

Anthropological Archaeology Underwater:
Hunting Architecture and Foraging Lifeways beneath the Great Lakes

by

Ashley Kate Lemke

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Anthropology)
in the University of Michigan
2016

Doctoral Committee:

Professor John M. O'Shea, Chair
Research Associate Professor Michael B. Collins, Texas State University
Professor Daniel C. Fisher
Professor Kent V. Flannery



© Ashley K. Lemke 2016

DEDICATION

Anthropologists have made a study of kinship – the ties that bind one human to another. Whether fictive, or familial, meat-sharing partners, joking relationships, or mentors; it is with this broadest definition that I dedicate this work to my kin. To all of you, and to each of you, there is no one I would rather be bound to.

ACKNOWLEDGEMENTS

Every good anthropological archaeologist knows it's not the things, but the people that really matter. With that, I send my sincere thanks and gratitude to the following:

The University of Michigan, Museum of Anthropological Archaeology provided the institutional support for the research conducted specifically for this dissertation, as well as my entire career in Ann Arbor. Those individuals that have been particularly helpful include Kay Clahassey, Amy Winchester, and Lauren Fuka. Funding for this research was provided by the National Science Foundation as well as the John and Linda Halsey Great Lakes Research Fund. Additionally, I'd like to thank the Michigan Archaeological Society for all their support and interest over the years, as well as the images used in Chapter 4.

The AAR Research Team represents an ideal collaboration of colleagues and dear friends and this research relied on my partnerships with Lisa Sonnenburg, Robert G. Reynolds and his graduate students at Wayne State University including, Dustin Stanley, Thomas Palazzolo, Areej Salaymeh, and in memory of Gerald Larson, as well as the help of University of Michigan undergraduate students Megan Krajewski, Tom Steffans, and Briana Gladhill and of course, Michigan Adventure Diving and the Great Lakes Wrecking Crew, most especially Tyler Schultz, Michael and Lori Courvoisier, Derek and Chantelle King, Chris Gula, Annie Davidson, and Betsy Campbell. My sincere thanks for research support go to Jamey Anderson, Colin Tyrrell, Guy Meadows, and Brian Abbott. My current and future research would be impossible without

Blue Traveler (Parker Boats) and Jake (Outland Technology). Overall, I can never thank John O'Shea enough for taking me aboard and introducing me to the Greatest of Lakes.

My fellow students at UMMAA and all my dear friends – thank you! Most especially, Kimi Swisher, Tim Everhart, Kara Pazan, Györgyi Parditka, and Eric Rupley. Every finishing graduate student needs to be reminded of how they felt at the beginning. For this, I thank the 2015 Michigan Archaeology cohort (or “Brohort”) Jim Torphy, Nick Trudeau, and Yuchao Zhao. Jo Osborn and Katie Lacy are my dearest friends and truly brilliant women whom I am extremely proud to call colleagues. Along those lines, I'd like to thank my Anthropology family especially Geoffy Hughes and most of all - Bethany Hansen. I cannot imagine where I would be without you.

Michael Collins for always believing in me. The Gault Family – all of you! Especially Clarke Wernecke, Nancy and Tom, Cinda Timperley, Robert Lassen (and Carol and Peter!), Jen Anderson, Sergio Ayala, Brendan Nash, and in loving memory of Sam who taught me that archaeologists are the cowboys of science.

The Ruthven Museum and all its society. Dan Fisher and Scott Beld have earned my deep gratitude, the former for serving on my committee, the later for fantastic talks and field experiences – and both for the opportunities to meet the Morrison Lake and Bristle Mammoths. My deep and unending appreciation goes to the UMMAA Curators. Robert Whallon for Archaeology I – it changed my life. Raven Garvey for endless advice and fun. Kent Flannery and Joyce Marcus, because of you I can take my trowel anywhere in the world.

John O'Shea – it's been a joy and privilege, Captain. Everything else you know.

And of course, and always, my family: Mom, Dad, and Big Sisters.

TABLE OF CONTENTS

| | |
|---|------|
| DEDICATION | ii |
| ACKNOWLEDGMENTS | iii |
| LIST OF TABLES | viii |
| LIST OF FIGURES | xi |
| CHAPTER 1 Introduction | 1 |
| <i>Organization</i> | 5 |
| <i>A Note about Terminology</i> | 8 |
| <i>A Note about Dates</i> | 9 |
| CHAPTER 2 The Problem with Studying Hunter-Gatherers in the Past | 10 |
| <i>Introduction</i> | 10 |
| <i>Normative Views of Hunter-Gatherers in Anthropology</i> | 11 |
| <i>Limitations of the Ethnographic Record</i> | 12 |
| <i>Enter Archaeology</i> | 16 |
| <i>Research Philosophy</i> | 17 |
| CHAPTER 3 Hunter-Gatherers and Hunting Architecture | 19 |
| <i>Introduction</i> | 19 |
| <i>Definition and Problem Orientation</i> | 21 |
| <i>A Global Phenomenon</i> | 21 |
| <i>Hunting Architecture and Hunter-Gatherer Lifeways</i> | 57 |
| <i>Archaeology of Hunting Architecture</i> | 65 |
| CHAPTER 4 The Ancient Great Lakes: Paleoenvironment and Archaeology throughout the Pleistocene-Holocene Transition | 88 |
| <i>Introduction</i> | 88 |
| <i>Lake Levels and Paleoenvironment during the Pleistocene-Holocene Transition</i> | 91 |

| | |
|--|-----|
| <i>Human Adaptations in the Pleistocene-Holocene Great Lakes</i> | 109 |
| <i>Discussion</i> | 131 |
| CHAPTER 5 Archaeology and Anthropology of <i>Rangifer</i> Hunting | 134 |
| <i>Introduction</i> | 134 |
| <i>Rangifer Natural History</i> | 135 |
| <i>Archaeology of Rangifer Hunting</i> | 147 |
| <i>Ethnographic Cases of Rangifer Hunting Architecture</i> | 183 |
| <i>Ethnographic Analogy and the Archaeology of Rangifer Hunters</i> | 193 |
| CHAPTER 6 The Evolution of Submerged Site Archaeology | 205 |
| <i>Introduction</i> | 205 |
| <i>History of Archaeology Underwater</i> | 207 |
| <i>The Investigation of Submerged Sites</i> | 218 |
| <i>The Importance of Submerged Sites</i> | 220 |
| <i>Conclusion</i> | 227 |
| CHAPTER 7 Interdisciplinary Investigations on the Alpena-Amberley Ridge | 228 |
| <i>Introduction</i> | 228 |
| <i>The Study Context</i> | 229 |
| <i>Environmental Modeling: Geoarchaeological and Paleoenvironmental Research</i> | 242 |
| <i>Agent-Based Computer Simulation</i> | 256 |
| <i>Archaeological Research</i> | 261 |
| <i>Conclusion</i> | 296 |
| CHAPTER 8 A Model of Foraging Lifeways on the Alpena-Amberley Ridge | 298 |
| <i>Introduction</i> | 298 |
| <i>Hunting Architecture and Material Correlates on the AAR</i> | 298 |
| <i>Discussion and the Creation of a Model</i> | 312 |
| CHAPTER 9 Testing the Model: Alpena-Amberley Ridge Results | 320 |
| <i>Introduction</i> | 320 |
| <i>New Research</i> | 321 |
| <i>Results</i> | 331 |
| <i>Evaluating the Model</i> | 365 |
| <i>Conclusion</i> | 374 |

| | |
|---|-----|
| CHAPTER 10 Conclusions | 376 |
| <i>Introduction</i> | 376 |
| <i>Great Lakes Caribou Hunters</i> | 377 |
| <i>Hunting Architecture and Foraging Lifeways</i> | 386 |
| <i>Anthropological Archaeology Underwater</i> | 388 |
| <i>Future Prospects</i> | 390 |
| REFERENCES CITED | 392 |

LIST OF TABLES

| | |
|---|-----|
| Table 3.1. The annual cycle of Tibetan antelope and associated traditional hunting strategies, (adapted from Huber 2005) | 28 |
| Table 3.2. Estimated number of people participating in communal caribou hunting with hunting architecture | 60 |
| Table 3.3a. Formal attributes of hunting architecture components and associated animal state, (adapted from Friesen 2013, see also O’Shea et al. 2013:41, Table 1) | 72 |
| Table 3.3b. Formal attributes of hunting architecture components and associated animal state, (adapted from Friesen 2013, see also O’Shea et al. 2013:41, Table 1) | 73 |
| Table 3.4. Inferring social and economic variables from hunting architecture | 75 |
| Table 3.5. Relationship between prey body size, typically butchering behavior, an archaeological expectations for hunting architecture sites | 79 |
| Table 4.1. Ancient Great Lakes water levels | 93 |
| Table 4.2. Major advances of the Laurentide Ice Sheet and associated lake stages, (adapted from Carr 2012:34, Table 2.1; Karrow 2004, Fig.1.1) | 95 |
| Table 4.3. Primary phases of Pleistocene-Holocene transition vegetation succession in the Great Lakes | 97 |
| Table 4.4. Lake Stanley stages | 103 |
| Table 4.5. Generalized early Holocene vegetation succession in the Lake Huron basin | 106 |
| Table 4.6. Relevant culture history in the eastern Great Lakes | 112 |
| Table 4.7. Absolute dates from Paleoindian sites in the Great Lakes basin | 113 |
| Table 5.1. <i>Rangifer</i> seasonal round | 142 |
| Table 5.2. Local extinction of Pleistocene reindeer | 149 |
| Table 5.3. Upper Paleolithic chronology and primary phases | 156 |
| Table 5.4. Radiocarbon dates from the Whipple site, (adapted from Curran 1984) | 176 |

| | |
|---|-----|
| Table 5.5. The antiquity of <i>Rangifer</i> hunting strategies | 180 |
| Table 5.6. Ethnographic studies of caribou and reindeer hunters and hunting strategies | 184 |
| Table 5.7. Early accounts of ethnographic groups using caribou fences/drive lanes, (adapted from Birket-Smith 1929:254-255) | 185 |
| Table 5.8. Ethnographic descriptions of caribou hunting architecture in North America | 187 |
| Table 5.9. Time periods and caribou hunting in Greenland, (adapted from Pasda 2014) | 198 |
| Table 7.1. Summary of general paleoenvironmental results from the AAR, (adapted from O’Shea et al. 2014, Table S1) | 249 |
| Table 7.2. Preserved wood samples from the AAR and their associated radiocarbon dates (when available), last date was run on charcoal recovered from the middle of a stone ring. Dates from Lake Stanley/AAR dryland are bold | 250 |
| Table 7.3. Types of stone constructions on the AAR and number of occurrences in each research area, (adapted from O’Shea 2015b:132, Table 10.1) | 265 |
| Table 7.4. Four primarily localities with hunting architecture on the AAR | 266 |
| Table 7.5. Representative sample of Open or V-shaped structures on the AAR | 272 |
| Table 7.6. Representative sample of Enclosed structures on the AAR | 273 |
| Table 7.7. Representative sample of Linear structures on the AAR | 276 |
| Table 7.8a. Localities on the AAR in Area 1 which have been tested for archaeological materials (n=12) (These do not include areas where only environmental samples were taken by a ponar geological sampler) | 289 |
| Table 7.8b. Localities on the AAR in Area 3 which have been tested for archaeological materials (n=19) (These do not include areas where only environmental samples were taken by a ponar geological sampler) | 289 |
| Table 7.9. Lithic artifacts from submerged sites on the AAR, (update to Lemke 2015c) | 291 |
| Table 8.1. Interrelated social and economic variables of hunter-gatherer lifeways utilizing hunting architecture. Archaeological expectations have been generated for each variable based on a global comparison of hunting architecture presented in Chapter 3 | 299 |
| Table 8.2. AAR hunting architecture and inferred season of use | 308 |
| Table 8.3. Interrelated social and economic variables of hunter-gatherer lifeways utilizing hunting architecture. Dark shading indicates the expectations met by the AAR data, lighter shading indicates the expectations minimally supported by the AAR data | 312 |

| | |
|--|-----|
| Table 8.4. Generalized model of human occupation and caribou hunting on the AAR | 318 |
| Table 9.1. Alternative hypotheses for the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR | 326 |
| Table 9.2. Targets in the Esker Locality and their interpretation | 357 |
| Table 9.3. Newly discovered human modified structures in the Overlook and Esker Localities | 359 |
| Table 9.4. Samples collected | 360 |
| Table 9.5a. Testate amoebae and paleoenvironmental summary, Contact 4 | 361 |
| Table 9.5b. Testate amoebae and paleoenvironmental summary, Contact 6 | 361 |
| Table 9.5c. Testate amoebae and paleoenvironmental summary, Overlook Locality, Contact 1 | 362 |
| Table 9.6. Cultural material | 363 |
| Table 9.7. Newly discovered human modified structures, type, and inferred group size | 366 |
| Table 9.8. Hunting architecture with measurable orientations and inferred season of use | 368 |
| Table 9.9. Generalized model of human occupation and caribou hunting on the AAR | 370 |
| Table 9.10a. Alternative hypotheses for test the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR. Shaded Area indicates results from the Esker Locality, First Element | 372 |
| Table 9.10a. Alternative hypotheses for test the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR. Shaded area indicates results from the Esker Locality, Second Element | 373 |

LIST OF FIGURES

| | |
|---|----|
| Figure 2.1. Historic decrease in hunting and gathering societies, 10,000 cal yr BP to 1972, (Frontispiece from <i>Man the Hunter</i> , Lee and DeVore 1968) | 15 |
| Figure 3.1. The Sayarim Kite, head of the kite is located inside a narrow wadi (Nadel et al. 2013, Figure 2) | 23 |
| Figure 3.2. Ariel view of the Pitam Kite, looking West. Animal trails are visible crossing the kite (Nadel et al. 2013, Figure 5) | 23 |
| Figure 3.3a. Ariel view of the Nahal Horsha kite, looking north (Nadel et al. 2013, Figure 9), b. Schematic section of Nahal Horsha (adapted from Nadel et al. 2013, Figure 11) | 24 |
| Figure 3.4. General view of Nahal Horsha with arms converging near the natural cliff (Nadel et al. 2013, Figure 12) | 25 |
| Figure 3.5. Funnel shaped game drives in Tibet (dzaekha) for hunting Tibetan antelope into small narrow areas (Fox and Dorji 2009:206, Figure 3) | 29 |
| Figure 3.6. Leg trap (khogtse) used within hunting drive lanes in Tibet, and one side of a trap barrier system with a hunting blind/depression area located near the narrow neck of the barrier where the traps are placed (Fox and Dorji 2009:207, Figure 4) | 30 |
| Figure 3.7. Hunter holding a leg trap (khogtse) (Huber 2012:198, Figure 11.3) | 30 |
| Figure 3.8. Locations of dzaekha traps maked by “T”, large arrows indicate major migratory routes of Tibetan antelope to a known calving area (Fox and Dorji 2009:207, Figure 5) | 31 |
| Figure 3.9. Hunting blind in Tibetan antelope wintering grounds, adjacent to a winter water source (Fox and Dorji 2009:207, Figure 2) | 32 |
| Figure 3.10. Ancient remains of a trap for chaccu (Inamura 2006:47, Figure 19) | 33 |
| Figure 3.11. Schematics of Archaic camelid hunting traps in the Andes (Aguilar 1988) | 34 |
| Figure 3.12. Hunting architecture in the Antofalla valley (Moreno 2012:108, Figure 3) | 35 |

| | |
|--|----|
| Figure 3.13. Hunting architecture in the Antofalla valley, A: alignment, B: board, C and D: landmarks, E: shelter, F: water hiding (Moreno 2012:110, Figure 6) | 36 |
| Figure 3.14. Apparent drive structures in Chile, scale bar is 50 meters (Moore 2014) | 37 |
| Figure 3.15. Apparent drive structures in Peru, scale bar is 50 meters (Moore 2014) | 38 |
| Figure 3.16. <i>Gran Chacu</i> (Inamura 2006:43, Figures 10, 12) | 39 |
| Figure 3.17. Historic pronghorn hunting architecture sites labeled “Indian Corral” north of Maltin, Box Elder County, Utah, Map by Henry Fitzhugh 1884 | 43 |
| Figure 3.18. Ariel view of the Barnett pronghorn hunting site, Canada with the two drive lanes outlined (Brink 2013, Figure 3) | 45 |
| Figure 3.19. Ariel oblique view of the Barnett pronghorn hunting site, arrows indicate the likely direction of animal movement from the surrounding landscape into the wide opening of the drive lanes (Brink 2013, Figure 4) | 45 |
| Figure 3.20. Ariel oblique view of the Barnett pronghorn hunting site looking northeast, left arrow indicates a circular cluster of stones, right arrow marks depression at the end of the drive lanes (Brink 2013, Figure 7) | 46 |
| Figure 3.21. Bighorn sheep catch pen and drive lanes at the Black Mountain Sheep Trap (Adapted from Frison et al. 1990:Figure 12.4) | 47 |
| Figure 3.22. Rollins Pass | 48 |
| Figure 3.23. Drive lane and hunting blind at the Olson site (LaBelle and Pelton 2013:Figure 5) | 49 |
| Figure 3.24. Generalized schematic of caribou drive lane (Gordon 1990:297) | 51 |
| Figure 3.25. Hunting blind and artifact distribution (LaBelle and Pelton 2013, Figure 15). Circles indicate effective bow and arrow range plotted as 18 meters from the center of each hunting blind – a likely area for projectiles to be located | 77 |
| Figure 3.26. Game traps/kites in southern Levantine Negev, bold “V” are kites on hilly terrain. Site names 1-2: Horsha north and south, 3:Achshuv, 4-5: ‘Ein Qadis, 6: Pitam, 7: Harut, 9: Eshel, 10: Sayarim, 11-13:Samar (Nadel et al. 2013, Figure 1) | 80 |
| Figure 3.27. Hunting architecture sites in the Great Basin region showing hunting architecture sites and rock art (Hocket et al. 2013:68 Figure 4) | 81 |
| Figure 3.28. Map of Tulugak Lake, Alaska, showing the microregional layout of Nunamiut settlements, caribou hunting architecture, and caribou migration trails (Binford | |

| | |
|--|-----|
| 1978:206) | 82 |
| Figure 3.29a-b. Rock art from the Sinai Peninsula depicting kites (adapted from Bar-Oz and Nadel 2013, Figures 2-3) | 83 |
| Figure 3.30a-c. Rock art depicting camelids in a drive lane and corral hunting structure in Peru (Hostings Figures 8-9, 10b, 11) | 84 |
| Figure 3.31. Rock art depicting bighorn sheep trap | 86 |
| Figure 4.1. The Lake Stanley stage and the AAR Grey/blue areas indicate ancient water levels, white areas are dry land, solid lines indicate the modern outlines of the state of Michigan, and Lakes Michigan (to the west) and Huron (to the east). Line with two arrows indicates the AAR | 90 |
| Figure 4.2. Lake Algonquin | 95 |
| Figure 4.3. Paleovegetation in Michigan at ~ 11,300 cal yr BP (9900 14C yr BP), post Lake Algonquin, early Lake Stanley, (adapted from Kapp 1999 Figure 2.6) | 101 |
| Figure 4.4. Lake Stanley | 103 |
| Figure 4.5. Lake Huron basin bathymetry. All orange and yellow areas would have been dry land during the Lake Stanley stage | 104 |
| Figure 4.6. Lake Nipissing | 108 |
| Figure 4.7. Submerged tree stump in Lake Huron. Image courtesy of Luke Clyburn | 108 |
| Figure 4.8. Great Lakes Basin with primary sites discussed in the text. 1. Hiscock; <i>Gainey Phase Sites</i> : 2. Gainey, 3. Udora, 4. Sandy Ridge, 5. Halstead, 6. Nobles Pond; <i>Parkhill Phase Sites</i> : 7. Leavitt, 8. Barnes, 9. Thedford II, 10. Parkhill, 11. Dixon, 12. McLeod, 13. Fisher; 14. Crowfield, 15. Holcombe, 16. Hi-Lo, 17. Cummins, 18. Sheguiandah | 116 |
| Figure 4.9. Gainey Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Dan Wymer, Don Simons, and George Davis. Photographs by Tim Bennett and Don Simons | 119 |
| Figure 4.10. Barnes Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Chippewa Nature Center, Don Simons, Doyle Smith, Bernie Spencer, Dan Wymer, and George Davis. Photographs by Tim Bennett and Don Simons | 122 |
| Figure 4.11. Hi-Lo Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Doyle Smith, Bernie Spencer, Dan Wymer, and | |

| | |
|--|-----|
| Tim Bennett. Photograph by Tim Bennett | 127 |
| Figure 4.12. Early Archaic Kirk Corner Notched Projectile Points, 9500-8000 cal yr BP. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributor Dan Wymer. Photograph by Tim Bennett | 130 |
| Figure 4.13. Early Archaic Bifurcate Projectile Points, 9,000 – 7,800 cal yr BP. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Dan Wymer, Tim Bennett, Doyle Smith, and Bernie Spencer. Photograph by Tim Bennett | 131 |
| Figure 5.1. Barren-ground (<i>left</i>) and woodland (<i>right</i>) caribou antlers to scale (scale bar is 20 cm). Zoological specimens 63246 and 124573 from the University of Michigan, Museum of Zoology, Ann Arbor (see also Lemke 2015b:280, Figure 4) | 138 |
| Figure 5.2. Primary Eurasian prehistoric reindeer hunting sites mentioned in the text | 150 |
| Figure 5.3. Engraved images in El Buxú cave which represent fences or corral sections (Straus 1993:90). Images from Berenguer 1988 | 167 |
| Figure 5.4. Rock art depiction of reindeer hunting corral near Alta, Norway, dated using elevation above sea level to 5500-6000 cal yr BP (Helskog 2012, Figure 10) | 171 |
| Figure 5.5. Primary North American Paleoindian caribou hunting sites mentioned in the text .. | 174 |
| Figure 5.6. Ethnographic groups listed in Table 5.7 | 186 |
| Figure 5.7. Sketch of caribou hunting architecture by Copper Inuit Ikpakhuak, (adapted from Jenness 1922:151). A caribou is being driven toward three archers waiting in hunting blinds, dots and lines represent stone cairns, some elaborated with skin, bird wings, or caribou scapulae | 190 |
| Figure 5.8. A Koyukon caribou drive in 1866. “A kind of corral, or enclosure, elliptical in form, and open at one end, is made on deer-trail, generally near the outlet of a wood. The further end of the enclosed space is barricaded; the sides are built of stakes, with slip-nooses or loops between them. Herds of deer are driven in from the woods, and, trying to break from the trap, generally run their heads into the noose, tighten them, and so get caught, or are shot, whilst still bewildered, and running from side to side” (Wymper 1868:187-188) | 191 |
| Figure 5.9. A communal caribou drive at an artificial crossing place drawn by Inuit artist Talirurnilik (Saladin D’Anglure and Vezinet 1977) | 192 |

| | |
|---|-----|
| Figure 7.1. Caribou drive lanes on Victoria Island, Canada (<i>left</i>), and similar structure under Lake Huron (<i>right</i>). Top right: linear drive lane feature is indicated on side scan sonar by A, hunting blinds indicated by B, (adapted from O’Shea and Meadows 2009:10121, Figure 2) | 230 |
| Figure 7.2. Schematic diagram of the research design for investigating the Alpena-Amberley Ridge. The research design is nested and recursive – dashed lined reflect new information that is fed back into the computer simulation (O’Shea et al. 2013, Figure 2) | 232 |
| Figure 7.3. Research areas on the AAR | 233 |
| Figure 7.4. Area 1 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between 20 and 30 meters. Each swath is 200 meters wide. Dark areas on the mosaic indicate areas of sand | 235 |
| Figure 7.5. Area 2 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between ~30 and 40 meters. Each swath is 150 meters wide. Dark areas on the mosaic indicate areas of sand | 236 |
| Figure 7.6. Area 3 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between 20 and 30 meters. Each swath is 200 meters wide. Dark areas on the mosaic indicate areas of sand | 237 |
| Figure 7.7. Area 1 Multibeam Moasic, 115 km ² . Survey was conducted with a digital hull-mounted RS Sonic 2024 multibeam echosounder with a F180 vessel attitude and position unit | 238 |
| Figure 7.8. Freighter near marker buoy | 239 |
| Figure 7.9. Remote Operated Vehicle used on the AAR project. “Jake” Outland 1000 ROV, Depth rating of 1000 feet | 240 |
| Figure 7.10. Scanning Sonar used on the AAR project. Kongsburg MS1000 unit (model 1171), dual frequency | 240 |
| Figure 7.11. The AAR and associated Paleolakes, including Lake Hough | 243 |
| Figure 7.12. <i>In situ</i> rooted spruce tree | 244 |
| Figure 7.13. Backscatter imagery of Area 1. Lighter areas indicated sand | 245 |
| Figure 7.14. Area 1 side scan mosaic with major waterways colored in, and areas of marsh are indicated by thin dashes | 246 |
| Figure 7.15. ROV image of sand ripples and the ancient lake shore with preserved wood across | |

| | |
|--|-----|
| the boundary | 247 |
| Figure 7.16. Scuba divers measuring and sampling sand ripples | 248 |
| Figure 7.17a-b. Wood 1 <i>in situ</i> | 251 |
| Figure 7.18. Paleogeographic reconstruction of Areas 1 and 3 indicating primary microenvironments, (adapted from Sonnenburg 2015:160, Figure 12.8). (Note: large area in grey indicated “High Ground/Outcrop” in Area 3 has receive limited sampling, and areas of bare outcrop are likely overrepresented in this diagram) | 252 |
| Figure 7.19. Dated <i>Rangifer</i> remains from the Great Lakes Basin and ancient water levels. Curved line represents generalized high water and low water stands across the entire basin. The absence of dated remains during Lake Stanley indicates that a portion of archaeological and paleontological records from this time period are underwater (Lemke 2015b:279, Figure 3) | 255 |
| Figure 7.20. Geographic distribution of <i>Rangifer</i> remains by county in Michigan (Lemke 2015b:277, Figure 1) | 256 |
| Figure 7.21. Screen shot of the AAR virtual world with simulated environment and caribou | 257 |
| Figure 7.22a-b. Caribou migration routes across the central portion of the AAR as predicted by the computer simulation. North is up, contour interval is 5m, and colored/grayscale areas represent larger research areas (see Figure 7.3) which have been mapped using side scan and multibeam sonars. a. Fall migration routes. b. Spring migration routes | 259 |
| Figure 7.23. Dragon Drive Lane and hunting blind on side scan sonar with schematic | 261 |
| Figure 7.24. Wall ring hunting blind facing caribou trails, (adapted from Stewart 2015:91, Figure 8.9) | 263 |
| Figure 7.25. Hunting blind facing a river crossing, (adapted from Stewart 2015:94, Figure 8.11) | 263 |
| Figure 7.26. The Dragon Locality in Area 1 with hunting architecture sites indicated. The distribution of structures is overlain on the multibeam sonar mosaic of depth. The contour interval is 5 meters reported in depth below surface. The location labeled “complex line” is the Funnel site | 267 |
| Figure 7.27. The Overlook Locality in Area 3 hunting architecture sites indicated. The distribution of structures is overlain on the side scan sonar mosaic. The contour interval is | |

| | |
|--|-----|
| 5 meters reported in depth below surface | 268 |
| Figure 7.28. The Crossing Locality in Area 1 hunting architecture sites indicated. The distribution of structures is overlain on the side scan sonar mosaic. The contour interval is 5 meters reported in depth below surface | 269 |
| Figure 7.29. The Gap Locality in Area 3 hunting architecture sites indicated. The distribution of structures is overlain on the side scan sonar mosaic. The contour interval is 5 meters reported in depth below surface. The majority of structures are placed within channeling glacial deposits | 270 |
| Figure 7.30a-b. V-Shaped hunting blind. Depth 105 feet (32 meters), a. ROV captured image of the structure, b. schematic of the same structures | 272 |
| Figure 7.31. The Dragon Blind | 274 |
| Figure 7.32. T-V Blind | 274 |
| Figure 7.33. Rectangular structure on the AAR, likely a meat cache. Depth 116 feet (35 meters) | 275 |
| Figure 7.34. Rectangular structure along the Kazan River, Canada (<i>foreground</i>), standing stone <i>inuksuit</i> in the background (Stewart 2015:89, Figure 8.7b) | 275 |
| Figure 7.35. Standing stone on AAR | 277 |
| Figure 7.36. Dragon drive lane schematic | 279 |
| Figure 7.37. Scuba diver mapping the Dragon Blind. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary | 279 |
| Figure 7.38. The Dragon blind and Jake the ROV. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary | 280 |
| Figure 7.39. Schematic of Funnel | 282 |
| Figure 7.40. Scanning sonar image of the Funnel site | 283 |
| Figure 7.41. Divers within the Funnel. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary | 284 |
| Figure 7.42. Schematic of Drop 45 site overlain on scanning sonar image | 285 |

| | |
|--|-----|
| Figure 7.43. Schematic of the Drop 45 site indicating location of lithic artifacts | 286 |
| Figure 7.44. The Overlook locality in Area 3, showing the topographic setting of the V blinds and the Drop 45 Drive Lane and associated features. Contour interval is 5 m and is reported in meters above mean sea level (modern Lake Huron datum is 176 m amsl). Hatching reflects areas believed to be underwater at time the locality was in use, (adapted from O’Shea 2015b:132, Figure 10.18) | 288 |
| Figure 7.45. Flakes and debitage from the Drop 45 site. <i>Top row</i> (left to right), specimen numbers DP-1-1a, EG-1-2b, EG-1-2a, EO-1-2a, FA-1-2a, FB-1-1a, <i>Bottom row</i> (left to right), specimen numbers DP-1-1b, Unit 1a, EZ-1a, EO-1-2b, FE-1-2b, FE-1-2a, Unit 8a. Scale bar is in centimeters | 292 |
| Figure 7.46. DE-1a flake from Crossing Locality, Area 1. Scale bar is in centimeters | 293 |
| Figure 7.47. Vial 1a flake from Crossing Locality, Area 1. Scale bar is in centimeters | 293 |
| Figure 7.48. DA-1-1a and DA-1-1b flakes from the Gap Locality, Area 3. Scale bar is in centimeters | 294 |
| Figure 7.49. Thumbnail scraper on Bayport chert from the Drop 45 site. Scale bar is in centimeters | 294 |
| Figure 7.50. Cervid tooth fragment | 296 |
| Figure 8.1. Schematic of seasonal occupations on the American portion of the AAR. Darkest color indicates modern land surface, lighter color indicates additional land surfaces that would have been dry land during Lake Stanley (see Chapter 4), (adapted from Lemke and O’Shea 2015: 175, Figure 14.1) | 319 |
| Figure 9.1. Scales of research on the AAR | 321 |
| Figure 9.2a-b. Computer simulated caribou migration routes across the AAR in the fall (<i>top</i>) and spring (<i>bottom</i>). The Overlook Locality is labeled A, the second bottleneck where caribou would have passed in both seasons is labeled B | 323 |
| Figure 9.3a-b. Glacial esker in Canada | 325 |
| Figure 9.4. AUV survey transects in the Overlook (<i>left</i>) and Esker (<i>right</i>) Localities | 330 |
| Figure 9.5. AUV mosaicked for the Overlook Locality | 332 |
| Figure 9.6. AUV mosaicked for the Esker Locality | 333 |
| Figure 9.7. AUV mosaic of the Overlook Locality placed over the SSS of Area 3 | 334 |
| Figure 9.8. AUV mosaic of the Esker Locality placed over multibeam coverage of Area 1 | 335 |

| | |
|---|-----|
| Figure 9.9. Overlook Locality, Contact 1 (North is up) | 337 |
| Figure 9.10. Schematic drawing of the Overlook Locality, Contact 01 | 337 |
| Figure 9.11. Ariel view of a Dorset longhouse on Victoria Island (Friesen 2007:201) | 338 |
| Figure 9.12. Caribou hunters' tent ring west of Hudson Bay positioned on an outcropping of bedrock and a shallow gravel substrate, with additional tent rings in the background (Stewart 2014:88, Figure 8.6) | 338 |
| Figure 9.13a-b. Harvaqtuurmiut tent ring and camp site overlooking Thirty Mile Lake, lower Kazan River (Stewart 2014, Figure 19) | 339 |
| Figure 9.14. Overlook Locality with Contact 1, the dwelling. Dashed lines indicate two large stone lines that likely acted as a funneling feature | 340 |
| Figure 9.15. The spatial organization of all investigated contacts in the Esker Locality | 342 |
| Figure 9.16. Esker Locality, Contact 1 (North is up) | 343 |
| Figure 9.17. Schematic drawing of Contact 1, textured fill indicates the natural esker, dashe lines with arrows indicate likely routes of caribou movement | 344 |
| Figure 9.18. Esker Locality, Contact 3 (North is up) | 345 |
| Figure 9.19. Esker Locality, Contact 4 (North is up) | 346 |
| Figure 9.20. Schematic drawing of Contact 4, textured fill indicates the natural esker, dashed Lines with arrows indicate likely routes of caribou movement | 347 |
| Figure 9.21. Scanning sonar of Contact 04, 20 meter range (i.e. diameter is 40 meters) | 347 |
| Figure 9.22. Esker Locality, Contact 5 (North is up) | 348 |
| Figure 9.23. Esker Locality, Contact 6 (North is up) | 349 |
| Figure 9.24. Schematic drawing of Contact 6, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement | 350 |
| Figure 9.25. Esker Locality, Contact 8 | 351 |
| Figure 9.26. Esker Locality, Contact 9 (North is up) | 352 |
| Figure 9.27. Schematic drawing of Contact 9, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement | 353 |
| Figure 9.28. Esker Locality, Contact 12 (North is up) | 354 |
| Figure 9.29. Scuba driver drawn plan map of Contact 12 | 354 |
| Figure 9.30. Scanning sonar of Contact 12 | 355 |
| Figure 9.31. Scuba divers sampling at Contact 12 | 355 |

| | |
|---|-----|
| Figure 9.32. Esker Locality, Contact 13 (North is up) | 356 |
| Figure 9.33. Placement of human constructed features overlain on the multibeam imagery in the Esker Locality. Solid line indicates the edge of the AAR landform, dashed lines indicate 35 meter elevation contour, and diagonal lines indicate the esker | 358 |
| Figure 9.34. Esker Locality, Contact 6, complex structure sample KB-1 microdebitage | 364 |
| Figure 9.35. Esker Locality, Contact 6, complex structure sample JQ-1 microdebitage | 364 |
| Figure 9.36. Overlook Locality, Contact 1, dwelling sample KI-1 microdebitage | 365 |
| Figure 9.37. The Overlook and Esker Localities presented at the same scale | 369 |
| Figure 10.1. Revised schematic of seasonal occupations on the American portion of the AAR. Darkest color indicates modern land surface, lighter color indicates additional land surfaces that would have been dry land during Lake Stanley. In the revised model, spring hunting is periodically characterized by group aggregation to operate complex structures (Spring 1), or is organized with small group hunting using different types of hunting structures (Spring 2) | 379 |
| Figure 10.2. Human occupation of the AAR in context. Blue curved line represents generalized ancient water levels in the Great Lakes. Black bars indicate dated caribou specimens from the Great Lakes basin. Environmental phases, AAR dates, and the generalized culture historical sequence for the Great Lakes are listed, (adapted from Lemke 2015c:279, Figure 3) | 381 |

Chapter 1

Introduction

Hunter-gatherers are foundational to anthropology. Ethnographic accounts of foragers have been essential in building classic anthropological theories of human evolution, kinship, social organization, and religion among others. Due to this long history of anthropological interest, hunter-gatherer lifeways have been well documented. From these studies, a normative view of foragers as simple, highly mobile, egalitarian band societies with limited or no property/ownership, and limited investment in the landscape, emerged and continues to be pervasive in the discipline. This restricted view of hunter-gatherer lifeways is largely due to inherent limitations in the ethnographic record, from which this conventional “Man the Hunter” characterization is drawn. In contrast to cultural anthropology, archaeology has access to vast stretches of time and space and can explore a greater range of hunter-gatherer societies as represented in the prehistoric past.

This larger issue frames the central problems addressed in this dissertation. It concerns hunter-gatherer societies and how they are effected by the construction of hunting architecture, such as drive lanes, animal corrals, hunting blinds, and fishing weirs. This dissertation investigates the global phenomena of hunting architecture by drawing on a regional case study - caribou hunting in the Great Lakes, where some of the oldest hunting structures have been preserved underwater. It develops a general theory of hunting architecture, reviews

archaeological and ethnographic investigations of *Rangifer* (caribou and reindeer) hunters, and tests a model of hunter-gatherer adaptations during the Pleistocene-Holocene transition in the Great Lakes region. This model is evaluated with new underwater archaeological data.

Overall, this dissertation creates a general picture of forager societies and hunting architecture in the past, problematizing our normative views of prehistoric hunter-gatherers. This dissertation highlights a range of hunter-gatherer lifeways within the context of the use of hunting architecture. Hunting architecture is defined as any form of permanent or semi-permanent built structure used to aid hunting activities. Such structures occur globally because they represent a common solution to a common problem as they increase the predictability and yield of natural resources and overall hunting success. Comparable built elements are found across time, space, environments, and cultures because they are conditioned by similar traits in animal behavior. Hunting architecture exploits innate characteristics of ungulates – such as their tendency to follow straight lines – and the local topography to intercept these animals by calculated means at strategic locations. Subsistence strategies adopting hunting structures present a fundamental shift in exploitation by actively modifying the hunting landscape (e.g. niche construction). It is argued that the creation and maintenance of hunting architecture is among the most significant subsistence innovations in prehistory prior to the origins of agriculture; as similar to large-scale food production, the adoption of hunting architecture has demonstrable social and economic repercussions.

The use of hunting architecture by foraging societies is at odds with traditional characterizations of hunter-gatherers. While foragers are considered to be highly mobile, built structures anchor them to the landscape for at least part of the year. In addition, the construction of such features demonstrates that despite traditional models to the contrary, hunter-gatherer

groups invest in their landscape and actively modify it. Furthermore, in order to build such structures, a significant number of people must cooperate to first construct and subsequently operate such features. Social aggregation of this kind, particularly for the purpose of constructing architecture, has been traditionally considered very rare among foragers, occurring in only unique or “ritual” contexts, e.g. Poverty Point. Such organization of labor is often linked to leadership – and the operations of communal hunts facilitated with hunting architecture involved specific individuals who acted with varying degrees of authority. These leaders stand in stark contrast to traditional conceptions of acephalous or egalitarian bands. Finally, built hunting facilities articulate with issues of ownership, property, and territoriality in terms of who “owns” the structures themselves, who has access to them, how resources gained from communal hunts are shared, and how these sites fit into larger territories.

Hunting architecture is significant because of the ramifications it had for forager social and economic life in the past. While there are hints of these relationships between foragers and such structures in the ethnographic record, the effects on hunter-gatherers lifeways were likely more common, more complex, and more diverse throughout prehistory. However, the majority of these sites are prone to destruction and are difficult to date and these factors have limited archaeological research and detailed comparisons. The case study examined in this dissertation stands in contrast to other regions as caribou hunting structures are intact due to a unique underwater setting in the Great Lakes, providing the preservation necessary to conduct a detailed archaeological study.

The regional case study examined in this dissertation therefore offers a novel context for investigating broader issues because it is submerged in a virtually unmodified landscape. In Lake Huron, hunting architecture, associated artifacts, and paleoenvironmental data can be analyzed as

an *in situ* engineered landscape, free from subsequent modification. This case study can therefore address both local archaeological problems (i.e. Great Lakes caribou hunters) and global anthropological problems, (i.e. prehistoric hunter-gatherer social and economic systems, hunter-gatherers and hunting architecture).

This case study articulates with two areas of previous anthropological and archaeological research: investigations of reindeer/caribou hunters and underwater archaeology. Due to a long standing anthropological interest in the arctic and *Rangifer* hunting adaptations, archaeological interpretations of reindeer and caribou hunters, from Neanderthals to Paleoindians, are deeply influenced by ethnographic data. In these cases, ethnographic analogies are common despite the fact that the extant historic and ethnographic records cannot accurately reflect the vast diversity of caribou hunting adaptations known only in the deep past. The long prehistory of human interactions with the *Rangifer* species, including the 9,000 year old caribou hunting structures underwater in Lake Huron, reveal prehistoric behaviors that differ from ethnographically known caribou hunters.

The investigation of these submerged sites also fits within the larger context of underwater prehistoric archaeology – an emerging field in anthropology more generally. Underwater archaeology has the potential to play a significant role in documenting novel forager lifeways, as entire prehistoric landscapes are preserved and offer unique data not available on land. The regional study of caribou hunting architecture submerged beneath the Great Lakes presented in this dissertation highlights hunter-gatherer behavior extending beyond the ethnographic record and reveals complex social and economic organization present in prehistoric foraging societies. The ability to investigate an intact prehistoric landscape provides insight into social organization and other features that extend far beyond hunting itself. It is demonstrated

that Great Lakes foragers using hunting architecture do not fit the normative characterization of hunter-gatherers, and that this regional case study is likely just a single example of many different kinds of prehistoric hunter-gatherers that do not conform to traditional models.

Overall, this dissertation provides a model for anthropological archaeology underwater. It combines underwater research methods, archaeological data, and anthropological theory. It builds connections between the terrestrial and underwater archaeological records to create a holistic picture of the prehistoric landscape and human adaptations therein. Lastly, it explores the role underwater archaeology can play in revealing novel hunter-gatherer lifeways. For while terrestrial “archaeology conceivably has access to a vast range of ethnographically unparalleled cultural pasts” (Sullivan 2007:56) and can often “reveal something invisible to an ethnologist” (Lyman 2007:145), underwater archaeology provides data which often eludes the terrestrial archaeologist.

Organization

The organization of this dissertation moves from general issues to the specific case study. **Chapter 2** presents the central problem concerning prehistoric hunter-gatherer archaeology, primarily the normative view of hunter-gatherers drawn from the ethnographic record and how archaeology has access to a greater range of forager lifeways in the past. **Chapter 3** explores hunting architecture, a form of human niche construction, and how hunting blinds, fishing weirs, and other built structures effect hunter-gatherer lifeways. This theoretical discussion draws on global comparisons of hunting architecture, and its influence on forager mobility, territoriality, property, leadership, and labor aggregation to problematize traditional views of hunter-gatherers.

This chapter moves on to explore the archaeological examination of hunting architecture and provides middle-range theory linking the behaviors of creating and maintaining hunting architecture to the material remains of these structures in the archaeological record.

