Contact	1267
Protohistoric	9
Woodland Inclusive	1730
Late Woodland	436
Middle Woodland	365
Early Woodland	140

Between the Contact Period and Woodland Inclusive categories, there are 3,027 occupations in the final dataset, representing 2,694 sites. Of these, 1,397 have only a Woodland Period component, 964 have only a Contact Period occupation, and 333 sites have occupation components spanning both time periods. These sites formed the basis of the spatial analysis for proximity of sites to waterways.

Analyses

The analyses in this chapter draw on characterizing site distributions and assessing the relationship between site locations and environmental features. This consisted of reviewing the overall placement of sites and identifying concentrations as well as patterns in the occurrence of sites and stream attributes. I used the Environmental Systems Research Institute (ESRI) product ArcGIS 10.5, a desktop GIS application, and analytic tools found within the software's ArcToolbox.

Environmental Component

This analysis begins with a brief discussion of environmental data and its representation. The environmental contexts are considered "stable" despite hydrologic variations; an assessment of settlement pattern changes show human flexibility, not environmental determinism. Figure 6.1 depicts the environmental components and forms the basis of subsequent data display. The base of this image is a Shuttle Radar Topography Mission (SRTM) elevation model, with the ridgelines of the Blue Mountains and the Appalachian Mountain range to the west and the Chesapeake Bay to the east.

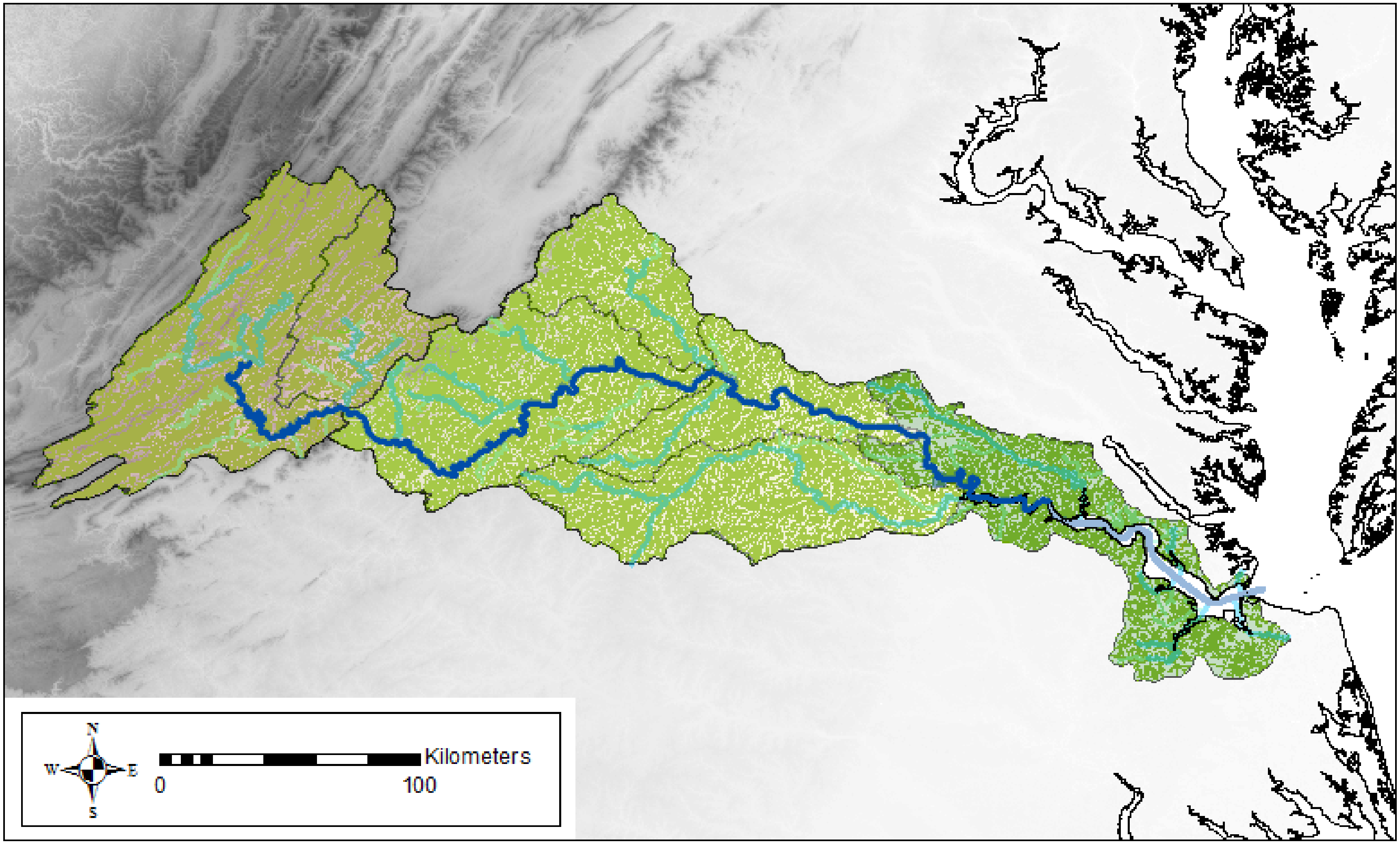

Figure 6.1. James River Basin with NHDflowline data and major rivers.
The James River is depicted as the central blue line through the basin.

Hydrological data from the National Hydrographic Dataset was clipped in ArcMap to display the same James River area used in the archaeological site query. This watershed marks the geographic extent of the analysis but the area is further delineated to facilitate analysis. Rivers can be thought of as having three zones: mountainous headwaters, the middle region where it widens, and the lower basin where flow meets the ocean, sea, or bay. These are useful "breaks" to discuss rivers as topographies create different river characteristics along its course. To facilitate discussion and display of site information, I depict these divisions using a color scheme to show the Upper (red), Middle (yellow) and Lower (green) basins. The thin grey lines that partition these river zones indicate watershed boundaries for the HUC 8 catchment areas supplying water to the major tributaries of the James River.

The stream network itself is the central feature for analysis but the most difficult to standardize and depict. In Figure 6.3, the green lines which densely populate the whole region depict the center flowline of all surface water channels. This attribute does not convey information regarding the scale of the stream in width or water volume. To mitigate display issues, larger waterways have been overlain with lines in different colors and widths to differentiate rivers, streams, and creeks. To increase the readability, only the major waterways are displayed in the site distribution maps accompanying the analyses in this chapter.

Woodland Period Occupations

The 1,730 sites with any Woodland Period occupation (including the 333 sites with Woodland and Contact Period components) were mapped against the stream network of the James River Basin (Figure 6.2). The projection of these sites creates a three km buffer within which the site itself is located. The overall pattern of site distribution shows concentrations in the upper and lower basins, with the sites in the middle basin appear either proximate to the James River or dispersed among the headwaters of the larger tributaries.

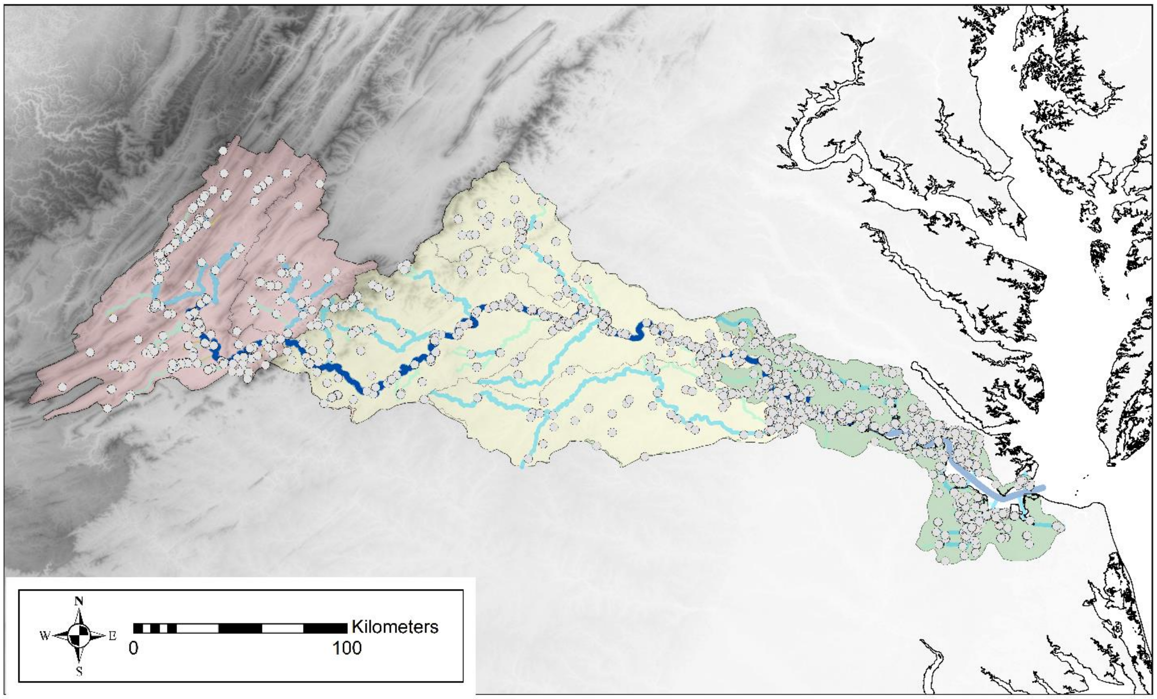

Figure 6.2. Sites with Woodland Period Occupations, James River Basin.
The James River is depicted as the central dark blue line through the basin.

A point density analysis of these settlements quantified the concentration of reported occupations. Point density calculations assume each point has a value of 1, unless otherwise stated by the user. A buffer is generated around the point. Per ESRI, this tool considers the area around the center of a raster cell to be a “neighborhood”, within which the sum of points and their overlapping buffers are totaled and divided by its area. Higher values in an area are denoted with darker colors. Figure 6.3 shows the relative density of these occupations across the three segments of the river basins. This image highlights the greater concentration of sites in the lower basin, an aggregation of sites along the James River, and a concentration of sites in the upper reaches of the James River along the larger waterways in the Ridge and Valley physiographic province.

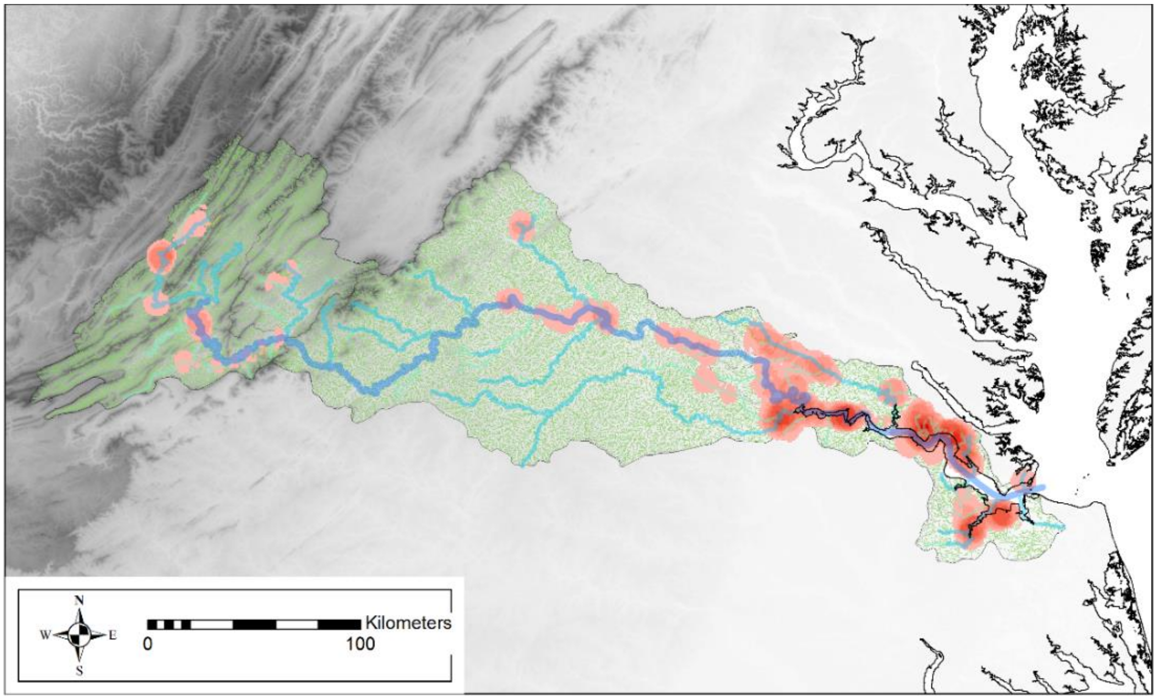

Figure 6.3. Point density of Woodland Period occupations.
The James River is depicted in blue; the areas of darker color indicate a higher density of sites.