Chapters 2 and 3 therefore provide the theoretical background for the regional case study which is introduced in **Chapter 4**. This chapter outlines the current state of knowledge concerning the ancient Great Lakes, specifically focused on the end of the last Ice Age. The specific time period investigated in this case study is a time of lower water levels in the Lake Huron basin, termed Lake Stanley (~11,500 – 8,300 cal yr BP). This lower water level lake stage spans the cusp of significant geological and paleoenvironmental changes, as well as cultural transitions, from the Pleistocene to the Holocene transition and from Paleoindian to Archaic archaeological records and both of these general processes are reviewed. First, changing lake levels in the Great Lakes basin throughout the Pleistocene-Holocene transition are outlined, as well the paleoclimatic and paleoenvironmental changes throughout this time frame. Second, the archaeology of hunter-gatherers during this broader time period (e.g. Paleoindian and Early Archaic) in the Great Lakes is reviewed, setting the stage for investigating caribou hunting sites preserved underwater in Lake Huron. The following two chapters provide the background for central issues in the case study, first *Rangifer* hunting over time (Chapter 5), and second the investigation of underwater archaeological sites (Chapter 6).

Chapter 5 presents a natural history of *Rangifer* and explores the antiquity and variability of *Rangifer* hunters, documenting the strategies used for their capture in prehistory. A common strategy, intercept or ambush hunting, represents the early roots of hunting architecture, an elaboration of old techniques by new means. This chapter also outlines the wealth of ethnographic and ethnohistoric information available concerning circumpolar peoples and their

hunting strategies, which has led to an extreme reliance on these accounts for interpreting prehistoric hunter-gatherers. Hunting architecture, which is the most common method of *Rangifer* hunting historically was likely much more common in the past than preserved in the archaeological record. Caribou hunting structures discovered under Lake Huron are the oldest such sites to be recorded and are preserved due to their underwater setting.

Chapter 6 reviews the history of archaeology underwater including the development of underwater methods and evolving research questions. The investigation and importance of submerged prehistoric sites is also discussed, providing the relevant background for underwater research in the Great Lakes. More specifically, **Chapter 7** provides an account of interdisciplinary research undertaken by the University of Michigan on the Alpena-Amberley Ridge (hereafter AAR), a submerged land bridge in Lake Huron that was dry land around 9,000 years ago. Previous research on the AAR has documented stone constructed caribou hunting features and has characterized their paleoenvironmental context. Overall, the AAR served as a refugium for ice-age adapted animals such as caribou in the context of the warming Holocene Great Lakes. Likewise it served as an exploitable ecological niche for prehistoric hunter-gatherers in the region.

Chapter 8 draws on the middle range theory of hunting architecture (Chapter 3) to generate a model of foraging lifeways on the AAR. **Chapter 9** reports the results of new archaeological research conducted to evaluate this model. Several new hunting architecture sites were identified through the use of an autonomous underwater vehicle survey, scanning sonar mapping, and scuba diving operations. This multi-scalar archaeological investigation results in a picture of an intact prehistoric landscape, including the spatial relationships between hunting structures, and their role in the larger settlement system and culturally engineered landscape.

Lastly **Chapter 10** provides a specific discussion of the AAR results as well as their broader implications concerning the regional archaeological record in the Great Lakes, and the wider anthropological issue of hunter-gatherers and the use of hunting architecture. It provides a summary of this dissertation's central contributions as well as the new questions generated by this research – ultimately highlighting the importance of anthropologically grounded underwater archaeology.

A Note about Terminology

It is necessary to define several key terms that are used throughout this dissertation, specifically concerning the geological and archaeological context of the case study. First, the *Pleistocene-Holocene transition* as used here, is defined as a period of environmental and climatic flux with increasing global temperatures, retreating glacial ice sheets, and global sea level fluctuations from ~12,000 – 10,000 cal yr BP. Second, the *Lake Stanley stage* is defined as a period of extreme low water levels within the Lake Huron basin from ~11,500 – 8,300 cal yr BP. This phase partially overlaps with the local Pleistocene-Holocene transition in the Great Lakes region. Third, *Paleoindian* is used to refer to an archaeological time period in North American prehistory commonly associated with various lanceolate projectile point forms, some fluted, and some not fluted. Fourth, the *Late Paleoindian* designation of the AAR archaeological sites is used simply as a chronological label to situate these structures within the context of the regional terrestrial archaeological record. Finally, distinct from the strictly chronological term *Paleoindian*, the *Conventional Paleoindian Model (CPM)* is defined as a highly mobile, big-game hunting adaptation that is thought by many to characterize the Paleoindian period.

A Note about Dates

Within this dissertation dates are primarily discussed in calibrated calendar years. These are indicated by “cal yr BP”. When specific radiocarbon dates are given, these are indicated by “¹⁴C yr BP”. When both dates are appropriate in the text, calendar years are listed first, with the equivalent radiocarbon years following in parentheses. The majority of tables list both the calibrated calendar years and the uncalibrated radiocarbon years. When citing calendar years from a listed reference the calibration made by the cited authors is used. Any new calibrations made for the purpose of this study were generated using OxCal and the IntCal13 Curve. These new calibrations are indicated by an asterisk in Tables.

Chapter 2

The Problem with Studying Hunter-Gatherers in the Past

“It is hardly possible to understand the significance of American archaeological remains without having recourse to ethnological observations, which frequently explain the significance of prehistoric finds”
Franz Boas (1902:1).

“The proper role for socio-cultural anthropology is as bed time reading for archaeologists”
David Clarke (Personal Communication 1975)¹

“...there is no alternative to using our knowledge of modern peoples to help us penetrate the past. Abandoning the ethnographic record makes archaeology like a paleontology cut off from the biology of living organisms. The real issue is not whether we do it, but *how* we do it.”
Ken Ames, *Supposing Hunter-Gatherer Variability* (2004:366, emphasis added)

Introduction

Hunter-gatherer societies have played a pivotal role in anthropology as a discipline. Early anthropologists such as Emile Durkheim, A. R. Radcliffe-Brown, Julian Steward, and Claude Lévi-Strauss used hunter-gatherer data to address broad anthropological topics such as kinship, division of labor, and the origins of religion (Kelly 2013). In fact, hunter-gatherers have been so foundational to anthropology that the entire history of the discipline could be viewed in terms of hunter-gatherer ethnography (Yengoyan 1979) and foragers can be seen as *the* quintessential topic of anthropology (Bettinger 1991). Unfortunately, a normative view of hunter-gatherers as simple, highly mobile, egalitarian band societies continues to be pervasive in the discipline. This

¹ John O’Shea’s seminar at Peterhouse in Cambridge, 1975.

simplified characterization of foragers is largely due to limitations in the ethnographic record from which it is drawn. In contrast to ethnography, archaeology has access to a greater range of hunter-gatherer phenomena in the past and as such archaeological data can problematize this limited view of foraging societies.

Normative Views of Hunter-Gatherers in Anthropology

The term hunter-gatherer most often refers to a mode of subsistence, but disparate cultures fitting these economic criteria have traditionally been grouped together despite variation in demography, mobility, foraging behavior, and sociopolitical organization. Because of this, there is considerable debate concerning who actually *is* a hunter-gatherer (Ames 2004). There are two primary definitions: the first is economic, referring to people without domesticated plants and animals (except dogs) and incorporates a number of different social forms (Kelly 1995, 2013); and the second is social, referring to band societies or small groups with flexible membership who are egalitarian in that differences within the society are based primarily on age, gender, and charisma. This social definition encompasses a variety of economies (Lee 1992). The existence of a dual definition of hunter-gatherers is illustrative of the vast amount of sociocultural and economic variability encompassed within this broad analytical category with which anthropological archaeologists continue to struggle.

It is well established that contemporary, historic, and ethnographic hunter-gatherers are extremely diverse – in all aspects of life – from economy, to social organization, kinship, and ritual (e.g. Ames 2004; Binford 2001; Kelly 1995, 2013; Kent 1996; Panter-Brick, Layton, and Rowley-Conway 2001). We can only suppose that variability is even greater in the past.

However, due to the wealth of ethnographic data, and the inherent material limitations of hunter-gatherer archaeological records, the problem remains: most pictures of prehistoric hunter-gatherers rely on ethnographic analogy, rather than archaeological evidence and conform to a single normative view:

“We have built up remarkably detailed pictures of early human society complete with family bands of twenty-five people who share food, trace kin relations bilaterally, reside bilocally, and eat a generalized diet with women gathering plant food and men hunting...But this detailed picture comes not from archaeological evidence as much as from ethnographic analogy...*If prehistoric hunter-gatherers all look the same, it is because we supposed them to be that way from the outset*” (Kelly 1995:339, emphasis added).

The central problem concerning prehistoric hunter-gatherer archaeology is therefore the limited view of foragers drawn from the ethnographic record – resulting in a normative characterization of simple, highly mobile, egalitarian bands with limited property. Ethnographic cases that do not fit this model are referred to as “complex” hunter-gatherers influenced by historical contingency or a unique resource suite. These restricted views of forager lifeways are largely due to inherent biases in the ethnographic record.

Limitations of the Ethnographic Record

The ethnographic record of foraging societies is incomplete and biased, as certain groups have been overrepresented, others underrepresented, and others left out of more general hunter-gatherer studies completely. In addition, all ethnographic groups have their own unique histories and contexts. As different forager groups wax and wane in popularity, their particular behaviors

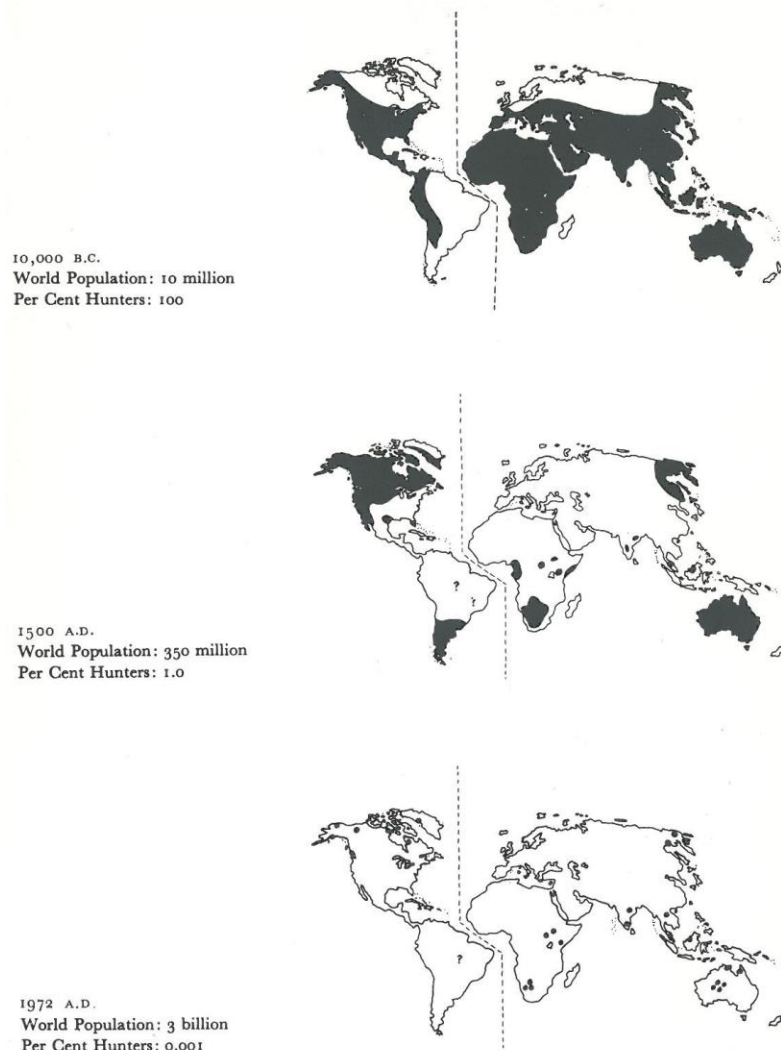
and view of the world has become the general model of hunter-gatherers (Kelly 1995). Historically, Kalahari groups, Arctic groups (specifically the Nunamiut), and more recently the Hadza, have come to dominate archaeological interpretations of foragers. This handful of ethnographic cases has been overrepresented in models of hunter-gatherers – characterizing foraging style as egalitarian, highly mobile, and with few material wants. In contrast, other ethnographic groups have been historically underrepresented, such South American foragers living in tropical rainforests. While these groups are generally thought to be too reliant on cultivation to be “real” foragers (Politis 2015), archaeological evidence demonstrates that hunter-gatherers have a long prehistory of occupying similar environments (Roberts et al. forthcoming).

Furthermore, other societies have been left out of more general studies and are often relegated to other archaeological and anthropological categories, such as “complex” hunter-gatherers. In many classic anthropological works concerning foragers, certain ethnographic cases that did not conform to the generalized model were left out. For example, Service kept Northwest Coast Native Americans out of *The Hunters* (1966), and many societies including the Tlingit, Nootka, and Calusa of Florida as well as horse-riding groups of Native Americans from the plains were excluded from *Man the Hunter* (1968). The rationale behind these analytical choices was that these were extreme cases of either environment (e.g. concentrated resources in both time and space, such as salmon runs on the Pacific coast) or historical contingency (e.g. the importation of Spanish colonial horses) (*cf.* unique local circumstances or diffusion, Garvey and Bettinger 2014). Historical contingency is often linked to contact with state societies, but it must be stressed that *all* ethnographic foragers were in contact with states. Significantly, archaeological evidence has demonstrated that many traits that were believed to be the result of culture exchange, such as social complexity, social inequality, and complex economies, pre-date

colonial contact (e.g. Prentiss et al. 2007, Zedeño et al. 2014). These traits are perhaps more characteristic of prehistoric hunter-gatherers than traditionally assumed (**Chapter 10**).

In addition to these biases, ethnographic data are inherently limited by the small amounts of both time and space in which ethnographers have been working with foraging groups. Historic ethnographic research with hunter-gatherers was often considered “salvage ethnography” as these cultures and economies were rapidly changing (**Figure 2.1**). The time and space available to ethnographers is particularly narrow when compared to the broad stretches available in the archaeological record. Not only were prehistoric foraging populations more numerous, and within the context of a world of hunters, but over the vast stretch of time when humans were hunting and gathering, massive global environmental changes took place. Global fluctuations of ice sheets and sea level are some of the most significant. Changes in both glaciers and sea level over the last 2 million years have submerged and re-exposed large portions of the prehistoric landscape. These coastlines, particularly on the continental shelf and in many inland lakes and karstic features, were likely some of the most attractive habitats for hunter-gatherers. These sites, and the evidence of prehistoric foraging lifeways they preserve, are now underwater and are only available through submerged archaeological research (see **Chapters 6-9**). These processes in the past resulted in unique environments that have no modern analog (see **Chapter 4**), and is likely that such environments supported novel hunter-gather lifeways unlike any known from the ethnographic record.

Figure 2.1. Historic decrease in hunting and gathering societies, 10,000 cal yr BP to 1972, (Frontispiece from *Man the Hunter*, Lee and DeVore 1968).



Finally, while beyond the scope of this dissertation, it must be stated that the ethnographic record of course is limited to biologically and culturally modern humans. Prior to modern human culture, our early human ancestors, such as Neanderthals and Australopithecus were likely very different kinds of hunter-gatherers (Kuhn and Stiner 2001, 2015).

Significantly, even within the biased and limited ethnographic record, diversity is clear. Ethnographic data demonstrates that even within small regions, such as the Kalahari Desert or

Southeast Asia, a variety of different hunter-gatherer lifeways are observed (e.g. Kelly 2013; Kusimba 2005; Stewart and Mitchell 2015). Some hunter-gatherer groups are highly mobile, others are more sedentary, many are band societies while others have different social systems, hunting is a large part of the diet and culture in some geographic regions such as the arctic, and gathering plant foods and smaller animals are more important in other areas (Kelly 2013). Given this diversity in the ethnographic record with limited time and space parameters, it can be expected that variability in the past was much greater, and certainly extends beyond the limited view of foragers still pervasive in anthropology.

Enter Archaeology

In stark contrast to the ethnographic record, archaeology has access to a broader range of contexts, including time, space, and environments, and likewise a greater range of hunter-gatherer lifeways. Archaeology's greatest contribution to general anthropology is the vast time scale at its disposal (Jochim 1991, Marcus 2008). It is the only method available for anthropologists to view all the variable aspects of behavior in both space and time, from the individual to groups, from small settlements to large regions, from single events to millennia (Wobst 1978:307), and before colonial contact. For these reasons, archaeologists should not be limited by the range of behaviors known only from the ethnographic record and the resulting biased characterization of hunter-gatherers. Furthermore, archaeology is the approach best suited for investigating forager diversity since it is the only discipline that explicitly and directly deals with prehistoric hunter-gatherers and the remnants of their actual behavior.

Hunter-gatherer studies are therefore in an ideal position within archaeology more broadly to push forager theory forward. To date, the primary goal for anthropologists concerning

hunter-gatherers has been to characterize the 99% of human history when foraging lifeways were dominant; while this 99% still represents a significant stage in human prehistory, it is far from homogenous. The tremendous diversity known from ethnographic record is only the tip of the iceberg of foraging lifeways. As demonstrated by the case study examined in this dissertation, archaeology has access to novel forms of social and economic organization only available in the deep past, and perhaps others only available underwater.

Research Philosophy

While contemporary studies of hunter-gatherers acknowledge both that ethnographic hunter-gatherers are not living a prehistoric lifestyle, and that forager lifeways are extremely diverse (e.g. Ames 2004; Binford 2001; Kent 1996; Panter-Brick et al. 2001); diversity within *prehistoric* foraging societies remains elusive. How do archaeologists document or even *recognize* novel forager adaptations in the deep past? To achieve this goal, archaeological investigations must move away from the normative characterization of hunter-gatherers, and work instead with models and hypotheses which are explicitly designed to capture variability. Toward this end, a comparative approach with a diverse theoretical and methodological toolkit is used throughout this dissertation.

What is the solution to the problem with studying hunter-gatherers in the past? As the quote at the beginning of this chapter illustrates, it's not whether or not we use ethnographic data, but it's *how* we use it (Ames 2004, emphasis added). Ethnographic data can serve as a hypothesis generating tool, presenting some of the ways in which hunter-gatherer societies may operate. Archaeologists should not expect to see "whole" societies from the ethnographic record

represented in the past, but rather some familiar elements which may be put together in novel ways. In order to utilize the wealth of ethnographic data (**Chapter 5**), but still be open to detecting novel hunter-gatherer behaviors, other lines of evidence including regional archaeological records (**Chapters 4-5**), an agent-based model (**Chapter 7**), and a borrowed perspective from ecological and evolutionary approaches (e.g. niche construction) (**Chapter 3**) are used in an integrative research design to test theory with empirical archaeological data rather than ethnographic analogy (*sensu* Kelly 1995, 2013). The creative and challenging role for archaeologists is to build portraits of hunter-gatherer lifeways in the past *de novo*, free from the traditional view of foragers. A specific case in which the normative view of hunter-gatherers is at odds with the archaeological evidence is the creation and use of hunting architecture among foragers, the phenomenon examined in this dissertation.

Chapter 3

Hunter-Gatherers and Hunting Architecture

“archaeologists...have underestimated the ability of egalitarian societies to erect public buildings, move multi-ton stones, produce art, and organize communal labor” (Marcus 2008:261).

“They practiced another method of taking deer, in herds. A large party of hunters was formed, and a brush fence was built in the shape of the letter V, two or three miles in length on each side. The woods were then fired in the rear at some miles’ distance, so as to drive the deer towards the opening, into which they were guided by parties stationed upon either side. They followed the fence down to the angle, where the arrows of the unseen hunters soon brought them down one after the other. Sometimes a hundred were thus taken at one time” (Morgan 1904:345-346).

Introduction

The use of built stone, wood, or dirt hunting structures has been documented on every continent except Antarctica and dates as far back as 12,000 years ago. This wide spread hunting tactic is a global phenomenon that is most often used to hunt hoofed and herd animals such as bison, elk, bighorn sheep, antelope, caribou, camelids, and many others. Such hunting features, similar to fish weirs (e.g. Connaway 2007) and other landscape modifications (Smith 2011) are communal construction efforts designed to increase the yield and predictability of natural resources. As such, they play a large role in the annual economy of small-scale societies (Smith 2013). The majority of these structures target specific species during a single season, and they rely on sophisticated knowledge of animal behavior and local environments to channel and capture animals in predictable places.

This common solution to a common hunting scenario crosses cultures, time, space, and environments and has significant social and economic implications. Similar behaviors across species such as caribou, bison, guanacos, antelope, and gazelles have been exploited in diverse cultures such as Sami reindeer herders, the Inka practice of *chaccu*, and ancient bison hunters on the North American plains. The social and economic ramifications which occur with the use of built hunting architecture are particularly significant for hunter-gatherer societies. While foragers are generally considered to be highly mobile, permanent hunting structures anchor them to certain places on the landscape and create sociopolitical and economic tensions concerning ownership, territoriality, leadership, labor aggregation, group size, and other social dynamics. For these reasons, *the adoption of hunting architecture can be considered among the most significant subsistence innovations prior to the origins of agriculture. Similarity to large-scale food production, this practice radically altered social organization and lifeways.*

This chapter explores hunting architecture, a form of human niche construction, and how hunting blinds, fishing weirs, and other built structures effect hunter-gatherer lifeways. This theoretical discussion draws on global comparisons of hunting architecture, and its influence on forager mobility, territoriality, property, leadership, and labor aggregation to problematize the traditional view of hunter-gatherers. This chapter moves on to explore the archaeological investigation of hunting architecture and provides the middle-range theory linking the behaviors of creating and maintaining hunting architecture to the material remains of these structures in the archaeological record.

Definition and Problem Orientation

Hunting architecture is defined as any human made modification to the natural landscape or built stationary structure with the primary goal of procuring animal resources. Primary examples of hunting architecture including drive lanes, hunting blinds, fishing weirs, and animal corrals. While these structure have been utilized across time and space by a groups with diverse sociopolitical formations – the theoretical discussion of hunting architecture in this dissertation is focused on hunting architecture used by hunter-gatherers. While hunting architecture is fairly common and is often noted by archaeologists, it has rarely been studied extensively or comparatively, often only receiving brief mention (Arkush 1986:247; Brink and Rollans 1990:152; Fitzhugh 1981:188; Mcfee 1981:161). This lack of archaeological research is largely due to preservation issues concerning the survival of such sites, difficulty dating them, and a general lack of artefactual remains (see below).

This dissertation therefore aims to provide a systematic investigation of hunting architecture. Beginning first at the broad, comparative scale. A global comparison of hunting structures reveals that these structures can be used to understand the organization of past societies and as a means of highlighting diversity and complexity in prehistoric hunter-gatherer lifeways.

A Global Phenomenon

Southwest Asia and Northern Africa

In Southwest Asia, large, stone built game traps named kites first appear in the Neolithic. These structures were dubbed “kites” by early airplane pilots who saw them from the air and noted their similarity in shape. Through a combination of satellite imagery and archaeological survey, over 4,300 such structures have been identified across the Arabian Peninsula, into North Africa and Central Asia including Syria, Jordan, Armenia, Yemen, Egypt ¹, Uzbekistan, Kazakhstan, and the Caucasus (Barge and Brockier 2011; Barge et al 2013; Betts and Helms 1986; Betts and Yagodin 2000; Brochier et al. 2014; Brunner 2008; Crassard et al. 2014; Gasparyan et al. 2013; Harding 1953; Hershkovitz et al. 1987; Kennedy and Bishop 2011; MacDonald 2005; Picalause et al. 2004; Skorupka 2010; Storemyr 2011; Zeder et al. 2013).

These low stone walled structures have a semi-enclosed round or oblong shape with funnel or v-shaped openings and are used to hunt a range of wild ungulate species; most commonly gazelles (*Gazella* sp.), but also onager (*Equus hemionus*), oryx (*Oryx leucoryx*), wild goats (e.g. bezoar goat (*Capra aegagrus*), and red deer (*Cervus elaphus*)) (Bar-Oz et al. 2011; Betts and Yagodin 2000; Chahoud et al. 2015; Helms and Betts 1987; Kennedy 2011, 2012; Legge and Rowley-Conway 1987; Nadel et al. 2010; Van Berg et al. 2004; Zeder et al. 2013) (**Figures 3.1-3.4**). Similar structures have been used historically by Bedouin groups in North Africa for hunting gazelle (Munsil 1928).

¹ There are some distinctions between desert “kites” and “chutes” in Egypt (see Storemyr 2011).

Figure 3.1. The Sayarim Kite, head of the kite is located inside a narrow wadi (Nadel et al. 2013, Figure 2).

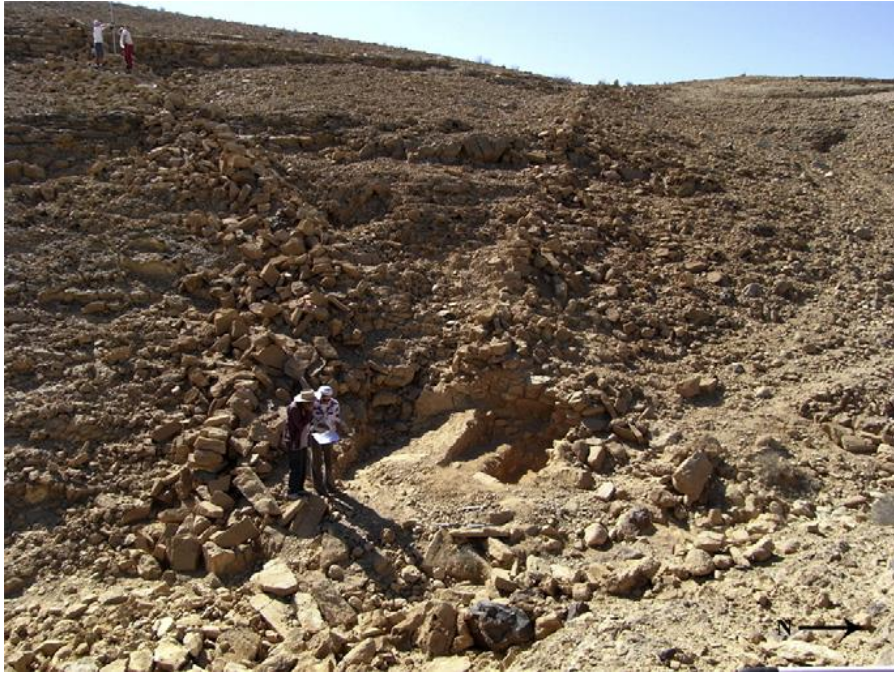


Figure 3.2. Ariel view of the Pitam Kite, looking West. Animal trails are visible crossing the kite (Nadel et al. 2013, Figure 5).

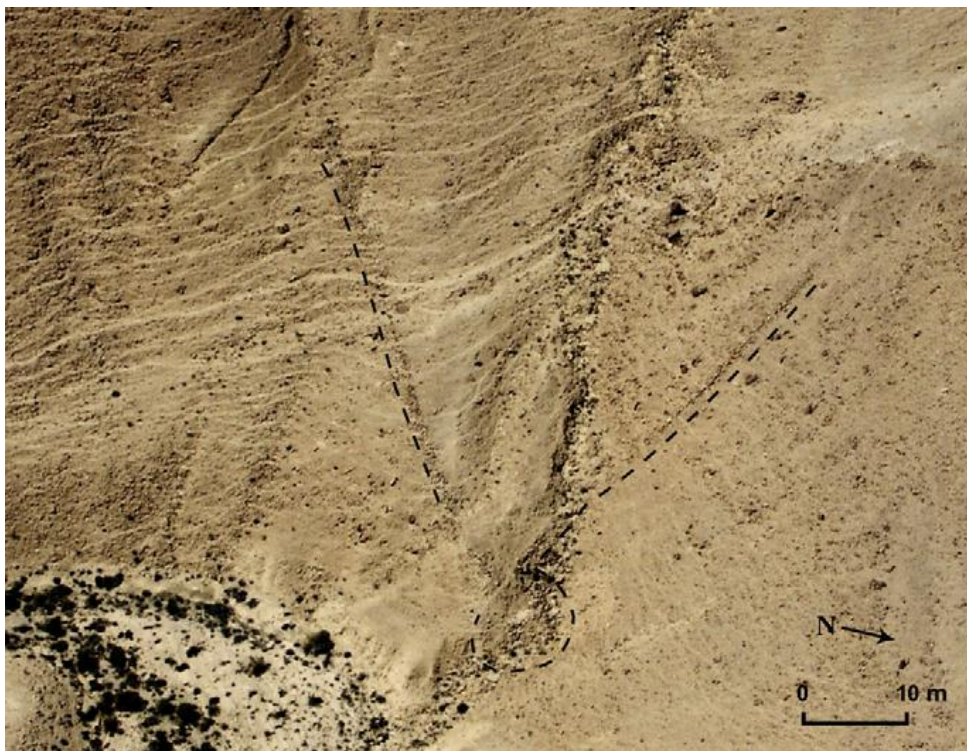


Figure 3.3 a. Ariel view of the Nahal Horsha kite, looking north (Nadel et al. 2013, Figure 9), b. Schematic section of Nahal Horsha (adapted from Nadel et al. 2013, Figure 11).

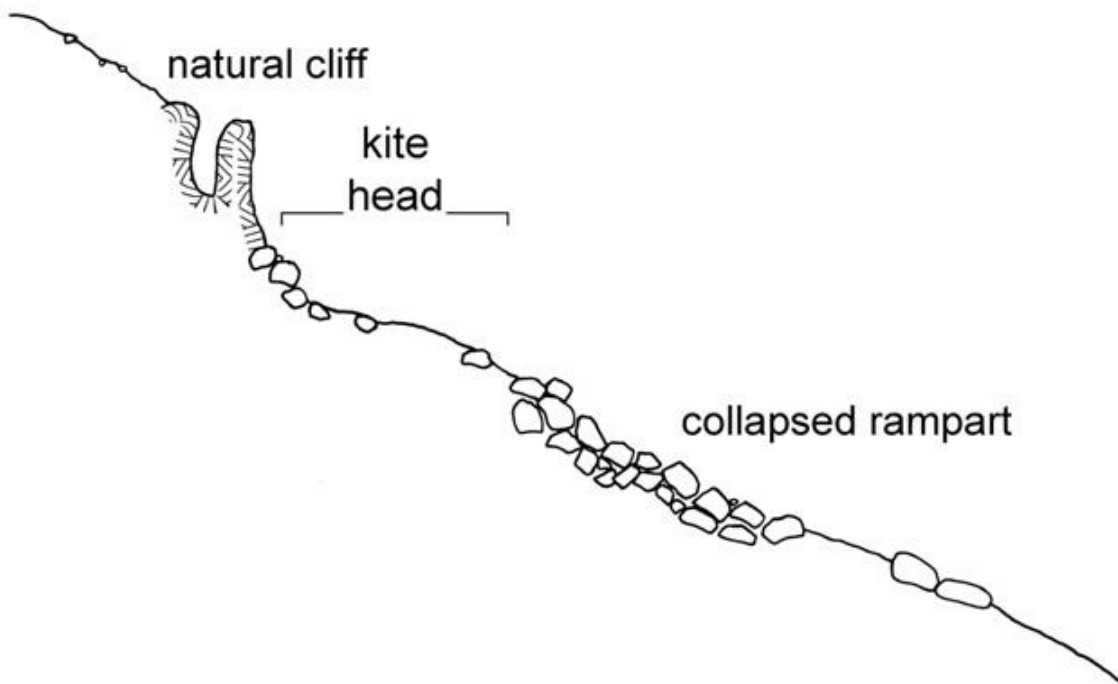


Figure 3.4. General view of Nahal Horsha with arms converging near the natural cliff (Nadel et al. 2013, Figure 12).



The density and distribution of kites over the landscapes varies considerably, from 0.1 kite per 100 km² in the Negev, Northern Sinai, and along the Nile (Holzer et al. 2010; Storemyr 2011) to 50 kites per 100 km² in some areas of Syria (Echallier and Braemer 1995). This difference is likely due to the targeted prey species which also accounts for diversity in other aspects of the structures. Hunting architecture sites vary in terms of their placement in relation to each other (i.e. one or many kites), the size and density of their walls, and their placement on the local topography.

For example, groups of kites or chain kites are interpreted to channel migrating herds of Persian gazelle, and single or paired kites from the Sinai and Negev Highlands were most likely targeting smaller numbers of non-migratory prey, such as other gazelle species, onager, and oryx (Nadel et al. 2013). Moreover, substantial kites with massive walls in hilly areas were most likely targeting larger-bodied ungulates such as onager, in contrast to thinner-walled kites on the flat plains which most likely targeted gazelles (Nadel et al. 2013).

In accordance with the variable habits of these different ungulates, specifically if they migrate in large herds or not, kites were placed in strategic spots on the landscape, either intersecting migration routes, near common game trails, or adjacent to grazing areas where browsing animals could be taken by surprise and driven into enclosures (Bar-Oz and Nadel 2013; Zeder et al. 2013:115). Overall, site locations take advantage of the local topography as kites are constructed behind natural slopes where it would be hid from approaching animals, or near hills and hillsides which acted as natural boundaries (Betts and Yagodin 2000; Brochier et al. 2014; Helms and Betts 1987; Holzer et al. 2010; Morandi Bonacossi, and Iamoni 2012; Nadel et al. 2013; Quenet and Chambrade 2013; Storemyr 2011:17). Generally, desert kites targeting an array of ungulate species demonstrate the adaptability of these methods of capture across prey size classes and range of behaviors.

Tibet

In Tibet, hunting architecture in the form of earth and stone lines as well as depressions are used to hunt Tibetan antelope (*Pantholops hodgsonii*). These antelope are the only large mammal endemic to the Tibetan plateau (Huber 2005) and they migrate between calving areas in

the north and wintering grounds in the south each year (Schaller 1998) – providing predictable routes and locations for hunting.

Tibetan antelope have been hunted in the Chang Tang, or Northern Plains region of Tibet for at least the last 20,000 years (Brantingham et al. 2001). Antelope hunts, including large communal round ups, are recorded in historic documents from the region (Huber 2005:6). More recently (ca. last 300 years to the present) antelope hunting has been an important component of local economies in the region. People here are primarily pastoralist, but pastoralism in the far north is difficult given a marginal and severe environment (i.e. high elevation, sparse forage, semiarid climate, abundant predation). Therefore seasonal hunting of antelope herds which migrate through the area is an important supplement to the diet, particularly in winter (Huber 2005).

Traditionally antelope have been hunted with a variety of techniques including drive lanes, foot traps, blinds, guns, and food lures (Huber 2005). These different strategies are employed during different seasons to exploit antelope behaviors (**Table 3.1**). Ethnographically, hunters generally do not use all or even most of these strategies throughout the year, rather they use one or two depending on food needs, labor constraints, weather, etc. Most hunting takes place in the winter when large migratory herds move south for mating season. Winter is also the time of year when the antelope are in their best condition (Fox and Dorji 2009; Huber 2005). Hunting architecture utilized in these different hunting strategies includes dzaekha (drive lanes) (**Figure 3.5**), khogste (foot traps) (**Figures 3.6-3.7**), and gugra (hunting blinds) (**Figure 3.6**).

Table 3.1. The annual cycle of Tibetan antelope and associated traditional hunting strategies, (adapted from Huber 2005).

| Time of Year | Antelope Annual Cycle | Hunting Strategy |
|----------------------------|---|--|
| Late Spring (April - May) | Young males born the previous year separate from mothers and join male bands | |
| Early Summer (May - June) | Adult and young females migrate north to regular calving grounds | Marling (“red island”) Hunt: hunting of females “en masse” while they are congregated and migration north, hunts take place along predictable migration routes that are re-used over generations, hunts use dzaekha (drive lanes) and khogtse (foot traps) |
| Late Summer (June –Sept.) | <p>Summer grazing, irritation by insects, antelope of both sexes dig out hollows or bowls in dust/sand to lay down in during the daytime to reduce insect irritation</p> <p>During late summer, at the peak of insect irritation, antelope migrate to higher, cool ridges still covered with snow and ice to reduce insect irritation and produce relief from hotter temperatures at lower elevations</p> | <p>Tshertö (“afflicted antelope”) Hunt: khogtse are placed near newly dug hollows to capture antelope returning to them</p> <p>Kangtsö (“snow antelope”) Hunt: Antelope tend to use the same easily accessible areas of snow and ice year after year, hunters place khogste and perhaps build dzaekha along access trails to these areas</p> |
| Early Fall (Aug.- Sept.) | All females and newborn calves return south for Fall and Winter grazing, the same winter grazing areas are reused year to year | Khogtse are removed from dzaekha, returned females are not hunted (which is why dzaekha are orientated to the north) |
| Early Winter (Nov. - Jan.) | Rut occurs, both males and females gather for mating, often at regular site which are used annually, animals are in their best condition (i.e. fattest) after summer and fall grazing | Ngartsö (“passionate”(referring to the rut)) Hunt: Large congregations of antelope and limited areas for drinking water produce predictable areas for hunting, hunting is mostly done from blinds (gugra) within shooting range of water source |

| | | |
|------------------------|--|--|
| Mid-Winter (Jan. – on) | Forage is scarce and buried under snow | Rustö (“bone antelope”) Hunt: bones from domestic livestock are dried and ground into powder, then deposited in piles near antelope winter grazing areas, antelope gather to eat the bone meal and both khogste and hunting blinds are placed near the piles |
|------------------------|--|--|

Figure 3.5. Funnel shaped game drives in Tibet (dzaekha) for hunting Tibetan antelope into small narrow areas (Fox and Dorji 2009:206, Figure 3).

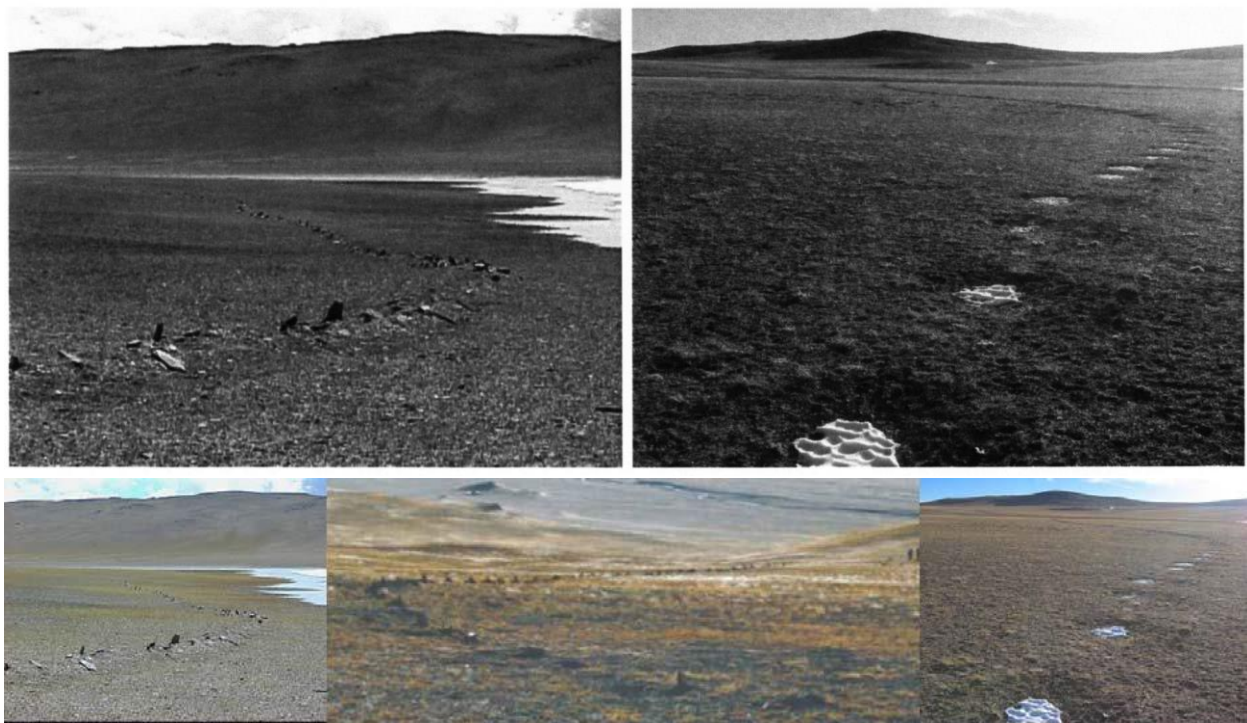


Figure 3.6. Leg trap (khogtse) used within hunting drive lanes in Tibet, and one side of a trap barrier system with a hunting blind/depression area located near the narrow neck of the barrier where the traps are placed (Fox and Dorji 2009:207, Figure 4).

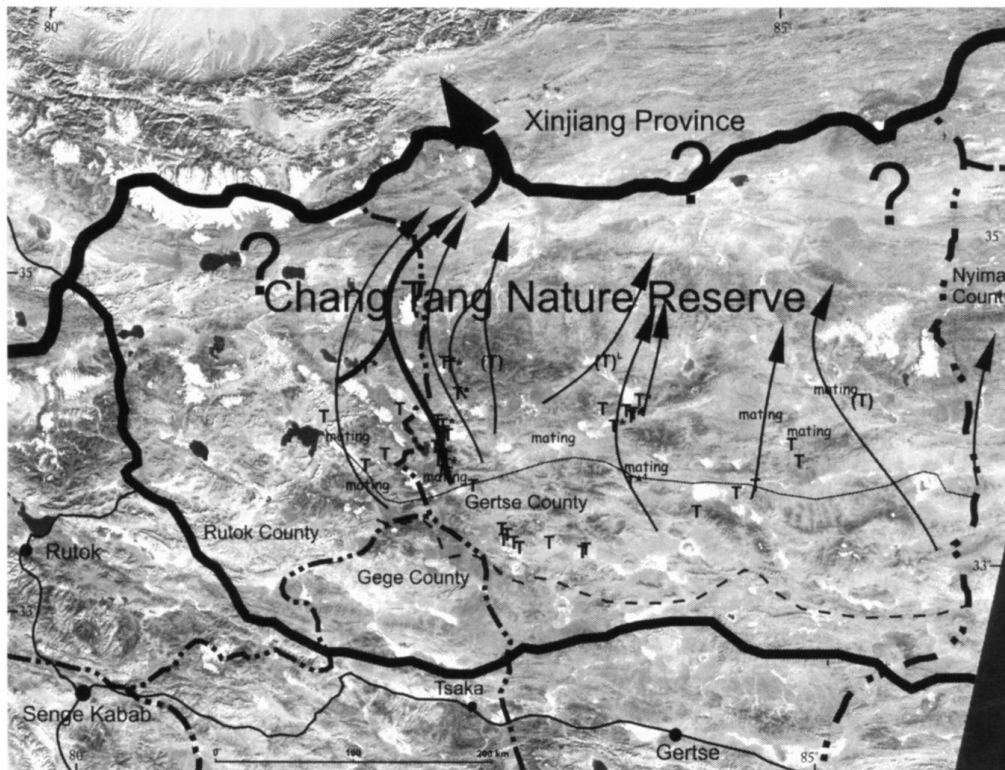


Figure 3.7. Hunter holding a leg trap (khogtse) (Huber 2012:198, Figure 11.3).



Dzaekha traps are made of two or more long lines of stone or dirt mound cairns (270 meters up to 1.06 km long). These cairns are small, 10 - 30 centimeters in height, and could easily be crossed by antelope but the animals prefer moving in large open areas and avoid crossing dzaekha lines (Fox and Dorji 2009:206; Huber 2005). Stone markers and other objects such as animal skulls or small twigs decorated with cloth are set on top of the cairns to attract the antelope. The long lines form a funnel shape with a large (5-10 meters across) northward facing opening; within this opening foot traps called khogtse are placed (Huber 2005). Dzaekha are often placed in valleys, passes, hillsides and areas of restricted topography (Fox and Dorji 2009:207). Dzaekha are orientated to the north along spring/early summer migration routes, and are often only used in this season to target the large herds of females migrating to calving grounds (Fox and Dorji 2009:206-207; Huber 2005:10) (Figure 3.8)

Figure 3.8 Locations of dzaekha traps made by “T”, large arrows indicate major migratory routes of Tibetan antelope to a known calving area (Fox and Dorji 2009:207, Figure 5).



Gugra, or hunting blinds, are shallow, circular pits ca. 2.5-3 meters in diameter, excavated to a depth of 40-50 centimeters, facing the target area. Stones are placed around the edge of the pit creating a low wall. Small spaces are often left between these stones for gun barrels (Huber 2005:14). These hunting blinds are often found with drive lane structures, up to four hunting blinds, two on each drive lane (Fox and Dorji 2009:206). While blinds are often found near dzaekha drive lanes, they also occur by themselves. This latter form of blind is often placed near water sources in antelope wintering/mating grounds (**Figure 3.9**). As the majority of water is frozen in the winter season, the few drinking areas that remain provide predictable locations for intercepting drinking antelope (Fox and Dorji 2009:205). Similar to kites, drive lanes and hunting blinds in Tibet take advantage of strategic places on the landscape to intercept antelope during different seasons.

Figure 3.9. Hunting blind in Tibetan antelope wintering grounds, adjacent to a winter water source (Fox and Dorji 2009:207, Figure 2).



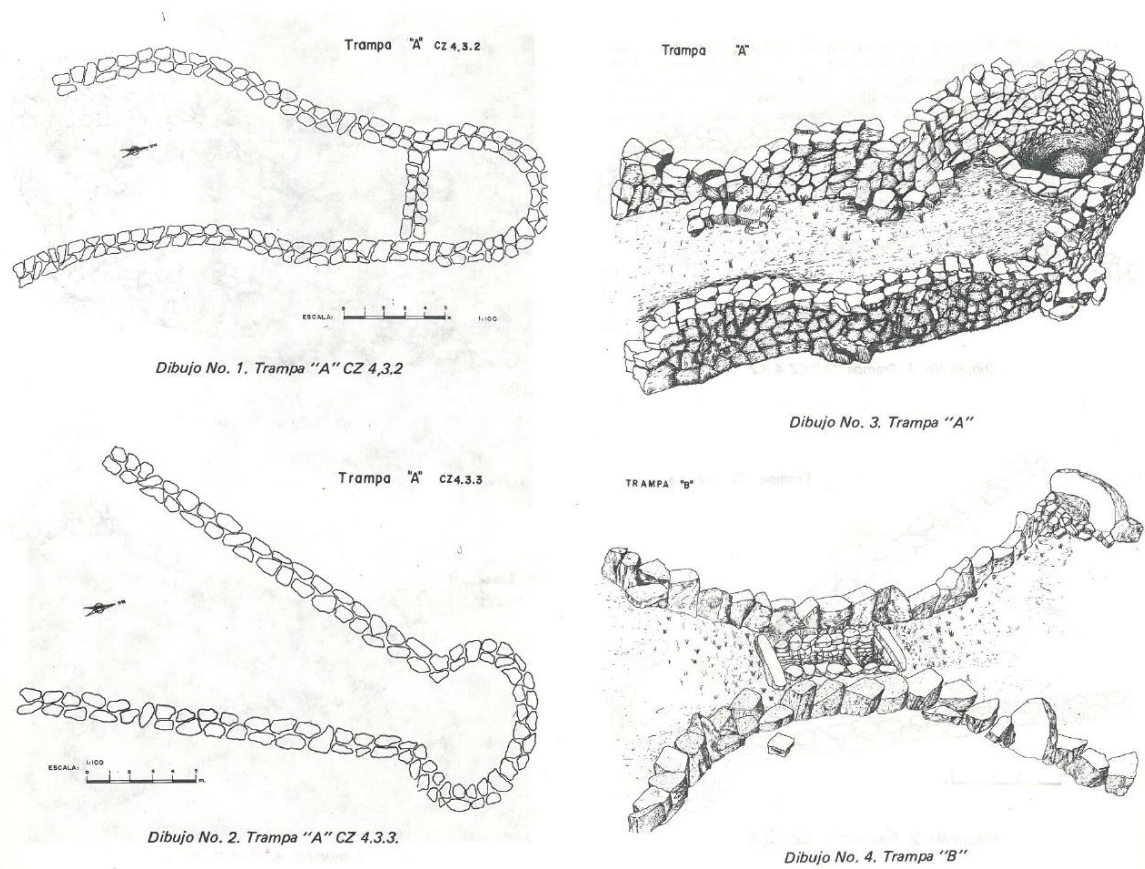
The Andes

Across Argentina, Peru, and Chile, elaborate hunting blinds and structures were used to exploit camelids such as vicuñas (*V. vicugna*). Hunting architecture in the form of stone traps have been found across the Andes (**Figure 3.10**). Two types of traps were described by Aguliar: 1) funnel shaped stone lines ending in an opening with a large pit, and 2) a rectangular walled pit, 2.5 meters long by 0.4 meters wide with two side corrals and a pit in the center (1988) (**Figure 3.11**). Similar features are found in Late Archaic rock art (4,000 – 5,000 years old) in the region (Hostnig 2011). Because vicuñas have specific and fairly small territories, archaeological evidence indicates sedentary hunters of wild camelids (Rick 1988), and these hunters likely increased their hunting success by adopting hunting architecture.

Figure 3.10. Ancient remains of a trap for chaccu (Inamura 2006:47, Figure 19).



Figure 3.11. Schematics of Archaic camelid hunting traps in the Andes (Aguilar 1988).



In the South-Central Andes, systematic survey of the Antofalla valley in Argentina identified five different types of stone structures used in camelid hunting from 9,000 BP to contemporary hunting with rifles. These structures include stone wall trenches, butchering tables, landmarks, shelters, and water hidings (Moreno 2012) (**Figures 3.12-3.13**).

The stone wall trenches are arrow or half-moon shaped, and are placed on high points on the landscape, usually on the steep slopes overlooking the valley where animals would be drinking and grazing. These structures appear to function as blinds to conceal hunters for observing and hunting, and also serve to protect hunters from the wind and sun. They are often found in clusters or groups presumably so many hunters could hunt together, since most are only large enough to

conceal a single individual. Tables, which is the local name given to large piles of rocks with flat rocks across the top, were presumably used for butchering camelids after a successful hunt, and provided a place to butcher the animal while protecting and keeping the hide intact. Landmarks are standing upright stones or stacks of stones which may serve to mark hunting territories, or were part of the hunting structures themselves. These landmarks are very similar in form to *inuksuit* from the North American arctic which served a range of functions, i.e. to mark the beginning of drive lanes, formed part of a drive lane themselves, and/or otherwise marked significant spots of the landscape (e.g. meat cache, burial, directions, etc.) (e.g. Brink 2005). Shelters are small circular or semi-circular structures that would usually fit one person, and served as hunting blinds and additional shielded areas on the landscape to hide from sun, wind, and animals. Lastly, small stone constructions which are designed to give constant shade most likely acted as hiding spots for water. Ceramic sherds found in these structures are likely the remains of water vessels (Moreno 2012).

Figure 3.12. Hunting architecture in the Antofalla valley (Moreno 2012:108, Figure 3).



Figure 3.13. Hunting architecture in the Antofalla valley, A: alignment, B: board, C and D: landmarks, E: shelter, F: water hiding (Moreno 2012:110, Figure 6).



These structures demonstrate a detailed knowledge of animal behavior and the local topography. Many structures acting as hunting blinds were located on the highest points on the landscape in order to offer the best viewshed of the valley and of grazing prey animals.

Additionally, these structures seem to be placed near common game trails used by camelids as they moved from higher to lower elevations and back throughout the day (Moreno 2012:113).

Camelids in general and vicuñas in particular are adapted for high altitude environments and rocky steep slopes, and therefore can quickly escape or outrun hunters that are actively pursuing them. The highly modified hunting landscape developed in the Central Andes with a focus on ambush hunting of large groups of animals by small numbers of hunters utilizing

hunting architecture demonstrates that prehistoric hunters had a detailed knowledge of animal behavior (Moreno 2012).

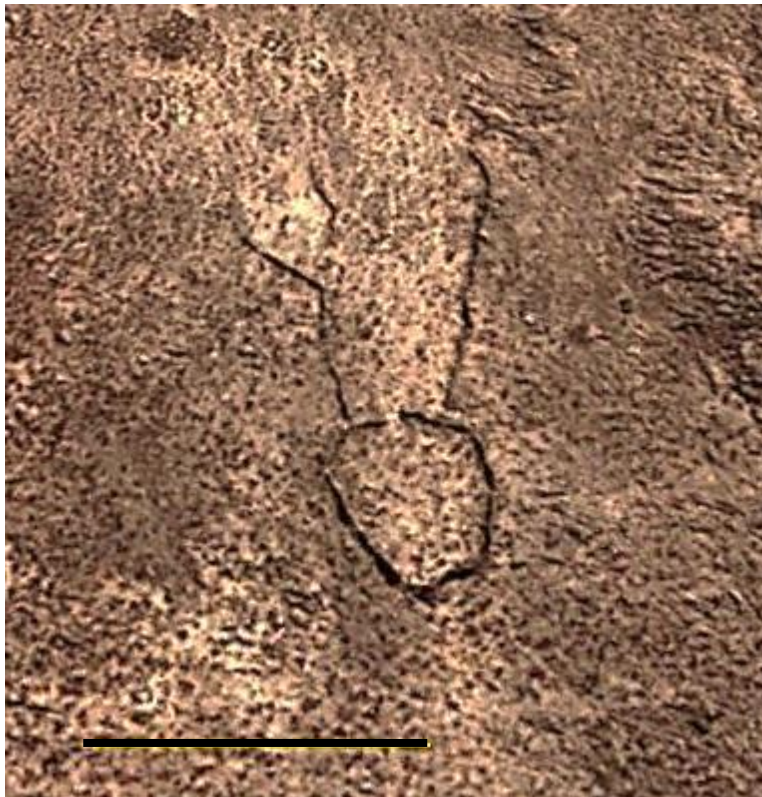
Similar structures have been identified on aerial photographs in Chile and Peru (Moore 2014) (**Figures 3.14-3.15**). One in Peru is noted to be at an elevation of 4,600 meters above sea level and consists of two stone fences 1.8 meters high, and 1000 meters long. These two fences are in the shape of a funnel with an opening of 20 meters wide into an enclosure (Custred 1979:12).

Figure 3.14. Apparent drive structures in Chile, scale bar is 50 meters (Moore 2014).





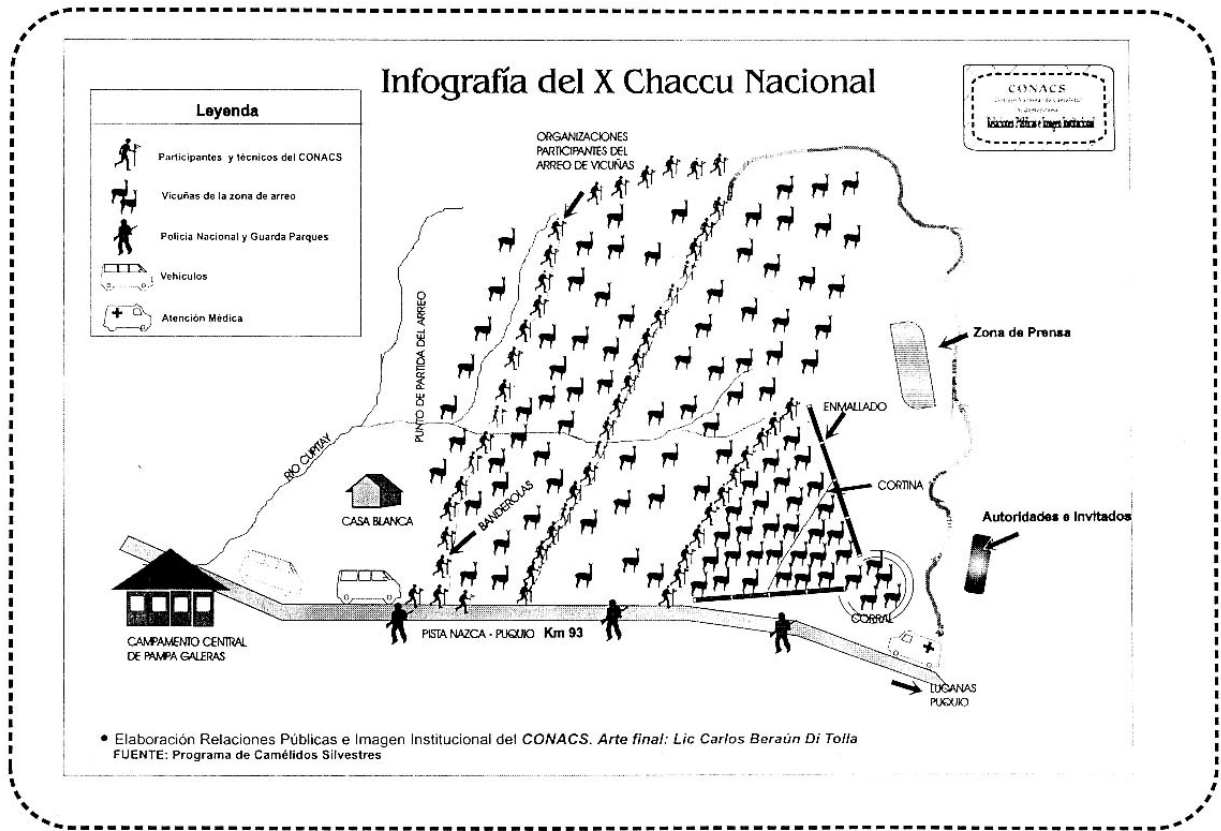
Figure 3.15. Apparent drive structures in Peru, scale bar is 50 meters (Moore 2014).



These examples of stone structures are echoes of the traditional practice of *chaccu* (or *chacu*, or *caycu* Quechua for “to enclose animals, or to place then in corrals” (Custred 1979:12)) where vicunas are chased, captured, and sheared. This practice dates back to pre-Hispanic times and the ritual was commissioned by Incan emperors (Custred 1979:12; Inamura 2006). Chaccu involves many people walking in two lines that are used to herd and corral vicuñas. People are spaced apart holding a rope tied with many flowing and colorful pieces of fabric. Vicuñas are trapped and corralled, sheared and released. Essentially during chaccu, drive lanes are made of people rather than permanent stones (**Figure 3.16**).

Figure 3.16. Gran Chacu (Inamura 2006:43, Figures 10, 12).





Overall, camelid hunting in the Andes shares similar characteristics with both desert kites and Tibetan hunting architecture. These stone constructed features are placed in similar locations on the landscape, and are aimed to take advantage of the specific traits of animal prey. In the case of the Andes, hunters were much more successful intercepting and ambushing camelids along their game trails rather than pursuing them across steep and difficult terrain.

North American Central Plains

In the North American central plains, bison (*Bison bison*) hunting using stone and dirt constructed jump and drive lane structures has a long history. The earliest bison trap reported, Jake Bluff, was created out of an arroyo and dates to $10,838 \pm 17$ RCYBP (late Clovis) (Bement

and Carter 2010). Behavioral traits of bison, such as herding in large groups at certain times of the year, and tending to stay together and flee as a herd when threatened, made them a prime target for human hunting using traps and structures. Diverse forms of bison traps include arroyos, corrals, and jumps (Carlson and Bement 2013).

Arroyo walls often functioned similar to drive lanes as bison were driven into dry river channels with steep walls and dead-ends. Once the lead bison reached the dead end and tried to turn around, they were blocked by the rest of the stampeding herd (Carlson and Bement 2013). Arroyo traps such as Jake Bluff are the earliest forms of bison hunting structures while elaborate jumps over cliff faces seem to have been developed later.

Bison jumps may be the best known and most illustrative example of peoples taking advantage of the local topography to complete large scale hunts. For bison jumps, the herd of animals is actively moved from a grazing area and stampeded over a predetermined cliff or precipice, to fall to their death or to be killed by hunters waiting on the bottom. Only certain points on the landscape will work and hunters had to take many factors into account to find the perfect spot, such as hiding spots for the hunters, milling areas, and the cliff itself. As only certain places would work, these locations were often re-used over time (e.g. Bonfire Shelter in Texas (e.g. Dibble and Lorrain 1968). Once the spot on the landscape was decided, drive lanes consisting of cairn-marked lines were added to lead the way to the jump. These bison drives can be very prominent on the landscape, such as Head-Smashed-In in Alberta which has over 500 stone cairns (Reeves 1978:154). These stone cairns were built using small stones and it has been suggested that they were used as the base of cairns constructed out of brush, trees, and other perishable materials (Brink and Rollans 1990).

In contrast to many other regions, these hunting features have been the subject of archaeological study for decades (e.g. Agenbroad 1978; Brink 2008; Carlson and Bement 2013; Frison 1970, 2004; Reeves 1978; Reher and Frison 1980). Numerous archaeological investigations and detailed GIS analyses of drive lanes in the American plains have concluded that prehistoric hunters had a sophisticated knowledge of animal behavior and natural topography, as drive lanes often followed least-cost paths across the landscape, and certain aspects bison behavior were actively exploited (e.g. Byerly et al. 2005; Carlson 2011). Furthermore, there is evidence of multiple uses of hunting architecture, and controlled burning to improve pastures for bison (e.g. Zedeño et al. 2014).

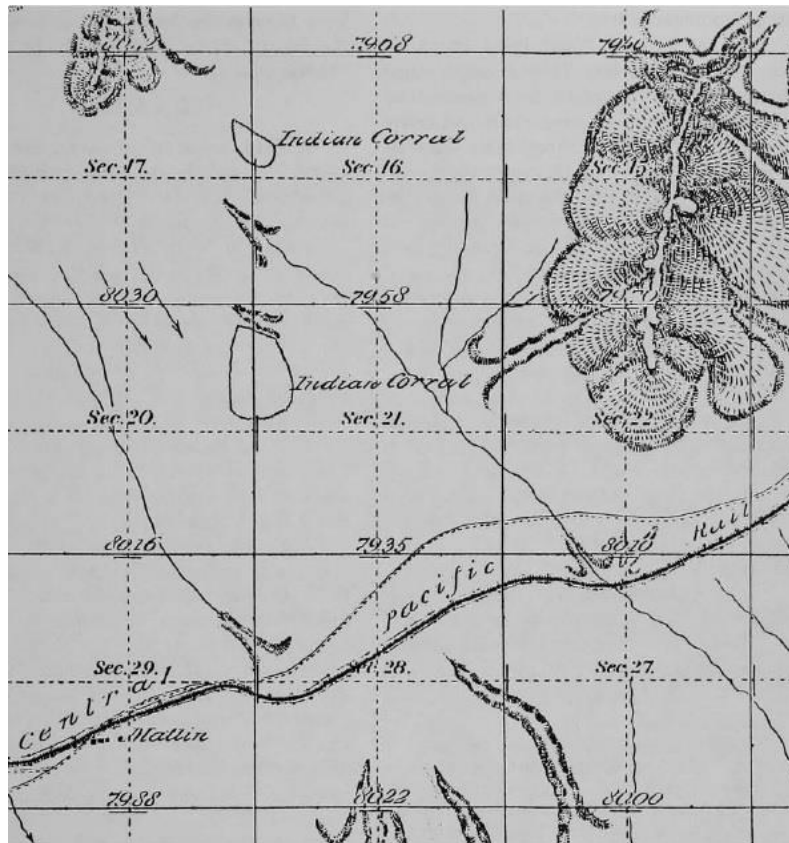
North American Great Basin

Over 100 large-scale hunting structures are known in the North American Great Basin dating from the Early Archaic (5000-6000 ca. years ago) to the historic era (700-800 years ago). These structures target four ungulate species common in the region; most often pronghorn antelope (*Antilocapra americana*), but also bighorn sheep (*Ovis montanus*), mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) (e.g. Benedict 2005; Burnett et al. 2008; Hockett et al. 2013; Lubinski 1999; McCabe et al. 2004).

Communal pronghorn drives using lines of brush, rocks, and wooden poles have been documented historically (Egan and Egan 1917:238-241, **Figure 3.17**) and ethnographically (Steward 1941). In these areas there was plenty of cedar and pine to use for fencing – and perhaps in areas where brush and trees are not as abundant (Egan and Egan 1917:239), stone lines were constructed. Juniper and sagebrush were used to build fences by many different Great Basin Shoshoni groups (Raymond 1982). Steward reports that the heights of pronghorn corrals varied from 18 inches (1943:359) to 7 feet (1941:328). While perhaps brush corrals were taller,

associated drive lanes or wings constructed out of rocks, brush, or a combination of both did not need to be very tall – as antelope, similar to caribou, will often go under a barrier, or run alongside it rather than crossing or jumping over it (McCabe et al. 2004:14). The diameter of pronghorn enclosures ranges to up to one mile (Steward 1941:219-220).

Figure 3.17. Historic pronghorn hunting architecture sites labeled “Indian Corral” north of Maltin, Box Elder County, Utah, Map by Henry Fitzhugh 1884.



Most pronghorn traps are elaborate hunting sites with many different kinds of structures functioning together. An example of this is the Whiskey Flat trap complex, which includes a drive lane or drift fence, corrals, and hunting blinds (Wilke 2013). These hunting stations or blinds are small v-shaped, u-shaped, or semi-circular single person stone constructions (Wilke 2013).

Pronghorn drives likely took place in every season except during summer when antelope are widely dispersed. Despite historic accounts that drives decimated antelope herds and could not take place every year (e.g. Egan 1917:241), it is likely that such low antelope populations were due to historic overhunting and had little to do with traditional game drives which were likely an annual occurrence (Arkush 1986).

While bison were *driven* in the Central Plains, in the Great Basin pronghorn were *lured* (Brink 2013 emphasis in original). Pronghorn have an innate curiosity and tend to run uphill when startled and the layout of drive lanes such as the Barnett site in Alberta, Canada display an exploitation of these behaviors, as these particular drive lanes are settled on an elevated ridge (Brink 2013) (**Figures 3.18-3.20**). Pronghorn were attracted to the drive lanes by many methods which are ethnographically documented, including lying down and raising a hand, kicking feet in the air, or raising and lowering a sort of flag. These methods rely on pronghorns' innate sense of curiosity and lure them slowly into traps. Unlike bison, pronghorn are more skittish and tend to scatter, double back or even run in circles to escape predators. Great Basin hunters clearly knew these attributes of pronghorn behavior and rather than attempting to stampede them over a cliff or into drive lanes, they were tricked and lured close to trap sites. As Steward highlights, these luring methods "would have been less effective with other species" (1941:219).

Figure 3.18. Ariel view of the Barnett pronghorn hunting site, Canada with the two drive lanes outlined (Brink 2013, Figure 3).

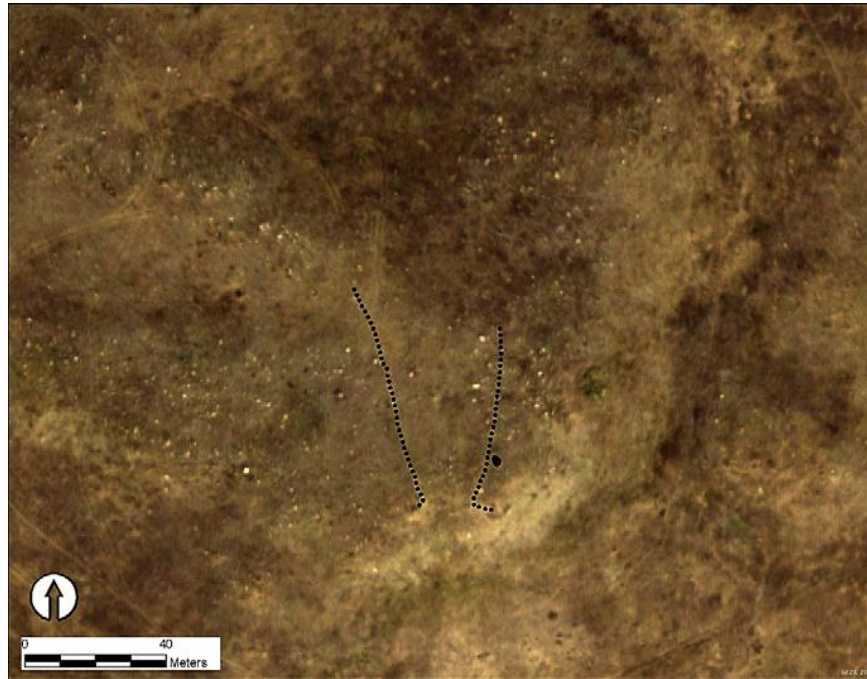


Figure 3.19. Ariel oblique view of the Barnett pronghorn hunting site, arrows indicate the likely direction of animal movement from the surrounding landscape into the wide opening of the drive lanes (Brink 2013, Figure 4).



Figure 3.20. Ariel oblique view of the Barnett pronghorn hunting site looking northeast, left arrow indicates a circular cluster of stones, right arrow marks depression at the end of the drive lanes (Brink 2013, Figure 7).

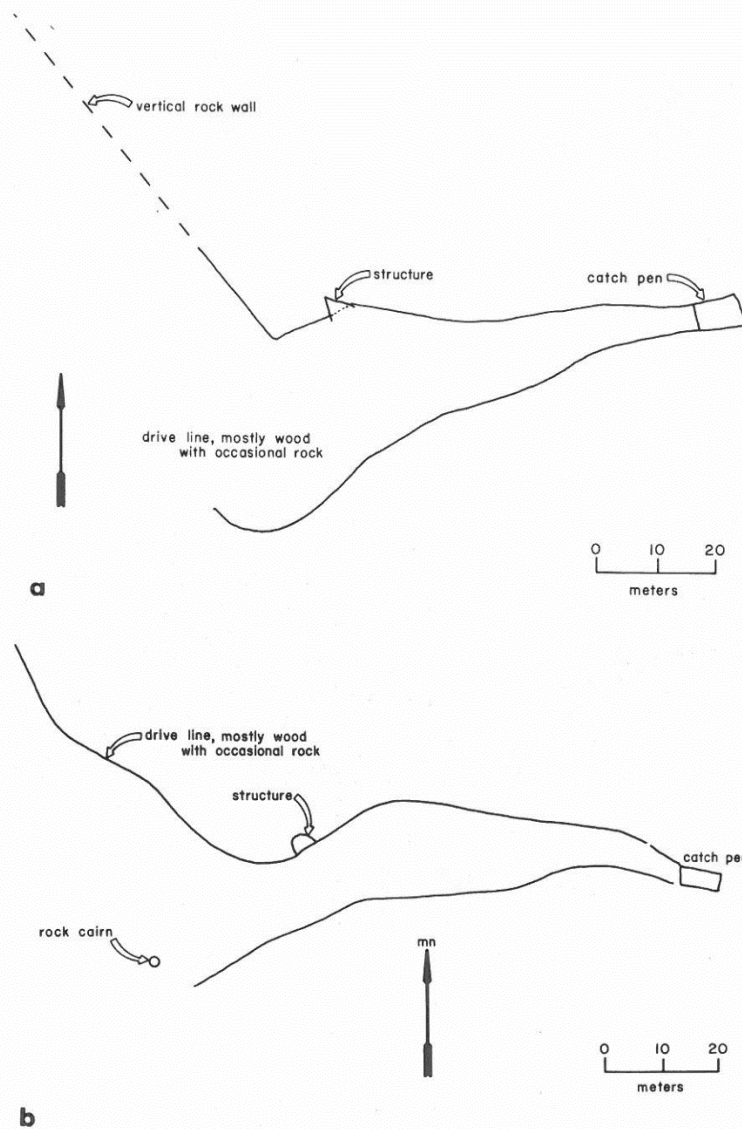


North American Rocky Mountains

Numerous high altitude game drives have been documented in the Rocky Mountains (e.g. Benedict 1970, 1975a, 1975b; Benedict and Olson 1978). Bighorn sheep (*Ovis canadensis*) are a common prey resource targeted by hunting architecture in this area (Frison et al. 1990), but bison, deer, and elk may have also been the targets of hunting structures in the region. From the Paleoindian period to the historic era (ca. AD 1800) stone alignments, hunting blinds/pits, wooden sheep traps/catch-pens, and likely caches (Frison 1975) have been documented. The design and location of hunting architecture in the Rocky Mountains is variable, and sites are often superimposed across the landscape – suggesting different animals being hunting in different ways over time (Morris 1990:196).

Several wooden sheep catch pens from the historic era have been documented with substantial fences that extend over long distances, and pens that are constructed with large logs and a ramp leading to the entrance (e.g. Frison et al. 1990). Drive lanes were placed as a funnel leading into the pen, so that the animals moved upslope. Ramps leading into the pen were camouflaged using dirt and gravel. Catch pen sizes varies from 14.8 – 23.9 feet (4.5-7.3 m) long, and 8.2 – 13.5 feet (2.5-4.1 m) wide (Frison et al. 1990:218) (Figure 3.21).

Figure 3.21. Bighorn sheep catch pen and drive lanes at the Black Mountain Sheep Trap (Adapted from Frison et al. 1990:Figure 12.4).



In addition to these clearly historic era wood catch pens, hunting architecture made of stone that likely dates earlier has also been documented in the Rocky Mountains. One of the largest and best documented sites is the Rollins Pass Complex in Colorado (Pelton 2012). Rollins Pass has 12 different hunting architecture sites which are likely related to restrict and channel game migration across the major pass. Hunting architecture is comprised of rock walls, hunting blinds, and cairn lines with over 8,000 meters of walls and 187 blinds (LaBelle and Pelton 2013) (Figures 3.22-3.23). One of these sites, the Olson site, has radiocarbon dates demonstrated that the site has been used multiple times over the last 6,000 years and have yielded faunal remains of bighorn sheep (LaBelle and Pelton 2013).

Figure 3.22. Rollins Pass.

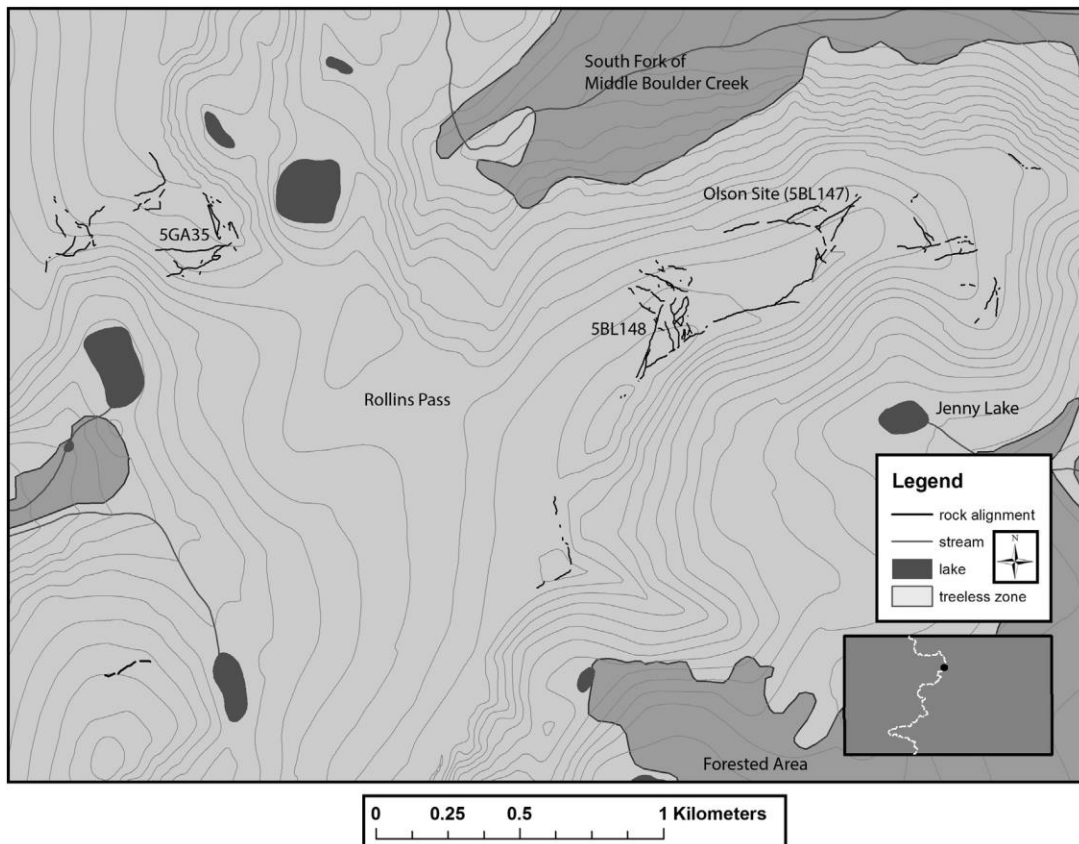


Figure 3.23. Drive lane and hunting blind at the Olson site (LaBelle and Pelton 2013:Figure 5).



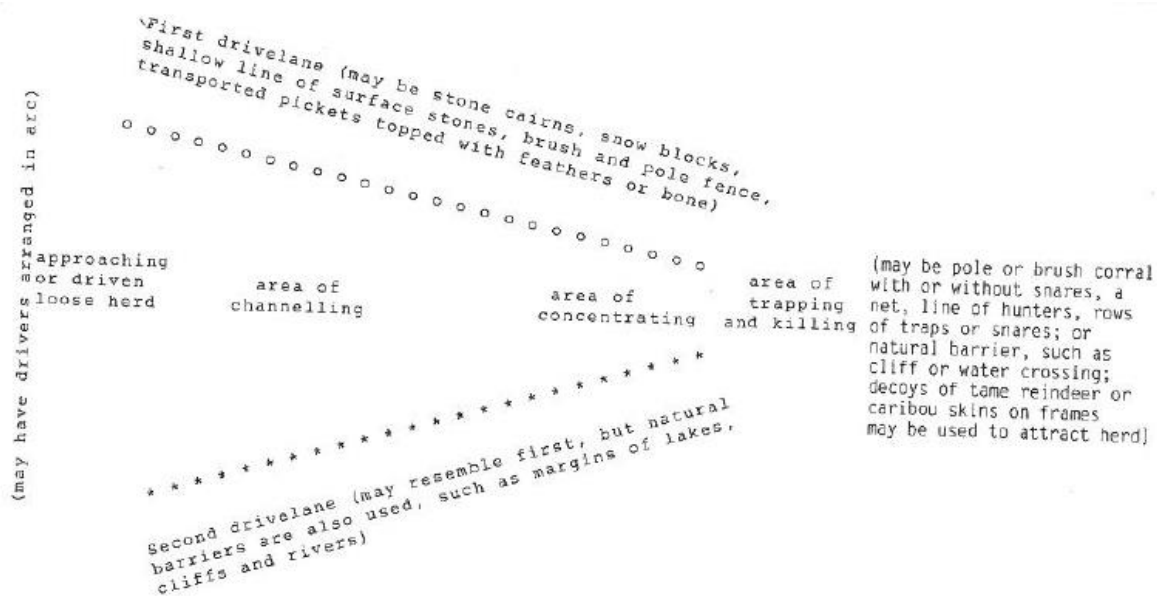
These sites demonstrate the same use of local topography as other hunting architecture, as well as detailed knowledge of bighorn sheep behavior. For example, “When disturbed, they

[bighorn sheep] tend to leave the bed-grounds, move rapidly downhill, and then make a half-circle and start uphill. The open ends of the drive lanes were placed in the optimum position to intercept the animals once they started uphill” (Frison et al. 1990:223). Additionally, many hunting structures are placed near natural funnels such as narrow passes with rocky slopes (Morris 1990:203). Sites are also placed strategically next to bedding grounds of bighorn sheep, and near common game trails as these animals migrate altitudinally, summering in higher elevations and wintering in lower ones (Honest and Frost 1942).

The Arctic

Across the Arctic, stone, wood, dirt or brush hunting structures were used to channel or drive caribou and reindeer (*Rangifer* sp.) herds to killing areas. These structures work because similar to other ungulates, caribou have innate curiosity, natural pattern recognition, and are attracted to linearity (Brink 2005; Spiess 1979:36). Additionally, they will often run alongside barriers rather than jump over or cross them (McCabe et al. 2004:14). Hunting architecture sites for targeting caribou are therefore often comprised of long drive lanes designed to lead the animals into water, narrow lanes or valleys, nets, or corrals and these lanes are elaborated with hunting blinds, cairns, and other features (e.g. Brink 2005; Gordon 1990; Riches 1982:33-39; Spiess 1979) (See **Figure 3.24**).

Figure 3.24. Generalized schematic of caribou drive lane (Gordon 1990:297).



Physical remains of hunting structures are well known from the North American Arctic, used by late prehistoric Dorset, Thule, and Inuit populations in Canada and Greenland.

Archaeological surveys in these areas reveal complex, modified landscapes with dozens of caribou hunting structures including drive lanes, meat caches, hunting blinds, cairns or *inuksuit*, and others (e.g. Brink 2005; Freisen 2013; Grønnow 1986; Stewart et al. 2000, 2004).

Ethnographic data concerning *Rangifer* hunting structures is covered in **Chapter 5**, here archaeological investigations of historic and prehistoric sites are briefly outlined to summarize the built elements and placement on the landscape similar to the other geographic regions above.

Historically in the Yukon, Kutchin and other groups constructed caribou fences between AD 1800 – 1900 (Greer 1984; McClellan 1975; Sidney 1980). These long funnels and corrals were made primarily of wood, specifically black spruce (*Picea mariana*) and willow (*Salix arbusculoides*). Flat slabs of limestone were used to reinforce parts of the fence, or as carins (up to 0.5 meters tall). Large bull antlers were placed at the beginning of several fences likely to

attract caribou and calm them (Mcfee 1981). Two arms of fences would lead to a corral area lined with snares.

Across the Yukon, it appears that large hunting complexes, such as fences, were common in the valleys and smaller single hunting blinds were placed in higher elevations near ice patches. This type of caribou hunting has a long history as stone hunting blinds have been found in close association with a wooden dart shaft fragment dated to 4360 +/- 50 (TO-6879) (Greer 1986; Kuzyk et al. 1999). Ice patches are often visited by caribou in the summer to escape heat at the lower elevations and insects (Kuzyk et al. 1999:218). Hunters targeted caribou at these predictable locations and perhaps also took advantage of the year-round ice to freeze and cache excess meat (Hare et al. 2004:262). This ice patch hunting with stone constructed hunting blinds in the Yukon is very similar to Kangtsö (“snow antelope”) hunting in Tibet where blinds are placed next to ice patches used by antelope in the summer also escaping heat and insects (see above). Hunting blinds near ice patches also took advantage of the natural topography and were placed in areas that would have shielded the hunters. Melting ice sheets in the Yukon in the last several years have exposed and preserved many organic hunting implements. These artifacts indicate a rapid transition in caribou hunting ice patch weaponry with the throwing dart being replaced by the bow and arrow around 1200 BP (Hare et al. 2004).

In the central barren grounds of Canada, historic Chipewyan (ca. AD 800 – 1900) and prehistoric Taltheilei built stone hunting blinds and fences. The placement of these sites on the landscape is non-random and correlated with contemporary caribou crossings (Morrison 1981). The Cairn Lake Site (KcNc-2) has several semi-circle stone constructed blinds with no drive lanes; it is therefore interpreted that during the southward migration large numbers of caribou

would be within easy range of the blinds and did not need to be actively driven (Morrison 1981:175).

In Greenland, hunting structures consist of shooting blinds, cairns, and fences (Grønnow 2009:203-204). Aasivissuit is a large summer camp in Greenland (Grønnow et al. 1983) located near a topographic bottleneck through which the Fall migration of caribou traveled. Around 1700 AD several large scale communal hunts took place there with the use of hunting architecture. The site has a drive lane with 104 cairns over 4.5 km which leads to a 70 meter long stone fence or shooting wall or to a lake crossing (Grønnow 2009:206). In contrast, in the area of Angujaartorfiup Nunaa, large scale drives were only occasional, with only 3 large and complex hunting structures identified, base camp locations in the area are not determined by the location of large scale communal hunts since these structures are far away, i.e. 2-6 km as the crow flies, from the base camps. This differences can be explained by topography, as Angujaartorfiup Nunaa is dominated by rolling high plains, steep side river plains, or bordered by large lakes and ice caps – in this landscape caribou were generally scattered, and mass migrations through the area were rare. These geographic features limit crossing areas where caribou could be easily intercepted during migrations such as passes, fords, or narrow lakes – such as the bottleneck at Aasivissuit (see also **Chapters 5 and 8**).