This analysis underscores two patterns that are less visible in the previous map. This representation draws attention to the concentration of sites in the higher elevations of the Middle James River Basin, particularly along the northern boundary of the catchment area. By virtue of being a watershed boundary, we can recognize the perimeter of the watershed area as being of relatively higher elevation even if the DEM does not display significant topographic changes. This concentration of sites suggests the importance of headwaters streams, in addition to larger flows, as these upland areas are typically characterized by smaller first and second order flows.

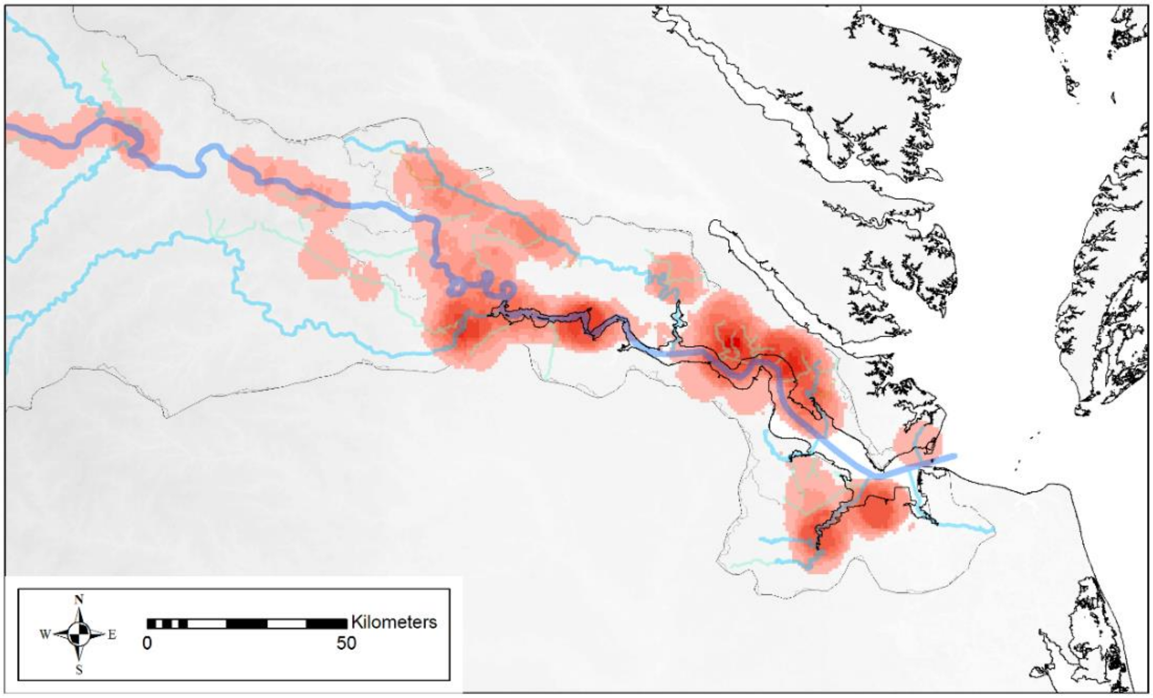

Figure 6.4. Point density of Woodland Period occupations, lower James River Basin.
The James River is depicted in blue; the areas of darker color indicate a higher density of sites.

The second significant cluster pattern underscored by the point density analysis is a series of smaller concentrations within the Lower James River (Figure 6.4). There are three areas of concentrated occupations evidenced in the figure, each warranting a brief discussion, beginning from the mouth of the James River at the Chesapeake Bay along the East and moving upstream to the west. The first concentrations are along the south bank concentrated near the mouth of the James River, extending up the tidal estuaries of the Elizabeth and Nansemond Rivers. The second major clusters are located on the north side of the James River's first major meander moving upstream. Finally, a closer view of this region shows that the largest cluster is actually a concentration of sites at the same longitude on three separate rivers. The Chickahominy River to the north is associated with a linear density of sites from its headwaters toward the confluence with the James River. The central river, shown as a wider line, is the James River. The densest part of this “linear” block occurs on the Appomattox River. The concentration of these sites occurs at the boundary of the middle and lower basins (illustrated with fine gray lines), which also marks the location of the Fall Line that separates the Piedmont and the Coastal Plain.

While the point density analysis suggests that Woodland occupations were less common in the middle portion of the James River, the site distribution itself suggests this area encompasses a number of sites but that these simply do not cluster in any meaningful way. This is seen in Figure 6.3, where a discussion of the Middle James River Basin illustrates patterns that characterize settlements within this time period. The distribution points to three variations in site location within this portion of the river basin. There is a concentration of sites along the eastern boundary of the Middle James River, presumably indicating the top of the Fall Line; there are many sites located along the banks of the James River along the extent of its course; and a number of sites are located in the higher elevations, away from major waterways and within the headwaters of water courses. Figure 6.6 uses a higher resolution image to show that sites which appear to be “off” waterways are in fact located in close proximity to lower order water courses.

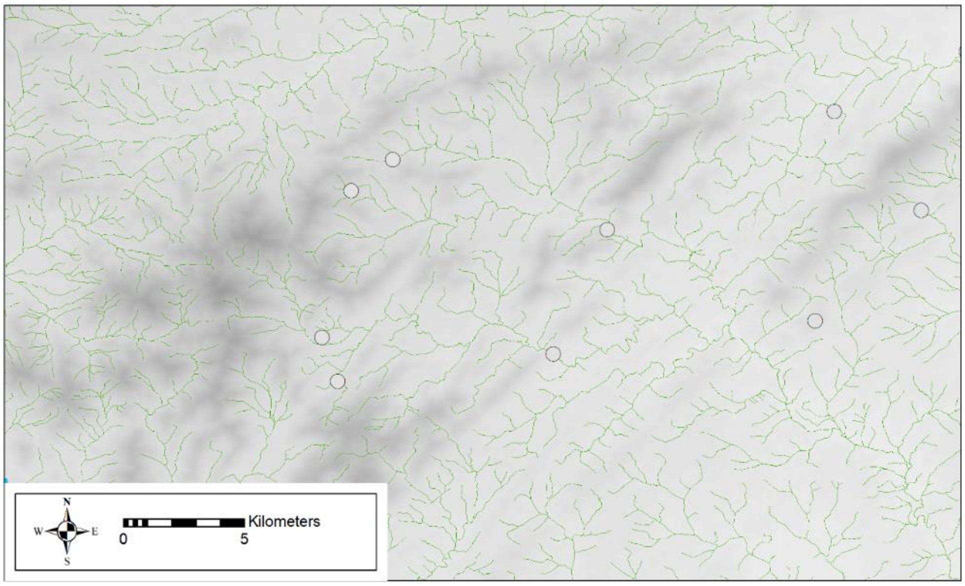

Figure 6.5. Woodland Period occupations along James River tributary headwaters.

Contact Period Occupations

The 1,297 Contact Period occupations were also mapped against the stream network of the James River Basin (Figure 6.6). These sites show an overall distribution heavily concentrated in the tidal zones of the James River, within the Coastal Plain. Sites in the Middle and Upper James River Basins are more dispersed from one another and generally are located along more significant waterways.

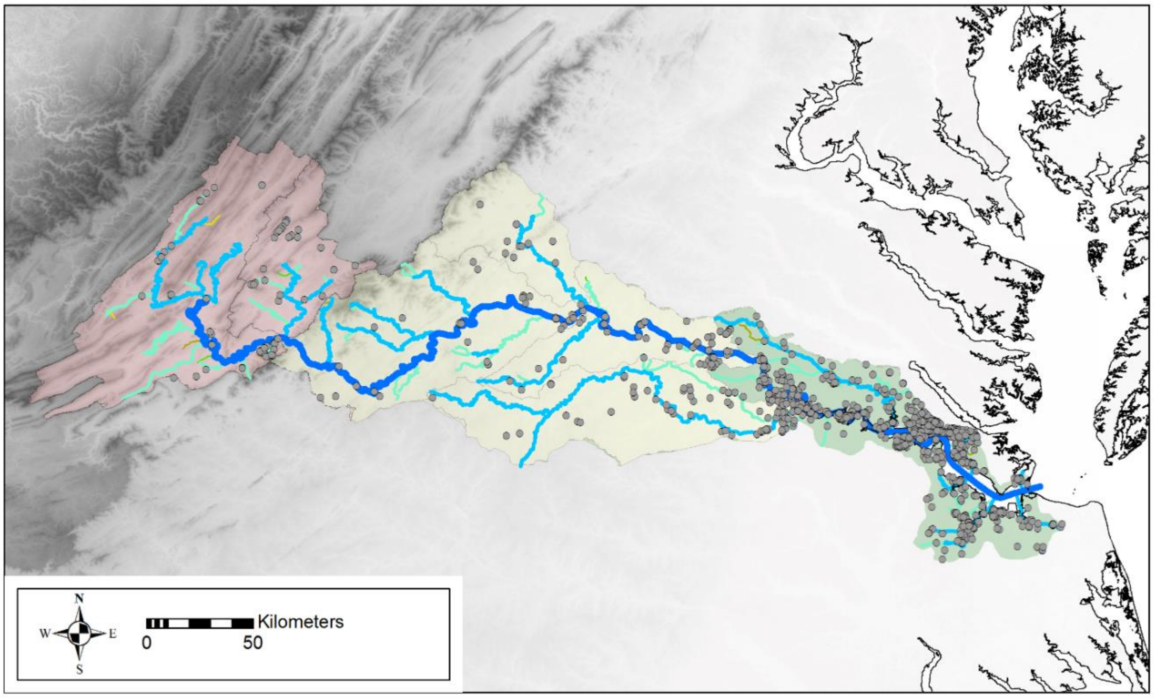

Figure 6.6. Sites with Contact Period occupations, James River Basin.
The James River is depicted in blue; the areas of darker color indicate a higher density of sites.

A point density analysis of Contact Period sites underscores this assessment of site distribution throughout the James River Basin. These densities (Figure 6.7) show a single moderate concentration of Contact Period sites along the boundary of the Upper and Middle James River Basins. There are no significant clusters of Contact Period sites in the Middle James

River Basin, while the rest of the sites appear heavily centered around significant meanders in the tidal portions of the James River.

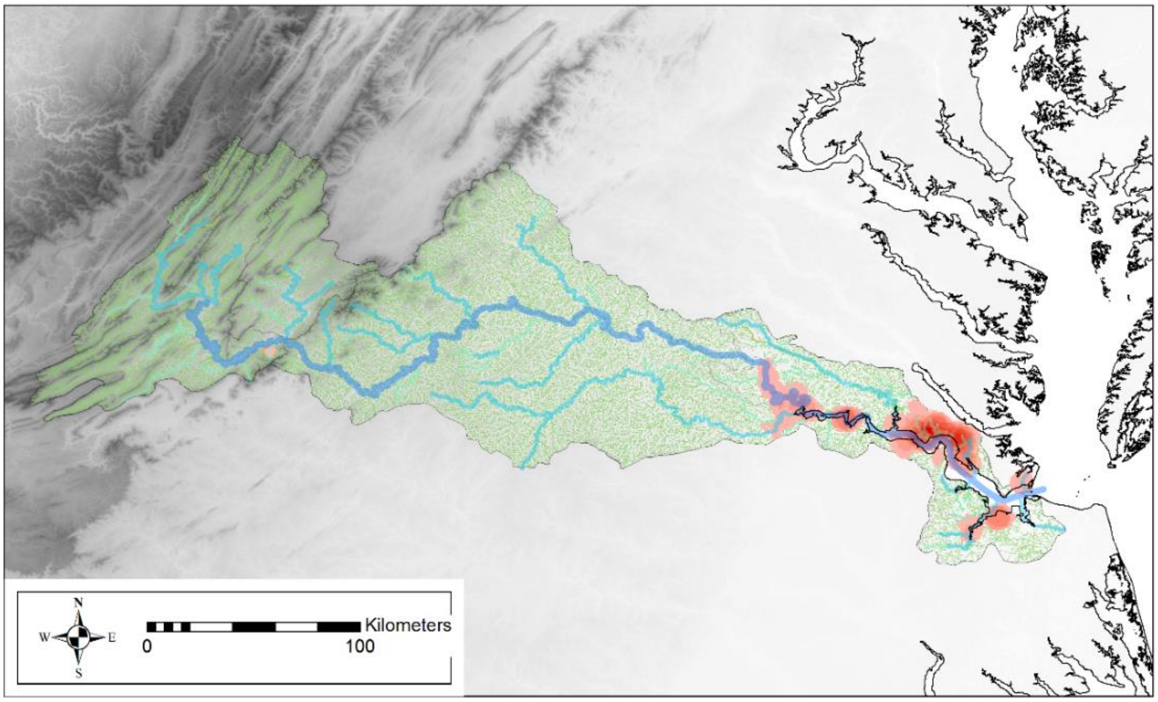

Figure 6.7. Point density of Contact Period occupations, James River Basin.
The James River is depicted in blue, the areas of darker red indicates a higher density of sites.