Shared Characteristics

This global sample of hunting architecture illustrates that the formal nature of hunting structures and their geographic placement demonstrates both a detailed understanding of animal behavior. Overall, hunting architecture works by exploiting unique aspects of animal ethology and their predictable movements. Ungulates share several characteristics in both anatomy and

behavior that make their exploitation similar across the globe. For example, in terms of eyesight, pronghorn, bison, and caribou (Brink 2005; Brink and Rollans 1989) are particularly sensitive to moving objects (O’Gara 2004:111), which is why drive lanes are often elaborated with flags, brush, or other objects that will move in the wind to both attract animals and make them sufficiently nervous to stay within drive lane boundaries. Furthermore, many ungulates including caribou, bison, horse, and pronghorn will often run alongside barriers, go around them, or try to go under them rather than cross or jump over them (McCabe et al. 2004:14), therefore drive lanes did not need to be substantial, and simple rock lines just 20-50 cm high were most likely substantial enough to channel ungulate movements (Brink 2013). Additionally, these animals are relatively social, and their herding together in groups during certain times of the year makes them susceptible to large-scale hunting by humans. This herding behavior also generally corresponds to seasonal variation in animal condition, and it is during autumn that most of these prey species, such as caribou, bison, and pronghorn are at their peak condition (in terms of body weight, fat content, skin and sinew condition, etc.). Understandably, many zooarchaeological assemblages of such animals are indicative of autumn hunting (e.g. Blehr 1990:320; Dobosi 1991:199; Enloe 2003:24; Enloe and David 1997; Frison 2004:125; McCabe et al. 2004:15; Reimers and Ringberg 1983; Stefansson 1951:337). To exploit these behavioral attributes, ungulate hunting structures from across the globe share many common elements, including standing or stack stones such as *inuksuit*, cairns (Wilke 2013), or landmarks (Moreno 2012), long linear structures collectively referred to as drive lanes, and hunting blinds.

In addition, the placement of structures on the landscape demonstrates an intimate familiarity with the local environment, often taking advantage of the natural and existing topography to either channel animals to kill zones or intercept animals at natural bottlenecks,

along migration routes, common game trails, near grazing areas, or on elevated ridges (Bar-Oz and Nadel 2013; Nadel et al. 2013; Moreno 2012; Morrison 1981; Smith 2013). Furthermore, natural features are used to conceal hunters in hunting blinds, or to hide the corral or pit from animals within the drive lanes (e.g. Frison et al. 1990). The natural topography is also used to the hunters' advantage, with natural features used to channel animals such as valleys, hills, and hillside. This elaboration of natural features reduced the amount of stone and other materials necessary for construction, and also limited the time and labor necessary to construct hunting architecture (Storemyr 2011:17).

Discussion

From this survey of hunting architecture a few points are made clear, specifically concerning the diversity, complexity, and deep time depth in patterns of ungulate hunting using structures.

While the geographic and temporal distribution of these sites and their shared characteristics underscore a common solution to ungulate capture and hunting and serve as an example of convergent evolution (Smith 2013), diversity in these methods is also apparent. While clear differences exist in the local environments and species, each case demonstrates sophisticated use of local landscapes and a detailed understanding of animal behavior. However, the diversity that is perhaps most interesting concerns the assumptions we make as archaeologists about the numbers of people and animals involved in these hunting structures, as they are more often than not thought to be associated with large groups of people (Carlson and Bement 2013; Smith 2013; Wilke 2013; see also Lemke 2015a).

Along with the diversity, the complexity of hunting features, alignments, and concentrations is clear from this global overview. When considered at a regional level, the large number of hunting structures and elaborate complexes reveal multi-purpose and multi-seasonal hunting landscapes. While individual blinds or drive lanes may have been used by small numbers of hunters during one season, the same groups of hunters and their families may have returned to those structures or others close by at another time of year. Hunting landscapes need to be examined with an eye for diversity, complexity and use over time at different scales - from seasonal, annual, and generational use - to much longer term maintenance and reuse of hunting structures and their change over time.

Indeed, there is a deep time depth in patterns of ungulate hunting using structures. Hunting features and modified hunting landscapes serve as examples of ecological inheritance, as they are modified and elaborated over time by subsequent generations and knowledge about their use and manufacture is passed down (Smith 2013). Specific regions such as the long record of bison hunting in the Central Plains show great diachronic change as different methods and structures came into, and perhaps fell out of use (Carlson and Bement 2013). It is the animal behavior that remains constant in these scenarios and reveals why humans have such a long history of preying on ungulates. The aid of hunting structures is an archaeologically visible method of exploiting these quirky animals that group together in peak times of the year which can be exploited successfully and fairly regularly with the correct understanding of their behavior and strategic use the natural landscape.

Hunting Architecture and Hunter-Gatherer Lifeways

As a global phenomenon, hunting architecture presents a fundamental shift in hunter-gatherer subsistence strategies. The construction, maintenance, and potential inheritance of both the specialized knowledge to operate such structures, and the general use of permanent structures themselves, are at odds with many classic tenants of hunter-gatherer lifeways; namely their highly mobile nature, their “weak development of facilities, storage, ownership, and claims to land” (Wobst 1978:304), their ability to organize communal labor projects, and egalitarian social organization.

Mobility

Although foragers are generally considered highly mobile, permanent hunting structures anchor them to certain places on the landscape for at least part of the year. Most hunting architecture sites are strategically located to intercept ungulates during migrations. These seasonal migrations happen at specific times and along specific orientations – requiring foragers to be in the right place at the right time. Therefore, hunting architecture sites play a significant role in shaping the seasonal round and settlement pattern of hunter-gatherers, and these large scale hunts create both the push and pull motivations for seasonal sendentism. This pattern of mobility stands in contrast to normative models of high mobility foragers, and limited mobility in certain seasons creates sociopolitical and economic tensions concerning ownership/territoriality, labor aggregation, leadership and other social dynamics.

Property

In terms of ownership, numerous ethnographic and historic sources indicate that hunting architecture sites were considered property. For example, among the Shuswap of British Columbia, berry patches and fishing grounds were shared, but deer-fences were private property:

“A deer-fence was inheritable property, the nearest of kin inheriting it. If he did not care to use it, he gave it to the next of kin; and if none of them wanted it, then it was sold, generally for a small sum, to a stranger, who henceforth owned it. If a deer-fence fell into disuse and was not repaired for a number of years, then any one might erect a new one and snare deer in that place.” (Teit 1909:573).

The Vanta Kutchin individually owned caribou drive lanes and corrals (Gordon 1990:287). Similarly, among the Tanana of central Alaska, although operated communally, drive lanes belonged to individuals (Gordon 1990:287-288). Large scale, communal reindeer hunts at river crossings among the Nganasan in Siberia were considered band property (Gordon 1990:295), and in the winter herds were funneled into low nets which were inherited property often owned by brothers (Popov 1966:56). Similarly, pronghorn corral traps in the Great Basin were considered the property of the group or groups that constructed and maintained them year to year (Steward 1938:175), Kwakiutl fishing weirs were considered private property (Boas 1921:1345-1347), and finally, large bison jumps on the North American Plains were owned by specific bands who wintered near them (Schaeffer and Schaeffer 1934). This type of property ownership is contra to normative models of hunter-gatherer territoriality and land tenure as specific portions of the landscape were modified and claimed by different individuals and groups.

Labor Aggregation

While there is diversity in the number of people using different forms of hunting architecture, the construction and operation of complex hunting structures does require a large labor force, with multiple people operating different parts of the drive, likely men, women, and children. It is also ethnographically documented that trapping ungulates like pronghorn was viewed as both a ceremonial activity and a subsistence venture (Sundstrom 2000), and for Great Basin peoples was often the largest social gathering of the year (Liljeblad 1986: 645). Therefore hunting architecture sites often also serve as loci for social aggregation. For example, several families of men, women, and children are known to cooperate through various tasks in large scale drives (e.g. Binford 1991; Frison 2004; Gordon 1990; Hocket et al. 2013; Spiess 1979) (see **Table 3.2** for the number of people involved in ethnographic caribou hunts with structures). In turn, the larger yields generated from the use of hunting structures can support these temporarily larger population aggregations (Binford 1991:35; Brink 2008; Carlson and Bement 2013; Frison 2004; Nadel et al. 2013; Smith 2013; Wilke 2013). For example:

“Most antelope hunting was communal, larger numbers of persons assembling from considerable distance once or twice a year for that purpose...social features were dancing, singing, gambling, feasting, courting, and visiting with people rarely seen during the rest of the year. These large gatherings could be fed only by the temporarily increased food supply produced by a large hunt” (Steward 1941:219).

Large scale aggregations for communal hunting also provide opportunities for other social activities such as feasting, social networking, information exchange, mate selection, and trade (Carlson and Bement 2013). While seasonal social aggregation in general is considered to be typical of foraging groups, aggregation and the construction and operation of large scale

architecture has traditionally been overlooked or considered very rare (see *Landscape Modification* below).

Table 3.2. Estimated number of people participating in communal caribou hunting with hunting architecture.

| Number of People | | |
|-----------------------------|------------------------------|--------------------------|
| Minimum | Maximum | Reference |
| “much smaller bands” | “several hundred people” | Morrison 1981:183 |
| | 10-15 people “large group” | Grønnow 2009:205 |
| | 20-30 people | Gordon 1990:288 |
| | 40 people | Balikci 1964:87 |
| | 30-50 people | Gordon 1990:284 |
| | 70-100 people | Leechman 1954 |
| | 200 people | Morrison 1982 |
| 15 families | 50 families | Mcfee 1981 |
| 50-400 people (winter/fall) | 350-600 people (late July) * | Hearne 1958:121, 252-256 |

* July herds are the largest and fission later allowing such large scale social aggregation

Leadership

The construction of hunting architecture, as well as the operation of complex, communal hunts were often scheduled and overseen by a particular individual. For example:

“The Vunta Kutchin has a succession of polygynous trial chiefs, economic leaders (owners of the caribou surrounds), moiety chiefs, war captains and religious leaders or shamans who acted on behalf of the whole community in crisis periods” (Balicki 1963:63).

“A village of perhaps 10 families was located in the northern end of Butte Valley in a canyon called Natsumbagwic (big water coming down), near Taylor Ranch...The chief

was Hugamuts, an antelope shaman who directed local hunts. These hunts were participated in by people from a wide area, including Ruby Valley, Cloverdale Valley, the Spruce Mountains, and elsewhere. BM also described an old woman who conducted antelope hunts in the Butte Valley, the only instance recorded of a woman antelope shaman” (Steward 1938:145-146).

“Such major operations were not left to chance individual enterprise. The construction of a corral, the stationing of sentinels, the appointment of scouts, and the need of checking premature attacks that might cause failure, all required careful planning and cooperation. Accordingly the tribal hunt was preeminently a period of rigid control by the camp chief” (Lowie 1935:73).

“There is a stereotyped form of drive for rabbits, for mud hens, and for antelope. A leader or head-man, elected or choose for each drive, is responsible for the direction of the undertaking” (Park 1938:62)

The type of leadership described in these ethnographic example is similar to other economic leaders in “egalitarian” societies, such as umiak captains. Umiak captains were the owners of the skin hunting vessels used primarily for whaling by North American Arctic societies. Umiak captains (or *umialik*, rich man (Burch 1975:209-210)), have been taken to be evidence of social hierarchies within an otherwise egalitarian hunter-gatherer context, as these captains have unequal access to social and material resources (Grier 2000). Contra to conceptions of highly mobile, egalitarian societies, such whaling crews represent a highly

formalized, hierarchical system of suprahousehold labor organization in a cooperative economic endeavor (Greir 2000:265) – very similar to communal hunts utilizing hunting architecture.

Whales served as a primary economic resource which produced a seasonal surplus, involved storage, allowed for seasonal sedentism, and required cooperative labor; all conditions which have been considered variables contributing to the evolution of “complex” hunter-gatherers (e.g. Greir 2000:266). Umiak captains, as well as antelope shaman, and other leaders of communal hunts with hunting architecture resemble a simultaneous hierarchy (*sensu* Johnson 1982), since decision making was left to a single individual rather than consensus (Greir 2000).

Niche Construction

Overall, the construction, use, and maintenance of hunting architecture has significant implications for foraging societies. These social and economic ramifications can be better understood within the theoretical concept of niche construction, and the interrelated issues of hunter-gatherer food production and landscape modification.

Hunting architecture is an example of human niche construction (Smith 2013). Niche construction, the process in which an organism alters its own environment, has been documented in a number of animal species, with human recognized as the “the ultimate niche constructors” (Odling-Smee et al. 2003:28; Smith 2007). Humans both inadvertently and deliberately modify their local environments, and their relationship with these environments in many ways (Smith 2011). Niche construction can be placed in a general evolutionary framework as it provides a distinct reproductive advantage by increasing the chance of survival of subsequent generations. Human niche construction primarily increases the abundance and predictability of wild plant and

animal resources, and well as reduces the amount of time and energy to gather or hunt them (Smith 2013). While many niche construction applications have focused primarily on wild plant foods, their stationary nature making them easier targets for human management, hunting architecture represents human ecosystem engineering targeting wild animal resources (Smith 2013).

The construction and use of hunting architecture relies on both a sophisticated knowledge of animal behavior and strategic use of the local topography, these attributes can be collected referred to as traditional ecological knowledge: “Traditional Ecological Knowledge: a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living being with one another and with their environment” (Berkes 2008:7). The construction and operation of hunting architecture relies on a detailed understanding of prey behavior and the shared attributes of ungulates, such as their tendency to follow straight lines rather than crossing them, and their tendency to run uphill to avoid predators, etc. Additionally, knowledge concerning where and when to target animals using hunting architecture can also be considered traditional ecological knowledge, and used for deliberate niche construction.

Furthermore, landscape modification in the form of built hunting architecture is literal niche construction. These structures take advantage of the natural landscape such as topographic bottlenecks, and steep ridges and modify it to channel and corral prey species. Such landscape modification can also be referred to as ecological engineering akin to other processes such as broadcast fires which activity modify the landscape and increase yield. In both these processes hunter-gatherers act as ecosystem engineers (Bird 2015). Anthropogenic fires to improve pastures around bison hunting architectures sites is well documented ethnographically,

historically, and archaeologically on the North American Plains (e.g. Oetelaar 2014). Similarly, Zedeño et al. argue that bison hunters on the plains using drive lane structures constructed a monumental engineered landscape (2014). Such constructions have been traditionally considered the work of complex hunter-gatherers, although archaeological data from the Southeastern United States has contradicted this view as monumental architecture such as Poverty Point, and Middle Archaic mounds were likely built by small-scale, mobile foragers (Sassaman 2004:231), and more generally, hunter-gatherer landscape modification is becoming increasingly acknowledged (Lovis and Whallon 2016). Importantly, the distinction here may be between planned monumental constructions, and monumental landscapes that are a product of the accumulation of many structures over time.

Related to niche construction is the general concept of food production. Many forms of human niche construction involve the deliberate management of wild plant foods by humans eventually leading to domestication. Hunting architecture is essentially the same process but concerning animal resources, and these structures and their associated communal hunts increase the predictability and yield of the hunt, “Corralling herds is, in a sense, food production, not just the simple harvesting of wild food” (Kehoe 1990:43). As the use of hunting architecture requires communal labor to produce significant surplus, it can be considered a form of food production that parallels domestication (1990:44). This seasonal surplus also produced the food necessary to feed the large aggregation of people participating in the communal hunt, essentially underwriting seasonal sedentism. Alternatively, if communal hunts took place in the Fall, surplus meat beyond the immediate needs of the group could be stored for the coming winter. Both of these processes, surplus and storage have been instrumental in discussions of the origins of agriculture and its associated social and economic consequences. Therefore, similar to the origins of agriculture, the

adoption, creation, use, and maintenance of hunting architecture among hunter-gatherers produced significant economic and social tensions.

Hunter-Gatherer Complexity

Overall, each of these traits associated with hunting architecture: seasonal sedentism, property rights, labor aggregation, leadership, food production, and landscape modification, have traditionally been considered characteristic of complex hunter-gatherers (e.g. Ames 1994; Arnold 1996a,b, 2004; Fitzhugh 2003; Prentiss 2007; Sassaman 2004; Widmer 1988). More recently, some of these attributes have been demonstrated in “simple” hunter-gatherer contexts. For example, landscape engineering such as hunting architecture could be used as a proxy measure for complexity (Zedeño et al. 2014), and ecosystem engineering among Australian aborigines is considered indicative of emergent complexity in foraging societies (Bird 2015). Essentially, “Nothing is simple” (Sassaman 2004:236) in hunter-gatherer societies, and hunting architecture presents a research avenue to further refine normative views of both “simple’ and “complex” hunter-gatherers (**Chapter 10**).

Archaeology of Hunting Architecture

Diverse hunter-gatherer groups on every continent except Antarctica used built stone, wood, or dirt hunting structures in order to capture or channel numerous prey species. It has been demonstrated that the construction and operation of such features has significant social and economic ramifications for hunter-gatherer societies. The archaeology of hunting architecture

must draw on this larger anthropological framework to find common patterns in structure types, seasonal use, and group dynamics.

Archaeological investigations of prehistoric hunting architecture can make use of spatial relationships between structures and the formal attributes of the structures themselves to infer a range of social and economic factors including: the targeted prey species, the number and nature of animals hunted, hunting technology, the season when the structure was used, and finally the number of people involved. Additionally, detailed comparisons of hunting structures reveal general archaeological expectations at both the regional and site-level spatial scales. This final section constructs the middle-range theory of hunting architecture by linking the behaviors of creating and maintaining hunting architecture to the material remains of these structures in the archaeological record.

Preservation Issues

While hunting architecture is fairly common and is often noted by archaeologists, it has rarely been studied comparatively, often receiving only brief mention (Arkush 1986:247; Brink and Rollans 1990:152; Fitzhugh 1981:188; Mcfee 1981:161). While these sites warrant studies of their relationship within larger subsistence and settlement patterns, such analyses have rarely been done (Fitzhugh 1981:188).

This lack of comparative and generalizable archaeological research is due to a number of factors. The first of which is preservation. While some forms of hunting architecture are constructed out of non-perishable materials such as stone, many are constructed out of, or elaborated with, organic materials such as dirt, wood, ropes, and/or brush (e.g. Arkush 1986:252). These latter construction materials typically will not become part of the

archaeological record. Additionally, even when hunting structures are made of stone or more substantial materials, post-depositional modifications particularly in the form of subsequent development, often destroy these sites (Benedict 1996:2-4). Even when preserved, hunting architecture sites have a low visibility profile and are not easily recognized to the untrained eye (Pasda 2014:69; Stewart et al. 2000, 2004); it is therefore easy to imagine scenarios where lines or piles or rocks are removed from agricultural fields or during construction efforts. This pattern of site destruction can be highlighted by the fact that the majority of hunting architecture sites have been identified in areas with low population densities, such as the arctic, desert regions, or areas of high elevation (e.g. Greenland, northern Canada, Sinai Peninsula, the Andes); or alternatively are preserved underwater, such as the caribou hunting sites discussed in this dissertation or Mesolithic fishing weir sites under the Baltic. Finally, there is often little to no sediment cover of architectural components or associated cultural materials, leaving such sites vulnerable to erosion, looting, or other disturbances.

The preservation issues often results in a lack of absolute dates (Fitzhugh 1981:188; Storemyr 2011). In addition, hunting architecture sites are often intentionally kept very clean in order to be reused (with the notable exception of large-scale bison drives, e.g. Head-Smashed-In (Brink 2008), in fact prey size significantly impacts archaeological expectations for hunting architecture sites, see below)). It is clear from both archaeological and ethnographic examples of hunting architecture that materials including bones, tools, etc. are often removed in order to get rid of the smell of human hunters and dead animals so that the sites may be reused (see below for archaeological implications). Such cleaning removes standard datable materials such as charcoal or animal bone. While some sites have been dated, and lichen/moss dating (lichenometry) has been applied with some success (Morris 1990 but see Osborn et al. 2015), these are the

exceptions. For example, of the thousands of known hunting structures referred to as kites in the Near East, very few have been excavated and even fewer have been dated (Crassard et al. 2014). Finally due to cleaning, and general preservation issues, diagnostic artifacts are rarely found – further hampering attempts at even relative dating and/or assigning cultural affiliation (Fitzhugh 1981:188; but see Arkush 1986:247-249).

Related to these issues of preservation and chronology, archaeological investigations on such sites have been limited since these sites may have indeterminate function, i.e. may not be identified as hunting architecture but some other form of built structure. Many of these sites – when preserved at all – are assumed to be historic, and ethnographic analogy is most often used to interpret them – despite the fact that the archaeological record presents discrepancies from the ethnographic record that need to be accounted for (Brink and Rollins 1990:153).

Due to all these issues, archaeological research on hunting architecture sites has been limited – particularly at a broad, comparative scale. There are some notable exceptions the general lack of archaeological studies of hunting architecture including several chapters in *Megaliths to Medicine Wheels: Boulder Structures in Archaeology* (Wilson, Road, and Hardy (Eds.) 1981), many chapters in *Hunters of the Recent Past* (Davis and Reeves (Eds.) 1990), and most significantly, a recent special issue of *Quaternary International* 297 (Bar-Oz and Nadel (Eds.) 2013).

Fortunately the case study analyzed in this dissertation is immune to many of these preservation issues as due to its unique submerged context (**Chapters 6-9**). These underwater investigations of caribou hunting architecture under Lake Huron therefore offers an ideal scenario for investigating such sites.

Hunting Architecture and Material Correlates

While overall preservation issues are rampant in hunting architecture sites, archaeologists have been creative in interpreting their function even in the absence of cultural materials. Despite the lack of artifacts which characterizes many hunting features, the formal attributes (i.e. the size, shape, and orientation) of the structures themselves can be used to infer a range of variables. Such features can be used to infer the targeted prey species, the number of animals hunted, the nature of the animals (i.e. whether they are panicked), the season of use of hunting structures, the types of weaponry, and the number of people/necessary labor. Each of these variables will be discussed in turn and are summarized in **Table 3.4**.

Prey Species

It is clear from prior studies of hunting architecture sites across regions that faunal remains are rarely recovered. In these cases the height, thickness, continuity, and placement of hunting walls and features can be used to infer the targeted prey species. Many times there is a range of potential prey species in a certain time period and region, and formal attributes can be used to link sites to one species or another, or rule out some possibilities. For example, due to differences in prey body size and migration routes, substantial kites in the Negev with massive walls in hilly areas were most likely targeting larger-bodied ungulates such as onager, in contrast to thinner-walled kites on the flat plains which most likely targeted gazelles (Nadel et al. 2013). Furthermore, in the Rocky Mountains of North America, potential prey species can be ruled out using the formal attributes of structures – in this case, their high elevation location and certain characteristics. Most sites in the region are inferred to be for bighorn sheep procurement as

antelope do not range at such high elevations, and most traps have substantial walls and a ramp for the larger-bodied sheep (Frison et al. 1990).

In addition to the physical properties of the structures themselves, hunting architecture sites can be compared to others in the region that have similar features and preserved faunal remains. For example, the Barnett site in Alberta had no surface faunal or lithic artifacts and no excavation had been done, however the structures are very similar in form to the drive lanes at the Laidlaw site, a site also on the Canadian plains which had pronghorn faunal remains. Due to the similarity in the drive lanes and their placement on the landscape, Barnett is inferred to be pronghorn hunting locality (Brink 2013). Similarly, in Southwest Asia, although many kites are lacking faunal material, archaeologists have been able to hypothesize the different types of ungulates targeted by these hunting structures by combining the formal attributes of the structures themselves as exemplified above, and further confirm these inferences by comparing sites to those with faunal remains.

In these ways, multiple, independent lines of evidence can indicate the targeted prey species at hunting architecture sites such as faunal remains themselves when they are preserved, but also the formal properties of the structures, and comparisons to other hunting architecture sites with preserved faunal remains.

Number and State of Animals

In addition to inferring the targeted prey species, the number of animals, as well as the state² of them (i.e. how actively driven they must be, how panicked they are) can also be

² As used here, animal state refers to whether the animals are panicked or bothered, and is distinct from animal condition or herd composition which are considered for *Rangifer* specifically in **Chapter 5**.

inferred. For example, the Cairn Lake Site, which is comprised of several semi-circle stone constructed hunting blinds with no drive lanes or other features is interpreted to be indicative of very large numbers of caribou migration southward. Such large numbers of animals meant there would be plenty of caribou well within range of the hunting blinds and they would therefore not need to be actively driven or panicked to approach close enough to the hunters (Morrison 1981:175). Observations of caribou behavior during migrations support this interpretation – as caribou are intent on the migration and are less likely to be skittish in larger, migrating groups than during other times (see **Chapter 5**).

The complexity of the hunting structures (measured by both the number of different types of structures, and how elaborate or substantial individual elements are) may also have to do with the number of animals being targeted. For example, while counter intuitive, it has been hypothesized that the elaborate game drive complex at Rollins Pass, Colorado targeted smaller groups of alpine game such as bighorn sheep since these animals likely did not aggregate in very large numbers, and the gaps in the drive lanes could only allow for small number of animals to pass through at any given time (LaBelle and Pelton 2013:59). Similar to Spiess' (1979:118) suggestion that bigger and more complex drives are needed when caribou are few or dispersed, the complexity of the Rollins Pass region is most likely intended to ensure a successful hunt of these inherently smaller groups of animals in an alpine environment. Conversely, simpler complexes or individual blinds may be sufficient when larger groups of animals are being hunted, such as during caribou migrations exemplified by the Cairn Lake Site. These cases illustrate that while no simple correlation exists, i.e. complex hunting features do not necessarily imply large groups of animals, the formal attributes of the structures themselves can be used to infer the number of animals able to move through and be targeted by the hunting features.

Related to this, Friesen has argued that the state of animals, in terms of how panicked they are, can be inferred from the physical characteristics of structures – specifically, the size of the gap between the end of drive lanes, how robust or diffuse the drive lanes are, and how substantial the hunting blinds are (2013). The general patterning as seen by Friesen is organized into two types of caribou hunting features, the first of which is characterized by diffuse and discontinuous drive lanes, comprised of several stones far apart, a wide gap between the end of the drive lanes, and shallow hunting blinds that are placed within or behind this gap. This first type is associated with animals that are not panicked, and likely also were in much larger groups. In contrast, a second type has robust and continuous drive lanes leading to a much narrower gap, with more substantial and continuously walled hunting blinds. This second type is associated with animals that are panicked and likely being actively driven (**Table 3.3a**).

Table 3.3a. Formal attributes of hunting architecture components and associated animal state, (adapted from Friesen 2013, see also O’Shea et al. 2013:41, Table 1).

| Drive Lines | Gap | Hunting Blinds | Animal State |
|------------------------|--------------------|-----------------------------------|------------------------|
| Diffuse, discontinuous | Wide, avg. 30 m | Shallow, in or behind gap | Bothered, not panicked |
| Robust, continuous | Narrow, avg. 4.5 m | Substantial, continuous with wall | Panicked |

While these analyses would work to determine the number and nature of the animals if the targeted species had already been identified, caution must be applied here since these same attributes (e.g. wall continuity, robustness, thickness, etc.) have been used to distinguish between prey species (see above).

Hunting Technology

In many cases, hunting technology can be inferred even in the absence of hunting implements themselves. Examining the formal attributes of hunting structures from the Canadian Arctic, Friesen argues that wide gaps, shallow hunting blinds, and diffuse discontinuous drive lanes were indicative of bow and arrow hunting, where the shooting range is longer and animals need only be channeled, not actively panicked (2013). This is contrasted with other types of hunting structures with robust and continuous drive lanes, narrow gaps between them and substantial and continuously walled hunting blinds necessary for lance hunting, which requires the animals to be panicked in order for the lance-armed hunters to be in close enough proximity (Friesen 2013) (**Table 3.3b**).

Table 3.3b. Formal attributes of hunting architecture components and associated animal state, (adapted from Friesen 2013, see also O’Shea et al. 2013:41, Table 1).

| Pattern | Lines | Gap | Hunting Blinds | Animal State | Weapon |
|----------------|------------------------|--------------------|-----------------------------------|------------------------|---------------|
| Type 1 | Diffuse, discontinuous | Wide, avg. 30 m | Shallow, in or behind gap | Bothered, not panicked | Bow and arrow |
| Type 2 | Robust, continuous | Narrow, avg. 4.5 m | Substantial, continuous with wall | Panicked | Lance |

Season of Use

Seasonality is a critical variable as it determines the quality of the animals in terms of fat content, sinew and hide quality, and taste. Where faunal remains are preserved, in many cases the seasonality of the hunt can be determined (e.g. tooth eruption, herd composition, etc.), but as many sites lack faunal remains the structures themselves can be used. For example, if the prey animals are a migratory species, and if the hunters are targeting these animals during migrations, the season of use of hunting structures can be inferred from the orientation of funneling features, drive lanes, and in some cases, hunting blinds. Seasonality can be inferred by predicting the

likely direction of movement of the prey animals during migrations and comparing this to the orientation of the hunting architecture. Since the general orientation of migrations is often known, the orientation of drive lanes can be used to infer the season of use with great accuracy (Morrison 1981:182). Therefore, orientation of hunting structures works particularly well for *Rangifer* or other species such as antelope that have predictable, bi-annual migrations.

For example, Tibetan antelope migrate north during summer, and return south in the early fall for winter grazing therefore dzaekha drive lanes are always orientated to the north, for hunting during the spring. Females returning south with their newborn calves are not hunted, and therefore all drive lanes target antelope when they are traveling north (orientated north) to calving grounds in the summer (Huber 2005).

Group Size

The creation, use, and maintenance of many hunting complexes often involved large groups of people for large-scale hunting of ungulates since prehistorically the structures may have served as the locus for family and band aggregations during cyclical nucleation (see above, and Carlson and Bement 2013; Smith 2013; Wilke 2013), and a large amount of labor was needed to build large constructions and carry out complex chores during the drive (Brink 2008; Frison 2004; Kornfeld et al. 2010; Nadel et al. 2013). While these aggregations of people and surpluses of animals are important social and economic phenomena that should not be ignored, we cannot make the assumption that all game drives, corrals, or other hunting structures equate with large groups of people taking large numbers of animals (see above). For example, stone constructed hunting blinds are often found independently, such as during ice patch hunting in Tibet and Canada.

Targeting animals with the aid of built drive lanes, or other hunting structures is not always a large-scale event, and hunting architectures sites can be built up over many years by accumulation. Given the geographic spread of these structures, not all environments at all times supported large populations of ungulates. The low density population of bighorn sheep in Alpine environments is just one example. In addition to smaller number of animals, hunting structures can also be constructed, maintained, and operated by small numbers of people. Some drive features or corrals can be quickly constructed and can result in limited numbers of animals (Spiess 1979:119). Therefore, sites need to be investigated on a case by case basis.

Table 3.4. Inferring social and economic variables from hunting architecture.

| Social and Economic Variables | Relevant Attribute of Hunting Architecture |
|--------------------------------------|---|
| Prey Species | Height, thickness, continuity, placement of hunting walls, similarity to other structures with faunal remains |
| Number of Animals Hunted | Size of gap between funneling features/drive lanes |
| State of the Animals | Size of gap between funneling features, robustness of blinds, presences of drive lanes with blinds |
| Hunting Technology | Distance of blind to drive lanes, robusticity of blind, location of blind, size of gap |
| Season of Use | Orientation of funneling features/drive lanes |
| Group Size | Complexity of hunting structure, number of elements (i.e. cooperative tasks) |

Archaeological Expectations

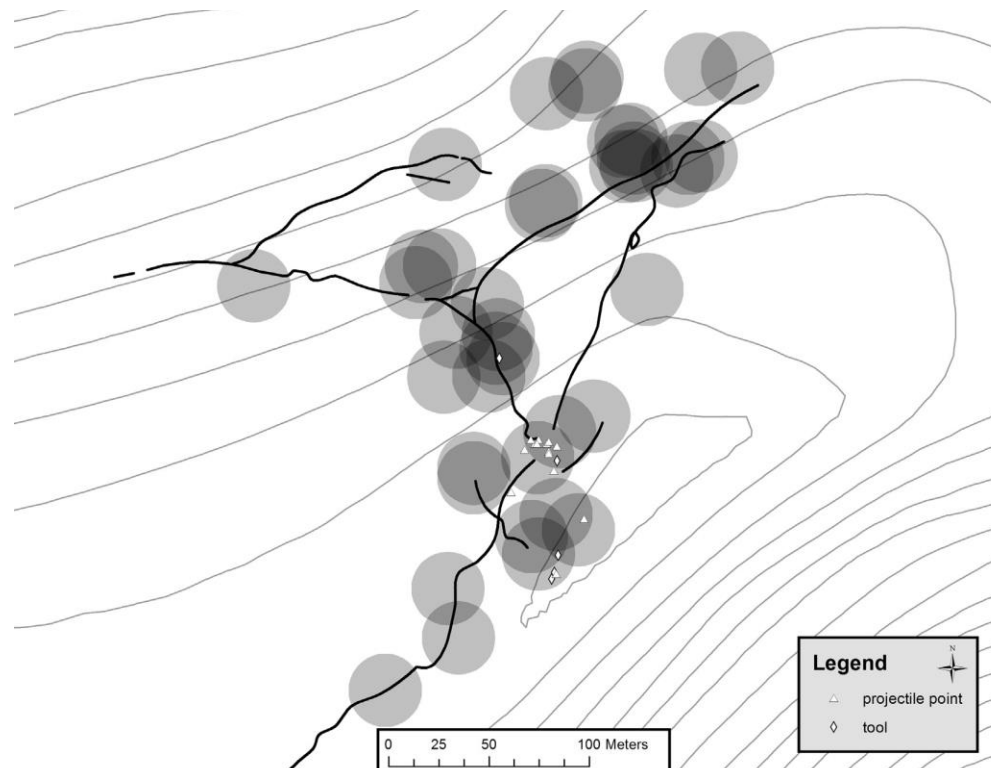
From comparing ungulate hunting structures across the globe, some general archaeological expectations can be developed at the both the site and regional levels.

Site Level Expectations

Overall, due to cleaning as well as the preservation issues discussed above, the presence of artifacts in hunting architecture sites is generally very low or entirely absent – again, with the exception of large-bodied prey, such as bison kills (Brink 2005; Morris 1990:202). Detailed ethnoarchaeological studies of hunting blinds such as Binford’s reveal that food and weaponry residues may not always become part of the archaeological record (Binford 1978a:347). Even in cases of large complex hunting structures, only five out of 12 excavated blinds yielded artifacts (LaBelle and Pelton 2013:50), and it is not uncommon for caribou drives to be devoid of artifacts entirely (Brink 2005:15).

In cases where artifacts have been recovered, lithic assemblages tend to be limited to projectile points and fragments, bifacial knives and other tools, and resharpening flakes (e.g. Carlson and Bement 2013; Morris 1990:202). The spatial distribution of lithic artifacts, particularly weaponry, is clustered around hunting blinds. For bow and arrow hunting, the ethnographically documented range is 11-20 meters (Blehr 1990; Dalton 2011), and at the Olsen game drive in Colorado, most projectile points and fragments were found at the intersection of numerous drive lanes, within the shooting range of several hunting blinds (LaBelle and Pelton 2013) (**Figure 3.5**).

Figure 3.25. Hunting blind and artifact distribution (LaBelle and Pelton 2013, Figure 15). Circles indicate effective bow and arrow range plotted as 18 meters from the center of each hunting blind – a likely area for projectiles to be located.



Similarly at the Peaker site (5CF128) in Colorado, numerous projectile points, a scraper, a biface, and numerous cores and flakes were recovered near a shooting pit next to a drive lane (Morris 1990:203). Generally, these tools are representative of hunting and butchering activities. Artifact scatters, primarily of flakes, on nearby ridges are interpreted to be workshop areas where hunters would prepare while waiting for game (Morris 1990:203). While the ranges for different weapons would be variable, such as atlatls for example, this general model of spatial distribution around hunting blinds is nonetheless a critical first step to understanding spatial patterning.

Faunal assemblages vary considerably from the large bone beds known from bison kills in the North American plains to a complete absence of faunal remains such as some kites in Southwest Asia. In general, larger bodied animals which are killed in large numbers tend to be

butchered at the site – resulting in bone beds. Many bison jumps and kills sites, such as Head-Smashed-In, Gull Lake, and Calderwood have distinct layers of burned bones (Brink 2008). These burned bone beds are inferred to be the result of cleaning out the drive lanes and removing the stench of butchered bison in order that the drives can be reused in the future (Brink 2008:166). Contrary to this pattern of butchering at or near the hunting structures for large bodied animals, smaller ungulates such as gazelles and pronghorn are usually removed whole (perhaps captured in nets) from the kill sites and butchered at other locations. It is ethnographically documented that in many communal pronghorn kills the animals were killed with clubs and were taken whole from the kill site to the campsite (Lubinski 1999). This pattern of removing whole carcasses from the hunting structures is also demonstrated archaeologically, as some habitation sites in Southwest Asia have large faunal assemblages of gazelle which seem to have been moved from desert kites to be butchered and distributed in the camp (Zeder et al. 2013). Additionally, the lack of faunal remains from many caribou drives is interpreted as the carcasses being moved to and butchered at nearby camps (Brink 2005:14). These various butchering patterns are critical for the resulting artifact distributions.

While burning episodes of large bison bone beds leave a clear archaeological signature, both the intense cleaning of hunting structures and the potential for removing smaller animals whole from the hunting features would leave little in the way of faunal materials. It is important to note that artifact densities are also a function of faunal preservation and site formation processes, as well as being highly contingent on a number of factors of the kill itself, including the number of people available to butcher, transport, and eat the meat, the number of animals killed, the size of the animals, the availability of storage, transport options, and distance to camp (Binford 1978b). Due to this range of factors, faunal expectations are best made for particular

environments and species where each of these factors can be taken into account, but a few generalizations between prey body size, likely butchering behavior, and archaeological patterning can be made (**Table 3.6**).

Table 3.5. Relationship between prey body size, typically butchering behavior, and archaeological expectations for hunting architecture sites.

| Prey Body Size | Butchering Behavior | Archaeological Patterning |
|---------------------------------|---|---|
| Large (e.g. Bison) | Butchered at kill site | Large bone beds, burning |
| Medium (e.g. caribou) | Primary butchering at kill site, secondary butchering elsewhere | Limited bone, perhaps feet/heads, portions of carcass cached nearby |
| Small (e.g. gazelles, antelope) | Removed whole from kill site, butchered elsewhere | No faunal remains at the kill site |

Regional Expectations

It is often the case that while blinds and other features may occur individually, they are often found in groups, e.g. desert kites often have four or more hunting blinds associated with them (Kempe and Al-Malabeh 2013), and the Rollins Pass game drive complex has numerous drive lanes and blinds (LaBelle and Pelton 2013). Considering a larger region, one can therefore expect to find many different types, but also different configurations of hunting features, including individual blinds, several hunting blinds together, groups of hunting blinds and other structures such as drive lanes, standing stones, and/or elaborate complexes incorporating several of these different types (e.g. Benedict 1985; Kehoe 1973; Frison 1975; Morris 1990:204). Other supporting features such as camps, processing sites, and caches also occur. When surveys have been done (e.g. Moreno 2012) or in areas where there is a long history of research concerning hunting structures such as the North American Plains (e.g. Agenbroad 1978; Brink 2008; Bupp 1981; Carlson and Bement 2013; Frison 1968, 1970, 1971, 2004; Frison et al. 1976; Morris

1990:202; Reeves 1978; Reher and Frison 1980; Todd et al. 2001), the larger regional picture is one of a complex, modified hunting landscape with a diverse set of features, usually grouped and functioning together, which were most were likely reused, refurbished, and modified over vast stretches of time (Smith 2013) (Figures 3.26-3.28).

Figure 3.26. Game traps/kites in southern Levantine Negev, bold “V” are kites on hilly terrain. Site names 1-2: Horsha north and south, 3: Achshuv, 4-5: ‘Ein Qadis, 6: Pitam, 7: Harut, 9: Eshel, 10: Sayarim, 11-13: Samar (Nadel et al. 2013, Figure 1).

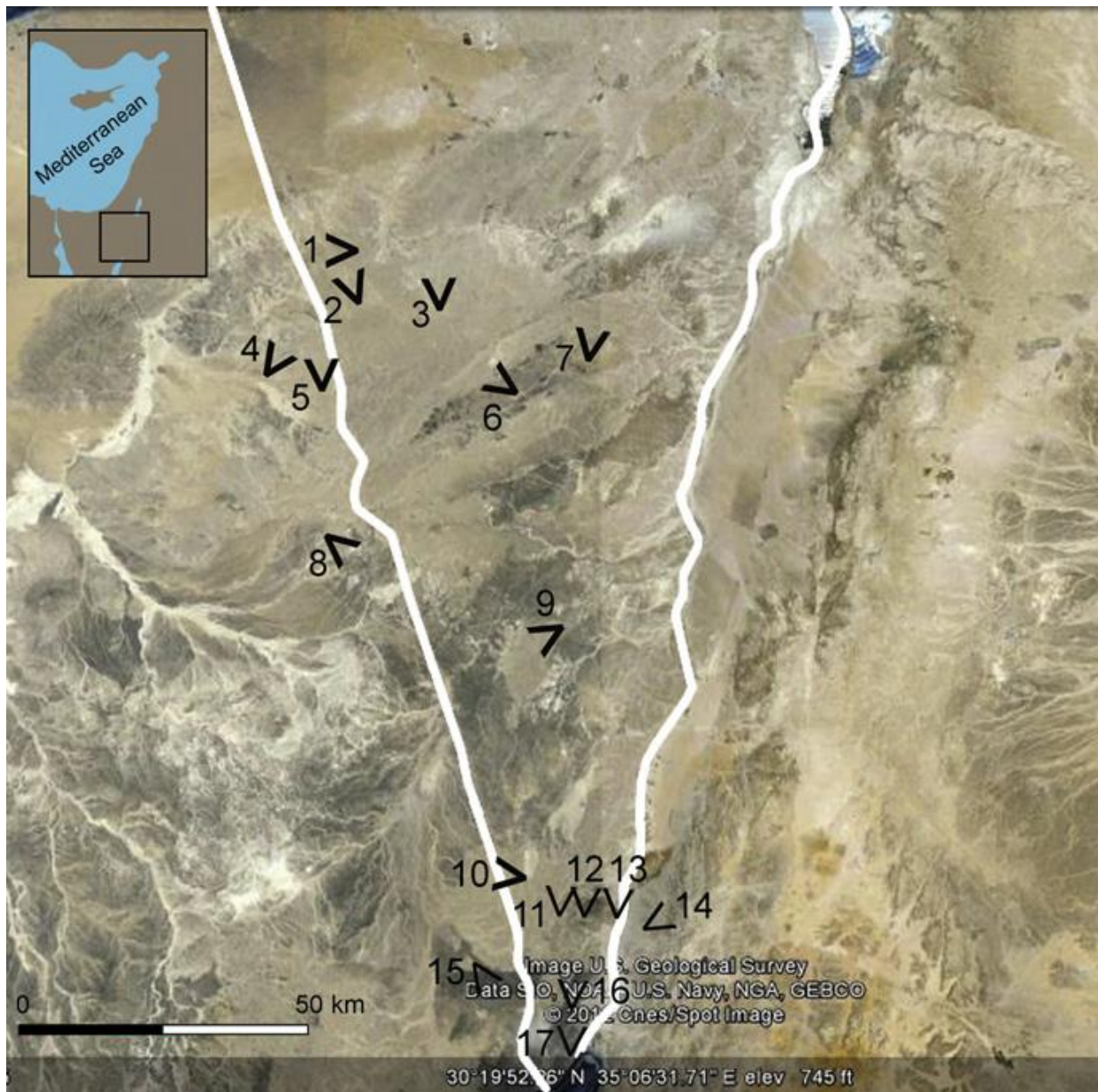


Figure 3.27. Hunting architecture sites in the Great Basin region showing hunting architecture sites and rock art (Hocket et al. 2013:68 Figure 4).

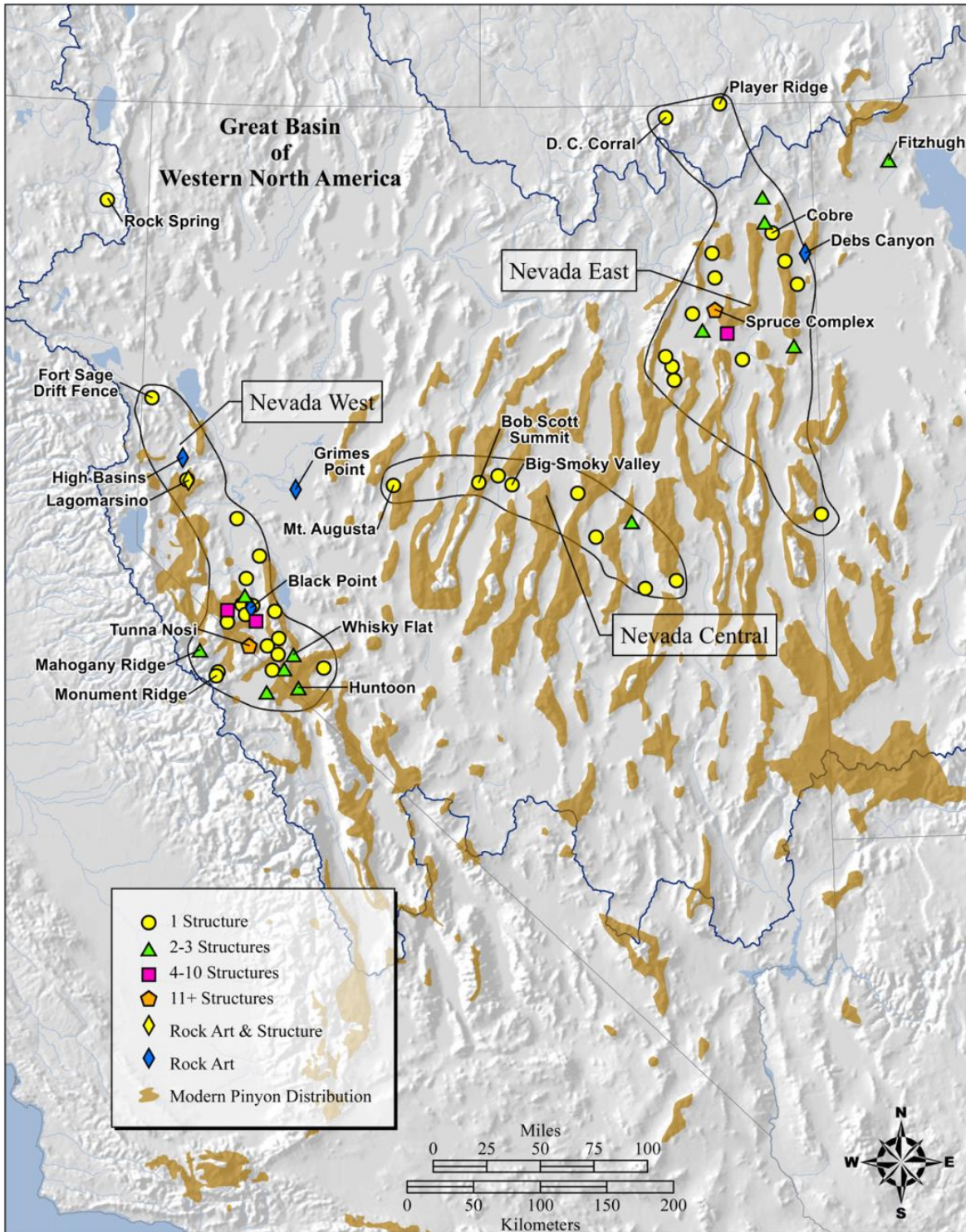
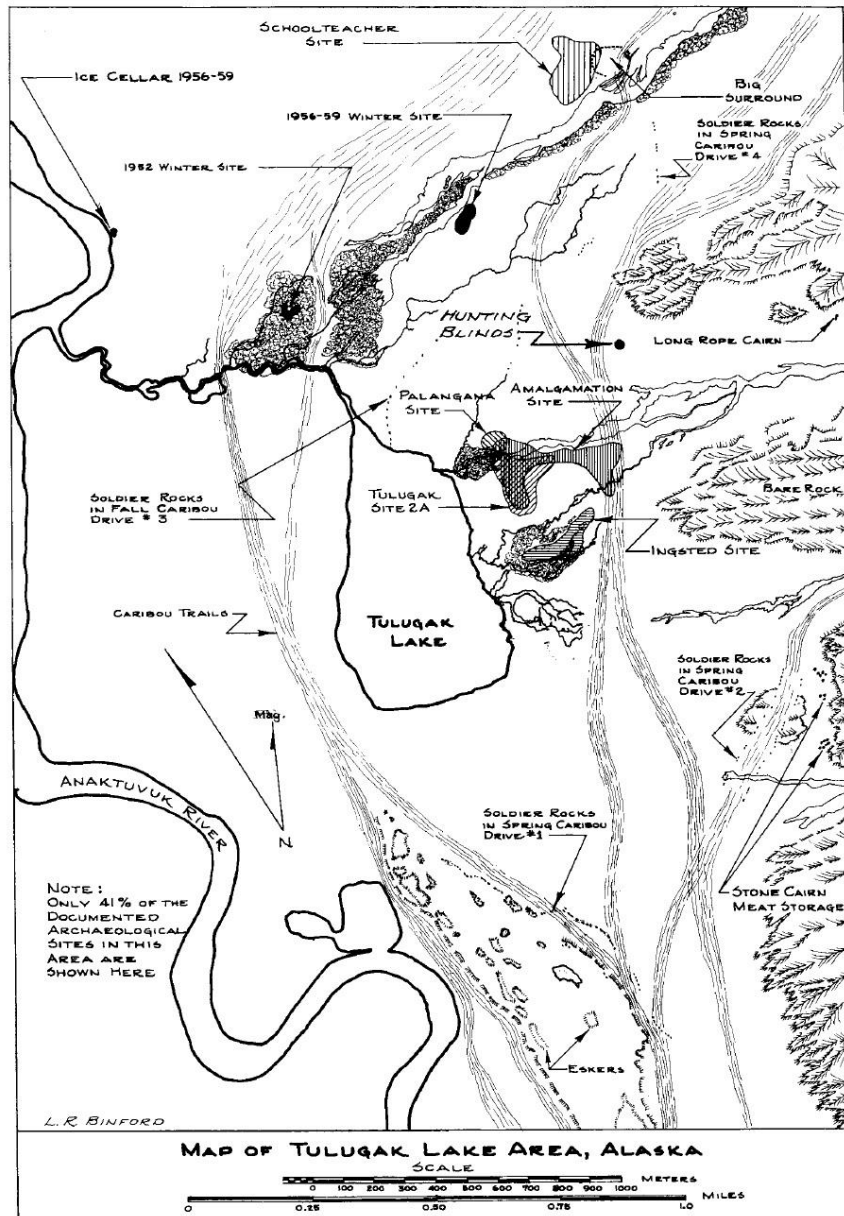


Figure 3.28. Map of Tulugak Lake, Alaska, showing the microregional layout of Nunamiut settlements, caribou hunting architecture, and caribou migration trails (Binford 1978b:206).

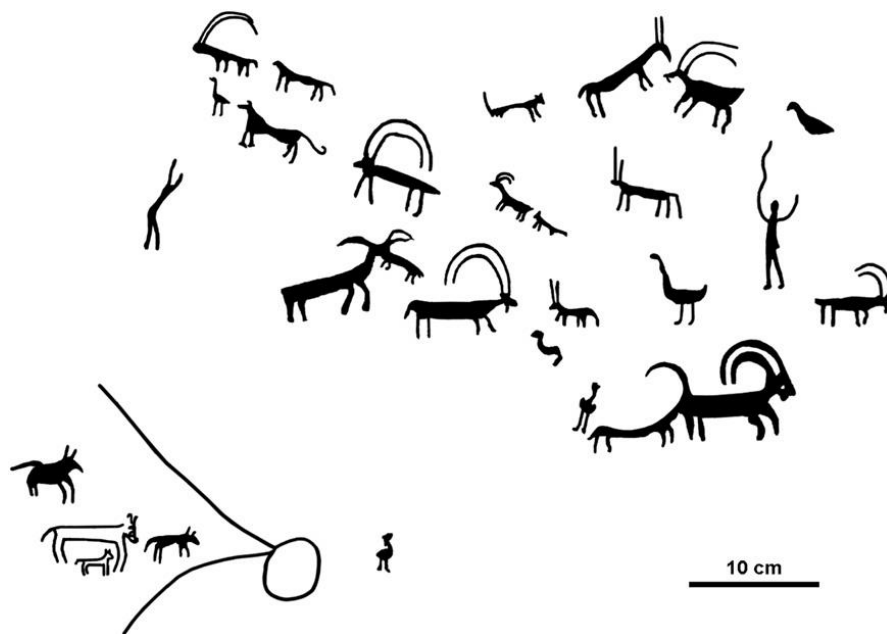


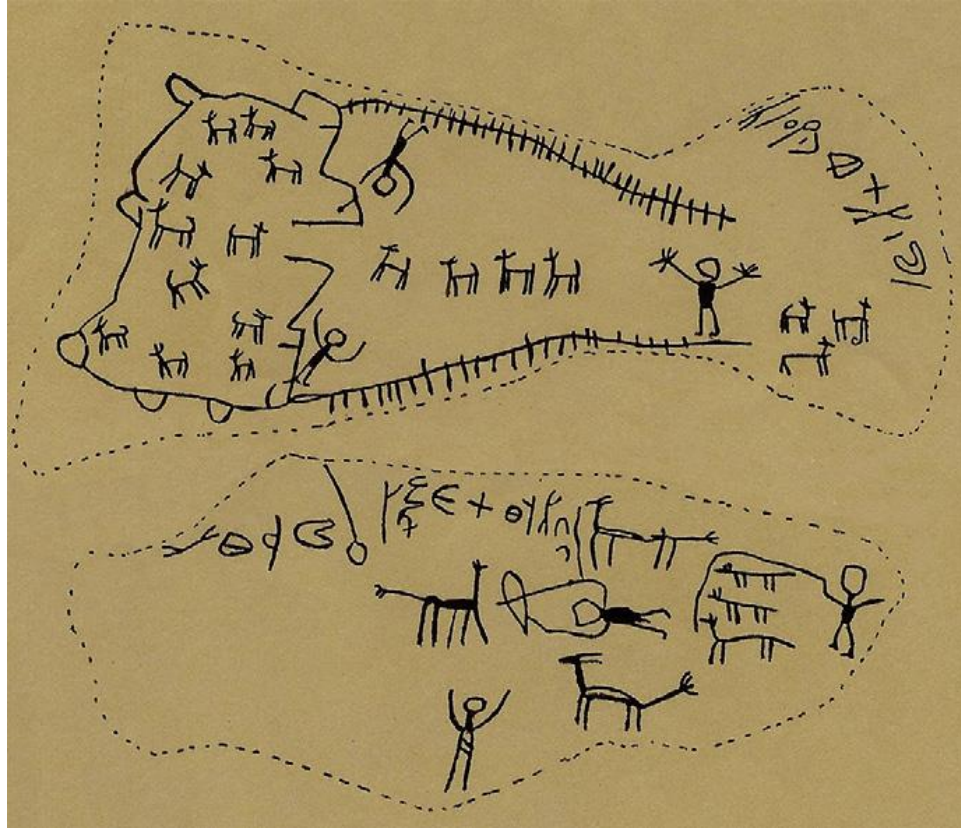
In addition to large-scale configurations of hunting structures, other regional expectations include other site types and their spatial distribution in relation to hunting features. When known, camps and habitation sites are usually some distance away from the hunting structures and kill

sites since camp activities, smells, and noises would likely disturb the animals and any efforts to hunt them (Bar-Oz and Nadel 2013; Brink 2005:15; Smith 2013; Stewart et al. 2000, 2004; Zeder et al. 2013:119).

Furthermore, in most regions, including Southeast Asia, Great Basin, and Peru, rock art is found near or within hunting structures. In fact, rock art often depicts hunting of specific ungulates and images of the hunting structures themselves (Eisenberg-Degen 2010; Harding 1953; Hershokovitz et al. 1987; Hockett et al. 2013; Hosting 2011; LeMaître and Van Berg 2008; Zeder et al. 2013) (Figures 3.29-3.31) (see also Chapter 5).

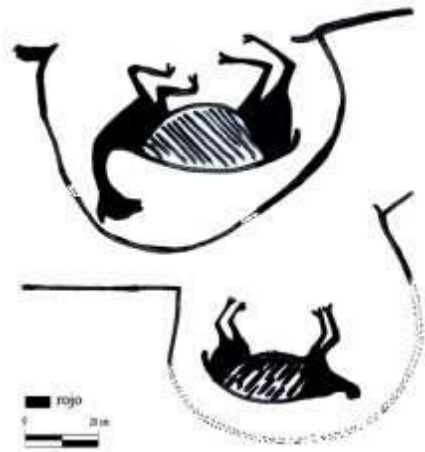
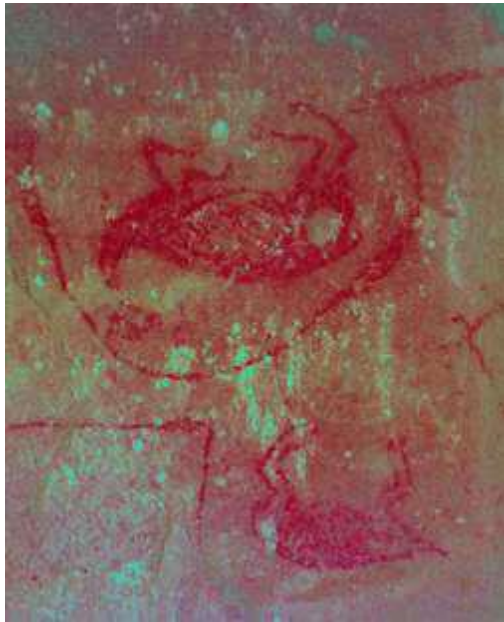
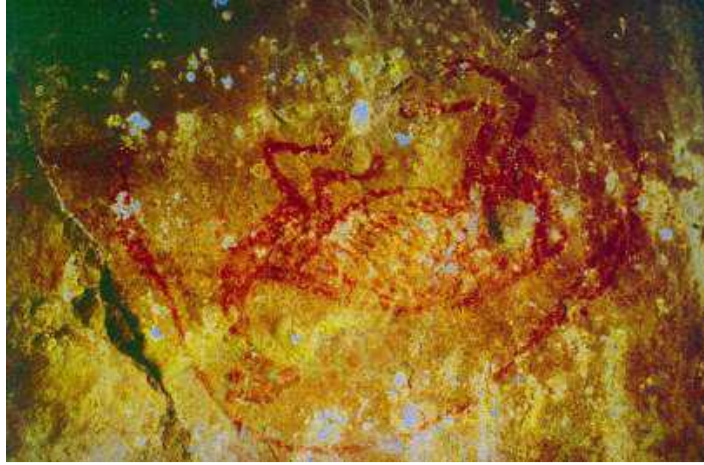
Figures 3.29a-b. Rock art from the Sinai Peninsula depicting kites (adapted from Bar-Oz and Nadel 2013, Figures 2-3).





Figures 3.30a-c. Rock art depicting camelids in a drive lane and corral hunting structure in Peru (Hostings Figures 8-9, 10b, 11).





Figures 3.31. Rock art depicting bighorn sheep trap.

<http://rockartblog.blogspot.com/2012/06/bighorn-sheep-trap-petroglyph-near-moab.html>



These brief examples demonstrate that expanding research at a more regional level is appropriate to gain the best understanding of hunting structures and the overall modified landscape in any given area. Overall hunting architecture sites are part of an actively modified, re-used landscape and are incorporated into larger settlement patterns (*cf* Zedeño et al. 2014).

Summary

While the archaeology of hunting architecture is hampered by preservation and dating issues, this discussion reveals that the formal attributes of the hunting structures themselves can be used to infer a range of both economic and social variables concerning the societies employing them. While hunting architecture is a global phenomenon, and sites share many similarities across time and space, these sites also vary in terms of the targeted prey species, the number and state of animals, their season of use, the hunting technology used, and the size of the social groups operating them. A detailed comparison across hunting architecture sites identified the relevant variables necessary to infer these characteristics. In this way, a middle range theory

of hunting architecture has been constructed as a means to extract human behaviors from the stone remains of hunting architecture. In **Chapter 8**, this middle range theory will be used in conjunction with insights drawn from the archaeology and anthropology of *Rangifer* hunters (**Chapter 5**), and previous research on the AAR (**Chapter 7**), to create a model of how prehistoric hunter-gatherers were using the AAR in Lake Huron.

Chapter 4

The Ancient Great Lakes: Paleoenvironment and Archaeology throughout the Pleistocene-Holocene Transition

Introduction

Global changes in sea level and glaciation throughout the last two million years have left large areas of land which were once habitable, underwater. These same prehistoric processes of sea level change also occurred in large inland lakes. Significant water level changes in the prehistoric Great Lakes correlate with shifts in paleoenvironment, climate, flora and faunal communities, and human responses to these fluctuations during and after the Pleistocene-Holocene transition. The Great Lakes region is therefore an ideal laboratory for investigating human responses to climate change and the occupation of recently deglaciated landscapes.

As elsewhere across the globe, the Pleistocene-Holocene transition in the Great Lakes is marked by significant changes in paleoenvironment and climate as global temperatures warmed. Within the context of rising global temperatures, fluctuating water levels in the Great Lakes and the movement of the Laurentide ice sheet boundary are unique to the region and play a significant role in paleoenvironmental reconstructions. Due to the slow and discontinuous retreat of Laurentide ice and isostatic rebound, various water outlets at different elevations and positions in basin were periodically opened or cut off (Monaghan and Lovis 2005:43). In addition, levels

of aridity and precipitation fluctuated, and these factors together caused significantly altered lake levels over time.

At a very general scale, changes in water levels resulted in two distant highwater stands in the Lake Huron basin, proglacial Lake Algonquin (~14,000 – 12,000 cal yr BP), and post-glacial Lake Nipissing (~7,600 – 4,000 cal yr BP). The Pleistocene-Holocene transition occurred between these two highstands, during a low water stand, Lake Stanley (~11,500 – 8,300 cal yr BP). The Lake Stanley stage saw water levels drop as much as 140 meters (Drzyzga 2007; Hough 1962; Lewis et al. 2007). During this time, over 250,000 hectares of land including the AAR were exposed and available for plant and animal habitation (Lewis, Blasco, and Gareau 2005).

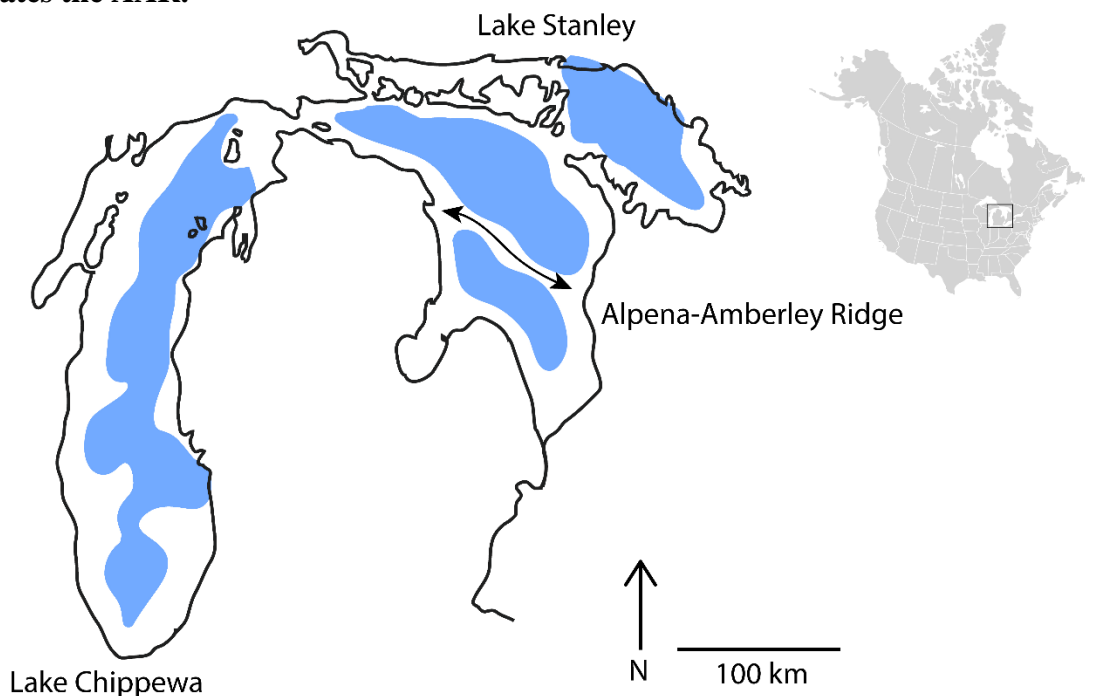
In contrast to the Lake Algonquin and Lake Nipissing high stands which left relict shorelines that can be investigated with traditional terrestrial geological and archaeological methods, the large areas of land which would have been habitable during the Lake Stanley are underwater. Despite these challenges, investigating the Lake Stanley time period is extremely important since it spans the cusp not only of significant geological and environmental changes, but also cultural transitions; from the Pleistocene to the Holocene and from the Paleoindian to Archaic periods.

It is argued that the Pleistocene-Holocene transition happened later and more gradually in the Great Lakes compared to other regions, from the draining of glacial Lake Algonquin to periglacial Lake Stanley (~11,500 – 8,300 cal yr BP). The continued presence of the Laurentide ice sheet during the Lake Stanley stage protracted Pleistocene-like climates, environments, plants, and animals well into the Early Holocene. While paleoenvironmental and archaeological data from Lake Stanley are limited, the available evidence is more characteristic of the Ice Age than

the Holocene. Significantly, the submerged archaeological record supports this characterization, as ice age adapted lifeways, including caribou hunting, persist well into the Holocene on the AAR.

Understanding the regional picture in the Great Lakes amidst these much broader and significant environmental and cultural changes is one of the goals of the research conducted on the AAR presented in this dissertation. It is clear that the Lake Stanley stage and the contemporary Paleoindian/Early Archaic periods was a time of immense environmental adjustment and cultural change in the Great Lakes (e.g. Jackson and Hinshelwood 2004). Interdisciplinary research on the AAR has demonstrated that Lake Stanley was an important piece of this puzzle, and that the land bridge exposed during this time had a unique environment which retained glacial conditions longer than the mainland – and as such was an ideal place for human hunters and ice age adapted plants and animals (**Chapter 7**) (**Figure 4.1**).

Figure 4.1. The Lake Stanley stage and the AAR Grey/blue areas indicate ancient water levels, white areas are dry land, solid lines indicate the modern outlines of the state of Michigan, and Lakes Michigan (to the west) and Huron (to the east). Line with two arrows indicates the AAR.



While the underwater archaeological record of Lake Stanley will be presented in **Chapters 7-9**, this chapter serves as a general introduction to the case study by providing the paleoenvironmental and archaeological background for the research on the AAR. It first provides an overview the ancient water levels and paleoenvironmental change, focused on glacial Lake Algonquin and periglacial Lake Stanley in Lake Huron, and the transition between these two stages. This is followed by a review of the archaeological record contemporary with the Pleistocene-Holocene transition, (i.e. the Early Paleoindian-Early Archaic periods) in the Great Lakes basin. Other key background information relevant for the case study, *Rangifer* hunting and conducting archaeology underwater, will be outlined in the two following chapters (**5** and **6**).

Lake Levels and Paleoenvironment during the Pleistocene-Holocene Transition

The Pleistocene-Holocene transition (~12,000 – 10,000 cal yr BP) can be generally characterized as a period of environmental and climatic flux with rising global temperatures, retreating glacial ice sheets, and global sea level rise. Across North America, the Pleistocene was generally drier and colder than the present, with characteristic megafauna such as mammoth, mastodon, giant sloth, and short-faced bear. These ice age environments are strikingly different from the subsequent Holocene, primarily in the presence of disharmonious floral and faunal communities. Plant and animal species which do not live in the same environments today are commonly found together in Pleistocene assemblages. As such, Pleistocene landscapes, environments, climates, and plant and animal communities have no modern analogs (See **Chapter 2**, Gaudreau 1988; Grimm and Jacobson 2004; Kelly and Todd 1988; Meltzer 2009; Shuman et al. 2002; Tankersley 1998).

While this transition can be generalized as moving from colder, glacial conditions to the current warm inter-glacial setting of the Holocene, the nature and rate of climatic and paleoenvironmental change during this period was not uniform (Rasmussen et al. 2007). For example, the climatic effects of the Younger Dryas, the last and most significant of shorter cooling period during the general warming trends of the Holocene, are variable across the globe (12,900-11,700/11,600 cal BP, 10,800-10,000 ^{14}C yr BP) (e.g. Ellis et al. 2011; Meltzer and Holliday 2010). Some areas experienced *warming* climates during the Younger Dryas; and in North America, severe climatic changes only occurred in the Northeast and Canadian Maritimes, such as colder temperatures and long-term changes in vegetation (Meltzer and Holliday 2010:9,30; Peteet 2000; Shuman et al. 2002; Shuman et al. 2005 see Newby et al. 2005 for possible Paleoindian responses).

Along with the changing climate during the Pleistocene-Holocene transition, over 35 genera of animals went extinct, with causal explanations ranging from environmental variation, to disease, extra-terrestrial impact, and human predation (e.g. Barnosky et al. 2004; Grayson and Meltzer 2002, 2003; Firestone et al. 2007; Haynes 2007; Martin 1984; see also Meltzer et al. 2014). Species density and geographic distribution also changed markedly throughout the Pleistocene, and the growing and wide-spread herds of some herbivores, such as bison, may have played a role in the extirpation of other competing mammals (Scott 2010). While the traditional view posited that the Paleoindian period, the Younger Dryas, and Pleistocene extinction happened simultaneously, it has been well established that extinctions were punctuated and their timing varied widely across the continent (e.g. Woodman and Athefield 2009:362). Furthermore, people were likely living in the Americas much earlier (Collins et al. 2014; Madsen 2015; Waters et al. 2011).

The Pleistocene-Holocene transition in the Great Lakes is less well known due to limited available evidence. Large portions of the paleoenvironmental and archaeological records dating to this time period have been submerged beneath the modern Great Lakes. While the ancient high stand stages Lake Algonquin and Lake Nipissing are well understood and can be investigated on land, these two periods date before and after the Pleistocene-Holocene transition – not during the transition itself. Proglacial Lake Algonquin is associated with tundra environments and Pleistocene megafauna and following this, post-glacial Lake Nipissing is characterized as similar to the modern environment, with closed, mixed forests, white-tailed deer, and other Holocene characteristics. The transition between these two stages, and the Pleistocene-Holocene more generally, corresponds with the draining of Lake Algonquin to the lower water levels of Lake Stanley (**Table 4.1**). Despite the fact that much of the evidence dating to this time period is submerged and offers unique challenges, it is critical for investigating the Pleistocene-Holocene transition and the associated changes in paleoenvironment and human behavior in the region.

Table 4.1. Ancient Great Lakes water levels.

| Lake Stage | Primary Dates (cal yr BP) | Primary Dates (¹⁴C yr BP) |
|-------------------|----------------------------------|---|
| Algonquin | ~14,000-12,000 | 12,000-10,500 |
| Stanley | ~11,500-8300 | 9900-7500 |
| Nipissing | ~7600-4000 | 6000-3500 |

What follows is a characterization of the Lake Algonquin and Lake Stanley stages of Great Lakes prehistory and paleoenvironment, since these two stages coincide with the Pleistocene-Holocene transition.

Lake Algonquin ~14,000 – 12,000 cal yr BP (12,000-10,500 ¹⁴C yr BP)

Lake Algonquin was the largest glacial lake in the upper Great Lakes region, and was recognized well over a century ago (Spencer 1888). Its high water levels combined the modern Lake Michigan and Huron basins. Hough recognized that the water of Lake Algonquin did not reach the Lake Superior basin since it was isolated by the Laurentide ice sheet (1958), although others have suggested that it occupied southeastern Lake Superior during its maximum extent (Karrow et al. 1995) (**Figure 4.2**). Algonquin was formed between the Laurentide ice sheet in the north and drainages to the south, after the Port Huron advance of glacial ice (Karrow et al. 1995, **Table 4.2**). The main high water stage of Lake Algonquin (184 meters above sea level, hereafter masl) persisted until ~ 12,000 cal yr BP (10,600 ¹⁴C yr BP) when the gradual retreat of the Laurentide ice sheet exposed new water outlets which drained much of the lake (Kincare and Larson 2009).

Figure 4.2. Lake Algonquin.

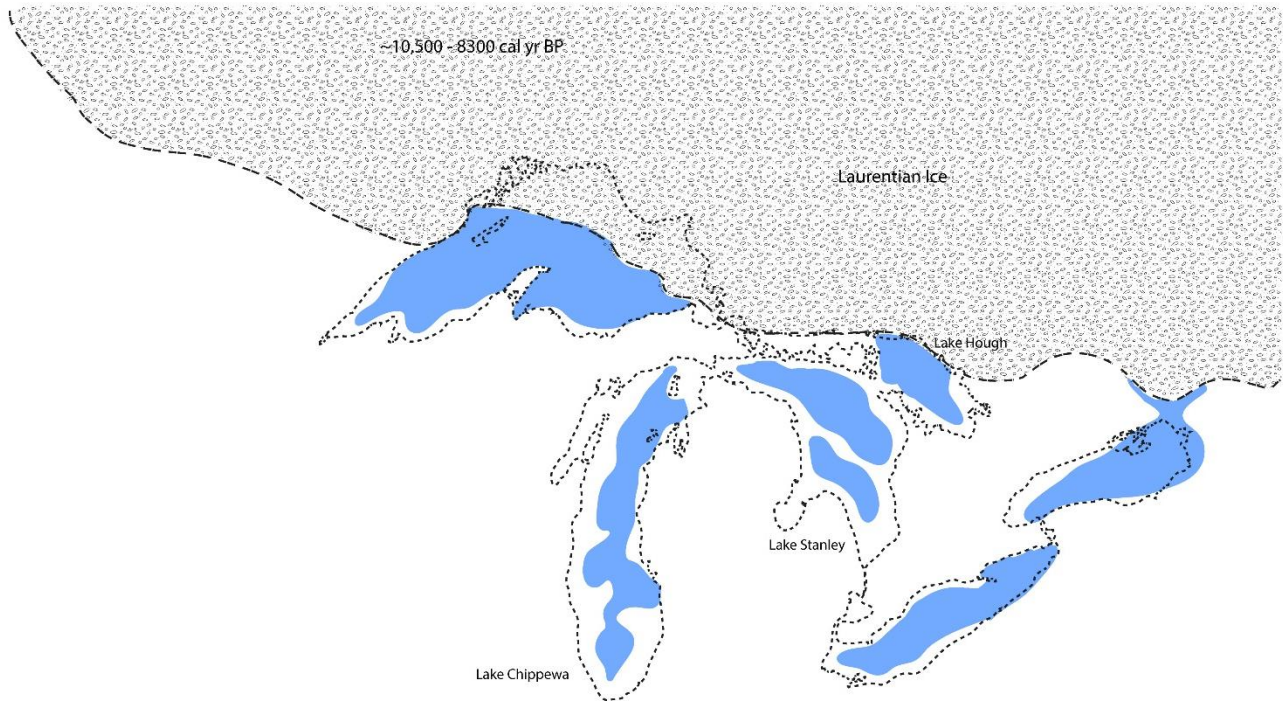


Table 4.2. Major advances of the Laurentide Ice Sheet and associated lake stages, (adapted from Carr 2012:34, Table 2.1; Karrow 2004, Fig.1.1).

| Laurentide Ice Front | Date cal yr BP | Date ¹⁴ C yr BP | Lake Stage |
|---------------------------|----------------|----------------------------|--------------------|
| Port Huron Advance | ~15,500 | 13,000 | Early Algonquin |
| Two-Rivers-Onoway Advance | ~13,300 | 11,500 | Main Algonquin |
| Marquette Advance | ~11,500 | 10,000 | Early Lake Stanley |
| Cochrane Advance | ~8800 | 8,000 | Main Lake Stanley |

Paleoenvironmental reconstruction in the region portrays glacial conditions during Lake Algonquin largely due to the close proximity of the glacial ice sheet and its periodic advances (Gravenor and Stupavsky 1976; Kincare and Larson 2009; Lowell et al. 1999). Overall, the environment during early Lake Algonquin was a cold, open tundra, particularly along the

margins of the Laurentide ice sheet. Evidence for the open tundra is primarily macro-botanical remains of arctic dryad (*Dryas integrifolia*) from several sites across the region, including northern Illinois (Curry and Yansa 2004), eastern Wisconsin (Maher et al. 1998), southern Ontario (Karrow et al. 1995; Terasmae and Matthews 1980), and northern Michigan (Larson et al. 1994). Additionally, macrofossils of willow (*Salix herbacea*), bog bilberry (*Vaccinium uliginosum*), American Dwarf Birch (*Betula glandulosa*), crowberry (*Empetrum nigrum*), mountain sorrel (*Oxyrid digyna*), and mountain saxifrage (*Saxifraga oppositifolia*) all indicate a paleoenvironment similar to modern arctic (Karrow et al. 1995).

While the general portrait of the Lake Algonquin environment is similar to the modern Arctic, it must be kept in mind that there is no exact modern analog. For example, some plant communities in the Pleistocene Great Lakes have unique combinations that are not associated anywhere in the world today, such as spruce (*Picea*) and black ash (*Fraxinus nigra*). These species are typically found in very different environments, e.g. northern boreal forests and mixed coniferous-hardwood forests respectively (Grimm and Jacobsen 2004).

In addition to the flora, fauna in the region during Lake Algonquin can also be characterized as mixed biotic communities that have no modern equivalent (Williams et al. 2004). Perhaps the most distinguishing characteristic in the Pleistocene Great Lakes is the large number and diversity of mammal species (Carr 2012) including Harlan's musk-ox (*Bootherium bombifrons*), American mastodon (*Mammuth americanum*), Jefferson's mammoth (*Mammuthus jeffersonii*), short-face bear (*Arctodus simus*), black bear (*Ursus americanus*), beaver (*Castor canadensis*), giant beaver (*Castoroides ohioensis*), stag moose (*Cervalces scotti*), elk (*Cervus elaphus*), armadillo (*Dasypus bellus*), horse (*Equus* sp.), woodchuck (*Marmota monax*), fisher/marten (*Martes* sp.), ground sloth (*Megalonyx jeffersoni*), striped skunk (*Mephitis*

mephitis), white-tail deer (*Odocoileus virginianus*), muskrat (*Ondatra zibehicus*), flat-headed peccary (*Platygonus compressus*), raccoon (*Procyon lotor*), caribou (*Rangifer tarandus*), hare (*Sylvilagus* sp.), and gray fox (*Urocyon cinereoargenteus*). However, it must be kept in mind that some of this diversity may be attributed to a lack of fine grained chronological resolution during the Pleistocene-Holocene transition and perhaps represents palimpsests.

The end of Lake Algonquin ~13,000 – 11,300 cal yr BP (11,000 – 9900 ¹⁴C yr BP)

The end of Lake Algonquin is characterized by a general transition from glacial tundra environments to warmer Holocene climates with significant changes in flora and fauna. Broadly during the Late Glacial period there appears to be three primary phases with two transitions, from tundra (Main Algonquin) to spruce/sedge (Late Algonquin), and then spruce/sedge to pine (Draining Algonquin/Early Stanley) (**Table 4.3**). Importantly, these vegetation transitions across the region seem to occur earlier in the south and west compared to the north and east (Carr 2012; Eren 2009:395; Ellis et al. 2011). Slower vegetation changes from glacial climates in the north are likely due to the lingering presence of the Laurentide ice sheet in the Northeast portion of the region.

Table 4.3. Primary phases of Pleistocene-Holocene transition vegetation succession in the Great Lakes.

| Lake Stage | Major Vegetation Phases | Date ¹⁴ C yr BP | Date (cal yr BP) |
|--------------------|-------------------------------------|----------------------------|------------------|
| Main Algonquin | Sparse Tundra, Periglacial Desert | 12,000 – 11,000 | 14,000 – 12,500 |
| Late Algonquin | Open Spruce Parkland | 11,000 – 10,800 | 12,500 – 12,000 |
| Draining Algonquin | Gradual closing of spruce parkland, | 10,600 – 10,300 | 12,000 – 11,000 |

| | | | |
|--|--------------------|--|--|
| | Transition to pine | | |
|--|--------------------|--|--|

Tundra to Spruce/Sedge

Paleoenvironmental change during Main Lake Algonquin can be generally characterized as the tundra becoming more restricted and limited to the Laurentide Ice Sheet periphery with a broad transition to open spruce and sedge parkland beginning around 12,500 cal yr BP (11,000 ¹⁴C yr BP) (e.g. Ellis et al. 2011). There is difference between north and south reflecting the distance from the ice, with more open parkland in the north, and more closed spruce forests in the south. This is indicated by higher percentages of sedges in the pollen record characteristic of more open environments in the north (specifically north of 43 degree latitude, see Carr 2012).

At this time, the Younger Dryas was a cold and dry reversal to Ice Age conditions during general warming at the onset of the Holocene at 12,900-11,700/11,600 cal yr BP (10,800-10,000 ¹⁴C yr BP) (e.g. Ellis et al. 2011; Meltzer and Holliday 2010; Walker et al. 2009). The end of Lake Algonquin co-occurs with the Younger Dryas, 12,900-11,700/11,600 cal yr BP (~10,800-10,000 ¹⁴C yr BP), although it did not cause abrupt or significant vegetation or climate change in Great Lakes. Instead the Younger Dryas prolonged existing environmental conditions, particularly in the eastern Great Lakes (Ellis et al. 2011). For example, there appears to be a continuation and brief expansion of spruce and non-arboreal pollen in Michigan and Ontario around 12,900 cal yr BP (10,800 ¹⁴C yr BP) during the onset of the Younger Dryas (Ellis et al. 2011 Fig. 4; Lewis and Anderson 1992:244; Oltz and Kapp 1963:344-345; Shuman et al. 2002; Shane 1994).

Spruce to Pine

During and immediately following the draining of Lake Algonquin, a general shift from spruce to pine is indicated in numerous pollen records between 12,000 – 11,000 cal yr BP (10,600 and 10,300 ^{14}C yr BP) (Karrow et al. 1975). In contrast to paleoenvironmental reconstructions of early Lake Algonquin and its glacial environment verified by macro-botanical remains, this later transition from spruce to pine is drawn primarily from pollen records. While the pollen record indicates an increase in pine pollen and a decrease in spruce, the interpretation of this evidence is not straight forward. Several methodological issues relating to pollen evidence are relevant here in order to properly characterize this transition.

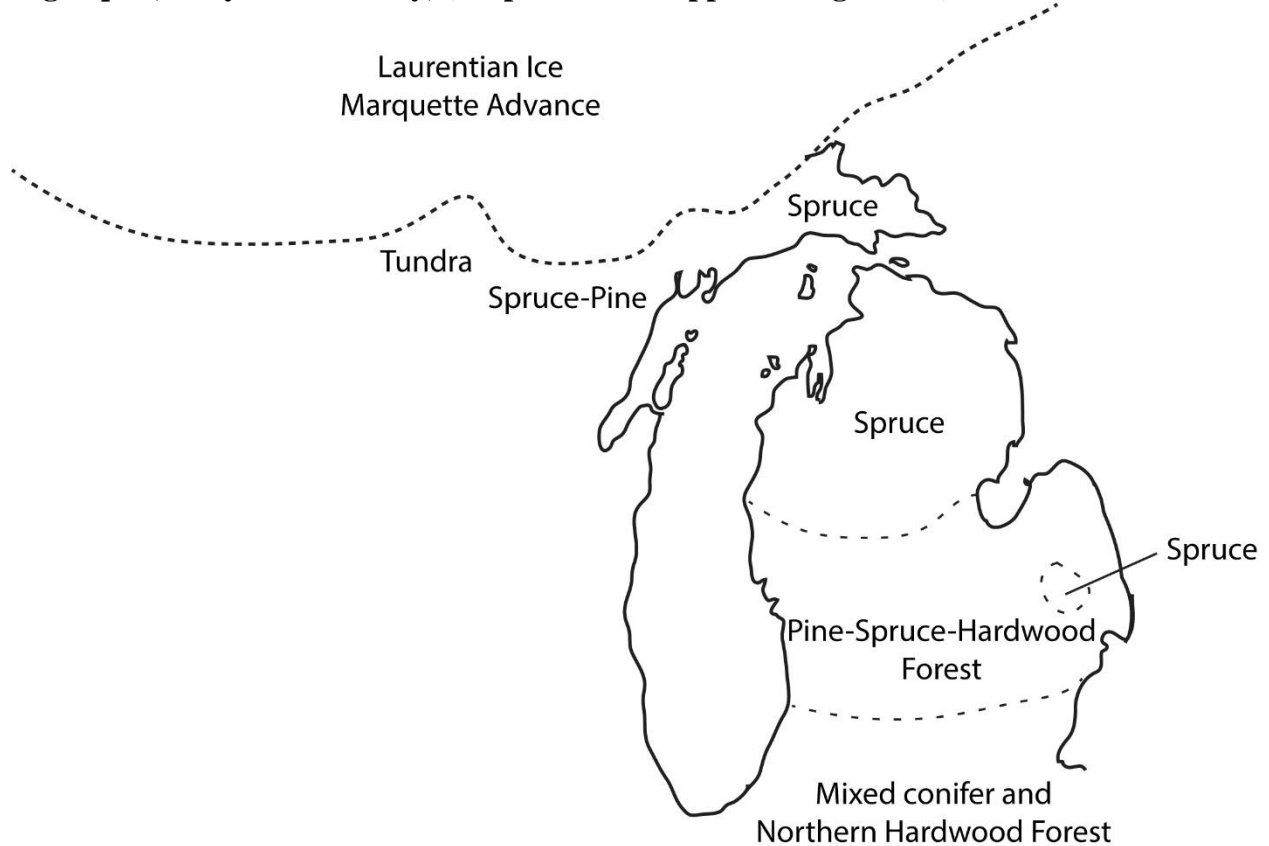
First, certain environments, such as glacial tundra are often underrepresented in the pollen record given the low occurrence of pollen generated by these environments (e.g. Bradshaw 1981; Curry and Yansa 2004; Carr 2012:46). For example, willow (*Salix*) stems and leaves have been recovered from several sites in the Great Lakes (Larson et al. 1994; Kerfoot 1974; Maher et al. 1998; Kapp 1986; Terasmae and Matthews 1980) but pollen core data from the same time period do not display any significant frequency of the species (Carr 2012, see also Hunter et al. 2006). Second, certain species, particularly pine, are overrepresented in pollen cores as the species is known to produce a far greater quantity of pollen relative to biomass (e.g. Delacourt et al. 1984) and is subject to long-distance transport. Additionally, there is potential contamination from “old carbon” in lake cores and the pollen sequence used to date this event, and samples may indeed be younger (Jackson et al. 2000). Lastly, cores are few and far apart and extrapolated results from one area to distant locations inherently mask significant local variation. For all these reasons, while the pollen data certainly indicate a spruce-pine pollen transition, it may not have happened as early, or was as widespread and dramatic as traditionally portrayed.