A concentrated view of the settlement density in the lower James River (Figure 6.8) shows occupations are predominantly concentrated along significant meanders in the water channel, rather than along smaller estuarine rivers. There is a moderately dense concentration of sites along the Fall Line for the James and Appomattox Rivers but no meaningful concentration of sites along the headwaters of the Chickahominy River.

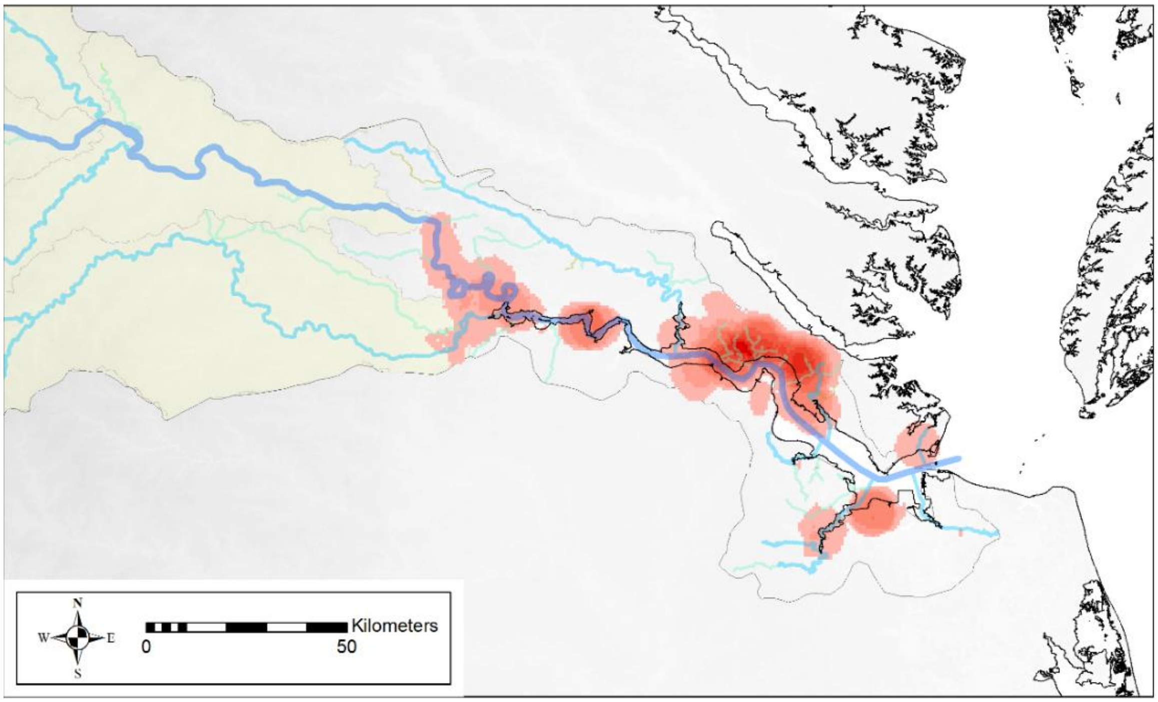

Figure 6.8. Point density of Contact Period occupations, lower James River Basin.
The James River is depicted in blue; the areas of darker color indicate a higher density of sites.

Although no clusters appear in the point density analysis, a review of the point locations in the Middle James River Basin, Figure 6.7 shows sites appear in correlation with particular riverine features. Sites occur at confluences along the James River and are located upstream of significant tributaries but there are relatively sites along the banks of the James River. There are also fewer sites in headwater regions; there is a slight decrease in the number of sites in the Upper James River Basin, where headwaters for the James River itself originate but there are also fewer sites within the headwaters starting in the Middle James River Basin/Piedmont physiographic zone, providing water to the James River tributaries.

Continuous Occupations

Because a relatively small number of sites were associated with Woodland Period and Contact Period occupations, I plotted these locations independently (6.9). Although the sites follow the same general trend, with concentrations in the Coastal Plain, no meaningful pattern could be discerned in the placement of sites to which both occupation periods are ascribed.

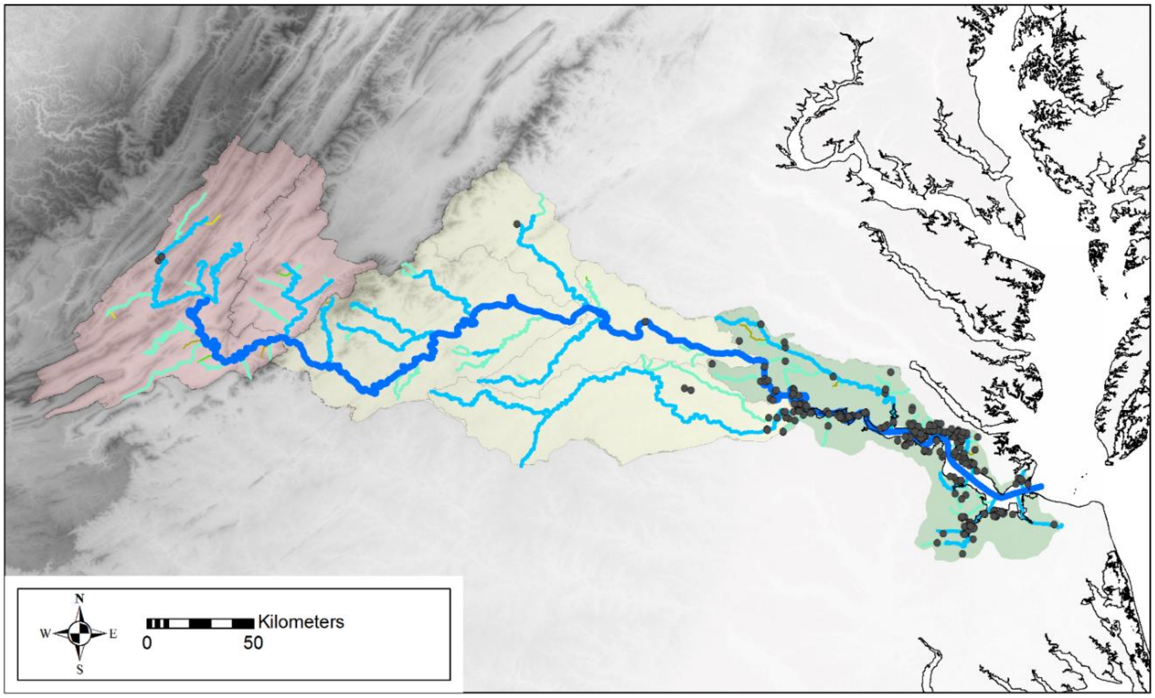

Figure 6.9. Sites with Woodland Period and Contact Period occupations, James River Basin. The James River is depicted in blue, the areas of darker red indicate a higher density of sites.

Interpretations and Discussion

Interpretations of the Woodland Period Occupation Distribution

Although the database precludes an assessment of site size, type, or permanence, the distribution of sites as plotted points suggests trends consistent with the known culture history of the region. Within the upper basin, sites occur less frequently and are generally along 2nd and 3rd order streams. This appears consistent with expectations, as previous archaeological projects (e.g. Gallivan 2016; Potter 1994) note that for the Algonquin inhabitants of the coastal plain and piedmont, the upper basin was primarily a resource zone for lithics. The sparsity and location of sites suggest these occupations were preferentially located on slightly larger waterways, perhaps because forays into the region were undertaken less frequently but with the intent of procuring larger quantities of stone. This pattern and rationale is in contrast with sites in headwaters of the middle region. In this area, sites are located either along the banks of the James River and within the first and second order streams that flow immediately into the main stem or they are located in the upland reaches, along first and second order streams of flows of larger James River tributaries. This is likely due to the greater amount of time spent in these areas, as the forested highlands are associated with longer occupations during hunting seasons. This would justify the investment in reaching the stream origins, as remote areas are likely to support hunting areas with less competition than in easily accessible areas.

There are two concentrations in the lower basin which center along the estuarine zone and at the Fall Line. The limitations of the data complicate the interpretation of these patterns, as estuary resources formed the basis for subsistence practices in the Early Woodland, while the

Fall Line is considered particularly important in the Middle Woodland as an access point to long-distance trade and in the Late Woodland Periods, when population increase and geographic circumscription created political tension among communities, particularly at notable landscape features that readily demarcated these territories.

Interpretations of the Contact Period Occupation Distribution

Within the Contact Period, there is a clear concentration of sites within the lower basin. One might argue that this density is a product of increased population density, particularly within this lower river region. This can be discounted, however, as the overall number of sites associated with each heuristic period under analysis are generally comparable. Therefore, this is not a product of additional site identification in the lower region relative to other parts of the river basin (where numerous sites have been identified in the Woodland Period) nor is it a product of intensified occupation within this more constrained coastal zone during the Contact Period. There are fewer sites immediately along the James River but this is better explored in a discussion of both periods.

In evaluating patterns within the “Contact” Period, I was concerned that the long duration of the Contact Period as defined by the V-CRIS database would obscure the settlement patterns relative to the initial interaction and colonialist influence on landscape use within the Native communities. Within a short window between the original colonial arrival and the establishment of larger Colonial settlements in the early or mid-17th century, I did not anticipate European-American sites very far into the Piedmont or uplands. The inclusion of sites dating as late as 1750, a period of 143 years between contact and the start of the “Colonial” period, raised some question as to what the overall pattern might show. The long duration of this period, as defined by V-CRIS, might have introduced significant pre-colonial changes throughout the basin. In practice, sites associated with this window remain concentrated within the lower James River Basin. There are in fact, fewer sites within the Middle James River for the Contact Period relative to the Woodland Period. The narrative of an intense coastal European population where cities were established, drawing trade to the coast rather than pressing into the interior, is evident. Briefer forays into the piedmont by Euro-Americans, or likely by Native American trade partners, to access natural trade resources may not have generated sites.

Evaluation and Interpretation of Diachronic Changes in Distribution

The database does not convey sufficient information resolution to associate occupations with a cultural affiliation. Sites with multiple components would have multiple cultural affiliations but no way to relate those cultures with a given occupation period. As a result, a discussion of the two periods is not a direct parallel. Interpretations shift from assessing a long history of Native American occupation to a generalized of “occupations.” This prevents a discussion of variances in settlement practices along cultural lines.

In evaluating the relatively lower density of sites in the Middle James River during the Contact Period, one is left to wonder whether how this occupation period was determined. It is possible that Native American communities aggregated to fewer but larger settlements in the region. If, however, Contact Period sites were labeled as such based on the presence of specific, diagnostic, and likely European tools, the absence of those materials at an indigenous occupation might prompt the site to be labeled “pre-contact” or “Late Woodland.”

Several possible interpretations may explain the shift in sites along the James River. This can be misattribution of occupation period, as discussed above. This pattern might also suggest that confluences are readily identified points for aggregation within and between communities. The predominance of sites along tributaries could suggest increased pressure to produce natural resources for the Colonialist economy. In this view, the shift of sites from the smallest headwaters to positions along the 3rd and 4th order streams might suggest either an increased pressure to reach hunting grounds and move resources out of these areas with greater east. The shift might also have had the effect of establishing presence on the slightly larger waterways, thereby remaining accessible to the James River while affecting mobility along the smaller channels upstream of the settlements. This would at least ensure an awareness, if not control, over who is moving between the headwaters and uplands for better hunting, and the central river ways along which trade occurred. This pattern may lend greater security to the settlement by creating distance from the major throughway (the James River) while continuing the establishment of settlements on streams of sufficient orders of magnitude that they are likely to be navigable year round.

As this data display does not communicate sites size or type, it is difficult to assert whether there is a shift in the placement of larger settlements versus short term resource procurement. The culture history, however, suggests that overall mobility diminished in the later periods. Despite this, in the period where we would expect less large-scale mobility, sites do appear to occur in accessible but slightly less visible locations, as along the tributaries of the James River rather than on the James River itself.

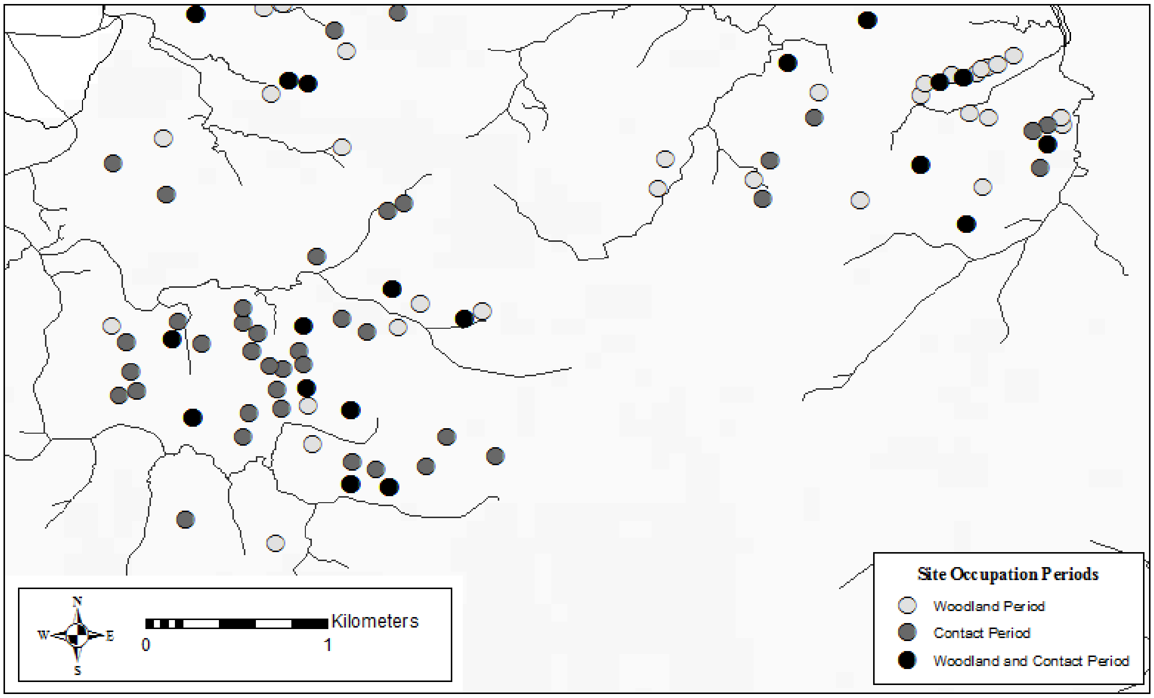

Figure 6.10. Tributary occupations along the James River.
Sites cluster near the James River, which is visible in the left corner in white, but within small tributaries rather than along the banks of the river itself. The precise location relative to the James River is cropped to protect the sites.

In both periods, sites are often slightly removed from the banks of the James River itself. Figure 6.10 is framed to obscure its precise location along the James River, though a portion of that waterway is visible in the upper left corner of the image. This configuration shows sites in very close proximity to a major river however the sites are, in practice, located a few km away from the major river banks and are instead found among the smallest tributaries of the James River. This figure shows three different occupation configurations. There is no identifiable pattern in this cluster other than to observe that in both periods, the sites are located at tributaries in close proximity to but not directly along the banks of the major waterways.

Interpreting the meaning behind the site density in the lower river for any period is difficult, because this is where the current occupation is so the degree of sites reported will be much higher. Even within that though, the point density clusters of the lower basin show sites along the estuarine zones and again at the fall line, where we know people went to trade. When comparing the point density, for the woodland and Contact Period, the occupation density in the Contact Period is significantly reduced. This is notable because the thorough coverage of this can be attributed to the work done on the Chickahominy River Survey which mapped sites along the Chickahominy and would be expected to record contact area sites with equal consistency and reliability in assigning relative occupation (Gallivan 2011; McCary and Barka 1977). This survey means that the visible changes in settlement patterns from the Woodland to Contact period are likely not just a product of survey coverage and site recognition.

Discussion of Analysis and Dataset

Several points relating to the data, analysis, and subsequent interpretations warrant additional discussion. While the total number of sites included in the analysis of each period are roughly equal, these occupations encompass significantly different time ranges. Due to the constraints of the data, the Woodland Period dataset includes sites with any Woodland Period occupation; sites may potentially have been occupied at any point within a 2,406-year period. The Contact Period, alternatively, represents only a 143-year period. Arguably, however, this time difference does not pose a significant problem, as the key issue is less how much time has passed but the extent to which new cultural practices are adopted. While social practices did change from the Early Woodland to the Late Woodland, the overall extent of these changes in settlement practice are minor in comparison to the disruption in social, political, and economic practices that accompanied the introduction of colonialism. Although the time periods are different in scale, both will capture significant variation within their own period while changes between the two can still likely be attributed to the introduction of colonists and colonial practices at the juncture of the two datasets used for analysis.

Another issue for consideration in analysis addresses the concept of “objective” data. These interpretations are drawn from proximity to water – data varies in format and comprehensiveness, so for example, we can look at coverage and completeness and associated attributes and to some extent, the data is provided in different formats and so efforts to convert or run particular analyses are then subject to further manipulation by the user that may not be readily replicable nor produce the desired results.

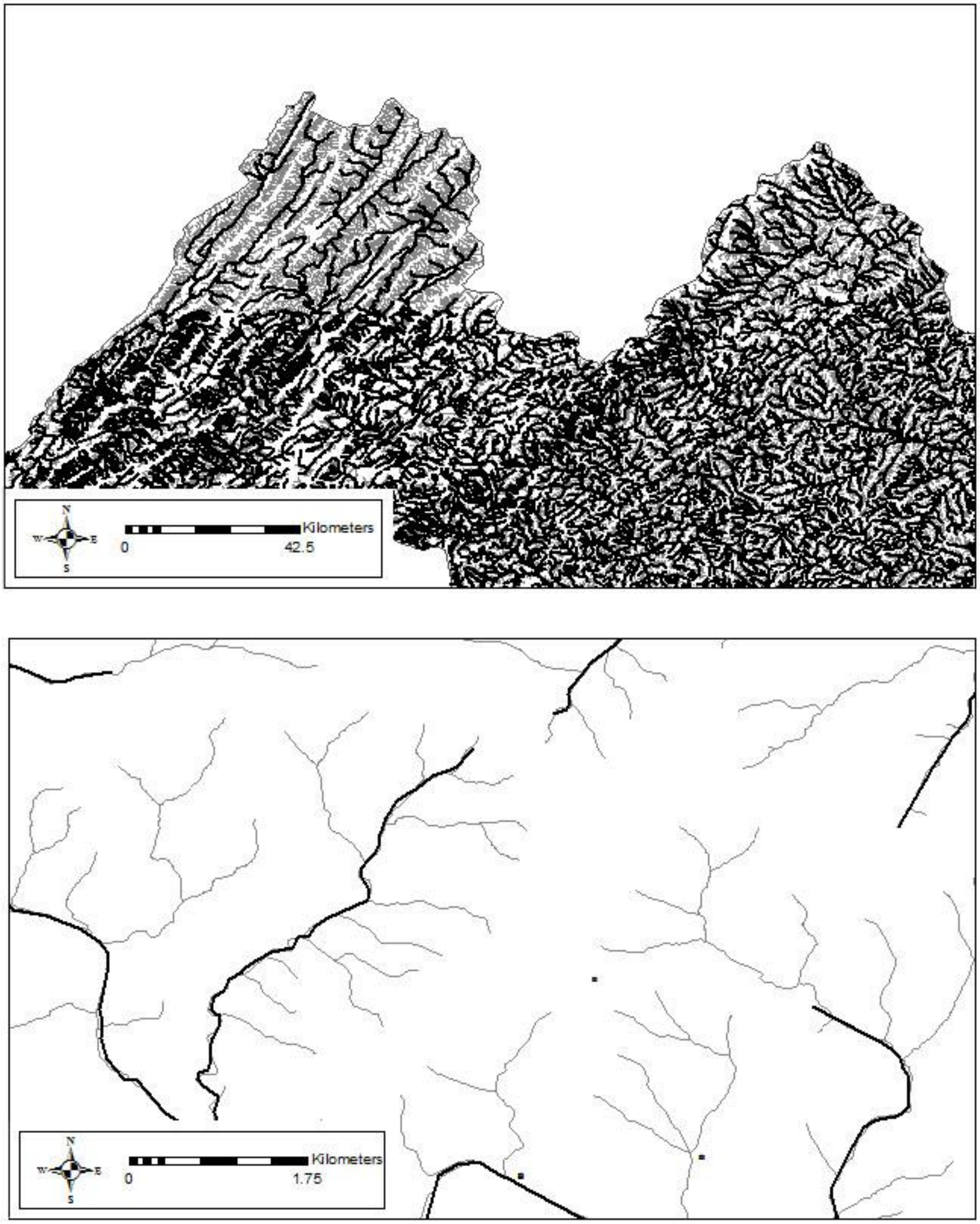

Figure 6.11. Comparison of hydrography datasets showing the skewing effects of data sources.

Figure 6.11 shows waterways from two different projections. The image on the top illustrates that analyses, even in objective contexts, is subject to data collection challenges. In this case, the NHDPlus data for the Mid-Atlantic region, which draws on elevation databases, shows that a lower-quality DEM creates a different stream network within a single tile for the upper James River Basin. This is clearly an artificial error, as the lower density of stream networks is within a perfect rectangle and follows a rigid linear line across the upper basin. The image on the bottom shows a comparison of two different stream network projections. The image is a close-up view of streams within the Middle James River. The darker blue lines are from the NHDPlus data (the same projection as on the left) while the lighter blue lines are stream networks from an older NHD Virginia river network file. This older file does not have stream attributes, such as stream order or flow, retained in the data set but is a more detailed projection. In this view, however, several small sites are seen from the Woodland Period. These sites appear at a slight distance from waterways using the NHDPlus data but is immediately along a first order stream when viewed in context with the earlier NHD file.

Conclusions

Surveys have been, and often continue to be, seen as a preliminary or superficial contribution to archaeological studies (Ammerman 1981; Bower 1986; Kowalewski 2008) yet they allow for much broader coverage of an area, identifying more sites and allowing people to make some comment on where there are no sites. This is a critical point in assessing the relation of sites to water, as most projects will then concentrate on finding sites near water when in practice, the assessment of sites near water is most meaningful when it stands in contrast to a known absence of sites away from water. CRM or broad surveys are more likely to undertake surveys in these areas that are more "high risk" for research projects that hope to find sites and concentrate on areas most likely to yield them.

The aggregation of known sites, within the context of broader reconnaissance coverage, enables useful studies in broad patterns. Despite the many variable pressures that can alter the accuracy of a given point or river location, when we step back, there is still a pattern relevant to a meaningful analysis. This analysis served, in some ways, as a test of this method. The site patterns visible in this case study are consistent with existing research in the area, but it serves to see how this approach using big data would work for a region that is less thoroughly attested to in historical or archaeological research.