Similar to other vegetation changes, this transition was also not a uniform change across the entire Great Lakes region.

Rather than a single extensive and rapid shift, the transition from spruce to pine appears to have happened at different rates in different places. Specifically, it appears to have occurred faster and earlier in the south and slower and later in the north in areas closer to the Laurentide ice sheet (Kuehn 1998; Muller 1999). Specifically as early as ~13,000 cal yr BP (11,500 ¹⁴C yr BP) in the south (Indiana and Ohio) and as late as ~10,500 cal yr BP (9900 - 10,000 ¹⁴C yr BP) in the north (Michigan and Ontario) (Karrow et al. 1975; Kapp 1999; Muller 1999).

Overall the transition from spruce to pine is likely related to changes in both aridity/moisture and temperature. While the two species have similar tolerances to temperature, pine is more drought resistant (Chinn et al. 2004; Shuman et al. 2002:1787). While it appears that there is a general drying out with an expansion of pine, smaller circumscribed areas retained an adequate moisture balance to prevent the replacement of spruce with pine, such as the Michigan “thumb,” areas near the ice front, and the recently drained Algonquin lake bottom, i.e. the AAR (**Chapter 7**, Bailey and Ahern 1981; Carr 2012:52; Ellis et al. 2011:538; Kapp 1986:371, 1999) (**Figure 4.3**).

Figure 4.3. Paleovegetation in Michigan at ~11,300 cal yr BP (9900 ¹⁴C yr BP), post Lake Algonquin, early Lake Stanley, (adapted from Kapp 1999 Figure 2.6).



Productive Environments on the old Algonquin Lake Bed

The transition from spruce to pine is important since open spruce parkland and closed pine forest represent significantly different environments in terms of moisture, but also in terms of available forage for animal species. During the draining of Lake Algonquin, between ~12,000 – 11,000 cal yr BP (10,600 and 10,300 ¹⁴C yr BP), on the mainland overall vegetation changed from spruce to pine dominate forests and from more open to closed habitats (Karrow et al. 1975). In contrast, the former lake bed was colonized by vegetation with succession from first marsh to sedge swamp, with herbaceous ground cover of cattail, mosses, sedges, and trees such as black

spruce (*Picea*), tamarack (*Larix*), cedar (*Thuja*), alder (*Alnus*), and willow (*Salix*) (Anderson 1971; Karrow et al. 1975). An ecotone therefore developed between closing conifer forests on the old Algonquin *mainland*, and the sedge swamp on the old Algonquin *lakebed* (Storck 1984). Certain animal species would thrive in the sedge swamp environment including moose, deer, elk, (Storck 1984:290), and caribou. Particularly caribou with their unique ability to move into newly available territories and their preference for low, wet habitats (Jackson et al. 2000:435; Kuhn et al. 2010:1321). The creation of these restricted but dense animal patches would have presented an ideal environmental niche for hunter-gatherers during the next water level stage, Lake Stanley (**Chapter 7**) (See also Ellis et al. 2011:538, Paleoindian increase in habitation of wetlands).

Lake Stanley ~11,500 – 8,300 cal yr BP (9,900 – 7,500 ¹⁴C yr BP)

The Lake Stanley stage is less well understood than the Lake Algonquin and Nipissing high stands since these larger lakes left relict shorelines on land which have been well documented and dated (e.g. Krist and Schaetzel 2001; Larson and Schaetzel 2001; Schaetzel et al. 2002). When meltwater from the Laurentide ice sheet was diverted north of the upper Great Lakes through the North Bay outlet around ~10,000 cal yr BP (Eschman and Karrow 1985; Kincare and Larson 2009; Larson and Schaetzel 2001; Lewis et al. 1994), isolated and hydrologically closed Lakes Stanley, Hough (north of Lake Stanley in the Lake Huron basin), and Chippewa (in the Lake Michigan basin) formed as water levels lowered (Eschman and Karrow 1985; Lewis 1969; Lewis et al. 2007; McCarthy and McAndrews 2012; McCarthy et al. 2015; Sly and Lewis 1972) (**Table 4.4, Figures 4.4-4.5**). In addition to the diversion of the meltwaters, increased aridity in the early Holocene, specifically due to stronger and more

prevalent Pacific and Arctic air masses reaching the Great Lakes, contributed to the negative water budget, and together lowered lake levels significantly (McCarthy et al. 2015). Using an average of a 20 meter drop in lake levels during the Lake Stanley lowstand (140 masl), over 250,000 hectares of land including the AAR, would have been available in the Lake Huron basin alone, which are now submerged (Lewis, Blasco, and Gareau 2005).

Table 4.4. Lake Stanley stages.

| Low Water Stage | Date (cal yr BP) | Date (¹⁴ C yr BP) | Elevation above Mean Sea Level |
|--------------------|------------------|-------------------------------|--------------------------------|
| Early Lake Stanley | 11,000 – 10,000 | 9900 – 9500 | 55 – 80 m |
| Main Lake Stanley | 10,300 – 10,100 | 9300 – 9000 | 85 – 100 m |
| Late Lake Stanley | 8770 – 8300 | 7900 – 7500 | 90 – 95 m |

Figure 4.4. Lake Stanley.

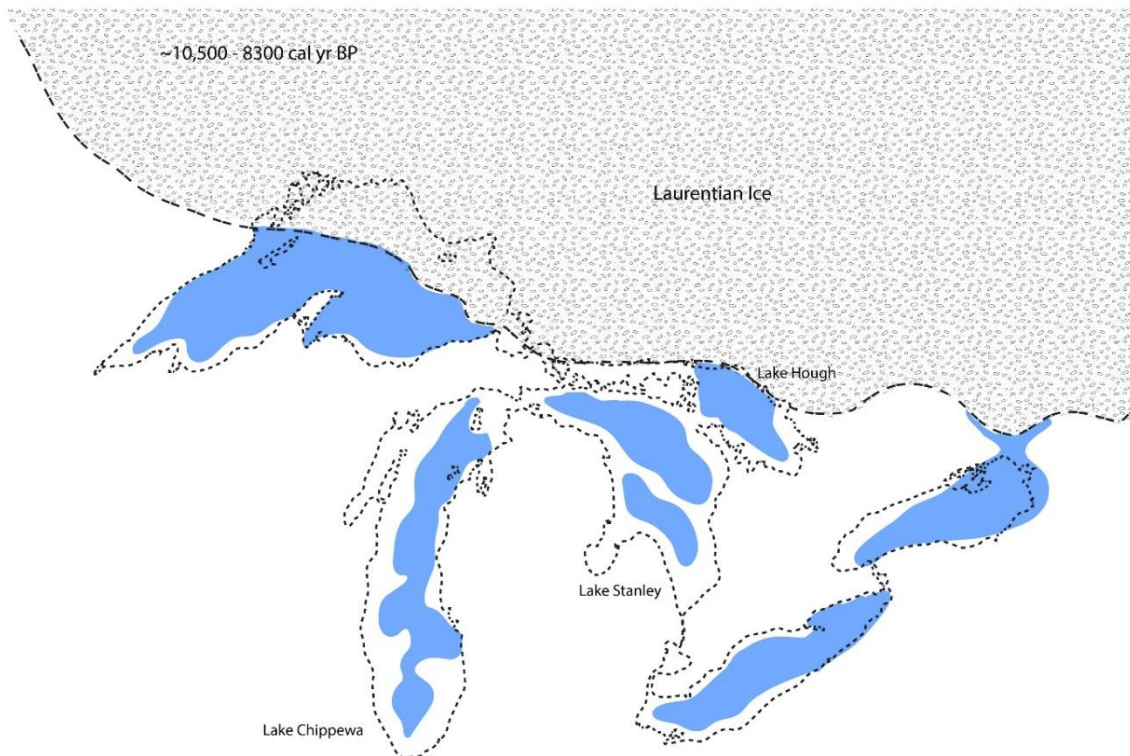
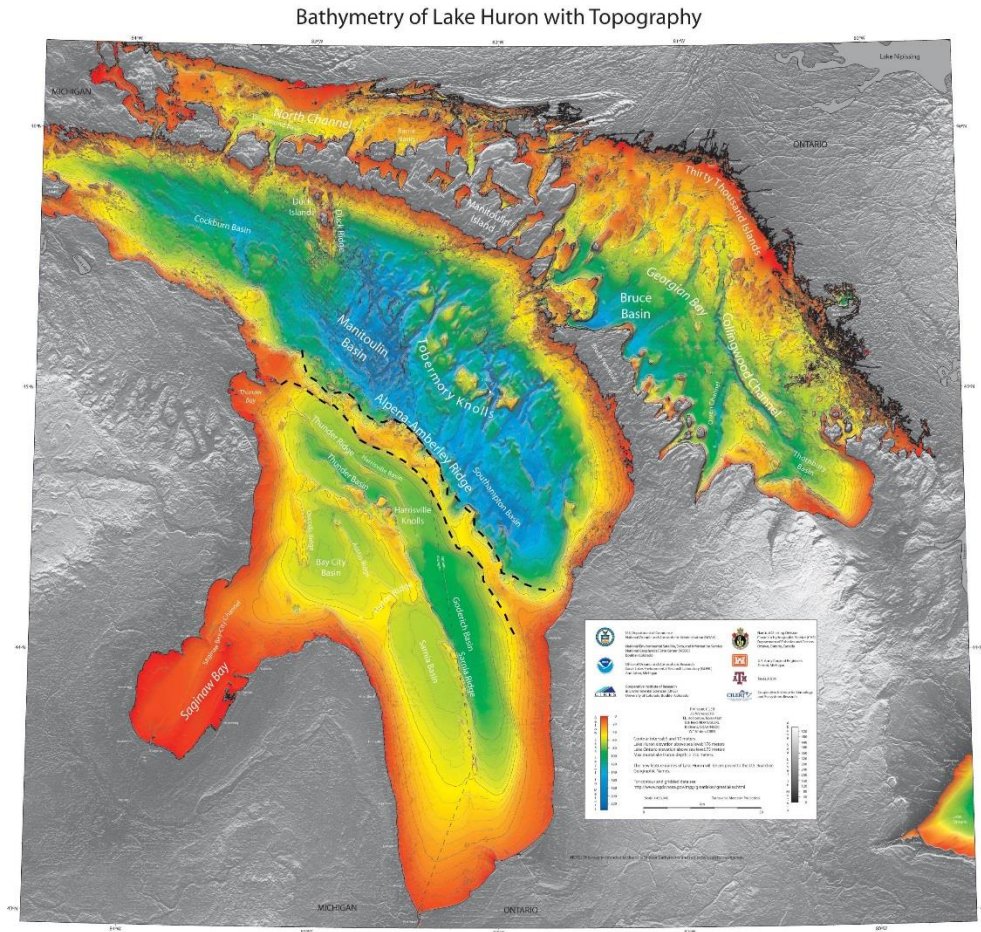


Figure 4.5. Lake Huron basin bathymetry. All orange and yellow areas would have been dry land during the Lake Stanley stage.



The new land exposed by the lower water levels during Lake Stanley was the ancient lakebed of Lake Algonquin, with a highly productive sedge swamp with enough moisture to maintain scattered spruce and delay pine replacement. These areas would have been more productive than the adjacent closing pine forests beyond the old Algonquin shoreline, or the mixed conifer and northern hardwood forests much further to the south (e.g. Indiana/Ohio, Carr 2012). These new areas would have been a natural magnet for ungulates due to the open landscape and pioneer vegetation/forage that would be present.

Pollen records for the Lake Stanley period around the Georgian Bay region show a dominance of pine with a variety of other species such as birch (*Betula*), oak (*Quercus*), elm

(*Ulmus*), maple (*Acer*), and spruce (*Picea*). This mixed assemblage has been interpreted to represent a white pine dominated woodland (McCarthy et al. 2015, Figure 3.1). However, the peri-glacial boreal forest once thought to be restricted to areas along the lingering Laurentide ice front has been found well south of the ice front in the Georgian Bay basin (McCarthy et al. 2015, McCarthy and McAndrews 2012). This boreal forest persisted after Lake Stanley and well into the Holocene, ~8200-7500 cal yr BP (McCarthy and McAndrews 2012). Areas in Michigan retained spruce populations as well (Bailey and Ahern 1981; Kapp 1986:371, 1999). Therefore, for the upper Great Lakes, we can envision a mosaic of paleoenvironments during Lake Stanley, with patches of open subarctic spruce taiga, and pine-dominated woodlands. This fits with the open spruce/sedge environments on the Algonquin lake bed, and recent findings on the AAR in Lake Huron (see **Chapter 7**).

Although limited, the available evidence demonstrates a continuation of Pleistocene environments in the Great Lakes region; specifically spruce/sedge parkland and subarctic boreal forests during the Lake Stanley stage. This should not be surprising as climates would have remained cooler near lakeshores (Jackson et al. 2000). This conclusion may explain why many “ice age” species continued into the Holocene in the region. For example, mastodons appear to have a protracted attrition in the Great Lakes, with two specimens dated to the Early Holocene (~11,217 cal yr BP (9600 +/- 110 ¹⁴C yr BP) in Michigan, ~11,725 cal yr BP (10,032 +/- 40 ¹⁴C yr BP) in Indiana) (Fisher 1984, 2010; Kapp 1986; Woodman and Athefield 2009)). Likewise, caribou are still present in the northern Great Lakes today, were common on the Pleistocene/Holocene landscape, and have been a consistent prey choice for prehistoric peoples throughout the Holocene (e.g. Cleland 1966, 1968; Lemke 2015b; Martin 1995; Martin and Perri 2011). The persistence of both these species is consistent with the later occurrence of

spruce/subarctic-like habitats in parts of the region (see Ellis et al. 2011; Teale and Miller 2012; Whitehead 1973; Whitehead et al. 1982).

Indeed, in the immediate area of the Great Lakes, the major shift to post ice age/Holocene environments happens well after the Lake Stanley stage, with a significant vegetation change from pine to mixed forest occurring as late as 8300 cal yr BP (7500 ¹⁴C yr BP) (Yu 2003), after Lake Stanley and well into the Lake Nipissing highstand.

The end of Stanley

The end of Lake Stanley corresponds with the Holocene climatic optimum or Mid-Holocene Hypsithermal ~8200-4000 cal yr BP (9000-5000 ¹⁴C yr BP) (Meyers 2003), a period characterized by warm and dry climates as well as severe drought in the Midwest (Dean et al. 1996; Hassen et al. 1997; Krishnamurthy et al. 1995). In contrast, the Great Lakes region, particularly in the east, were warmer (especially in the summer) and wetter (Dwyer et al. 1996; McCarthy et al. 2015: 15; Hunter et al. 2006). Lake core data suggest warmer summers in the Lake Ontario area and greater precipitation throughout the Great Lakes (Mullins 1998), resulting in fairly sudden warming, increased precipitation, and succession of dense mixed forests at the end of Lake Stanley (McCarthy et al. 2015) (**Table 4.5**).

Table 4.5. Generalized early Holocene vegetation succession in the Lake Huron basin.

| Lake Stage | Major Vegetation Phases | Date ¹⁴ C yr BP | Date (cal yr BP) |
|--------------------|---|----------------------------|------------------|
| Draining Algonquin | Gradual closing of spruce parkland, Transition to pine | 10,600 – 10,300 | ~12,000 – 11,000 |
| Early Lake Stanley | Jack/Red Pine Boreal Forest | 11,200 – 9500 | ~11,000 – 10,000 |

| | | | |
|-------------------|--|-------------|----------------|
| | Spruce/Sedge swamp | | |
| Late Lake Stanley | White Pine Boreal Woodland Subarctic Open Boreal Forest | 9500 – 7100 | ~10,000 – 8000 |
| Lake Nipissing | Mixed Hemlock/Maple/Beech Forest | 7500 – 5000 | ~8200 – 7500 |

See also McCarthy et al. 2015 Figure 3.1

Following Lake Stanley, is post-glacial Lake Nipissing, ~7,600 – 4,000 cal yr BP (6000 – 3500 ¹⁴C yr BP). During the Nipissing transgression water levels rose once again above modern elevations in Lakes Superior, Huron, and Michigan (184 m). Waters rose as the North Bay outlet which flowed during Lake Stanley was gradually closed due to isostatic uplift, and a new Port Huron drainage was still gradually eroding (Lewis 1970; Larsen 1985; Monaghan and Lovis 2005:43) (**Figure 4.6**). The beginning of Nipissing is strongly correlated with the mid-Holocene hypsithermal which ushered in warmer and wetter climate in the Great Lakes, as well as a transition to mixed deciduous hemlock, beech, and maple forests (McCarthy et al. 2015).

Evidence for this warmer and wetter environment is evidenced by intact tree stumps in 12.5 meters of water in south Lake Huron, which are indicative of a middle Holocene conifer swamp (e.g. cedar (*Cedrus*), hemlock (*Conium*), pine (*Pinus*), spruce (*Picea*), and ash (*Fraxinus*) (Hunter et al. 2006). Absolute dates place this forest between 7920 – 7180 cal yr BP.

Dendrochronological and stable carbon and oxygen isotopic analyses on this submerged forest indicate an environment with high inter-annual climate variability and overall slightly warmer conditions than today (Hunter et al. 2006). This forest is interpreted to be consistent with the mid-Holocene hypsithermal and provides an absolute date for the *terminus post quem* of Lake Stanley and rising Nipissing waters at 7350 cal yr BP (6420 ¹⁴C yr BP) in Southern Lake Huron. Similarly, in Thunder Bay, Michigan, additional inundated tree stumps date between 7930 –

7473 cal yr BP (Luke Clyburn pers. comm. 2015) (**Figure 4.7**) were also submerged by Nipissing waters. Water levels continued to fluctuate from the mid-late Holocene, ultimately resulting in the modern Great Lakes post 4000 cal yr BP (Larsen 1987).

Figure 4.6. Lake Nipissing.



Figure 4.7. Submerged tree stump in Lake Huron. Image courtesy of Luke Clyburn.



Summary

Generalizations concerning the paleoenvironment across North America during the Pleistocene-Holocene transition are problematic due to substantial variation on a global scale, a continental scale, and even arguably on the scale of large region such as the Great Lakes. As demonstrated by the overview above, even generalizations on a more refined scale made from a limited number of data points can conceal significant variability.

There is evidence of intra-regional variability and punctuated change in the Great Lakes, as general paleoenvironments are not consistent across the basin. There are significant differences in the rate and nature of vegetation changes from north to south and east to west. Rather than uniformity across the region, variation should be the expectation for environmental change, indicating a need for detailed regional and micro-regional investigations, so that substantial and significant variability is not masked. For example, the mosaic environments and ecotones created by fluctuating water levels of Lakes Algonquin and Stanley are extremely important as these settings would have been highly productive areas for hunter-gatherers.

Human Adaptations in the Pleistocene-Holocene Great Lakes

Lakes and coastlines are productive environments that are attractive to hunter-gatherers (e.g. Julig et al. 1990) and the Pleistocene waterways in North America were no exception. During this time there is archaeological evidence of littoral adaptations on the West Coast (e.g. Erlandson et al. 2005, 2011; Rick, Erlandson and Vellanoweth 2001; Rick et al. 2005), in the

Great Basin (e.g. Beck and Jones 2010), and the Great Lakes (e.g. Jackson et al. 2000:428; Julig et al. 1990).

Archaeological research in the Great Lakes has therefore focused closely on changing shorelines and their associated paleoenvironments – as prehistoric peoples are thought to have lived close to these lakes shores for at least part of the year to take advantage of the abundant fresh water and lacustrine resources, such as fish and waterfowl (e.g. Greenman and Stanley 1941; Lee 1957; MacNeish 1952; Jackson et al. 2000:435). There are also numerous raw material sources for stone tool manufacture lining the Great Lakes (e.g. Fox et al. 2015). Together, these factors would have significantly influenced human settlement in the region.

This view is primarily based on the distinct association between the relict shoreline of glacial Lake Algonquin and Paleoindian sites, and Late Archaic sites with the Lake Nipissing shoreline (e.g. Deller 1976, 1979; Ellis and Deller 2000; Fitting et al. 1966; Jackson 1983; Julig and McAndrews 1993; Jackson et al. 2000; Mason 1958, 1960, 1962; Ritchie 1957; Quimby 1958; Roosa 1965, 1968; Storck 1979, 1982, 1984, 1997). As a result of this association, the geological identification and dating of shorelines has been intimately connected with archaeological survey and the relative dating of sites and deposits. This use of paleoshorelines for dating and/or interpreting archaeological patterns has been consistent despite significant methodological challenges.

While the previous discussion provided a general background for dynamic lake levels, these processes have been dubbed one of the most complex problems in North American geology (Jackson et al. 2000:416). It is critical to note that ancient lake levels are continually being reevaluated and revised due to new data relative to dating, isostatic rebound, and glacial movements (e.g. Jackson et al. 2000). In addition, connections between the archaeological record

and ancient shorelines are not always straightforward. For example, isostatic uplift along the north shores of Lakes Superior and Huron has preserved the relict shoreline of Lake Algonquin and its associated Paleoindian sites. In contrast, consequent flooding further south has resulted in the submergence of Paleoindian sites and a skewed archaeological record (Ellis and Deller 1986; Jackson 2004:27).

Furthermore, recent reinterpretations of the Lake Algonquin shoreline, specifically in southern Ontario, suggest it was much further north than traditionally assumed and therefore cannot be used to date Paleoindian sites further south traditionally believed to be on the shoreline (Jackson et al. 2000:423). Also in this region both proglacial Lake Algonquin and postglacial Nipissing reached the same maximum elevation (184 meters) and much of the older shoreline has been effectively removed and reworked by the later highstand (Karrow 1980). Finally, a significant portion of the area inhabited by prehistoric populations dating to critical time periods is now underwater (Jackson et al. 2000). Similar to the paleoenvironmental record, these drowned landscapes have resulted in a biased picture, with some archaeological time periods being better represented than others.

Despite these issues, archaeologists have consistently made connections between Paleoindian occupations and paleoshorelines as a means to date sites and to infer the paleoenvironment in which these populations were living and foraging; i.e. if Paleoindian sites are located near the Algonquin shoreline they must date to the Pleistocene, and therefore they were living in glacial tundra environment, and subsisting on big-game Ice Age animal resources, (e.g. Simons et al. 1984). While surely the fresh water and littoral resources of the ancient Great Lakes were a draw to prehistoric populations (perhaps even for fishing in Lake Algonquin (Deller and Ellis 1992)), detailed analyses of the relationship between subsequent lake levels,

their associated paleoenvironment, and cultural adaptations is perhaps premature. This dissertation makes a contribution to this area by drawing connections between the terrestrial and underwater archaeological records (See **Chapter 10**).

A General Note Concerning Systematics and Chronology

Cultural historical reconstructions in the Great Lakes during the Paleoindian and Early Archaic periods have been difficult to establish due to issues of submerged landscapes and indirect methods of dating. In addition, the limited number of direct dates from Paleoindian sites in the Great Lakes has long been recognized as a significant problem (e.g. Shott 1986:122 (similar to limited Paleoindian dates across North America more generally, e.g. Meltzer and Holliday 2010:26)) and continues to plague cultural historical reconstructions in the region. Overall preservation of organics, i.e. datable materials, is extremely limited in this region of acidic soils. Therefore, while the relative cultural sequence in the Great Lakes is generally agreed upon (see below, and **Table 4.6**), anchoring subsequent phases in any kind of absolute chronology has been extremely difficult (Ellis et al. 2011:534).

Table 4.6. Relevant culture history in the eastern Great Lakes.

| Period | Phase | Assumed Age (cal yr BP) | Assumed Age (¹⁴C yr BP) | Lake Stage |
|-------------------|--------------|------------------------------------|---|--------------------|
| Early Paleoindian | Gainey | ~13,000 – 12,700 | 11,000 – 10,800 | Main Algonquin |
| | Parkhill | ~12,700 – 12,500 | 10,800 – 10,500 | Draining Algonquin |
| | Crowfield | ~12,500 | ~10,500 | Draining Algonquin |

| | | | | |
|------------------|----------|---------------------|-----------------|--------------------|
| Late Paleoindian | Holcombe | ~12,500 – 11,900 | 10,500 – 10,200 | Draining Algonquin |
| Late Paleoindian | Hi-Lo | ~11,900 – 11,300 | 10,200 – 9900 | Stanley |
| Late Paleoindian | Plano | ~10,000 – 8300 | 9500 – 7500 | Stanley |

There is a total of eight terrestrial absolute dates (6 radiocarbon, 2 thermoluminescence) spanning the Paleoindian period in the Great Lakes (**Table 4.7**); and this small sample has a number of problems. First, the carbon date associated with mastodon bones from the Hiscock site is not generally accepted as the association between fluted points and these animals has been questioned (Laub 2000; Laub et al. 1996; see discussion in Metcalfe and Longstaffe 2014:374). Second, the radiocarbon date from the Leavitt site, assumed to be an Early Paleoindian occupation on typological grounds, was considered too young. Moreover, this date was run on spruce, and paleoenvironmental reconstructions at the time implied that spruce should have already been replaced by pine. Thus, the radiocarbon date was dismissed (Shott 1993:21). It is included here, however, since more recent paleoenvironmental studies are not inconsistent with spruce in central Michigan at this time (see above, e.g. Bailey and Ahern 1981; Kapp 1986:371, 1999). This radiocarbon date also fits well within the span of radiocarbon dates on submerged wood and charcoal from the AAR (see **Chapter 7**).

Table 4.7. Absolute dates from Paleoindian sites in the Great Lakes basin.

| Site | Date (cal yr BP) | Date (¹⁴ C yr BP) | Reference(s) |
|--------|------------------|-------------------------------|---------------------------------|
| Gainey | 12,360 +/-1234* | | Simons et al. 1984; Simons 1997 |

| | | | |
|-------------|----------------------------|-------------------------|-----------------------------|
| | 11,420 +/-400* | | Simons 1997 |
| Hiscock | ~12,700; 13055-12751 (95%) | 10,990 +/- 100 | Laub 2000; Laub et al. 1996 |
| | 12,945-12560 (95%) | 10,810 +/- 100 | Laub 2000; Laub et al. 1996 |
| Leavitt | ~9010-8450 (95%) | 7886 +/- 115 (AA-1223) | Shott 1993:21 |
| Cummins | ~9500; 10513-8540 (95%) | 8480 +/- 390 (NMC-1216) | Julig et al. 1986:76 |
| | ~10,450; 10646-10248 (95%) | 9260 +/- 70 (TO-547) | Julig 1984, 1988, 1993 |
| Sheguiandah | ~10,250; 11080-9564 (95%) | 9130 +/- 250 (W-345) | Julig and McAndrews 1993 |

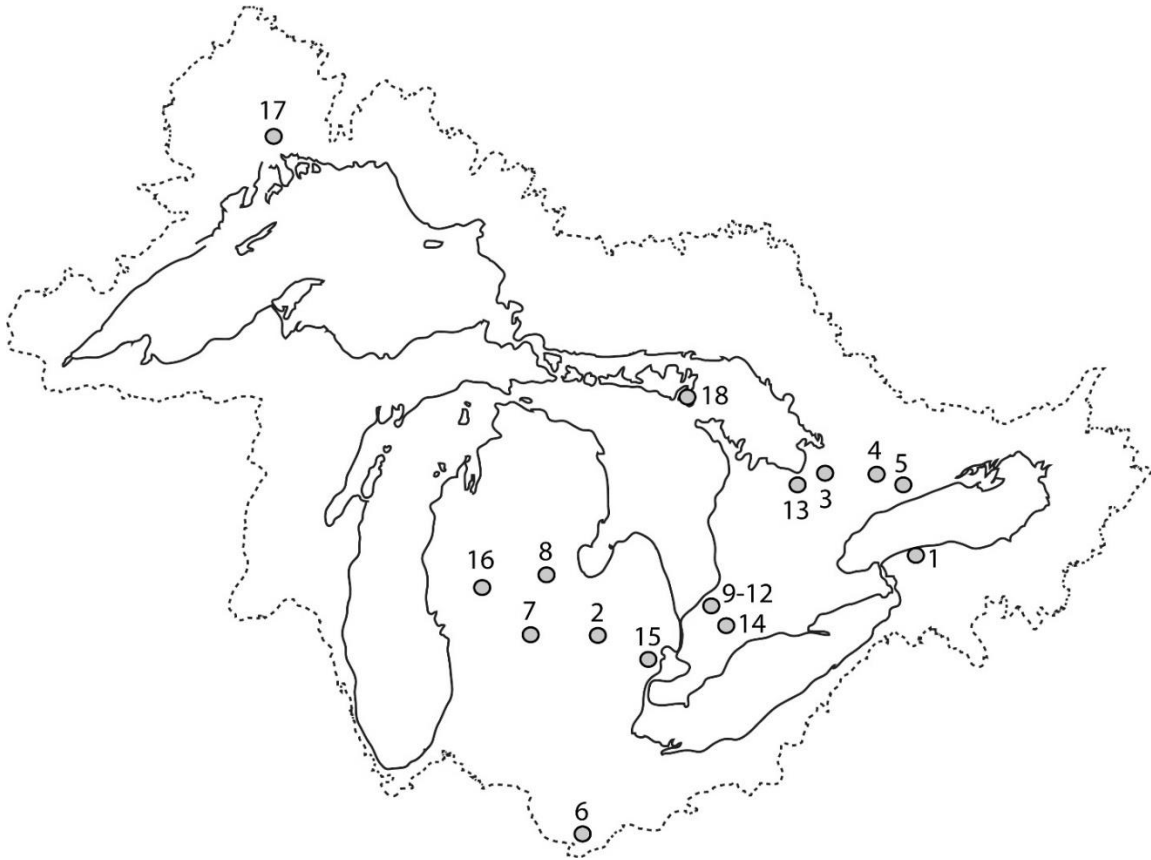
* Thermoluminescence dates

The paucity of absolute dates from the Paleoindian period has resulted in a reliance on indirect and relative dating methods, such as the ancient lake shores but also typological comparisons. Great Lakes forms are often compared to better dated sites from other parts of North America and assumed to be contemporaneous. For example, Great Lakes fluted projectile points such as Gainey and Barnes are assumed to be similar technologies and thus part of the Clovis and Folsom cultural horizons (e.g. Simons 1997 but also Morrow and Morrow 2002). Since this is common practice, these assumed dates are listed **Table 4.6** but it cannot be overemphasized that they are *assumed*, not demonstrated, for the Great Lakes region.

With these issues as preamble, what follows is a review of the conventional cultural history of the Great Lakes region during the Pleistocene-Holocene transition and the contemporary archaeological periods, i.e. Early Paleoindian to Early Archaic in the Great Lakes region. This discussion largely presents a review of typological analyses and standard projectile point chronology. While culture histories in the Great Lakes are often separated into Eastern and Western regions using Lake Michigan as a boundary (e.g. Ellis et al. 2011; White 2013), the Great Lakes basin will be used here (**Figure 4.8**).

The Eastern/Western division is often made due to typological differences between these regions. Paleoindian artifacts in Western Great Lakes, specifically Wisconsin, Illinois, and Indiana, are typologically more similar to the West and Plains (e.g. Clovis and Folsom) than they are to the Eastern Great Lakes (e.g. Michigan, Ontario, New York). The appearance of Folsom in the Western Great Lakes is likely linked to the expansion of prairie habitat and bison in these areas ~12,500 cal yr BP (10,500 ¹⁴C yr BP) (Munson 1990). In contrast, artifacts in the eastern Great Lakes share more typological similarity with the Northeast and Canadian Maritimes (e.g. comparisons between Holcombe in Michigan and Reagan in Vermont). However, within the modern basin material culture is internally consistent compared to these outlying regions and given the placement of the AAR across Lake Huron, the basin is an appropriate unit of study.

Figure 4.8. Great Lakes Basin with primary sites discussed in the text. 1. Hiscock; *Gainey Phase Sites*: 2. Gainey, 3. Udora, 4. Sandy Ridge, 5. Halstead, 6. Nobles Pond; *Parkhill Phase Sites*: 7. Leavitt, 8. Barnes, 9. Thedford II, 10. Parkhill, 11. Dixon, 12. McLeod, 13. Fisher; 14. Crowfield, 15. Holcombe, 16. Hi-Lo, 17. Cummins, 18. Sheguiandah.



Early Paleoindian 13,000-12,500 cal yr BP (11,000-10,500 ¹⁴C yr BP BP)

The earliest human occupation in the Great Lakes is dated to ~13,000 cal yr BP (11,000 ¹⁴C yr BP) (or 10,900 ¹⁴C yr BP Ellis et al. 2011) and ends prior to ~11,500 cal yr BP (10,000 ¹⁴C yr BP). The assumed end of the period varies from ending as early as ~12,700 cal yr BP (10,800 ¹⁴C yr BP) (White 2013) to as late as ~12,200 cal yr BP (10,400 ¹⁴C yr BP) (Deller and Ellis 1992). The span employed here is 13,000-12,500 cal yr BP (11,000-10,500 ¹⁴C yr BP) as this span accounts for the earliest evidence of human occupation in the region (Joyce 2006;

Overstreet and Kolb 2003) and is consistent with the thermoluminescence dates from Gainey (Table 4.7).

The Early Paleoindian period in the Great Lakes has three distinct phases – Gainey, Parkhill, and Crowfield (potentially four, with Enterline preceding Gainey but this type is not generally accepted (Deller and Ellis 1992:34; Roosa and Deller 1982)). Two of these phases are named for specific biface types, e.g. Gainey and Crowfield, while the Parkhill phase is characterized by Barnes projectile points. These phases or technological complexes are thought to represent distinct chronological periods, despite the lack of supportive radiocarbon dating.

The relative chronology of these Early Paleoindian phases in the Great Lakes has been principally established by Deller and Ellis (e.g. 1988, 1992, 1998). Their extensive work in southern Ontario has established the Gainey-Parkhill-Crowfield typology by the documentation of co-occurring morphological and technological traits (Deller and Ellis 1988). They argue that their morphological and metric analyses are consistent with models of temporal variation (1992:125), and that the Gainey, Parkhill, and Crowfield phases are chronological stages rather than contemporary technologies (1988, 1989, 1998).

First, Gainey, Parkhill, and Crowfield have nearly identical geographic distributions (Deller and Ellis 1992:34) and if these types were indicative of different social groups, they would likely have distinct spatially distributions (1992). Second, most sites are single component with lithic artifacts associated with only one phase (Deller and Ellis 1988; Shott 1986). If they represented contemporaneous variation, different types would likely be found in the same assemblages, especially at larger social aggregation sites, but this is not the case (1992:35). Third, raw material access cannot account for the typological variability since there are examples of each point type made on the same raw material (e.g. Gainey, Barnes, and Crowfield examples

all made on Collingwood Chert from the Bruce Peninsula in Ontario). Lastly, these different types do not result from resharpening or reworking the same original form (i.e. Dibble's arguments for the variation in Mousterian technology cannot be applied here (Dibble 1984, 1987, 1988; Rolland and Dibble 1990)).

The boundaries of these types, however, are not strict. In fact there are several fluted bifaces which cannot be classified clearly as one type or another. For example, in Ontario there are several points that seem intermediate between Gainey and Barnes or Barnes and Crowfield. The fact there are no artifacts that seem to be transitional between Gainey and Crowfield is offered as support for the temporal distinction between these two phases, with Barnes in between (1992:36). Consequently, far from being discreet categories, early Paleoindian, "...types represent arbitrary segments in a temporal continuum of morphological and technological change" (Deller and Ellis 1992:36). Until these phases are rooted in an absolute chronology however, the relative sequence will remain a hypothesis.

Gainey

The Gainey phase is often assumed to be the earliest and to represent the initial colonizing population in the region (Shott 1986). As listed in **Table #**, there are two thermoluminescence dates from the Gainey type site, dating the phase contemporary with glacial Lake Algonquin. In addition to these dates, Gainey is considered to be early based on its presumed similarity to Clovis technology (e.g. Simons et al. 1984; Simons and Wright 1992, but see Morrow and Morrow 2002) and is assumed on this basis to date prior to ~12,500 cal yr BP (10,500 ¹⁴C yr BP) (see Brose 1994; Deller and Ellis 1992; Ellis et al. 1998, 2011; Jackson 1998;

Seeman 1994; Shott 1986, 1990, 1993; Simons 1997; Simons et al. 1984) most likely centering around ~12,700 cal yr BP (10,900-10,800 ¹⁴C yr BP) (Ellis et al. 2011:535-536).

Gainey points are thick in cross section, tend to have deep basal concavities, are roughly parallel sided, and generally have a single flute on each face, which usually extends to ½ or 1/3 the length of a complete unsharpened point, with a lack of, or only slightly developed ears (Figure 4.9) (Seeman 1994; Spiess et al. 1998). Gainey flutes are typically shorter than those on later Barnes and Crowfield points, and on these grounds they are considered to be earlier in a sequence of evolving fluting technology similar to the transition between Clovis and Folsom in the West (Deller and Ellis 1992; Ellis and Deller 1990; Shott 1986; Simons et al. 1984; Storck and Spiess 1994:126). Other tools associated with Gainey points from excavated contexts include numerous scrapers (e.g. beaked, spurred end scrapers, trianguloid, and side scrapers), graters, and perforators (Seeman 1994; Simons et al. 1984).

Figure 4.9. Gainey Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Dan Wymer, Don Simons, and George Davis. Photographs by Tim Bennett and Don Simons.



In terms of raw material economy, the Gainey assemblage at the type site is mostly Upper Mercer and Flint Ridge cherts from Ohio, with only small amounts of local cherts such as Bayport. Gainey therefore appears to fit the broader Early Paleoindian tradition of preferential selection of high quality, exotic materials (e.g. Speth et al. 2013). In contrast, most sites which are assumed to date later (e.g. Butler, Barnes, Leavitt, Holcombe, and Hi-Lo) have large amounts of local Bayport chert from the Saginaw Bay region (e.g. Ellis 1989; Fitting et al. 1966:18-20, 126; Simons 1997; Simons et al. 1984). This has been interpreted to indicate that Bayport Chert source was inundated by Lake Algonquin, and was not readily available to hunter-gatherers in the region until the draining of the lake around ~12,200 cal yr BP (10,400 ¹⁴C yr BP) (Shott 1986; Simons et al. 1984:268; Wright 1981). The presence of Bayport chert has therefore been used as an additional indirect method of dating sites. However, some of the outcrop was likely above water during Lake Algonquin, such as the outcrops on Charity Island (Fox et al. 2015:72).

The spatial extent of Gainey seems to be similar to the subsequent Parkhill phase and is localized in the Central and Eastern Great Lakes, including Michigan, upstate New York, and southern Ontario (Deller and Ellis 1992:126; Lothrop 1988; Ritchie 1957) (See **Figure 4.8**). The similarity between Gainey points and points from Bull Brook in Massachusetts ¹ (Byers 1954) was noted early on by Roosa (1965) which suggests a spatial spread of a similar technology, from the Eastern Great Lakes to the Northeast.

In addition to the type site, another notable Gainey phase occupation is Nobles Pond in Ohio. Nobles Pond is one of the largest Paleoindian sites in eastern North America (8.1 ha). Raw material selection and the overall assemblage mimics the Gainey type site. Lithic tools include

¹ Lithic procurement patterns are also similar in the Bull Brook and Gainey phase sites. For example, at Bull Brook over 90% of the lithic raw material was from at least 250 km away, and local sources were the minority (Robinson et al. 2009:427) – similar to the Gainey type site.

Gainey fluted points, trianguloid end scrapers, side scrapers, gravers, and perforators (Seeman 1994) and the majority are made on high-quality exotic materials, specifically Upper Mercer (70 km away) and Flint Ridge (100 km away) (Seeman 1994). Protein residue analyses conducted on 130 tools from the Nobles Pond assemblages included positive reactivity for deer, caribou, elk, bovine, bear, rabbit, and dog (Seeman et al. 2008). Nobles Pond is interpreted to be a large camp, mostly likely where people aggregated for communal caribou hunting (Seeman 1994).

Additional Gainey phase sites include Halstead, Sandy Ridge, and Udora. Sandy Ridge has also been interpreted as belonging to the Gainey phase although no Gainey points are present (Jackson 1990; Jackson and McKillop 1991). Udora is well known for preserved faunal remains of caribou, hare, and arctic fox (Storck and Spiess 1994). Subsistence economies during the Gainey phase are thought to be heavily reliant on caribou (with direct evidence from Nobles Pond and Udora) (see also Simons 1997, **Chapter 5**).

Parkhill

The Parkhill phase, first outlined by Roosa (1977a,b) is characterized by Barnes fluted projectile points and knives (Roosa and Deller 1982). Barnes points are narrower and thinner than Gainey points, with a long flute on each face, often extending near the tip on at least one face, with convex lateral sides expanding out from a narrow base, fishtails, and a relatively shallow basal concavity (Ellis and Deller 1997:5; Spiess et al. 1998). As is clear from **Figure 4.10**, Barnes points are highly variable (Ellis and Deller 1997; see also subtypes listed by Roosa and Deller 1982).

The phase is considered to represent the middle of the fluted point, or Early Paleoindian occupation of the Great Lakes and is assumed to be contemporary with Folsom and Cumberland phases, as well as the Debert/Vail sites in Northern Maine and the Canadian Maritimes. As such, it is assumed to date to ~12,900 – 12,500 cal yr BP (10,800 - 10,500 ¹⁴C yr BP) (Deller and Ellis 1992:125-126, Fig. 88; Roosa and Deller 1982).

Figure 4.10. Barnes Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Chippewa Nature Center, Don Simons, Doyle Smith, Bernie Spencer, Dan Wymer, and George Davis. Photographs by Tim Bennett and Don Simons.



The spatial distribution of Parkill Phase sites ranges from southern Ontario, to eastern Michigan, northern Ohio, and upstate New York (e.g. Deller and Ellis 1992:125). Key sites include the type site and others in Ontario including Fisher, Thedford II, Dixon, and McLeod

(Deller and Ellis 1992; Ellis 1984; Storck 1997, 1983), as well as Barnes, Leavitt, and Dobblaar in Michigan (Roosa 1965, 1977b; Shott 1993; Wright and Roosa 1966). In addition to Barnes points, other tool types found in Parkhill sites include piercers, endscrapers, and sidescrapers that are common in Paleoindian sites but are not particularly diagnostic of the phase. Less common tool forms at the Thedford II site and others in Ontario include channel flake points, large beveled bifaces, backed bifaces, backed unifaces, and combination notch/borers/denticulates (Deller and Ellis 1992).

Very little is known about subsistence economies during Parkhill, as no faunal remains have been preserved from any Parkhill Phase site. It has been argued that similar to Gainey, Parkhill technology and site locations may indicate reliance on caribou hunting (e.g. Deller 1980).

Crowfield

Crowfield bifaces are distinct from Gainey and Barnes and are thought to represent the end of the Early Paleoindian period in the Great Lakes basin. They are characterized by multiple flutes, a marked expansion of the lateral edges from the base of the point, shallow basal concavities, and extreme thinness (Deller and Ellis 1984, See Ellis 2009, Fig. 7). The spatial distribution of this phase is much smaller than the preceding Gainey and Parkhill phases and is restricted to southern Ontario.

The Crowfield site itself (AfHj-31) is a unique Early Paleoindian site – interpreted to be a small campsite with a small number of exhausted stone artifacts, but with an additional significant feature. The partially disturbed feature contained over 182 heat destroyed stone

artifacts, some of which were finished, and is interpreted to be best evidence of ritual activity among fluted point groups in Eastern North America. This feature is thought to be a functioning tool kit of a single individual which was deliberately burned (Deller 1988; Deller et al. 2009; Deller and Ellis 1984, 2011; Ellis 1984). The possibility of the feature being a cremation burial has been suggested (Deller and Ellis 1984, 2011). Although no human remains were found, its diverse composition and very large size distinguish it from almost every other lithic cache site in North America as the assemblage seems to represent the “active gear” used by a single individual (Deller, Ellis, and Keron 2009).

Crowfield points and fluted biface blanks have been recovered from a number of sites in southern Ontario (e.g. Bolton, (Deller and Ellis 1996), Zander (Stewart 1984), and Alder Creek (Timmins 1994)), suggesting that this technology does represent utilitarian tools as opposed to specially made ritual artifacts (Deller and Ellis 1996). In terms of raw material sources, chert artifacts are primarily made on non-local Onondaga (100 km away), Fossil Hill, or Collingwood chert (200 km away), with some minor amounts of Ancaster chert (100-120km) (Ellis 2009). Out of the three Early Paleoindian phases, Crowfield is the least well understood.

Late Paleoindian 12,500-8500 cal yr BP (10,500-7500 ¹⁴C yr BP)

The Late Paleoindian period is characterized by a change in biface technology, specifically the absence of flutes common in the preceding period. Similar to the end of the Early Paleoindian period, there is considerable debate concerning the span of the Late Paleoindian period and the transition to the Early Archaic. This transition has been placed as early as ~11,600 cal yr BP (10,000 ¹⁴C yr BP) (e.g. White 2013) or later at ~11,200 cal yr BP (9800 ¹⁴C yr BP)

(Ellis et. al 2011), ~9500 cal yr BP (8500 ¹⁴C yr BP) (Jackson and Hinshelwood 2004), or ~8500 cal yr BP (7500 ¹⁴C yr BP) (Julig et al. 1990). Here, the Late Paleoindian period is defined as ending ~8500 cal yr BP (7500 ¹⁴C yr BP), to better root the phase in an absolute chronology by incorporating the radiocarbon dates from the Cummins and Sheguiandah sites in Ontario (**Table 4.7**). Broadly within this period, three primary phases are recognized in the Great Lakes basin: Holcombe, Hi-Lo, and Plano.

Holcombe

Holcombe points are small, very thin, and gracile, with shallow concave bases that have multiple flutes and are basally thinned. Holcombe is interpreted to represent the end of fluting technology in the eastern Great Lakes. The phase has been relatively dated as Late Paleoindian since Holcombe points have been found on the bed of Lake Algonquin (Spiess et al. 1998) and are assumed to date between ~12,500 – 11,900 cal yr BP (10,500 and 10,200 ¹⁴C yr BP) (e.g. Ellis et al. 2011). The geographic distribution of Holcombe is Southern Ontario, Michigan, and Northern Indiana.

Holcombe sites are considered to be the product of a caribou hunting economy similar to the Gainey and Parkhill phases (Fitting et al. 1966). The Holcombe type site has distinctive lithic clusters assumed to be the remains of individual families that were aggregated to participate in caribou hunts (Cleland 1965; Fitting et al. 1966:81). In support of this, a burned caribou phalanx was recovered from a hearth feature at the site (Cleland 1965; Fitting et al. 1966; see also Spiess et al. 1985:155) (See also **Chapter 5**).

Raw material selection during Holcombe sees a large shift from Earlier Paleoindian use of exotic and non-local to local sources, as Holcombe assemblages are mostly made on Bayport chert. Additionally, the phase displays a marked conservation of raw materials with greater amounts of resharpening and refurbishment compared to other geographic regions (Fitting et al. 1966)

Hi-Lo

Hi-Lo points have been called “unfluted-fluted” (Prufer and Baby 1963:22) and Aquaplano (Quimby 1961). The points are fairly common in the Great Lakes (Ellis and Deller 1982), particularly Southern Ontario, Michigan, and Northern Illinois, with a geographic spread that is very similar to Holcombe. Hi-Lo points have concave bases, are heavily laterally ground, and range from lanceolates to slightly stemmed to side-notched (**Figure 4.11**). They are often beveled and reworked and perhaps served as multi-function tools (Ellis 2004; Ellis and Deller 1982; Mason 1981:111-139).

Due to this variation from lanceolates to stemmed or notched, Hi-Lo is often labeled Late Paleoindian/Early Archaic as it appears to be transitional between fluted points and later Archaic notched and stemmed points. The interpretation of Hi-Lo as Late Paleoindian/Early Archaic is based primarily on typology as the overall lanceolate shape, basal thinning, and basal and lateral grinding are found during both the Late Paleoindian and Early Archaic periods. There is also a separate phase, Hi-Ho, a transitional point form between Holcombe and Hi-Lo. Holcombe, Hi-Ho, and Hi-Lo are considered to be three Late Paleoindian complexes with concave based points (Jackson 1998, Ellis 1999; see also Ellis 2004 for a discussion of Hi-Lo subtypes).

Figure 4.11. Hi-Lo Projectile Points. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Doyle Smith, Bernie Spencer, Dan Wymer, and Tim Bennett. Photograph by Tim Bennett.



Ellis has argued for a strictly Late Paleoindian classification of Hi-Lo however, suggesting that lithic procurement strategies, chaîne opératoire, and tool kits seem more similar to Paleoindian practices than later Archaic technologies (1999). For example, associated tools with Hi-Lo points are similar to those found in early fluted point sites; such as backed bifaces, drills, perforators, unifacial gravers, and beaked scrapers (Ellis and Deller 1982).

Hi-Lo points are considered to be a Great Lakes variant of the more wide-spread Late Paleoindian Dalton complex (Ellis et al. 2009; Ellis and Deller 1982; Justice 1987; Koldehoff and Walthall 2009; White 2006). Given this typological similarity the Hi-Lo phase is considered to date between ~11,900 – 11,300 cal yr BP (10,200 – 9900 ¹⁴C yr BP) (Deller and Ellis 1992a). Similar to many Great Lakes Paleoindian sites, Hi-Lo sites seem to be the result of small groups and short occupations and there is no evidence of cemeteries, formalized exchange, or portable

artwork such as those associated with the broader Dalton phase in other regions (Lemke et al. 2015; White 2012).

Plano

The Late Paleoindian Plano Phase seems to be contemporary with Hi-Lo in Ontario (Ellis 2004:69). Plano points are diagnostic of the phase and are parallel-flaked lanceolates (Julig et al. 1990). Plano phase sites include Cummins and others of the Lakehead Paleoindian complex along the north shore of Lake Superior (See **Figure 4.8**) (Fox 1975, 1980; Dawson 1983; Julig 1984, 1988; Julig et al. 1990). This locale was ideal for human occupation due to abundant freshwater and local lithic raw material sources. The George Lake Paleoindian complex is another such locality. Sheguiandah and other related sites are situated along the north shore of Lake Huron near abundant raw material sources (Lee 1954, 1955, 1957; Greenman 1966). Both Cummins and Sheguiandah have associated absolute dates on the Late Paleoindian period (see **Table 4.7**). A fragmentary cremation burial from Cummins was dated to 8480 +/- 390 ¹⁴C yr BP and occupation at the site across several locals dates between 9500 – 7500 ¹⁴C yr BP (Julig et al. 1990:42-43), and the occupation at Sheguiandah has been dated at 9130 +/-250 ¹⁴C yr BP. The Cummins site demonstrates that Late Paleoindian groups expanded into the region shortly after the Marquette glacial advance (See **Figure 4.8**).

During all three phases of Late Paleoindian in the Great Lakes, evidence for subsistence is fairly limited. In addition to the caribou phalanx from the Holcombe site, there is blood residue on lithic artifacts from the Cummins site which tested positive for bison, deer (cervid), and a variety of small mammal species (Newman and Julig 1989). The best preserved faunal

evidence from this time period is preserved further west in Wisconsin and indicate a generalized diet with white-tailed deer, black bear, porcupine, beaver, muskrat, turtle, birds, and fish (Kuehn 1998).

Overall the Late Paleoindian period is poorly understood in the Great Lakes. This is most likely due to the large portions of land dating to this period which are now submerged beneath the modern Great Lakes. Late Paleoindian sites have been particularly affected by changing water levels. There is direct evidence of Late Paleoindian sites being submerged by later Nipissing waters as diagnostic artifacts are water-rolled, smoothed, and have heavy patination (Deller 1976, Deller, Ellis, and Kenyon 1985, Ellis and Deller 1986). In addition to submerged sites, the Nipissing transgression also deeply buried numerous sites beneath lake sediments (Larsen 1985, Monaghan and Lovis 2005), and these two processes together result in a distinct absence of sites dating to this period.

The Late Paleoindian - Early Archaic Transition

The Late Paleoindian to Early Archaic transition did not happen uniformly across the region. Rather, there are significant geographic differences in the timing of this shift. Generally, Late Paleoindian occupation continues in the north until ~8300 cal yr BP (7500 ¹⁴C yr BP), as demonstrated by the Cummins and Sheguiandah sites, and Lakehead and George Lake complexes more generally (Greenman 1940, 1943). Further south, particularly in southern Michigan, Late Paleoindian types are replaced by Early Archaic styles earlier, beginning just after ~11,600 cal yr BP (10,000 ¹⁴C yr BP) (Julig and McAndrews 1993). This has been

interpreted as a recolonization of the southern Great Lakes by Early Archaic populations from further south (e.g. White 2012).

Following this transition, the Early Archaic period is characterized by point styles with wide geographic horizons (White 2012). Stratified sites and radiocarbon data from the Southeastern United States suggests a general sequence from side-notched, to corner-notched, to bifurcate projectile points (e.g. Anderson and Hanson 1988; Broyles 1971; Chapman 1977:51; Collins 1979; Jefferies 1988; Tuck 1974), and this general sequence is accepted for the Great Lakes as well, such as the Kirk Corner Notched and bifurcate phases (**Figures 4.12-4.13**). These Early Archaic populations are more similar to the later Archaic and Woodland periods than they are to the preceding Paleoindian period, particularly in their consistent use of documented semi-permanent domestic structures and cemeteries (Walthall 1998, 1999; White 2011:193).

Figure 4.12. Early Archaic Kirk Corner Notched Projectile Points, 9500-8000 cal yr BP. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributor Dan Wymer. Photograph by Tim Bennett.



Figure 4.13. Early Archaic Bifurcate Projectile Points, 9,000 – 7,800 cal yr BP. Image courtesy of the Michigan Archaeological Society 2015 Calendar, Artifact contributors: Dan Wymer, Tim Bennett, Doyle Smith, and Bernie Spencer. Photograph by Tim Bennett.



Discussion

Typological variation is evident in the Great Lakes basin during the Pleistocene-Holocene transition. Such variation serves as background to changes in raw material selection, procurement strategies, mobility regimes, subsistence economy.

Early Paleoindian typological variability in the Great Lakes is just a small part of the larger picture concerning variation in Early Paleoindian fluted points and lifeways more generally. Variation in fluted points has been argued to be a function of stylistic/cultural drift rather than regional adaptation (proposed by Morrow and Morrow 1999; formally tested by Buchanan and Hamilton 2009). The Pleistocene-Holocene transition archaeological record in the

Great Lakes appears to be a case study of local adaptations to diverse micro-environments within the context of the larger region. While some aspects of hunter-gatherer lifeways remain consistent, others are adjusted. For example, despite projectile point style changes, overall toolkits and site sizes remain fairly stable (e.g. Eren 2009) amid significant reorganization of raw material procurement (i.e. exotic to more local sources, Ellis et al. 2011) and likely changes in subsistence economies around one fairly consistent resource, i.e. caribou.

Paleoindian technologies in the Great Lakes, specifically in terms of chaînes opératoires and overall toolkits are fairly consistent across the period (Ellis 1999) despite broad changes in raw material selection and procurement strategies. The same tool categories (e.g. projectile points, endscrapers, side-scrappers, retouched flakes, bifaces, and graters) are found from Gainey to Hi-Lo (Ellis 2004:76; Eren 2009:396). The earliest peoples in the region, e.g. Gainey, used large proportions of exotic raw materials from distant sources. Later Paleoindian populations in the Great Lakes showed a greater reliance on local lithic resources. Beginning with Parkhill, subsequent phases used mostly local raw materials, with some non-local lithic sources, but very few from very distant exotic sources (Simons et al. 1984; White 2012:188, but see Eren 2009:400). Importantly, some of these sources may have been periodically submerged and/or easier to access over time (potentially using boats to access Bayport Chert sources). This general shift in procurement strategies could indicate a reduction in group mobility from the Early to Late Paleoindian periods (Ellis 2011), and/or a change in other methods of obtaining raw materials, such as exchange (White 2012).

Very little direct evidence is available for the subsistence economies due to the highly acidic soils in the Great Lakes region which degrade bone and other organic materials. However, both direct and indirect evidence suggests that Paleoindian economies in the Great Lakes

included caribou (**Chapter 5**). Because caribou exploitation is fundamental to this dissertation's regional case study, all aspects of Paleoindian caribou hunting, the presence of caribou in the Great Lakes and on the AAR are covered in greater detail in following chapters (Chapters **5** and **7**).

Perhaps the single most important, yet overlooked, aspect of the Pleistocene-Holocene transition in the Great Lakes was that it was delayed. Ice age paleoenvironments, fauna, and human adaptations associated with the Pleistocene persisted well into the Holocene. Indeed, the most significant shift in vegetation did not occur until ~8300 cal yr BP (7500 ¹⁴C yr BP), from pine to the mixed forests characteristic of the modern Holocene (Yu 2003). It is this precise time that Lake Stanley ends, and water levels begin to rise to Nipissing. Significantly, ~8300 cal yr BP is also when late Paleoindian lifeways are finally replaced by the Early Archaic in the Northern Great Lakes. The earlier emergence of Archaic types in the Southern Great Lakes is most likely related to changing environments during the Mid-Holocene Hypsithermal. Drought in the Midwest likely made the warmer and wetter Great Lakes an attractive pull on growing Early Archaic populations. It seems likely that the Paleoindian adaptations that were well suited to Pleistocene environments and resources thrived in the Great Lakes longer than any other region in North America, especially in refugia such as the AAR.

Chapter 5

Archaeology and Anthropology of *Rangifer* Hunting

Introduction

The genera *Homo* and *Rangifer* have a long history of interaction dating as far back as the Lower Paleolithic. Over this vast stretch of time archaeologists have documented a broad range of strategies for the capture and exploitation of these animals. The diversity present in the archaeological record supplements, expands, and problematizes models that have been derived from more recent ethnographic and historic cases. A diachronic perspective of *Rangifer* hunting reveals four primary hunting strategies: 1) opportunistic 2) passive technologies (e.g. snares, pitfalls, etc.), 3) intercept hunting, and 4) hunting with the use of built structures. This last strategy presents a fundamental shift in exploitation by actively modifying the hunting landscape (e.g. niche construction) and has significant social and economic implications (see **Chapter 3**).

The use of hunting architecture is nearly ubiquitous among ethnographic caribou and reindeer hunters, and these societies are an ideal example of normative models of foragers derived from the present being applied to the past (**Chapter 2**). Due to the wealth of ethnographic data concerning *Rangifer* hunters, archaeological interpretations of reindeer and caribou hunters, from Neanderthals to Paleoindians, are deeply influenced by ethnographic accounts. In these cases, ethnographic analogies are common despite the fact that the extant

historic and ethnographic records cannot accurately reflect the vast diversity of caribou hunting adaptations known only in the deep past.

This chapter first provides a natural history of *Rangifer* before exploring the antiquity of *Rangifer* hunting methods, documenting the strategies used for their capture in prehistory. A common strategy, intercept or ambush hunting, represents the early roots of hunting architecture, an elaboration of old techniques by new means. Hunting architecture, which is the most common method of *Rangifer* hunting historically was likely much more common in the past than preserved in the archaeological record (see **Chapter 3**). Ethnographic cases of the use of hunting architecture by caribou hunters are reviewed, and finally this chapter provides a critic of ethnographic analogy for interpreting the archaeological record of *Rangifer* hunters.

***Rangifer* Natural History**

Reindeer and caribou are an ice age remnant species. In the Pleistocene, *Rangifer* were found throughout Eurasia from Northern Iberia to Southern Russia, and in North America as far south as Alabama (see below). The modern distribution of these animals is circumpolar, and extends from 5° E to 14° W, and 46 to 80° N (Geist 1998). They thrive in cold arctic tundra and subarctic taiga environments. *Rangifer* feed on soft plant matter, such as lichens and mosses (Geist 1998; Yesner 2000) but their diets are seasonally and geographically variable and may include willow buds, shoots, and leaves, herbaceous plants, grass, sedge roots, and fungi (Spiess 1979:31).

It must be kept in mind that Pleistocene *Rangifer* populations, behaviors, and life cycles may have differed from extant caribou. Certainly caribou/reindeer populations were much larger in prehistory and their ranges much wider (see below, Geist 1998:335). Direct methods for

reconstructing paleoenvironments and *Rangifer* biogeography are essential for archaeological investigations (Britton et al. 2011:177; Spiess 1979). However, in general some degree of behavioral, ecological, and biological similarity exists between modern caribou and their Pleistocene ancestors (e.g. Blehr 1990), making a detailed knowledge of the species essential for understanding their role as a human resource. Indeed, despite tremendous variability within the species, all reindeer and caribou from the Pleistocene to the modern era are considered a single species (Kurtén 1968:171).

The species *Rangifer tarandus* comprises caribou in North America and Greenland and reindeer in Eurasia. In general, caribou refers to the North American varieties of the species while reindeer refers to the Eurasian animals including those that were eventually domesticated. Since reindeer and caribou can breed successfully and produce reproducing offspring they are considered a single species (Yesner 2000) and will generally be referred to as *Rangifer* in the following discussion.

Subspecies distinctions have been proposed due to geographic isolation of certain populations and different environmental conditions in their territories (Kenyon 1997:8). These two factors produce broad, regional variety in size, pelt coloration, antler morphology, etc. but this variation is likely environmental rather than genetic (e.g. Cronin et al. 2005; Flagstad and Røed 2003). Banfield's (1961) taxonomy is generally used and recognizes nine extant subspecies (but see Flerov 1952; Geist 1998; Heptner et al. 1961 for other taxonomies). Some distinctions can be made between (1) woodland varieties (e.g. *Rangifer tarandus caribou*, *Rangifer tarandus fennicus*), which occupy wooded, temperate areas, can be more sedentary, and congregate in smaller numbers; (2) tundra varieties (e.g. *Rangifer tarandus groenlandicus*, *Rangifer tarandus tarandus*) which are more gregarious, aggregate and migrate in large numbers

over vast distances and have specific adaptations such as splayed hooves to reflect these behaviors, and; (3) island or mountain varieties (e.g. *Rangifer tarandus terraenovae*, *Rangifer tarandus osborni*) which may be dwarfed or have other specific characteristics brought on by these restricted environments (Geist 1998).

Archaeologists have attempted to use caribou subspecies for understanding prehistoric herds and hunter-gatherer adaptations. Within the nine extant subspecies of *Rangifer*, two of these found in North America have had the most influence on archaeological interpretations, barren-ground (*Rangifer tarandus groenlandicus*) and woodland (*Rangifer tarandus caribou*). Subspecies identification has been important since behaviors, specifically group size and migration patterns, are often thought to differ a great deal between modern woodland and barren-ground caribou subspecies (Bergerud et al. 2008). Therefore, identification of either subspecies has been used to make inferences concerning hunter-gatherer subsistence strategies and mobility regimes (e.g. Carr 2012; Deller 1976, 1979; Peers 1985; Storck 1982). Likewise, subspecies have been used to infer paleoenvironments since modern subspecies generally have different environmental preferences, giving rise to “barren-ground” or tundra caribou vs. “woodland” or forest classifications (e.g. Cleland 1965:351). However, *Rangifer* as a species is extremely variable, and skeletal morphology and behaviors differ a great deal both between and *within* subspecies.

Overall, behavioral and morphological plasticity is a hallmark of animals living in periglacial or arctic ecological zones, and *Rangifer* are no exception – large woodland varieties can become dwarfed in island settings, and individuals from the same herd transplanted in different environments can grow to very different sizes (Klein 1970; Reimers 1972). *Rangifer* is the only deer where both males and females carry antlers, and variation in antler morphology is

due to differences in sparring and foraging behaviors between different populations of caribou (Geist 1998:323). Between woodland and barren-ground caribou for example, woodland antlers are on average larger and less palmate, have greater proximal development, flat and short beams, and bez tines that are located well above the brow tines primarily for practicing harem defense, while barren-ground caribou form tending bonds with individual cows and have antlers designed for foraging over defense (Geist 1998:317, Fig 12-1, 331). In addition, female barren-ground caribou retain their antlers in order to dig foraging craters for their calves, and to defend these craters from male yearlings (Geist 1998:317). While antlers are often used to identify subspecies due to such broad morphological differences between woodland and barren-ground forms (Figure 5.1), extensive overlap in size and shape makes identifications of fragments tentative at best (e.g. Banfield 1961:24; Bubenik 1975; Goss 1980; Spiess 1979:35).

Figure 5.1. Barren-ground (*left*) and woodland (*right*) caribou antlers to scale (scale bar is 20 cm). Zoological specimens 63246 and 124573 from the University of Michigan, Museum of Zoology, Ann Arbor (see also Lemke 2015b:280, Figure 4).



In addition to morphological variability, behavior is highly variable across *Rangifer*. For example, while woodland caribou tend to be more sedentary than long distance migrating barren-ground varieties, some caribou that are *morphologically* assigned to the woodland variety are known to migrate great distances (e.g. from the forest to tundra about 200 miles each way (Spiess 1979:31)). Likewise, some barren-ground caribou splinter off from large migratory herds and become sedentary (Geist 1998:333; Pasda 2014; Spiess 1979). These are only a few examples of variability that exists in *Rangifer* which makes strict correlations between subspecies and certain traits problematic if not impossible (e.g. Bergerud et al. 2008; Klein 1970; Reimers 1972; Spiess et al. 1985). Importantly, rather than being genetically determined, these behavioral and morphological differences arise in response to local environments (Flagstad and Røed 2003; Geist 1998:317, Figure 12-1). Thus, the variability in *Rangifer* seems to have evolved as adaptive responses to postglacial climate change (Flagstad and Røed 2003), and behavioral differences are so clearly mediated by local environments that barren-ground and woodland varieties and other “sub-species” are better referred to as ecotypes (Bergerud et al. 2008:34; Lemke 2015b; Spiess et al. 1985).

Life Cycle and Migration

Caribou in general are gregarious herd animals that are cursorial, i.e. morphologically designed to run, with fairly short legs for their body size. Individual animals can average 20 km of movement a day (Heuer 2008). They combine speed and endurance to avoid predators, primarily wolves, but also humans, bears, wolverines, and lynx (Gambaryan 1974; Geist 1998:328). They also partake in some of the longest distance migrations of any known land

mammal (Geist 1998), and are excellent swimmers, often crossing lakes rather than going around them (see below).

Caribou tend to aggregate in bands of dozens of animals or herds of thousands. Herds are comprised of several bands with most of the animals being born in the same spring calving area that is used by the majority of female animals in the herd (Spiess 1979:64). Bands are smaller groups within which the age and sex composition and geographic location varies seasonally. There are seven basic and composite types of bands: cow; bull; subadult; juvenile; cow-juvenile; cow-juvenile-bull; and bull-cow-juvenile (See Miller 1974 for detailed descriptions).

Rangifer migrations take place bi-annually in the Fall and Spring to and from calving grounds. These seasonal migrations take place for a number of ecological reasons. First, seasonal migrations limit the impact of large groups foraging on the very delicate plant communities they feed on (Spiess 1979:20). Second, migrations reduce predation by wolves for at least part of year since wolves den in the spring and early summer and cannot travel to follow migrating herds to their calving grounds (Spiess 1979:64).

Migrations to and from calving grounds may move groups between forested and open environments, across tundra, or altitudinally from forest to alpine meadows (Spiess 1979:20). The distance traveled during these migrations varies, from 160 (Kelsall 1968:58; Spiess 1979:79) up to thousands of kilometers (~ 2400 km) (e.g. Britton et al. 2011:177; Burch 1972; White et al. 1980); often traveling between 7-24 km a day, but daily rates can exceed 40 km if the migration is delayed due to snow cover (Fancy et al. 1989:664). Distance of migrations is dependent upon factors such as available forage, insect infestations, and predator avoidance (Heard 1997; Pruitt 1960; Skoog 1968). In general, caribou will migrate longer distances when (1) they live in a broad, ecological zone where preferred summer food areas are far away from

preferred winter areas, and (2), when population pressure forces them to find enough forage (Skoog 1968).

Again, while some ecotypes are assumed to be more migratory than others, e.g. barren-ground vs. woodland, there is no strict correlation between ecotypes and migration behavior. For example, caribou on the Labrador-Quebec peninsula are morphological assigned to the woodland variety but migrate from the forest to tundra and back about 320 km, or 200 miles one way (Spiess 1979:31). Additionally, some tundra caribou move very little as some groups splinter off from larger migratory herds and become sedentary populations. These groups may also adopt behaviors associated with woodland caribou such as harem herding and larger body size (Geist 1998:333; Spiess 1979).

Caribou tend to follow general geographic principles when migrating (Spiess 1979:38):

1. Follow contours in hilly terrain and traverse hillsides rather than move across contours
2. Usually use ridgelines, the lowest passes, and the most gentle slopes when traveling through hilly terrain, although they do occasionally travel steeper terrain (to avoid insects (Peers 1985:33)
3. Travel in narrow lanes in steep areas and spread out in flat areas
4. Follow natural features (e.g. rivers, steep slopes, valleys, eskers, cut banks) for a some distance before crossing them
5. Tend to follow the trails left by other caribou
6. All these principles cause funneling of caribou between or along topographic features that form obstacles.

Table 5.1. Rangifer seasonal round.

| Season | Herd Composition | Primary Activities |
|---------------|------------------------------------|---|
| Fall | Bull-Cow-Juvenile | Rutting/mating (Sept.-Oct.), Fall migration, <i>en masse</i> |
| Winter | Bulls separate from Cows-Juveniles | Small group foraging |
| Spring | Bull-Cow | Spring migration started by females (April) Calf births (June-July) Joined by males, form large herds |
| Summer | Bull-Cow-Juvenile-Calves | Largest herds Grazing for Winter |

Fall

The start, pace, and progress of the autumn migration to and from summer grazing grounds to wintering grounds is largely dictated by the weather. Caribou move slowly and are more dispersed until the weather turns colder and then migration begins quickly. If the weather improves the migration may slow down, halt, or even reverse ¹ (Heuer 2008, see also **Chapter 7**).

Composite bands of bulls, cows, and juveniles are common in this season during the rutting period. Rutting and mating take place between September and October, wherever the herd happens to be during their migration south, and bulls shed their antlers after the rut (**Table 5.1**). The gestation period for caribou is 7.5 months. Similar to calving grounds which are often reused over generations, certain areas traveled during fall migrations, such as water crossings have been documented to be consistently re-used for centuries (Gordon 2003:17). Importantly, in autumn males and females are together and migration is more concentrated than in the spring when males and females migrate separately (Petersen and Johansen 1991:27-28).

¹ This migration behavior is similar to stopover ecology documented for other ungulate species (e.g. Sawyer and Kauffman 2011).

Winter

Smaller groups winter together as larger summer and fall groups disperse. Caribou often browse for lichens on windswept ridgetops in the winter, where the snow cover is lightest (Peers 1985:33). Winter ranges are the most variable (Spiess 1979:20), making hunting during this season difficult and unpredictable.

Spring and Calving

Pregnant cows start the migration northward to calving grounds around April (Peers 1985:33). Composite groups are common during the spring northward migration, which usually corresponds with snow melt in April and May, with bulls and cows traveling together (Miller 1974:39; Spiess 1979:39), although non-pregnant cows and young males drop out and gather in smaller groups south of the calving grounds (Nowak 1999; Spiess 1979:40). Spring calving grounds are the most consistent over time, and different populations have been documented returning to the same area year after year (e.g. Kelsall 1968; Skoog 1968). Calving grounds are usually areas that provide shelter for the calves from wind (Spiess 1979:41) and have limited wolves and insects (Heuer 2008). Most calves are born in the beginning of June.

Summer

Late summer and fall have the largest herds of the year, as bulls rejoin cows and newly born calves (Gordon 2003:20). It is spent grazing to gain energy for the return migration south in the fall. Groups tend to go to low lying areas in tundra environments, such as lake shores, since their preferred foods, i.e. willows and sedges, are abundant in these areas (Peers 1985:33; see

also Johnstone et al. 2002; Person et al. 1980). In addition, cool and windy uplands are also preferred to avoid insects (Baales 1999:70). Spring and early summer are the time of year when insects are most problematic for caribou, and after calving, aggregations move 25 km a day to avoid mosquitos and flies and to forage. At the end of summer/early fall (August and September) they are in the peak condition prepared for winter (see below).

Demography

Caribou populations fluctuate significantly (Spiess 1979:20) and their overall cursorial nature leads to wide-ranging movements and rapid colonization of uninhabited areas, where their populations can increase rapidly until climatic changes, such as the icing of a range, can lead to massive die-offs (Meldgaard 1986; Miller, Russell, and Gunn 1977; Viebe 1967). Area studies throughout the Arctic have documented this process in several herds (see Spiess 1979:40-61).

Sensory Perception

Caribou eyesight is designed for recognizing patterns as a method of predator avoidance. They are able to detect wolf hunting postures and patterns, called a flight release pattern which, when recognized, causes caribou to flee (Pruitt 1960; Spiess 1979:36). This innate pattern recognition is one of the reasons caribou are exploited with hunting architecture such as drive lanes (see below, and **Chapter 3**). Caribou hearing does not seem to be particularly sensitive, but they will avoid human sounds more often on clear, cold, winter days when sounds carry further as opposed to summer when they are less likely to hear and/or avoid sounds such as human voices (Spiess 1979:37). However, due to their curious nature, caribou may also be lured by

certain sounds, such as tapping a rock on sandstone (Gordon 1974). Their sense of smell is highly sensitive since caribou communicate with other individuals through pheromones, and sniff out plant foods under snow, therefore hunters will usually stay downwind (Spiess 1979:37).

Food and Raw Material Value

Very little of caribou lacks food value, including the rumen. Their fat is high in vitamin content and their meat (unlike rabbit) does not have amino acid imbalance which can cause nutritional issues (i.e. protein starvation, Speth 2010; Speth and Spielmann 1983). Their fur is prized for clothing in cold climates as individual hairs are hollow and have insulating properties. Hides are an important resource since they can be used for clothing, kayaks, bedding, tents, and other purposes. Ethnographically, a family of five will need 70-80 hides a year for these different purposes (Spiess 1979:30). In addition, caribou antlers and bones are ideal for making tools (Geist 1998:336; Guthrie 1983). Certain elements, such as the lower limbs (i.e. metapodials, tibiae, radii, and hooves) are poor in meat but have high marrow content (Spiess 1979:23, see also food utility and marrow indices in Binford 1978b; Metcalfe and Jones 1988).

Many of these attributes are seasonally variable, including fat stores, hide quality, and overall nutritional value and taste. For instance, just before the rut, and right after antler growth in the Fall, bulls deposit a layer of back fat up to eight centimeters thick that is prized for its taste and nutritional value; during the rut this fat becomes layered with blood vessels and hormones and has a foul taste (Geist 1998:335-336; see Spiess 1979:28, Fig. 2-2 for the seasonal variation of fat stores for male, female, and juvenile caribou).

During the fall (mid-September to mid-October), animals are in their peak condition, with maximum body weight and fat, and hides and sinews are the highest quality (Blehr 1990:320;

Enloe 2003:24; Reimers and Ringberg 1983; Stefansson 1951:337; Spiess 1979:29).

Additionally, soft calve skins collected in the Fall were used for winter undergarments and socks ethnographically (Simeone 2007:318). Herds are the most concentrated during this time of year (Kelsall 1968), and are therefore less skittish (Morrison 1981:185). For all these reasons, Late summer – early Fall is the most common season for hunting caribou both ethnographically and in the past (see below, e.g. Mcfee 1981:168; Morrison 1981:185, **Chapters 7 and 9**).

Seasonality is therefore a critical variable for understanding caribou exploitation since it influences the availability, predictability, and overall quality of the animals (Bouchard 1953, 1966; Burch 1972; Spiess 1979; Enloe and David 1997:53).

Rangifer as Prey

In addition to their food and raw material value, behavioral traits of *Rangifer* make them an ideal prey resource. Many of these behaviors can be used to predict strategic places and times of the year for hunting. For example, migration routes are often consistent as the same fall migration water crossings and spring calving grounds are reused for centuries. Additionally, the animals are more concentrated during the fall migration and are in their peak condition – resulting in an ideal time for hunting. Lastly, caribou eyesight is designed for pattern recognition and they are innately attracted to straight lines as they are prone to follow natural features such as ridge lines and the hoof prints and trails from other caribou. This innate tendency has been exploited by ethnographic and historic caribou hunters by the construction of drive lanes and funneling features (**Chapter 3**). These behaviors can also be modeled through computer simulation, including migration rules, the specific parameters for calving grounds (e.g. shelter

from wind, wolves, and insects), and the rapid colonization of newly available areas (**Chapters 7 and 9**).

Archaeology of *Rangifer* Hunting

The nutritional and raw material value of *Rangifer*, along with their dense aggregations and relatively easy capture, has made them an important resource for hunters throughout the Northern hemisphere for millennia (Yesner 2000).

Prehistoric Reindeer Hunting in Eurasia

The genus *Homo* has a long history of interaction with *Rangifer*, dating back as far as the Lower Paleolithic in Eurasia. This long record of interaction provides an ideal laboratory for documenting the diversity of reindeer and caribou hunting strategies. There is a general evolution of *Rangifer* hunting strategies over time and space during the Paleolithic.

Availability

From as early as 680,000 years ago (Kurtén 1986), reindeer were among typical cold-adapted Pleistocene fauna such as cave lion (*Panthera spelaea*), woolly rhinoceros (*Coelodonta antiquitatis*), woolly mammoth (*Mammuthus primigenius*) in Eurasia. The species had a wide distribution across Eurasia during the last glacial period, from Northern Iberia to southern Russia, including France, Central and Eastern Europe, and the British Isles (Kurtén 1968:170). They were particularly common between 24,000 – 15,000 cal yr BP (Rankama and Ukkonen 2008).

While the majority of Pleistocene species went extinct soon after the collapse of the mammoth steppe biome, *Rangifer* were more resilient. The taxon displayed greater plasticity in terms of diet and paleoenvironmental range when most others (e.g. mammoth, woolly rhinoceros, cave lion, etc.) vanished. For example, in Northern Europe during the early Holocene reindeer were able to coexist with typical temperate species such as red and roe deer (*Cervus elaphus*, *Capreolus capreolus*) (Sommer et al. 2008, 2009).

While more tolerant than others, the species did experience a drastic decline in population and local extinction in certain regions during and after the Pleistocene-Holocene transition from 25,000 – 9,000 cal yr BP, (see Sommer et al. 2014, Table 1). For example, reindeer disappear from Hungary, Romania, and Moldova after the Last Glacial Maximum (Sommer et al. 2014:302). In Northern Iberian Peninsula, primarily in the Cantabrian region reindeer remains have been found at 55 sites dating between 42,000 – 10,000 cal yr BP (with some evidence of active hunting at Santa Catalina (Gómez-Olivencia et al. 2013:14, 17 Fig. 13)). Reindeer in this region are likely the result of climate-induced range expansion and only moved into this region during cold periods (Sommer et al. 2014) and/or during migrations (Gómez-Olivencia et al. 2013). The species was extirpated from this region after 10,000 cal yr BP.

As glaciers retreated during the Late Pleistocene, reindeer herds expanded northward in newly available territories between 12,000 – 11,000 cal yr BP (Aaris-Sørensen 1992; Liljegren and Ekström 1996). While reindeer bones are commonly found in Early Holocene Mesolithic sites, their numbers appear to have dropped significantly by this time as herds definitely retired to the north (Kurtén 1968:170). Reindeer persisted longer in the north, as late as the early Holocene in Northern Europe and Southern Scandinavia (Sommer et al. 2014) (**Table 5.2**). After ~ 9,000 cal yr BP, wild populations more or less approximated their modern geographic

distribution (**Figure 5.2**). For example, ancestors of European Pleistocene reindeer expanded into their modern Finland habitats around 9,000 cal yr BP, others migrated into the area from Siberian refugia around 7,000 cal yr BP (Rankama and Ukkonen 2008). Significantly elk populations expanded at the beginning of the Holocene in Northern Europe (e.g. Aaris-Sørensen 1992; Geist 1998) and likely competed with *Rangifer* for browse and territory – further limiting *Rangifer* population growth.

Table 5.2. Local extinction of Pleistocene reindeer.

| Region | Region/Countries | Local Extinction | Reference(s) |
|--------|---------------------------|------------------------------------|---|
| Europe | Hungary, Romania, Moldova | Last Glacial Maximum | Gómez-Olivencia et al. 2013 |
| | Iberian Peninsula | Early Holocene (~11,000 cal yr BP) | Sommer et al. 2014 |
| | Germany | Early Holocene (~11,000 cal yr BP) | Bratlund 1996; Sommer et al. 2014 |
| | British Isles | Early Holocene (~11,000 cal yr BP) | Coard and Chamberlain 1999; Sommer et al. 2014 |
| | Southern Scandinavia | Middle Holocene (~8,500 cal yr BP) | Aaris-Sørensen 1992; Aaris-Sørensen et al. 2007; Björck et al. 1996; Sommer et al. 2014 |

Importantly for considerations of prehistoric hunting strategies, Pleistocene *Rangifer* are assumed to migrate, and behave generally similar to modern *Rangifer* (e.g. Blehr 1990:332; Thacker 1997:87). For example, prehistoric reindeer were large and migratory, and most likely had mass breeding events and close synchrony of calving like modern barren-ground caribou (e.g. Bouchard 1966; Delpech 1983; Geist 1998:335; Pike-Tay and Bricker 1993). It is assumed that similar to reindeer and caribou today, that Pleistocene reindeer had two annual migrations (Bahn 1977; Weniger 1982) but that prehistoric populations were much larger (Gordon 1988; David and Enloe 1992; Enloe and David 1997).

Rangifer are an ideal case study for examining broad changes in human hunting and processing strategies over time. The species was a common and consistent prey resource in

Eurasia beginning in the Lower Paleolithic and can be used to investigate changes in hunting strategies from our early human ancestors to modern humans.

Figure 5.2. Primary Eurasian prehistoric reindeer hunting sites mentioned in the text.



Earliest Occurrence

Rangifer hunting is first documented in Eurasia, where glacial climates provided ideal habitats for these animals. The earliest evidence of the species being utilized is over 500,000 years ago at Caune de l'Arago, near Tautauval, France (de Lumley et al. 1984).

Caune de l'Arago Cave is in southern France, 25 km away from the Mediterranean Sea. Prehistorically the cave would have provided shelter as well as an advantageous viewpoint situated 80 meters above a valley. The cave contains prehistoric archaeological deposits dating from 690,000 – 100,000 years ago, with over 20 levels of discrete Lower Paleolithic *Homo*

erectus occupations. The lithic technology is distinctly Acheulean, with characteristic handaxes (Barsky 2013).

Lower levels in the cave are dominated by accumulated bones that appear to be the result of carnivore activity; in these levels (M, N, and O) stone tools are rare, cutmarks are limited, and carnivore gnawing marks are common. Later occupations (Layers F, G, J, and L) in the cave belonging to *Homo erectus* are indicated by abundant stone tools, and faunal remains with diagnostic cutmarks and conchoidal fractures (Rivals et al. 2004). Faunal remains in these layers are dominated by argali (*Ovis ammon antiqua*), musk ox (*Praeovibos priscus*), red deer (*C. elaphus*), fallow deer (*Dama cf. clactoniana*), and reindeer (*Rangifer tarandus*) (Rivals et al. 2004).