CHAPTER 7: DATA AND ANALYSIS FOR RIVER USE IN A NORTHEASTERN RIVER BASIN: THE SAINT JOHN RIVER IN MAINE

The Canadian Province of New Brunswick and the adjacent territory in the northeastern-most U.S. State, Maine, are characterized by subarctic climates, mountains, and dense forests that extend to a coastal plain and jagged coastline. The northern context of this environment, though rich in its own analytic value, complements the previous investigation from the Mid-Atlantic by similarly addressing the ways in which people perceived and utilize waterways as tools to structure movement, and the extent to which said use is implicated in regional social and political transformations in the late prehistoric occupations and early Contact Period. As in the previous chapter, the data in this chapter describe the archaeological site distributions and their proximity to hydrological features within a major river basin; this chapter concentrates on the Saint John River. Though the specific developments in political organization before and after the introduction of Colonialist pressures in this region differ than from those that affected the paramount chiefdoms of the Mid-Atlantic region, the cultural responses to the environment and between cultural groups suggest that the communities in this region also competed to exploit the conduit affordances of this waterway.

The Saint John River Basin spans a number of environmental and cultural boundaries. From the headwaters to the estuarine mouth, the river moves across several physiographic zones. As the river flows across political boundaries today, it similarly moved through and was competed over by three cultural groups in the past millennium. These communities sought to control access to the river, both for the ecological resources and for its utility as a pathway.

As with the previous chapter, this chapter describes the archaeological site distributions and the environmental context in which they are situated throughout the Saint John River Basin. After reviewing the contextual background for the environmental and cultural history of the region, I describe the data sets used to address the land use during the Ceramic and Contact Periods. For the latter period, data include sites with both Native American and European affiliated occupations. A GIS analysis integrates hydrographic data with archaeological settlement data to assess proximity of sites to water, as well as comparing the occurrence of sites along different classifications of streams and compare these patterns diachronically. The chapter closes with a discussion of how these analyses may indicate shifting heuristics and perceptions of a stream's role. The analyses of settlement patterns relative to water features help to quantify different perceptions of water affordances – under what environmental or social contexts and scales it is a conduit, barrier, or obstacle. This elucidates how the water features are incorporated in promoting or delimiting interactions among different communities and over time.

Objectives

The premise of this dissertation is that people's use of land is a reflection, in part, of shifting perceptions of waterways' affordances across periods of cultural transitions. Broadly, this assessment is considered through a rubric that evaluates changing use of rivers in a localized context by considering how these landscape features are used for social networking and mobility in the prehistoric and early historic period and then comparing these diachronic changes.

Communities may utilize the characteristics of rivers to integrate or delineate their social boundaries at different scales of interaction with a social structure. The traits of a stream present an objective physical impact on the landscape, yet cultural perceptions determine its utility with regards to the mobility of people along particular paths across the physical terrain. From an analysis which incorporates regional site distribution with geographic information software (GIS) to assess the spatial relationship between archaeological sites and stream channels, we can infer the relationship between communities and waterways as paths and, perhaps, the relationships between communities.

Data

The Saint John River originates in Maine, the northeastern-most state in the United States. While the river itself flows into New Brunswick, a Canadian province, the watershed boundary extends from New Brunswick and into the province of Quebec. In order to find data of sufficient resolution for this study, the hydrographic and archaeological data for this basin was aggregated from several separate databases.

Environmental Data

As in the previous chapter, an assessment of how surface water systems create affordances of use to local communities and which uses are employed in the community's land use, requires an understanding of the environmental context. Because surface water systems, as part of the hydrologic cycle, are heavily influenced by a number of variables in the environment, the quantitative assessment of the physical environment is an essential first step to GIS analyses.

Geographically located in the northeast of the United States and the southeastern provinces of Canada, the environment is characterized as rugged and, though seasonally variable, harsh and “wild.” The region is known for its jagged coastline, mountains, densely forested interior, and dramatic seasonal temperature and snowfalls (Cunjak and Newbury 2005). These features and climatological phenomenon intersect in a number of ways that impact the rivers of the region. A thorough description of the physical environment through which water moves provides context for the cultural processes that evolved in conjunction with the physical environment.

Within Maine and New Brunswick, forested slopes extend to the jagged and rocky seashore. The shoreline is a “drowned coast” as rising sea levels at the end of the Holocene flooded the former hills and valleys to create cliffs, bays, inlets, and islands; this flooding precedes most occupation and precedes my period of interest. The northern latitude and mountainous terrain in Maine contribute to significant snowfall and frigid temperatures in the upper basin. Even today, 84% of Maine is forested (UCSB 2011) despite extensive timber harvesting in the 19th Century. Glacial melt and annual precipitation or melting snowpack produce the many rivers and streams in upstate Maine. According to the 2012 Environmental Statistics summary of the United States Census Bureau, there are 5,910 square km of inland water (USCB 2012, Table 358). The Kelly Rapids form a portion of the northern boundary between the United States and Canada while the Saint John River forms a portion of the northeast international boundary. The upper, middle, and lower stages of the river are defined by channel characteristics rather than regional topography; the cascade in the city of Grand Falls, New Brunswick marks the transition from the upper to middle basin but does not align with any major watershed boundaries. The Saint John River Basin is one of the least densely populated, with approximately 500,000 inhabitants (Canadian Rivers Institute [CRI], accessed May 23, 2017).

To build the GIS for this analysis, I acquired quantitative data to reflect this region. As hydrographic analysis becomes increasingly important to a broad range of studies, both research and commercial, this type of data is frequently “packaged” so that a user can acquire the GIS data for stream networks and the associated data from which these networks were defined. Stream networks are produced by a number of environmental variables, including precipitation and groundcover. The most significant and stable factor in stream networks is topography, as this defines the boundaries of the catchment area and the slopes within it, thus where water will drain. These datasets include a digital elevation model (DEM), analysis of which defined the watershed boundaries, as well as the slope and directions of flow within that boundary. Based on these relationships, any GIS user can construct a stream network from a DEM. The efforts to aggregate and disseminate this information as a package ensures consistency across users and allows the dataset to include additional information, including, for example, the waterway’s given name.

Although some independent sources have generated global river data files, these were generally restricted to larger waterways. To ensure a higher resolution stream network, I integrated separate datasets from the United States and Canada. For the Maine portion of the Saint John basin, I used the National Hydrographic Dataset Plus, a dataset which incorporates a DEM and files for the watersheds and various hydrographic attributes. In the James River case study, I used the NHD dataset, as it had a higher resolution of stream networks. Because this river basin required the integration of separate datasets, I used the NHDPlus dataset to define the river system of the upper Saint John River, as this more recent dataset is more similar to the resolution available for the Canadian portions of the basin. From the prepackaged datasets available at geogratis.gc.ca, I downloaded separate hydrography files New Brunswick and Quebec, at 50K resolution.

Although the low European population in the basin has left the Saint John River relatively less impacted over time, this does not mean there have not been human-driven alterations to the channel. The river was a focal landscape for indigenous communities, a primary conduit for colonial exploration and expansion, and saw substantial lumbering activity within the catchment. Today, there are more than 200 dams across the river network, including eleven hydroelectric generating stations. Of these, the Mactaquac Generating Station built in 1968 on the main stem of the Saint John River will reach the end of its use life in 2030 (CRI, accessed May 23, 2017). In deciding the future of this powerhouse and spillway, the New Brunswick Power company (NB Power) has relied on the Canadian River Institute (CRI) to conduct research on the economic, environmental, and social consequences of various plans for powerhouse and spillway management.

The Mactacquac Aquatic Ecosystem Study (MAES) was designed to generate a rigorous scientific perspective on the optimal future for the Mactaquac Generating Station. This project is a multi-year investigation of the entire river system. In addition to a full series of MAES reports and a comprehensive publication on the environment and history of the Saint John River, available online at the University of New Brunswick Libraries scholar research repository website,[10] the Canadian Rivers Institute provides digital access to GIS data for personal use.[11]

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[10] Research reports and publication available at: https://unbscholar.lib.unb.ca/islandora/object/unbscholar%3A8030

[11] http://canadarivers-gis.maps.arcgis.com/apps/webappviewer/index.html?id=f4d83a4f66104c36bece0a221d17f832

This content includes layers depicting the river and island conditions of the Saint John in the 1950s, prior to the Mactaquac Dam, including an aerial photomosaic of the area near the dam. This information provides a valuable reference to better access historical river conditions, including the previous existence of islands within the river. Though it is not a comprehensive reconstruction, the representations provide a perspective on the river channel without influence of its most significant alteration.

Archaeological Data

Addressing landscape archaeology questions, particularly those that compare different environmental conditions, different communities' approaches to land use, and efforts to observe a diachronic shift requires an approach to data that can address a larger geographic scale and temporal scope. In order to encompass a variety of environmental and cultural conditions, I elected to concentrate on regional analysis of site distribution. Following the model in the previous chapter, this type of data gives a picture of the interactions and distribution of people over a larger geographic area, which is necessary for understanding how water systems that extend across a region help to facilitate or restrict movement within those regions.

Data Acquisition and Sample Description

For the primary analyses in this dissertation, I concentrated on assembling a database of site-level information throughout my research area. This research area spans multiple regional administrative jurisdictions. As a result, archaeological data for this area is maintained by three separate offices, the Maine Historic Preservation Commission, the New Brunswick Archaeological Services Branch, and the Quebec Ministère de la Culture et des Communications. Within each region, archaeological data is subject to different legal treatment and data management structures. In building the archaeological component of this analysis, data was derived from extant collections and site records made available through these offices. Although the basin itself extends into Quebec, archaeological data for this portion of the survey area was excluded from this dissertation, as the region represents a small percentage of the overall basin and is significantly removed from the main river and its larger tributaries. The inclusion of the material was deemed likely to introduce further variability in archaeological practices to exceed the analytical value of additional sites.

Maine and the Maine Historic Preservation Commission

Requests for archaeological data from the State of Maine are processed through the Maine Historic Preservation Commission (MHPC), whose director is also the State Historic Preservation Officer. The archaeological branch of the MHPC maintains the records for archaeological sites located within the state. These sites and the associated information and summaries are generated through a variety of processes, including individual site reporting and confirmation from the office representatives, academic research, and CRM firms. Research inquiries are directed to the State Archaeologist, with whom a researcher must clear their project proposal and develop a plan for investigation. Through conversations with the state archaeologist, it was evident that the site locations, at least, are digitally maintained but access to this information is restricted to office use. In conducting research for this dissertation, requests for data were submitted to the lead archaeologist who then assessed their collections and generated a summary, email, or images deemed relevant. These results were then forwarded back to me.

The State of Maine maintains the prehistoric archaeology reports within their MPREHIST Computer Database. The database itself is not directly accessible but the MHPC website's link for professional archaeologists presents an overview of the system. An overview of the information within the database is presented in searchable PDF format.[12] This information is presented in three configurations, with entries sorted according to 1) the author's last name and then the map quadrangle number, 2) the quadrangle number and then the author's last name, and 3) by site number. These files yield citations for the site reports or other references, both published and unpublished. This resource serves primarily as a guide by which to pursue further site data. Access to the file reports which make up the majority of listed resources is limited to archaeologists on the Maine Approved Lists or at the discretion of the SHPO officer or senior staff, pending approval of the research interests. As of May 2017, the website stated the available documents were current through January 2015.

To ensure that the current analysis drew on the most recent data and in order to access those sites with relevant occupation components, a request for site locations of Woodland and Contact Period sites in the upper Saint John Basin was submitted to the state archaeologist. Though site locations are sensitive data, precise locations are necessary for analyses such as visibility of sites from water, where even short distances of a ½ km are sufficient to obscure visibility, particularly when one considers the density of vegetation in northern Maine. The departmental policy is not to release locations any more specificity than a ½ km square within

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[12] These files are accessible at: http://www.maine.gov/mhpc/archaeology/professional/mprehist.html

which the site is located. This is a protective measure but precludes analyses like visibility Although some alternatives were discussed to receive point-specific data but obfuscate data within the data presentation, such as by using randomized points to represent (but not analyze) sites or tables with distance ranges, the ½ km protocol remains the basis of analysis for sites in the upper Saint John Basin.

In response to my request for locational information regarding Woodland and Contact Period sites in the upper Saint John Basin, the state archaeologist queried their records and sent a series of JPEG images. These images each depicted a portion of a USGS topographic quadrangle map, on which were overlain computer generated rectangles each associated with a site identification number. Maine relies on a different naming convention, with each site identified by its USGS topographic quadrant number followed by the chronological number of when a site was reported in that quadrant. The associated correspondence indicated that these images represent the entirety of sites (as ½ km squares) within the Maine portion of tributaries to the Saint John and that the state archaeologist would complete further assessment of the data to determine which of these sites contain components dating to Ceramic period or Contact Period occupations.

The 46 sites in the Maine portion of the Saint John River Basin were added into the GIS. The limited information associated with these sites precluded efforts to clean or otherwise prepare the data for inclusion in the GIS. As each JPEG was added to the GIS, it was geo-rectified using control points in the georeferencing toolbar to create a relationship between corresponding spatial points on the GIS topographic basemap in the GIS and the JPEG overlay. This process was facilitated by GoogleMap searches, in which a distinctive landmark on the JPEG topo could be located and used to identify the general location within the state. This was necessary as the JPEG images were cropped in a way that removed the coordinate or topographic quad names commonly used to locate the mapped regions. A separate layer was then created with rectangular polygons drawn over the ½ km site indicators on the original image files to fully incorporate the spatially-referenced sites within the GIS.

Because the ½ km areas are spatially linked to four points, they are defined at a particular scale that may not be visible from a regional perspective. To improve site presentation, I created a new layer denoting sites with a point at the center of each site polygon. Since the center of a point retains spatial integrity regardless of the viewed scale, they are visible at different scales, though the point will create a buffer around the central coordinate.

New Brunswick

The Archaeological Services, within the Tourism, Heritage and Culture Department in the Government of New Brunswick, is responsible for the stewardship of the region's cultural resource management and preservation of archaeological heritage. As part of their data management and accessibility efforts, they have established an Archaeological Services Spatial Database. This database contains qualitative and spatial information regarding known and predicted sites within the province. Access to this database is restricted; permission for use was not granted within the timeframe for completion of this project.

Analysis

As in chapter 6, the analyses draw on characterizing site distributions and assessing the relationship between site locations and environmental features. This consisted of reviewing the overall placement of sites and identifying concentrations as well as patterns in the occurrence of sites and stream attributes. I used the Environmental Systems Research Institute (ESRI) product ArcGIS 10.5, a desktop GIS application, and analytic tools found within the software's ArcToolbox.

Environmental Component

The presentation of environmental data and the mode of representation for this analysis are discussed first. Despite the changes a landscape may undergo throughout the year or over longer durations of time, the environmental context is generally considered more "stable" than the cultural components. These mutable aspects of the environment are frequently predictable even in their changes and the alterations are due to geologic and biologic processes compared to cultural changes often assoicated with ideology and more abstract perceptions or mutable socio-economic pressures. Figure 7.1 depicts the environmental components that form the basis of subsequent archaeological data and display.

The base component of this image is a Shuttle Radar Topography Mission (SRTM) elevaion model. The international boundary between Maine and Canada is demarcated by a heavy black line (Figure 7.1). The stages of the Saint John River are defined by characteristics of the river channel, the boundary of the upper basin, for example is Grand Falls, New Brunswick, just beyond where the international boundary turns south away from the Saint John River. This location does not correspond with any identified watershed projections. This basin is less readily divided into upper, middle and lower portions; the stages are defined by the river rather than its surounding topography. As such, these areas are not distinguished in this map.

The individual datasets for water flowlines in each state or province are depicted in separate shades of green. The boundary between Quebec and New Brunswick is not shown. The sharp square demarcation of the New Brunswick waterways is a product of data collection independent of the govenmental boundaries. A fourth region is faintly visible where the boudaries of the Quebec and New Brunswick hydrography files overlap. The major rivers and tributaries as defined by MAES are depicted in blue. Where the Kelly Rapids and Saint John Rivers define the nothern international border, these features are layered but both are present. To increase the readability, only major waterways are displayed in the site analyses in this chapter.

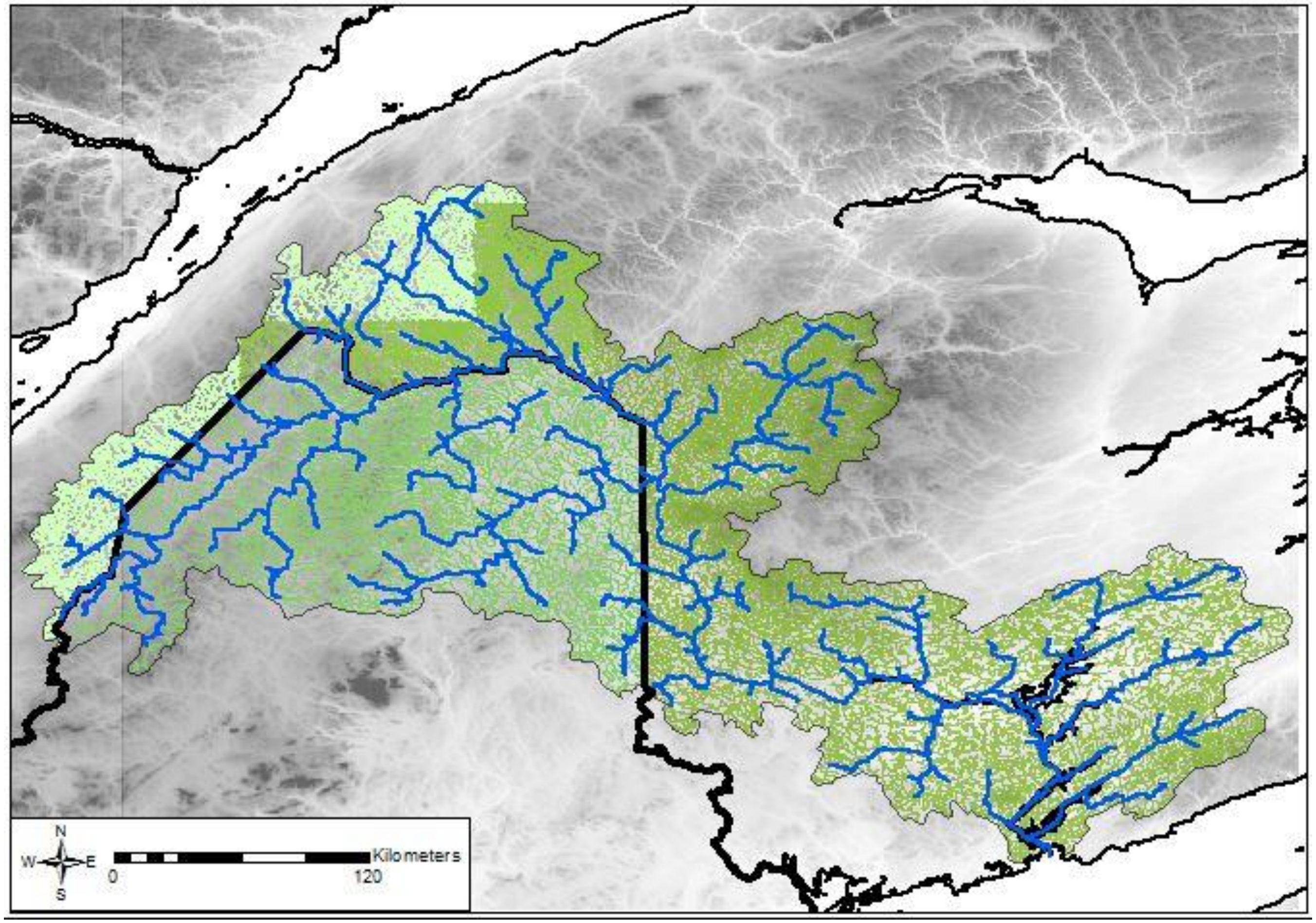

Figure 7.1 Major rivers and flowline data for the Saint John River Basin.
Blue lines indicate major rivers and tributaries with the central line depicting the Saint John. Data from each regional hydrology dataset is depicted in a different shades of green for Quebec (light green), Maine (green), and New Brunswick (dark green) within the Saint John River Basin.

Archaeological Data

The 46 sites reported in the Maine portion of the Saint John watershed were mapped against the stream network. This distribution of these sites, shown in Figure 7.2, show a general trend toward site identification along rivers, particularly near to the international border. Preliminary patterns are evident even within this small sample.

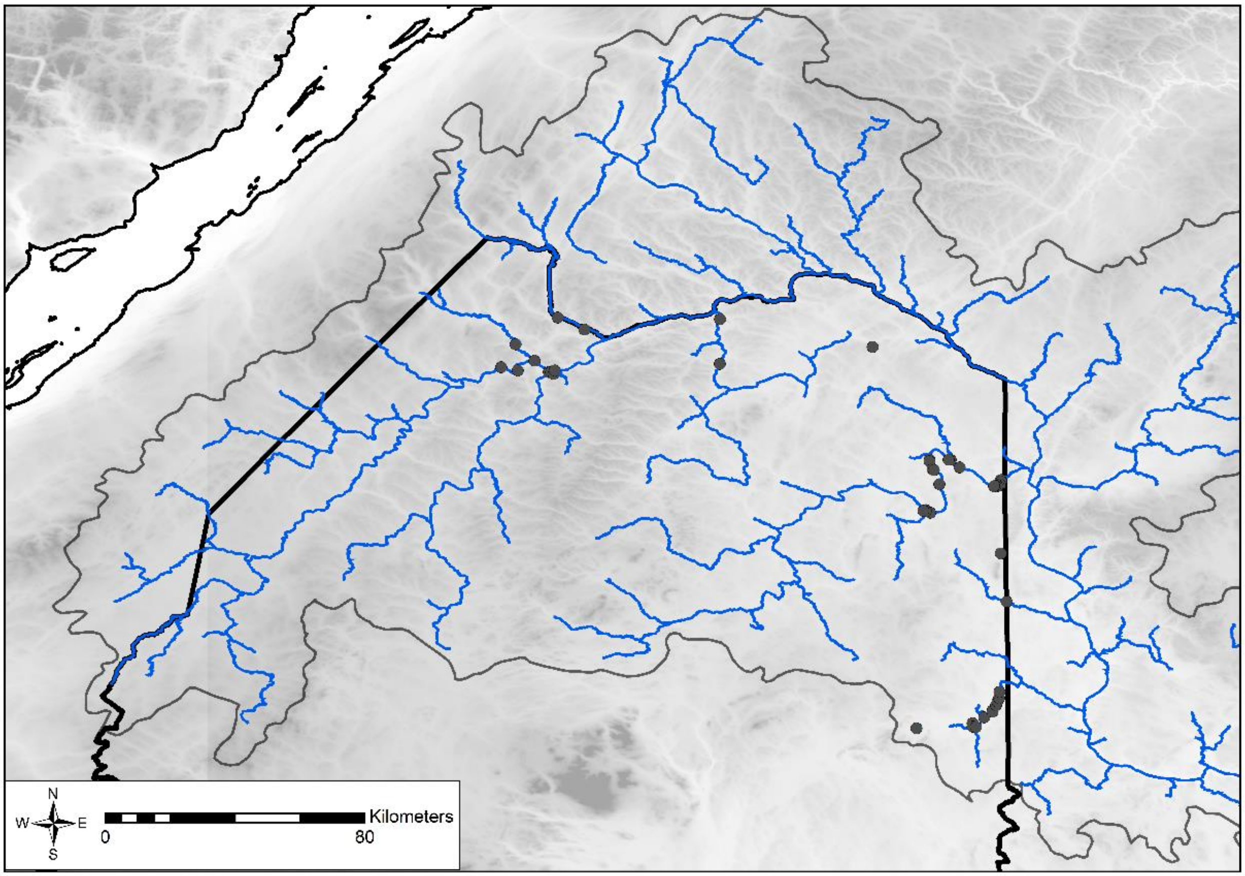

Figure 7.2 Archaeological sites within the Maine portion of the Saint John River Basin.

Even on a map with only larger waterways depicted, only 3 of the 43 sites are not located on one of these more substantial flows. When compared against the higher resolution stream network, only one of these three sites is located near smaller streams and headwaters; the site that appears “off water” along the international boundary is located on a small waterway. The northern and southern most “off river” sites are both placed along a lakeshore, removed from the flowline of moving water that feeds or drains the lake but are still a part of the contiguous water network.

More preliminary patterns are evident within distributions. The majority of sites are located along tributaries to, rather than on, the Saint John River. A quarter of the sites are located within a km of a confluence. Sites across the northern extent of the Maine portion of the Saint John River are within the upper reaches of the river, while sites that appear grouped along the eastern boundary of Maine are clustered on the Aroostook River and tributaries that feed the main stem of the Saint John River in the middle reaches of the river.

Interpretation and Discussion

With a small sample size of sites dating to an undefined (though not necessarily indeterminate) age, the confidence in interpreting any identified patterns is tempered. One cannot say with certainty whether the distribution of sites, concentrated along the major tributaries of the Saint John is a reflection of historical settlement patterns, site accessibility, or survey in an underpopulated region.

Interpretation of the few sites along the Saint John is more promising. As this is a major river and forms an international boundary, one might expect that it has been traveled or surveyed more extensively than other rivers. Despite this, there are few sites on the river itself within the Maine portion of the channel. This suggests the dearth of sites might be a reflection of cultural practices, though without an age for the known sites, it is hard to know whether this is due to pre-colonial contestation over rivers as manifest in reduced sites along the central waterway.

Although this is common to all archaeological survey work, the implication of an unknown survey was brought to sharp focus in this case study. Certainly, archaeologists have long understood the concerns regarding the area of coverage relative to site identification and interpreting patterns. Most reports or publications are supplemented with descriptions or images that define the area that was surveyed. This information – the extent of the survey area – is not preserved in a large database. In areas like Virginia, where sites have been widely reported, the impact of this is diminished, though there is a potential to formalize the seemingly spatially comprehensive distribution. In the case of Northern Maine, it is necessary to complement site data with some indication of where CRM efforts have provided some degree of reconnaissance. Without this corresponding information, it is difficult to draw conclusions on site location. One can assume this pattern is due to reduced survey since historical records indicate that the 19th century timber industry would have generated some sites in the region. These assumptions and interpretations of data are rarely necessary when dealing with primary file reports.

The process of presenting site data in this GIS so that they are visible at different projections introduced some error in their spatial context that could influence subsequent analysis in this GIS. Because polygons are not visible at certain projections, I added points to depict sites. Though polygons were meant to safeguard site location, the use of points rather than polygons creates an additional buffer depending on the projection at which the GIS is viewed. In this study, they created a buffer of one to four km. The supplied data reflected a ½ km area within which a site of unknown size is located. Because the files were sent as a jpeg without associated xy coordinates, the images were georeferenced by hand. Although care was taken, this method may have introduced an additional degree of error. I placed points as close to the center of the squares as possible for consistency in any error introduced, though this placement was estimated. As some of the ½ km site areas covered the flowline of the waterway, using points may have altered which side of the stream a site appears to be located. This was deemed acceptable in this study, as it retains the ability to measure site proximity to a waterway or confluence, although it would prevent more specific local ecology studies, such as how communities position sites near bends in the channel which could affect calculations of visibility and perceptions of a site "lookout" function.

Conclusion

The interpersonal approach to data, rather than direct engagement with a database, can have a significant impact on the trajectory of research. Traditionally, scholars have relied on regional expertise of both scholars and local inhabitants who may carry local knowledge of sites. Without negating the contribution of these consultations, they can prompt significant changes to the archaeological investigations. This is true to some extent with archival research, as discussions with the V-CRIS administrator for the archaeological archives in Virginia guided me to a more efficient survey of all available data in ways similar to the survey-planning for a field reconnaissance. In the absence of a database, these consultations assume greater importance as access to archival data may be more deeply dependent on inter-personal engagement. The Maine data is not available in a format or policy that allows new patterns to be discerned from the meta-data. Each project must be individually defined, with the dissemination of "relevant" data predicated on an individual perspective. In the initial dissertation proposal, this study intended to compare the settlement patterns of the James River, the largest river wholly in Virginia, with the Penobscot River, which holds the same distinction in Maine. In requesting access to these sites' data, the concern of the Maine State Archaeologist was the persistence of occupation sites along the Penobscot River. Based on published accounts and information communicated by the department, the settlement pattern in the basin has been concentrated on the river's banks for the full 20,000 years of occupation in the basin (e.g. Prins and McBride 2007; Spiess and Lewis 2001). Although this continuity contrasts the Virginia data, the Saint John River settlement pattern's potential to reflect inter-community competition rather than cohesion, as seen in the Powhatan Confederacy on the James River, was deemed more "innovative." The Maine department's focus on the Penobscot River obscures the potential for new approaches and new interpretations through knowledge discovery (Fayyad et al. 1996).

CHAPTER 8: CONCLUSIONS

There is no such thing as a pristine river through the depth of time. Not only does a river's natural characteristics create change in the flow of the waterways, people influence the course of a water feature directly and indirectly. Humans have redirected rivers, cutting new courses or creating dams to alter the direction or rate of flow but humans also have many indirect influences on the flow of a river. Clearing vegetation can increase erosion while farming and animal husbandry alter the sediment levels and chemical composition of the water. The intimacy and complexity of this recursive entanglement makes the relationship both necessary and challenging to study.

Not unlike rivers, the course of dissertation research often shifts over time, undergoing meanders and rapid course change. In keeping with the aims of the initial research inquiry, these changes in the flow of research may alter the perceived "affordance" or utility of the project. The initial hypotheses considered how the entanglement of human communities and rivers alters the social networks. The discussion in this final chapter considers the broader theoretical and methodological results of the study. The completed work produced a basis for preliminary conclusions relevant to the subject matter - the nature of this hydrosocial relationship and methods of further evaluating it – but also serves as a topic in itself, assessing the practicalities of database-driven research.

This chapter is structured to discuss methodological and theoretical aspects of studying the human-hydro relationship in archaeological contexts in two parts. The first portion of the chapter discusses the complications and considerations associated with the use of aggregated databases. In light of these limitations, the second portion of the chapter is dedicated to the broader conclusions and implications for the anthropological concepts raised in this project.

On the Use of Open-Access and Large Databases for Analyses

A history of excavations, data accumulation, obligations to maintain archaeological material, and the longstanding awareness that contexts excavated are contexts destroyed have all contributed to an increasing push for archaeological research drawn from extant datasets. The proliferation of technology that enables digital record-keeping and remote data sharing has changed the scope of what is theoretically possible when using existing collections. Vast collections can be digitized and even multiple terabytes of digital files can be economically stored and transmitted. In the context of file sharing, primary data can become accessible to scholars *in situ,* without the financial and infrastructural obligations of commuting or hosting scholars who wish to view collections first hand. This is particularly useful where a comprehensive analysis of massive collections would be implausible given constraints of research. The ability to aggregate, organize, and disseminate data has contributed to an expectation that remote or large scale analyses, including across multiple repositories, are easily undertaken.

Recent treatments of using open-source aggregates of data have highlighted the growing realization that large databases and open-access information can be used to address some research questions but may obscure subtleties in data (e.g. Faniel et al. 2013; Kansa et al. 2011; Lake 2012). The uniform presentation of data may suggest the information is a “clean” data set but researchers who conduct analyses of these databases must employ the same considerations of data survey, sampling, and biases as those scholars conducting field research with additional tiers of bias added.

The archaeological investigations and data-entry themselves act as taphonomic processes affecting the understanding of a site. There is variable preservation of information, both at its acquisition and recording as well as in the transcription and data-entry phases, as information is "standardized" across fields and where extraneous or anomalous information may be "lost" where it does not fall within established and explicitly requested attribute fields. This is compounded if the data originates from multiple field projects, as the database is likely to include information which in its primary form reflects projects conducted under different research standards or investigative aims. Many databases include "legacy" records from 20th century investigations conducted under very different practices. Government-based databases are also likely to include sites found through Cultural Resource Management work. The aims of CRM research are often satisfied with surface surveys, so the depth of information is more limited than data gained through excavation. This does not negate the value of survey, as archaeologists have long recognized that survey data is essential to region-based inquiries (e.g. Ammerman 1981; Bower 1986). The inferential potential of surface data can be extensive, as scholars apply analytic techniques to this data, such as nearest-neighbor, point-density, or correlation with environmental features. The proliferation of GIS expands the ability to conduct these surface analyses and maintain relations between data and inference at multiple scales.

Because cultural and environmental boundaries do not always correlate with contemporary political boundaries, regional studies may require the integration of data from multiple databases. This raises questions about where the disjuncture in data acquisition or recording occurs. Within the United States, there are extensive federal standards regarding the completion of archaeological survey on public lands or with projects using federal funding. However, additional regulations and the management of site records, including whether or not to generate a digital database and its structure, are left to the discretion of each state. River basins, such as the Potomac, may cross multiple administrative boundaries. The inclusion of the Saint John River Basin allowed me to consider not only the variance between states but across international boundaries. Unlike the United States, where federal standards must be applied in all States, the regulations for archaeological survey as well as data management in Canada are, for the most part, provincially regulated, with the exception of National Parks and National Historic Sites, which are administered by Parks Canada. Military bases may adhere to the regulations of the province in which they are located but this is at the discretion of the base commander. The biggest difference between the United States and Canada is associated with mandated archaeological actions associated with funding. In Canada, private land is subject to the same provincial rules as crown land regardless of where the funding for construction originates, while private property is exempt from federal regulations in the United States.

Across these managerial contexts, archaeological data is subject to different proprietary pressures relative to other types of spatial information, which may create challenges in using large databases particular to the discipline. In many cases, the locational data is intentionally obscured. Open-access databases such as the Digital Index of North American Archaeology (DINAA) supported by the Alexandria Archive explicitly exclude any locational data. This information can be difficult to obtain even within restricted-access databases, such as those maintained by government officers for which researchers must demonstrate academic intent and affiliation. The Virginia Department of Historic Resources provided decimal digit locational information for sites but raised a potential for introducing obfuscation in post-processing. The department requested that all final images be evaluated by their office; images at a sufficient scale to identify precise site locations would require a similar randomization of site points, although precise data was made available for analytic purposes. In comparison, the Maine Historic Preservation Commission would not provide site information in specificity beyond a ½ km area within which the site was located even for analysis. The New Brunswick agency did not respond to data inquiries. This means that an image might not reflect the interpretations; for instance, a site in close proximity to a spring might be displayed separately. These practices for obfuscation can be rationally, even responsibly, credited to the desire to safeguard sites from looting. Though the practice itself may not warrant critique, it is necessary to recognize the effect this can have in the utility of data analysis.

Within archaeological data management, there is a striking difference in treatment of sites dating to the pre-colonial versus historic periods. In the Virginia records, architectural and archaeological records are both within the access-restricted V-CRIS database but this is not a universal practice. Although there is stringent protection for pre-colonial archaeological sites established by federal regulations, historic sites are often readily identifiable and locatable. In Maine, access to archaeological data was restricted by policy and practice, yet 28,675 historic, above ground sites are readily viewed through the Maine Historic Preservation Commission's Cultural & Architectural Resource Management Archive (CARMA)[13], which provides a public map viewer including coordinates and imaging with Google Street View. The CARMA website emphasizes in bold print that it does not contain archaeological sites, though the threshold for that classification is undefined. As historic sites are likely to contain architectural elements with

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[13] An overview and access portal to this database can be found at the web address http://www.state.me.us/mhpc/carma_disclaimer.html

a comparable market value for looting materials sufficiently generic to obscure provenience, this is an interesting reflection of how historic sites are treated differently from prehistoric sites.

These challenges of creating or using a database and the efforts to address them are not new. The simplistic answer to these concerns is to adopt a suite of “standards” of data collection and recording. In practice, however, efforts to institute strict data collection, identification, and analytic standards is an impractical solution. The efforts undertaken in the early 1970s by the Southwest Anthropological Research Group (SARG) tested this approach and ultimately demonstrated the impracticality of this approach. The group was a co-operating and collaborative undertaking, in which several dozen archaeologists established a common research design and research strategy that was implemented across individual research projects (The Members of SARG 1974). This project was designed to generate a shared database. The endeavor showed the impact of how questions affect data collection. One of the significant modifications adapted after the initial design was a switch from interval data, i.e. proximity to arable lands, to ordinal location data which preserved information suited to a broader set of questions (Gaines and Most 1982). While SARG has been credited with establishing foundational standards for database structures and sharing, as well as initiating data-driven site modeling (Verhagen 2007), the consortium ceased to operate as a collaborative endeavor and the use of common criteria became secondary to the individual exigencies of each project.

The answer to rectifying challenges of datasets is likely not in the standardization of data collection but in the expansion of datasets. This expansion must include both the scope of data included and the depth of data associated with each projects. The Digital Index of North American Archaeology (DINAA) is a multi-institutional collaboration for site databases in the eastern United States. As an open-source database, the content has no spatial information.

Additionally this resource does not extend beyond Pennsylvania to the north nor west past the Mississippi River. The other frequently noted resource, the Digital Archaeological Record (tDAR) in an international digital repository for archaeological records, housed at Arizona State University. This resource has potential value as more scholars contribute primary data to the inventory but in its current state, it remains difficult to extract primary data from the database. Many scholars include only their research papers and the importation of extant databases means that many searches for Maine or Virginia data produced citations rather than full documents or primary data.

As digital storage space is increasingly affordable and even personal use hardware and software are able to filter and format large amounts of data, the ability to process and extract knowledge from data will improve. In some cases, we may be able to automate the complete of data fields, for example, the Virginia dataset might define drainage affiliations through GIS. This process however, would be further rectified by including additional fields. For example, when identifying with which hydrologic unit level a site is associated, it would be beneficial to know how that information was ascribed, e.g. whether the affiliation is reported by the archaeologist or computer generated. Similarly, in using the Virginia dataset, this additional information would have more quickly communicated software errors, though it risks creating a false dichotomy in trust-worthiness of self-reported or computer-generated attributes.

An additional onus falls on those researchers who use large databases. Though it makes for dry reading, scholars must be exceptionally detailed in describing how they approach deriving knowledge from databases. This not only ensures that a project is replicable but helps to establish common knowledge in how to deal with frequent vagaries so that they may be addressed with some standardization (e.g. Marwick 2017). Without being excessively detailed about how the data is cleaned and processed, the content generated by an analysis risks further obscuring the database rather than contributing to knowledge and functionality to expand its utility.

As archaeological projects are often assessed against environmental contexts, a discussion of large and open-access databases requires a reiteration that these, too, are less objective than may be recognized. These databases are also subject to variance in collection and processing strategies. Additionally, many datasets are produced through methods that may further obscure subjectivity. This was evident in the course of this research. Watershed boundaries are, by definition, delineated based on topographic features however the depiction and designation of these boundaries is dependent on the initial elevation data and processing. This project initially drew on boundary designations of the James River Basin as defined by the Commission for Environmental Cooperation, however the level 6 hydrologic unit defined by other common data sources, such as "Hydrosheds," an independently produced dataset widely used in hydrology projects (Lehner et al. 2008), and the US Watershed Boundary Dataset both incorporate more terrain in the "equivalent" catchment area associated with the James River. These catchments, in turn, form the basis of delineating stream networks which are derived from elevations within a watershed boundary. These stream locations and even stream orders are then heavily influenced by the initial data and the subsequent methods used. Though environmental data is widely available, even seemingly objective information can obscure variation and nuance.

If we consider archaeology and data aggregation as an additional step in the formation of an archaeological record, the reliance on meta-data is a new manifestation of "surface" survey. If we are to argue that database research is a vital component of future research, we must consider the viability of database-driven inference, without requiring one to "dig" into the site's records.

The summation of this is that the use of large databases requires significant awareness in the processing and application. This does not mean that it is an unproductive endeavor. The extraction of knowledge from datasets, despite vagaries with any specific data point, can show informative patterns and trends at a large scale.

Understanding the Hydrosocial System in Archaeological Contexts

The broader aim of this research is to address about how people perceive and employ waterways and how to access this culturally-contextual decision making through archaeological research. In the summation of this project, I discuss the practicalities, implications, and future of this work from both a methodological and a theoretical perspective. Rivers are simultaneously large-scale features spanning a geographic area through connected stream networks and localized features, defining the ecological niche within the bounds of its channel and banks. Similarly, an archaeological understanding of human interactions with rivers must be considered at multiple scales. The approach used in this dissertation is a study of site proximity to waterways.

Knowing where sites are located in relation to a waterway first requires a precise understanding of the river channel. One must also be able to reliably calculate the course of flowing water. To assess this from an archaeological perspective requires evaluating the stability of water channels and attempting to produce a stream network devoid of historical effects. Though the degree to which human and river movements affect one another preclude a “pristine” river network, a reconstruction of river networks requires addressing the effects of dams and impoundments. Many activities, such as logging, impact waterways because the reduced land cover can increase runoff, affecting water quality and causing sediment erosion and deposition that can alter the course of the river channel itself. This extent of human impacts extend to processes we do not yet fully understand. One of the major economic resources of colonialist endeavors was beaver pelts, a decrease in these populations would have an impact on river channels and flow of rivers, yet we are increasingly cognizant of the impact of animal populations within catchments (e.g. Ripple and Beschta 2012). Reconstructing ancient stream channels can therefore be difficult. Streams are likely to shift course in regions with loose sedimentation prone to erosional shifts, such as river valleys and plains. In these contexts, the sinuosity and variability in course is more readily observed through remote sensing. Such observations are much more difficult in heavily forested regions, where vegetation obscures soil differentiation. Similarly difficult to assess are diachronic changes in volume or rate of flow within a stable channel.

The discovery of archaeological sites and an understanding of the extent to which they are representative of either settlement or survey systems is critical. There may be a bias by which archaeological sites near water are more frequently identified than interior sites. The contemporary human-hydrology entanglement prioritizes occupation and recreation near water as well as infrastructure such as dams that would lead to survey or incidental site discovery along river banks. This may create a biased view of settlements near waterways but a meaningful assessment is dependent on these locations being preferentially selected by communities in the past, which requires a confirmation of the absence of settlements away from water. However, there is often relatively less pressure to survey interior regions. Modern people and infrastructure tend to develop around waterways even when we do not depend on natural water courses for transportation or subsistence. As a result, most archaeological research is conducted in these areas. One future elaboration on this research would be to focus on a survey of interior terrestrial areas in order to establish site presence or absence in areas least accessible to water, as supplement to the known sites near water. One exception is CRM for utility infrastructure, which may cross-cut otherwise under populated areas. Although inland surveys might complement an interpretation of sites near water, the political or ecological environment may preclude terrestrial surveys.

In regions where an areal survey of evenly spaced transects is not viable, linear surveys may help extend coverage into otherwise under-evaluated regions. This is particularly valid in regions where the terrain is difficult to traverse, suggesting that past communities would have been similarly restricted in movements. In Maine, for example, the low population density and dense vegetation may preclude most interior survey, however these regions are riven with waterways. This recommendation for future survey is predicated on the successful application of linear surveys elsewhere. As John Bower (1986) notes, his surveys in sub-Saharan Africa depict the value of surveying roads, especially those that are deep-cut, as cultural material may be exposed in the walls. Though his application concentrates on regions of dense individual land-holdings, this approach is readily transposed to riverine contexts through heavily forested areas, where a shallow draft watercraft might penetrate the landscape. This is similar to Norder's (2003) dissertation, though that research sought to increase site interpretation rather than identification based on waterway accessibility. Norder's study sought to contextualize sites based on how they were accessed and who was likely to "experience" the rock art from a given perspective. His study was not intended to identify sites but to place them in a context of landscape experience and inter-personal information exchange. A site survey based on this linear approach, however, would allow not only an experiential aspect of the landscape but could expand the feasibility of survey in riverine environments.

Interpretation is a product of our own heuristic perception of waterways as affordances of travel. We readily consider rivers, known conduits in the present, to have held a similar value in the past and certainly archaeological and ethnographic cases attest to this use in many contexts. Far less attention has been given to other potential functions of waterways in the past. The United States border between Maine and Canada is defined in part by the Kelly Rapids and the Saint John River and a significant portion of the United States-Mexico border is defined by the Rio Grande. We readily accept this boundary affordance of rivers in contemporary contexts and should not negate this potential use among past communities.

Assessing the cost associated with water-based movement remains difficult, even with advances in GIS. It is difficult to include terrestrial water in an analysis of ancient mobility. While it is easy to say that flowing water is important in understanding past mobility, it is difficult to include terrestrial water in these analyses. Least-cost path analysis focuses on slope and linear distance. Projects that have sought to assess water-based travel are often within the context of associating networks with water-travel across places where the water is expansive and flat, such as the Mediterranean (e.g. Leidwanger 2013). The amount of data available in GIS regarding stream order, slope, and permanence suggest that it should be possible to quantify mobility and landscape access in terrestrial waterways but that this would require the incorporation of cultural effects to accurately weight the effects of these variables in least cost path calculations (e.g. Gustas and Supernant 2017; Supernant 2017).

Scale of a waterway is also important: a big river like the Mississippi is always an access route, while a mountain tributary may provide access to highlands but is not likely to be a conduit for social interactions. Even then, the larger waterways are associated with costs, both practical in terms of exposure, and cultural through accessibility. Most terrestrial rivers are, however, somewhere in between these extremes. Building a GIS to assess these conditions requires consideration of both environmental variabilities between seasons, through time, and across culturally-sourced pressures and perceptions. In reality, GIS calculations are devoid of the complex emic perspectives and seasonality that affect both the physical and phenomenological perceptions of water and thus makes it much more difficult to assess the cost of travel. Such calculations may be possible through the aggressive manipulation of values associated with cells in order to lend cultural weight to environmental features.

The final component is in determining the extent to which people traveled by or around waterways. The model for archaeological materials associated with each use, as laid out in Chapter Five, presents a guide for future research. The chapter lays out the particular correlates within archaeological sites that would connect the localized tie between a site and waterway with a broader perspective of how that site is associated with resource procurement zones, and more importantly, economic or social networks. The extent and degree of connectivity within this social structure may then compared with stream networks and complete various path analyses to project the cost of land versus water travel within this interaction sphere.

Despite the challenges associated with conducting an archaeology of river use, the endeavor remains a promising undertaking for future research. The entanglement between flowing water and societies mean that an archaeological investigation can provide insights to two closely related but inverted questions that can both drive research projects but also contextualize findings.

The first question considers how characterizing a community’s use of waterways can yield insight into that culture. Such an analysis can complement extant work on settlement and subsistence practices, as well as social networks, by highlighting the paths by which people traveled through their environments and how landscape features, particularly waterways, may prompt certain actions. In many cases, new responses to waterways indicate a perception of their utility, based on the cultural requirements and values placed on these features rather than a significant change to the river as a physical features. Where discrete communities co-existed or where smaller groups were dispersed but identified within a broader social and political structure, it can be difficult to discern the spatiality associated with maintaining these relationships at different scales. Rather than draw assumptions regarding settlement territory, a study of water may show the boundaries of these areas and the time or effort associated with aggregation periods and the way that landscapes fluctuate seasonally. In an archaeological context, this allows the researcher to begin associating behaviors with possible insights into how agents themselves perceived the landscape, better illustrating the intentionality behind peoples' use of landscapes as conduits, obstacles, boundaries, or barriers to movement or interaction.

The second question is whether we can use cultures' engagement with waterways to construct a broader understanding of water and its influence within the human-hydro system. Though scholars are likely to suggest that water contexts are very different, they are no more varied than humans. If the field of anthropology can explicate basic patterns of human action while acknowledging nuance, there is no reason we cannot project the same expectations of predictability onto rivers despite many contributing variables. In this case, we can expect that humans and rivers have some predictable interaction patterns. Across the broad scope of uses, this generates numerous interactions but the variations are manageable when focus remains on biomechanical activities, such as social interactions mediated by riverine access and mobility rather than explicitly religious practices.

Both of these inquiries have implications for contemporary communities. As the world faces increasing competition for this essential but finite resource, a deeper understanding of human behaviors and the influence of water will help inform practices. In some parts of the world, there is competition to access water and so understanding the various perspectives may help mediate these conflicts. In other parts of the world, communities struggle to frame the global pressures for water with sufficient immediacy to change human actions. Understanding how communities perceive water may inform our approach to the human-hydro relationship and anticipate changes to that relationship. By studying a wide range of cultures' relationships with water, we can better characterize the extent of its effects and then use that to better address conservation issues or anticipate future sources of conflict in the human-hydro relationship.

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