Reindeer remains with diagnostic cutmarks and conchoidal fractures indicative of marrow processing are associated with the *Homo erectus* occupations (Rivals et al. 2004). These animals seem to have been hunted nearby and transported whole to the cave ² for butchering and consumption (Magniez et al. 2011). Detailed zooarchaeological analysis has been completed for two occupation layers and reindeer hunting patterns reflect change over time.

In the older occupation, Layer L (570,000 – 530,000 cal yr BP, MIS 14), pollen provides evidence for a cold and dry climate with steppe vegetation (de Lumley et al. 1984). The zooarchaeological assemblage is dominated by reindeer with few remains of bighorn sheep (*Ovis ammon antiqua*) and red deer (Magniez et al. 2011). Reindeer hunting took place during late autumn/early winter on large groups consisting of males, females, and calves. Complete or

² In terms of transportation costs, adult female reindeer weigh ~220 lbs. and adult males weigh ~260 lbs.

nearly complete carcasses were brought back to the cave and were primarily processed for meat (Rival et al. 2004; Magniez et al. 2011).

Later, Layer G (480,000 – 400,000 cal yr BP, MIS 12), reindeer are found with several other ungulate species including horse, elk, and bison among others. In this layer, reindeer remains appear to result from several opportunistic hunting events where a few individuals were taken at different times of year. As in the earlier occupation, nearly complete animals were transported to the cave for meat and marrow consumption (Magniez et al. 2011).

The patterns discovered at Caune de l’Arago Cave indicate that *Homo erectus* was the first early human ancestor to intensively hunt and process reindeer, taking advantage of their high marrow content and herding behavior. The proportions of utilized animals in the cave of all the artiodactyl species, including reindeer, are similar to the proportions in natural populations, therefore the strategy is considered to be opportunistic. Additionally, a wide variety of animals were hunted, even in Level L traditionally considered to be represent specialized reindeer hunting (Barskey 2013). Therefore, despite intensive use of reindeer, hunting strategies appear to be opportunistic rather than selective or specialized during the Lower Paleolithic (Rivals et al. 2004).

Middle Paleolithic – Neanderthals

Middle Paleolithic exploitation of reindeer provides the earliest solid evidence of *seasonal* specialized hunting. Significantly, specialization does not necessarily imply selective behavior such as a preference for certain sex or age categories (Rivals et al. 2004), but these two strategies are often combined. For example, reindeer exploitation in the Middle Paleolithic

becomes both seasonally specialized and selective, with a focus on adult individuals of that particular taxon.

Neanderthals have been traditionally characterized as big-game hunters but more recent evidence indicates varied subsistence pursuits and broad diets as early as 125,000 – 250,000 years ago. For example, remains of fish, birds, and plants are present in the Neanderthal occupation of Payre, near Ardeche France alongside large terrestrial herbivores (Hardy and Moncel 2011). While this suggests that Neanderthal diets were diverse and likewise subsistence pursuits were varied, there is also evidence of specialized and selective reindeer hunting strategies (Gaudzinski 1996).

Salzgitter Lebenstedt in Northern Germany represents the northern most extreme Neanderthal occupation. The site is situated on the northern slope of a small but steep river valley, which joined a wide, flat glacial valley. Deposits are Middle Paleolithic in age, with a large lithic assemblage of handaxes, scrapers, and Levallois flakes (Tode 1953).

Paleoenvironmental reconstructions indicate an arctic setting during the early Weichsel glacial period OIS 5-3 (58,000 – 50,000 ¹⁴C yr BP). The site is well known for reindeer remains which dominate the assemblage.

Large groups of reindeer were hunted at the same time, with an MNI of 86 individuals all taken in the autumn. This evidence suggests that Neanderthals were targeting reindeer at their peak time of year, specifically in September-early October (Gaudzinski 2006:143-144). During this time, reindeer were most likely migrating to their wintering grounds, and herds would be mixed with females, males, and subadults. This natural population is represented in the faunal assemblage at Salzgitter Lebenstedt. Therefore while the hunting is not selective in the

traditional sense (i.e. focusing on a particular age/sex subset of the population), it *is* selective in terms of the time of year.

In addition to this seasonally selective hunting at Salzgitter Lebenstedt, the site is also one of the best examples of systematic and routinized processing of game during the Middle Paleolithic. There is evidence of two levels of selection, first for adult animals, and second for marrow rich elements. Butchering evidence reveals both meat consumption and marrow processing. Adult animals were clearly preferred over younger individuals at this processing stage, and during marrow processing, marrow rich bones were disproportionately selected compared to poorer marrow elements (Gaudzinski and Roebroeks 2000, but see Munson and Marean 2003). Both the systematic and selective processing of reindeer at Salzgitter greatly resembles Upper Paleolithic processing of reindeer (Gaudzinski 2006; Gaudzinski and Roebroeks 2000:510), and the site clearly indicates both specialized hunting (i.e. reindeer hunting in the autumn) and selective processing (i.e. a focus on adult animals, and high quality marrow elements) (Gaudzinski and Roebroeks 2000; see also Rivals et al. 2004).

In addition to the faunal evidence, the geographic position of the Salzgitter, adjacent to a major river valley and broad plain, is well suited for hunting reindeer (Gaudzinski 2006:144; Spiess 1979). These areas are especially strategic during migrations when reindeer tend to follow rivers for some distance before crossing them (see above). Knowledge of this aspect of *Rangifer* behavior and the ability to predict and use these locations as successful hunting sites was clearly practiced by Neanderthals.

Indeed, reindeer zooarchaeological remains from several other sites provide a strong case that Neanderthals were targeting reindeer in their peak time of year, i.e. autumn, and intercepting them at predictable locations during their migration. Isotopic signatures from reindeer remains in

the Mousterian occupation of Chez-Pinaud Jonzac demonstrate that these animals had migrated and it is hypothesized that Neanderthals likely occupied the rock shelter since it was situated close to migration routes (Britton et al. 2011; Niven et al. 2012). Reindeer at the site were hunted during both the fall and spring migrations (Jaubert et al. 2008; Steele et al. 2009).

In addition, the Les Pradelles zooarchaeological assemblage is dominated by reindeer. Reindeer carcasses seem to have been butchered elsewhere and skeletal portions were brought to Les Pradelles. The reindeer appear to have been killed during the autumn, again, an ideal time of year since they can be targeted “en masse” and meat surpluses may be stored for the coming winter (Driver 1990). Despite a lack of physical storage facilities dating to the Middle Paleolithic, evidence often used to indicate storage at later Magdalenian sites (e.g. abundance of filleting cutmarks and an under-representation of ribs (David and Enloe 1992; Enloe 2003)) is present at Les Pradelles (Costamagno et al. 2006). Redundant patterning in seasonality and carcass processing indicates that fall migration interception was most likely a strategic choice of Neanderthals in this region (Costamagno et al. 2006). Such strategic site location in the Middle Paleolithic at all three sites is very similar to later, Late Glacial reindeer hunting camps in Germany, such as Meiendorf and Stellmoor (Bratlund 1996; Tode 1953) (see below).

Significantly, Middle Paleolithic reindeer hunting by Neanderthals demonstrates a sophistication often presumed to only be found in “modern” humans. Evidence for a seasonal focus of a particular animal at the peak time of year and selective butchering and processing behaviors is found at a number of sites. Furthermore, seasonal surplus of meat, as well as storage and sharing are likely present in Neanderthal and other early human societies (see also Stiner et al. 2009). Many of these behaviors are presumed not to exist simply because these sites and assemblages belong to Neanderthals, and this pretext often precludes obvious interpretations of

faunal assemblages and site locations indicating intercept hunting, selective processing, communal hunting, and storage – but these ideas are changing (e.g. Costamango et al. 2006; Gaudzinski and Roebroeks 2000). Similar to the idea that Neanderthals were incapable of big-game hunting (e.g. Binford 1984, 1985, 1987), the recognition of Neandertals as sophisticated hunters (and cultural humans) will eventually take place (Speth 2004). Along these lines, reindeer hunting techniques are an ideal case study for further investigating these ideas as many aspects of reindeer hunting in the Upper Paleolithic were already practiced by Neanderthals, such as strategic interception hunting (e.g. Boyle 1996; Burke 1995; Enloe 1993; Jochim et al. 1999; White 1985).

Upper Paleolithic

The Upper Paleolithic in Eurasia is the initial time period represented by anatomically and behaviorally modern human hunter-gatherers. During the Last glacial maximum at 18,000 cal yr BP there is evidence of vast diversification in cultures, weaponry, site locations, and general subsistence strategies. In terms of reindeer exploitation, many Upper Paleolithic groups and most especially Magdalenian populations in Western Europe have traditionally been viewed as specialized reindeer hunters. The following review of reindeer hunting moves forward through time across the Upper Paleolithic and different regions in Eurasia.

Table 5.3. Upper Paleolithic chronology and primary phases.

| Period | Phase | Age (cal yr BP) |
|-------------------|---------------|------------------------|
| Upper Paleolithic | Gravettian | 29,000 – 22,000 |
| | Pavlovian | 29,000 – 25,000 |
| | Solutrean | 22,000 – 18,000 |
| | Magdalenian | 18,000 – 10,000 |
| | Hamburgian | ~15,000 |
| Epipaleolithic | Ahrensburgian | 13,000 – 11,000 |

Upper Paleolithic Reindeer Hunters in Russia (40,000 – 12,000 cal yr BP)

There are two sites which date the earliest occupations in Siberia, Mamontovaya and the Yana RHS site, both of which include reindeer remains. Mamontovaya produced several lithic flakes, a side-scraper, and a biface not diagnostic of any particular period. In fact they show similarities to both Middle Paleolithic Mousterian technologies as well as early Upper Paleolithic assemblages. With dates between ~43,000 – 39,000 cal yr BP (40,000 – 35,000 ¹⁴C yr BP), the occupation of Mamontovaya could have been produced by either Neanderthals or modern humans. Paleoenvironmental reconstruction during the occupation of Mamontovaya indicates a treeless steppe dominated by herbs, grasses, with local strands of willow (*Salix* sp.) along the river banks. The Yana RHS site in Siberia is dated to ~31,000 cal yr BP (28,000 ¹⁴C yr BP). These sites represent the oldest evidence of human habitation north of the Arctic Circle before the Last Glacial Maximum (Basilyan et al. 2011; Pavlov, Svendsen, and Indrelid 2001; Pitulko et al. 2004). While mammoth bones dominate the zooarchaeological assemblages at both sites, woolly rhinoceros, bison, horse, wolf, bear, and reindeer bones were also recovered (Basilyan et al. 2011; Pavlov, Svendsen, and Indrelid 2001).

Similar to Mamontovaya and Yana, reindeer are found in Upper Paleolithic faunal assemblages across Russia. Reindeer are commonly found among mammoth (*Mammuthus primigenius*), horse (*Equus* sp.), steppe marmot (*Marmota bobac*), and hare (*Lepus* sp.) (Abramova 1983:94; Guslitzer and Pavlov 1993:178; Soffer 1985:87); as well as arctic fox (*Alopex lagopus*) and wolf (Kornitez 1962; Kornitez et al. 1981; Pidoplichko 1969; Polikarpovich 1968; Shovkoplyas 1965; Vereschagin 1971). Between 15,000 – 12,000 cal yr BP, different reindeer hunting strategies occurred on either side of the Ural Mountains – with

opportunistic hunting in the west on the Central Russian Plain and intense reindeer exploitation toward the east in Siberia.

On the Central Russia Plain, mammoth bones dominate faunal assemblages and hunter-gatherers in the region built long-term, substantial mammoth bone dwellings, such as at Mezhirich and Indinovo I. The role of reindeer among other species, as well as hunting or butchering practices, are difficult to reconstruct for the central Russian Plain since little detailed zooarchaeological information is published. Indeed, many reindeer faunal remains are antlers, which could be shed from both males and females and do not indicate hunting per se (Klein 1973; Pidoplichko 1969; Shovkopyas 1965). However, in a few cases zooarchaeological remains are found which suggest active hunting, e.g. at the Mezin site. In addition reindeer remains from Mezhirich (well-known for its mammoth mandible houses) indicate these animals were hunted during the fall (Kornietz et al. 1981).

The remains of juveniles reindeer are often absent from archaeological sites on Central Russia Plain, which has been used to suggest that this region was only occupied by reindeer during the winter months in between migrations (Pidoplichko 1969; Verechagin 1971, 1977, 1979). A similar case has been made for the Ukraine (Cohen 1997). However, the absence of juvenile faunal remains may be reflecting natural taphonomic processes as these bones are more susceptible to density-mediated attrition (e.g. Grayson 1989). In general, reindeer seem to be hunted primarily in the north of this region (Soffer 1985:285), but they were not the sole or most important food resources. Instead Upper Paleolithic foragers seem to have generalized diets including both small and larger mammals with opportunistic hunting of reindeer when they migrated into the regions where hunter-gatherers lived more permanently (Soffer 1985:293).

In contrast, sites in Siberia are dominated by reindeer and prehistoric peoples in this region constructed ephemeral occupations/dwellings, such as the site of Kokorevo I. At Kokorevo, reindeer comprised 89% of the faunal assemblage and no mammoth bones were recovered. Two contemporary sites close by are also dominated by reindeer, Novoselovo VI (98%) and VII (95%). Kokorevo appears to have seasonal surface dwellings with central hearths similar to the French Upper Paleolithic reindeer hunting site of Pincevent (see below) (Abramova 1993).

Likewise, sites along the Dnestr River in Moldova are dominated by reindeer, with some hare (23,000 – 10,000 cal yr BP). It is hypothesized that large reindeer herds migrated north of the region during the summer, but were hunted locally during the fall, spring, and winter along migration routes near the river. It is presumed that Late Paleolithic hunters remained in the region, targeting locally available bison and horse during the summer, and reindeer the rest of the year. Reindeer of all ages are present in the zooarchaeological samples, and appear to have been transported back to sites both as whole carcasses and dismembered parts. It has been hypothesized that reindeer were likely hunted with mass surrounds using fire to drive animals toward large numbers of hunters (Borziyak 1993:69). Additionally, site locations in the region suggest the use of geomorphological features such as precipices and water barriers as strategic intercept points for migrating reindeer. Reindeer were clearly an important and major resource for hunter-gatherers in Siberia. In addition to their use for food, reindeer bones and antlers were often used as raw material to make bone knives, points/rods, and other items such as needles for producing tailored clothing (Borziyak 1993).

*Upper Paleolithic Reindeer Hunters in Central Europe (Gravettian and Pavlovian
29,000 – 22,000 cal yr BP)*

Traditional models for reindeer specialization and cultural historical chronologies from Western Europe are often applied to Central Europe (i.e. southern Poland, the Czech Republic, Slovakia, northern Hungary) despite significant paleoenvironmental, cultural, and economic differences between these two regions (Thacker 1997).

Despite the overall poor organic preservation and a limited number of excavated and dated sites from the Late Pleistocene, reindeer bones have been recovered from a number of Upper Paleolithic sites in central Europe (Thacker 1997). Reindeer are often not the dominate species, and are instead found in mixed assemblages with mammoth, horse, arctic fox, and hare. Importantly however, reindeer were used more often than traditionally assumed by Eastern Gravettian and Pavlovian groups, while mammoth hunting during to these time periods is most likely overemphasized by archaeologists (Thacker 1997:92).

A few sites in northern Hungary have faunal assemblages dominated by reindeer bones. The open air sites of Pilismarot and Esztergom appear to be seasonal reindeer hunting camps (Dobosi 1991). These sites are strategically placed along likely migrations routes as they are positioned on ridge lines and hilltops (Dobosi 1991:199).

Compared to sites in Siberia or Western Europe there is little evidence for intensive reindeer hunting in the central European Paleolithic. While interception hunting is likely, the available evidence thus far cannot distinguish between human groups anticipating herd movements of reindeer, or people taking advantage of opportunistic encounters in a territory in which they were already living (Thacker 1997:96). However, Gravettian sites in Hungary

provide the best evidence of intercept hunting in that they seem to be strategically located similar to sites dating as far back as the Middle Paleolithic.

Similar to Siberia, bone and antler tools made of reindeer are common in central Europe within the context of the general increase in osseous technology in the Upper Paleolithic (e.g. Svoboda 1993). Reindeer bones are particularly well-suited for bone technology since both sexes carry antlers (Thacker 1997). The larger proportion of organic bone and antler tools in the Upper Paleolithic, and the high quality antler of reindeer may have had some influence on a hunting preference for this species (Albrecht 1977; Knecht 1993; White 1982).

L'age du Renne in Western Europe (Magdalenian 18,000 – 10,000 cal yr BP)

The Magdalenian period is a late Upper Paleolithic period in Western Europe, spanning from Portugal to Poland at its maximum extent. Magdalenian lithic technology has several phases including a blade technology as well as the later emergence of a microlithic component. Later Magdalenian technologies have a large portion of bone and antler items, most notably harpoons. These groups are considered to be the populations which re-occupy northwest Europe after the Late Glacial Maximum (see Jochim et al. 1999). Portable art and cave art are also particularly common and highly developed during the Magdalenian, including the well-known sites of Lascaux and Altamira.

Traditional views of the Magdalenian characterized these groups as specialized reindeer hunters due to the large amount of reindeer bones excavated from the type site and the period was labeled l'Age du Renne accordingly (Albrecht 1979; Bratlund 1996; Burke and Pike-Tay 1997; Lartet and Christy 1875; Mellars 1996; Schuler 1994; Sturdy 1975). This traditional picture has been revised, for while reindeer were an important subsistence resource, Magdalenian

diets were mixed with a variety of other foods including red deer, horse, bison, smaller mammals, birds, fish, and plants (e.g. Britton et al. 2011; Burke 1995; Burke and Pike-Tay 1997; Jochim et al. 1999; Lynch 1997; Peterkin, Bricker, and Mellars 1993; White et al. 1989).

Indeed, a regional synthesis of Magdalenian sites in Southern France reveals that specialized hunting is far from predominant. Less than 30% of sites are more than 80% dominated by one species, including reindeer (Costamagno 2003, 2004). This figure stands in stark contrast to previous figures which calculated that 90% of Upper Paleolithic sites in southern France were dominated by reindeer (Mellars 2004). Indeed, the Middle Paleolithic site of Les Pradelles (see above) has a narrower range of fauna than some Magdalenian sites which were originally held as the standard for specialized reindeer hunting, such as Dufaure (Straus 1995) and Gazel (Fontana 1998; Costamagno et al. 2006).

Instead, the Magdalenian economy targets large herd animals more generally, including reindeer, but also horse, ibex, bovids, red deer, and saiga antelope (Jochim et al. 1999: 137). This type of economy is therefore not a specialized focus on a single taxon but instead on herd animals more generally. Rather than a highly mobile year round, reindeer focused economy *sensu* ethnographic models, Magdalenian groups in Southwest France appear to have occupied certain regions year round with seasonal hunting of reindeer supplemented by locally available resources.

France in general, and southwest France in particular, was a geographic focus of Magdalenian subsistence economies. Many sites in France seem to have been occupied year round or at least for several seasons, with reindeer being hunted in the fall (Enloe and David 1997; Enloe 2003), spring, and winter (Gordon 1988). Across France, there is a bimodal distribution with sites either having large quantities of reindeer (well over 90%) or very little

(less than 20%) (Jochim et al. 1999) demonstrating variability in French Magdalenian reindeer hunting strategies.

At Abri Pataud, reindeer were hunted during winter, early spring, and fall, suggesting that reindeer used the area for wintering grounds, and also traveled through this area during both migrations. The zooarcheological assemblage at Abri Patuad is characterized by small numbers of reindeer of all ages/sexes (males, females, juveniles). Therefore, hunting at the site was not selective for any particular age or sex category. However the MNI is low, which does not suggest massive kills or large scale drives. Hunting methods were most likely either opportunistic or used passive technologies such as snares, pitfalls, or nets which are non-selective in age/sex (Spiess 1979).

Along with Abri Pataud, other sites in southwestern France such as Roc de Combe, la Gravette, le Piage (Mellars 1989:357), and la Flageolet I (Enloe 1993; Grayson and Delpech 1998) do not seem to indicate a specialized focus on reindeer despite high proportions of the species in faunal assemblages (which may be indicative of intense processing of a few individuals). Instead, rather than focal hunting, the abundance of reindeer in Magdalenian sites in this region and time period may be reflecting the high number of reindeer in the environment at the time, as opposed to a selective hunting strategy in which human choice favors this species (Costamagno 2003; Enloe 1993; Grayson et al. 2001).

In contrast, sites in the Paris basin, such as Pincevent and Verberie were clearly focused on reindeer hunting (reindeer comprise over 95% of the faunal assemblages (by MNI) at both sites). Both sites also have redundant patterning in seasonality and butchering which indicate fall migration interception hunting. In addition, reindeer hunting and processing appears to have been cooperative. For example, Pincevent is well known for direct archaeological evidence of meat

sharing as reindeer bones belonging to the same individual were found divided between numerous households at the site (Enloe 2003).

In German Magdalenian sites, reindeer are consistently important, representing an average of 80% of the big-game faunal remains, and appear to be the primary focus of many sites (Jochim et al. 1999). Here, reindeer were also primarily hunted in the fall (Weniger 1982) particularly at large sites where populations seem to be aggregated, with an overall settlement pattern of larger sites in the winter and fall, and smaller sites in the spring and summer.

Many Magdalenian sites are strategically located at entrances of narrow valleys, such as those in France leading up to Massif Central, at areas of high relief, or near water crossing in order to intercept migrating herds (Burch 1991; Burke 1995; Bouchard 1975; Enloe 1993; Jochim et al. 1999:134; Straus 1987, 1993; Thacker 1997:92; White 1985; White et al. 1989). Describing settlement pattern choices during the Magdalenian, Jochim et al. explain, “To be sure, Magdalenian economies included a variety of resources other than herd animals, but the landscape features associated with successful herd hunting appear to have been a powerful pull and determinant of settlement” (1991:134). Therefore, while little is known concerning Neandertal settlement systems, the Upper Paleolithic records in several regions demonstrate that reindeer hunting sites were situated within a wider array of campsites, logistical sites, and other hunting areas (Gaudzinski and Roebroeks 2000:514).

Likewise, in contrast to the early Mousterian/Neanderthal hunting strategies, Upper Paleolithic reindeer hunts are often interpreted to be massive, communal kills where a portion of the excess meat would be stored for later consumption (Bratland 1996:42; Geist 1978:308-310), although physical evidence of storage pits or other storage facilities in the Upper Paleolithic is also limited (but see Gaudzinski and Roebroeks 2000:514 for a discussion of Neanderthal

hunting behaviors). This variability in reindeer hunting strategies, between opportunistic uses (e.g. Southwest France) and intense exploitation with settlement patterns anchored by the species (e.g. Paris Basin, Germany)³, is similar to sites across Russia.

Patterns in Upper Paleolithic Reindeer Hunting

Across Eurasia during the Upper Paleolithic, reindeer hunting strategies were varied. There appear to be two primary strategies which can be situated as two ends of spectrum of exploitation. On one end, reindeer are opportunistically exploited as they appear, either on their winter grounds, or traveling through on their bi-annual migration. This pattern is seen in sites in Southwestern France, the Central Russian Plain, and Central Europe. On the other end, reindeer exploitation was the driving force behind settlement patterns, at least on a seasonal basis, and these animals were taken in large numbers and clearly dominate faunal assemblages. This pattern is likely the result of intercept hunting during both fall and spring, with an emphasis on fall. These intercept hunts were likely carried out by larger groups of people and served as loci for social aggregation and meat sharing. Additionally these massive hunts would have produced surplus meat which was likely stored for the winter season. Sites of this type are common in the Paris Basin, Germany, Siberia, and Hungary. Thus, the range of possible human adaptations for reindeer hunting is considerable, from a logistical strategy intercepting movements of large herds and an opportunistic strategy related to the local availability of reindeer and other faunal

³ There is good evidence that Upper Paleolithic cultures, especially during the Magdalenian period (e.g. Drucker and Bocherens 2004; see also Jochim 1983), also heavily exploited salmon; perhaps a portion of the stream-focused settlement patterns may have been influenced by salmon runs, optimizing both salmon and reindeer harvesting strategies.

resources. Some mix of these two strategies may have been employed on a seasonal basis (see Strock and Speiss 1994).

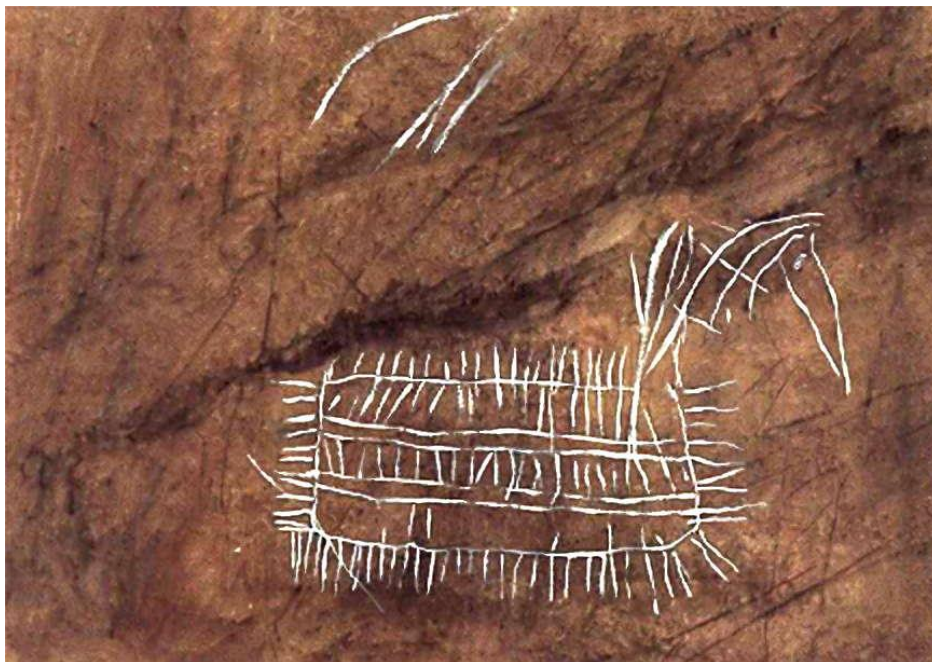
Beyond subsistence and due to their consistent presence in burials and art, it has been suggested that reindeer played an important role in ritual lives and/or shamanistic activities of Upper Paleolithic hunter-gatherer societies (Yesner 2000). Reindeer remains have also been recovered from a number of Upper Paleolithic burials. For example, a reindeer antler was found among lithic artifacts and a Magdalenian secondary burial in a rectangular pit lined with breccia blocks (Pettit 2010:221). Additionally, an adult male secondary interment was covered with a mammoth scapula, tusk, shells, an ivory marionette, and a reindeer antler rod at the site of Francouzská Street, Moravia (Svoboda et al. 2002; Oliva 1996, 2000 a,b, 2005). This burial is Pavlovian in age, and was dated to ~28,194 – 27,463 cal yr BP (23,680 +/- 200 ¹⁴C yr BP) (Pettitt and Trinkaus 2000). Lastly, at the large Pavlovian occupation of Předmostí, in the Czech Republic, a large burial pit with fragmentary remains of ~20 individuals contained faunal remains of mammoth, fox, horse, wolf, bear, wolverine and reindeer (Pettit 2010:195; Svoboda 2008).

Reindeer figure prominently in cave art during the Magdalenian, including Lascaux and Trois Frères. Reindeer antler has been identified in the pigment used to paint Lascaux suggesting antlers were either use to mix paint, or were carved near the pigments in the cave (Chadefaux et al. 2008). Reindeer are also a consistent theme in portable art objects such as batons and carved animal motifs.

It has been suggested that some artwork, such as grid-like symbols (i.e. quadrangles) represent nets, corrals, or fences for hunting (Straus 1993:90) (**Figure 5.3**). For example the dots, lines, and other geometric shapes in such iconic sites such as Lascaux may indeed be hunting

structures (Kehoe 1990). These images may be the oldest known in a long tradition of rock art depicting hunting architecture (see **Chapter 3**).

Figure 5.3. Engraved images in El Buxú cave which represent fences or corral sections (Straus 1993:90). Images from Berenguer 1988.





Late Glacial Hunters in Northern Europe (Hamburgian and Ahrensburgian 15,000 – 11,000 cal yr BP)

At the end of the Ice Age, on the Northern Plains of Europe and further north in southern Scandinavia, Late Glacial hunters targeted reindeer in periglacial environments. Two particular phases are associated with these reindeer hunters, the Upper Paleolithic Hamburgian, and the Epipaleolithic Ahrensburgian. Hamburgian archaeological sites show close affinities with the preceding Magdalenian period, with similar artifact classes and types, and comparable economies (Bratlund 1994 a,b). They have also long been considered reindeer hunting specialists. Likewise, the later Ahrensburgian is considered to represent specialized reindeer hunters (Baales 1999). These characterizations were largely drawn from well preserved faunal assemblages dominated by reindeer at the Stellmoor (Bratland 1990, 1996; Grønnow 1987; Rust 1943) and Meiendorf (Bratlund 1994) sites in Germany (and ethnographic analogs, see above).

Meiendorf is Hamburgian, and Stellmoor has both Hamburgian and later Ahrensburgian components with some mixing (Bratlund 1996). Both sites have evidence of local reindeer hunting supplemented by other resources such as hare, grouse, red fox, wolverine, swan, and geese (Bratlund 1996). Despite this faunal diversity however, both sites are dominated by reindeer (Rust 1962:204-205; Clark 1968:242).

Hunting at Stellmoor, ~11,250 cal yr BP (9810 +/- 100 ¹⁴C yr BP) is similar to the pattern from the Middle Paleolithic site of Salzgitter – with an unselective hunting (i.e. remains for all ages/sexes) but selection against subadults and juveniles during processing. Limb bones were sorted according to marrow quality and poorer bones were discarded (Grønnow 1987). Thus, the physical treatment of reindeer by both Neanderthals and modern humans in this case is very similar (Gaudzinski and Roebroeks 2000).

Similar to both the Middle and Upper Paleolithic periods, Late Glacial hunters targeted reindeer during both of their annual migrations from strategic locations. Stellmoor, Meiendorf, and other sites in Northern Germany are assumed to be special purpose reindeer hunting camps along migration routes (Bokelmann 1979). Numerous unshed male antlers have been used to infer autumn hunting during the migration to wintering grounds at Stellmoor (Sturdy 1975). Ahrensburgian sites in Belgium indicate intercept hunting during the spring migration, e.g. Hohler Stien, Rémouchamps, and Karstein (Baales 1996, 1999:70; Gordon 1988:215; Kierdorf 1992).

Site placement seems to be strategic, either on high ridges for viewing animal movements (e.g. Sølbjerg, Steinbeck, Westerhausen (Petersen and Johansen 1991:25), or along river valleys where herds were likely to cross (e.g. Stellmoor, Meiendorf (Bokelmann 1991; Bratlund 1990, 1991), and most are generally placed in relation to migration routes (Petersen and Johansen

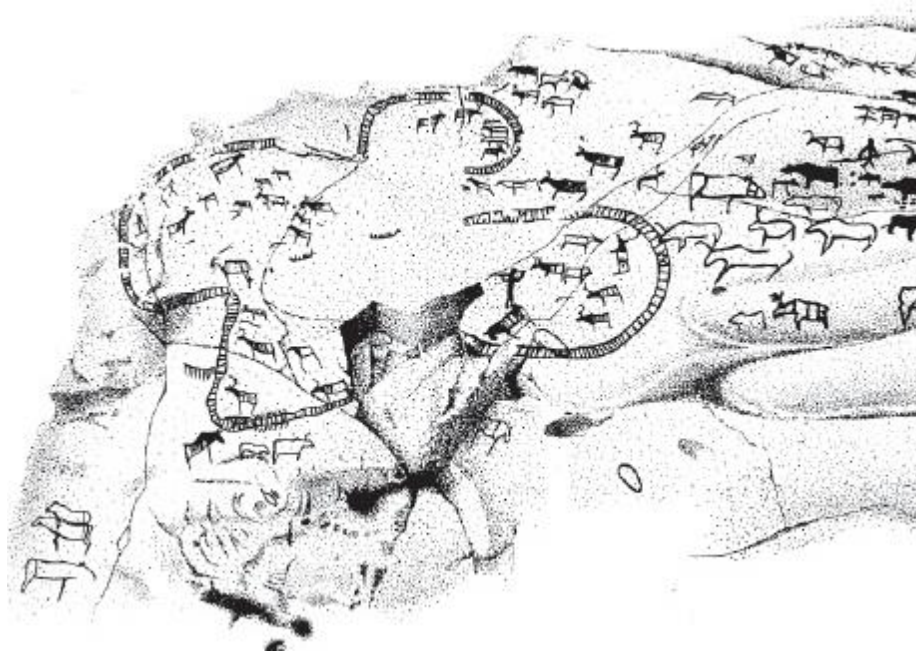
1991:28). The large Ahrensburgian site of Stellmoorhügel appears to be an area where hunters positioned themselves on a small ridge on the edge of valley and targeted reindeer crossing a lake below. The bones of over 600 reindeer are associated with more than 1,000 fragments of arrow shafts (Bokelmann 1991; Bratlund 1991).

During these intercept hunts, entire groups of men, women, and children likely drove animals into natural bottlenecks, such as those near Hohler Stein and Karstein site in Belgium (Baales 1999:70). It has been hypothesized that Ahrensburgian hunters used artificial obstructions, such as drive lanes, to further channel migrating reindeer (Baales 1999:71, Figure 9 caption). Lastly, similar to the Upper Paleolithic, Late Glacial reindeer hunts were most likely situated into a wider array of site types and base camps (Baales 1996).

Tanged-points such as Arhenburgian types of Northwest Europe plains are found in Norway for several thousand years after they disappear on the continent (Indrelid 1975). This pattern has been interpreted to represent the movement of reindeer herds into Northern Europe and likewise the persistence of reindeer hunting adaptations in this region (Hagen 1963). In support of this, many later Mesolithic sites are located close to modern wild reindeer migrations routes, especially in topographic bottlenecks. These are likewise interpreted to be specialized reindeer hunting sites used either by individuals or in communal drives (Bang-Andersen 1989:347; Johansen 1978:109-140; Bang-Andersen 1996:435).

Hunting structures are depicted in Late Mesolithic rock art in northern Norway which features corrals and enclosures. These images date to 5500 – 6000 cal yr BP and are evidence of caribou hunting strategies using constructed hunting features although no physical remains of prehistoric structures have been found (Helskog 1977, 2012) (**Figure 5.4**).

Figure 5.4. Rock art depiction of reindeer hunting corral near Alta, Norway, dated using elevation above sea level to 5500-6000 cal yr BP (Helskog 2012, Figure 10).



Prehistoric Caribou Hunters in North America

Paleoindian Caribou Hunters in the Northeast and Great Lakes (13,000 – 10,000 cal yr BP)

Late Glacial Hamburgian and Ahrensburgian hunters in Northern Europe are contemporary with Paleoindian populations in the Americas. Similar to Magdalenian subsistence economies, Paleoindian hunting strategies, particularly those in the Early Period (~13,000 – 10,000 cal yr BP), have long been thought to be specialized on large terrestrial mammals, primarily mammoth (*Mammuthus*), mastodon (*Mammut*), bison (*Bison* sp.), horse (*Equus* sp.), and caribou (*Rangifer* sp.) (e.g. Surovell and Waguespack 2008, 2009; Waguespack and Surovell 2003). The Paleoindian archaeological record is biased in this direction since it is dominated by

kill sites of large animals (which are more likely to be preserved and discovered) and there is overall poor bone preservation. While some existing faunal assemblages are dominated by large animals, a variety of other animals have also been recovered representing a broad range of species such as deer, rabbits, rodents, turtles, and fish (e.g. Cannon and Meltzer 2004).

Ultimately, Early Paleoindian economies seem to be regionally diverse with an emphasis on different prey species in different areas due to variation in the background plant and animals communities, e.g. proboscidean predation in the Southwest, Plains, and Midwest, bison in the Southern Plains and Southwest, and caribou in the Northeast and Great Lakes (Cannon and Meltzer 2008:7).

The oldest caribou fossil from North America dates to 1.6 million years ago from Fort Selkirk in the Yukon (Harington 1999). Caribou are found throughout Eastern North America during the Pleistocene, as far south as Alabama, Kentucky, Virginia, and Tennessee (Eschelman and Grady 1986; Guilday 1968; Guilday et al. 1975; Kurten and Anderson 1980); although during the Paleoindian period they were geographically more restricted to the Northeast (i.e. Northeast United States and the Canadian Maritimes) and the Great Lakes (See Bergerud et al. 2008 Table 3.1) (**Figure 5.5**). Caribou are thought to be the primary prey species hunted by Paleoindians and Early Archaic peoples in these regions (e.g. Cannon and Meltzer 2004, 2008; Cleland 1965; Funk, Fisher, and Reilly 1970; Gramly 1982; Jackson 1988; Peers 1985; Simons 1997; Spiess, Curran, and Grimes 1985). For the Great Lakes in particular, the specific importance of caribou has been difficult to investigate due to significant changes in ancient lake levels which have obscured or drowned much of the archaeological record of this period (**Chapter 4**). Additionally, due to acidic soils, there is very poor preservation of organic materials in this region (Bergerud et al. 2008; Carr 2012; Lemke 2015b; Storck 2004).

While direct evidence for subsistence economies in general, and caribou hunting specifically is limited, the available evidence suggest significant levels of caribou hunting by Paleoindians in the Great Lakes and Northeast. While caribou were certainly a prey species, the evidence for specialization (i.e. a sole focus on caribou) is scant (Spiess et al. 1998). Most likely, this resource was supplemented with other locally and seasonally available resources such as elk (Ogden 1977:10), beaver (Spiess et al. 1985), hare, and fox (Spiess and Storck 1990; Storck 1988; Storck and Spiess 1994; see also Kuehn 1998). Indirect evidence also exists for the exploitation of mastodons which inhabited the Great Lakes region as late as ~11,217 cal yr BP (9600 ¹⁴C yr BP) (Fisher 1984, 1987; Fisher et al. 1994; Garland and Cogswell 1985; Palmer and Stoltman 1976; see also **Chapter 4**).

Direct evidence for Paleoindian exploitation of caribou comes in the form of faunal remains and blood residue on stone tools. Caribou bones have been recovered from five Paleoindian sites, Holcombe, Bull Brook, Whipple, Udora, and Sheridan Cave ⁴. Each of these sites is discussed further below) (Cleland 1965; Jackson 1990; Redmond and Tankersley 2005:512; Robinson et al. 2009; Spiess et al. 1985; Spiess et al. 1998; Stork and Spiess 1994).

⁴ Dutchess Quarry Caves in New York have produced caribou bones and Early Paleoindian artifacts but the association between these bones and stone tools is debated (Funk et al. 1969, 1970; Guilday 1968; Kopper et al. 1980; Steadman and Funk 1987).

Figure 5.5. Primary North American Paleoindian caribou hunting sites mentioned in the text.



Bull Brook

The Bull Brook site in Massachusetts provides the strongest evidence for large-scale aggregation in the Paleoindian period. The site is attributed to the Gainey/Bull Brook phase of

Great Lakes and Northeast Paleoindians, thought to represent the earliest inhabitants in the region (Curran 1999; Ellis and Deller 1997; Spiess et al. 1998; **Chapter 4**). At this time, the environment around Bull Brook was an open coniferous/deciduous forest (David and Jacobson 1985; Newby et al. 2005). Thirty-six discrete clusters of artifacts are arranged in a large circle and are interpreted to represent a single occupation (Jordan 1960; Robinson et al. 2009). These clusters often have hearths including concentrations of burned bone, with identified caribou and beaver (Byers 1955:274; Spiess et al. 1998:211). Bull Brook is adjacent to a funnel-shaped valley with steep slopes, strategically located to intercept caribou during their fall migrations, perhaps from a now submerged island (Robinson et al. 2009:439) (see also **Chapter 10**).

Bull Brook, as well as other large Paleoindian sites in the Northeast and Great Lakes (e.g. Nobles Pond, Holcombe, and Debert, are presumed to be associated with communal caribou hunting (Ellis and Deller 1997:17; MacDonald 1968:116-120; Spiess 1984:282). Discrete activity clusters/domestic structures (Robinson et al. 2009) like those at Bull Brook were also present at Nobles Pond and Holcombe. Similarly, they are interpreted to be the remains of individual families aggregated to participate in caribou hunts (Cleland 1965; Fitting et al. 1966:81; Seeman 1994).

Udora

The Udora site in southwest Ontario has also been assigned to the Gainey phase of the Early Paleoindian period. Paleoenvironmental reconstructions of Udora indicate a spruce parkland at the time of Paleoindian occupation (Storck and Spiess 1994). It has 11 concentrations of artifacts and debitage recovered from survey and excavation. Seven of these concentrations contained diagnostic Paleoindian lithic materials. A subsurface pit feature was excavated and

contained numerous calcined bone fragments including those of hare (*Lepus* sp.), arctic fox (*Alopex lagopus*), and caribou (*Rangifer tarandus*) (Storck and Spiess 1994). This pit feature may be a cache. The faunal remains identified at Udora suggest a mixed subsistence economy with both large and small mammal hunting and/or trapping (Storck and Spiess 1994:135).

Whipple

The Whipple Site in New Hampshire also belongs to the Bull Brook/Gainey phase. During Paleoindian occupation the site was a spruce parkland near a small pond (Curran 1984, 1987). Similar to Udora, a subsurface feature was excavated containing debitage, burned bone, and charcoal, but rather than being a cache, this feature is interpreted to be a hearth (Curran 1984:9-10). Of 350 calcined bone fragments 15 are cervid, 36 are large or medium mammal and 3 are caribou (Curran 1984:5; Spiess et al. 1985). Numerous radiocarbon dates were run on material from Whipple (**Table 5.4**). Overall, conifer samples averaged ~12,000 cal yr BP (9,550 +/-320 ¹⁴C yr BP) while hardwood samples averaged ~13,500 cal yr BP (11,050 +/-300 ¹⁴C yr BP). Of these two populations of charcoal, the earlier date is assumed to date the Paleoindian occupation (Haynes et al. 1984).

Table 5.4. Radiocarbon dates from the Whipple site, (adapted from Curran 1984).

| Context | ¹⁴C yr BP | Cal yr BP |
|--------------------------------|---------------------------------|-----------------------------------|
| Locus A, Geochron Lab GX-6003* | 8180+/-360 | 10,156 - 8363 |
| Locus C, Geochron Lab GX7497* | 8240 +/-380 | 10,191 - 8382 |
| Locus C, AZ (C-344) | 9820 +/- 450 | 12,658 - 10,228 |
| Locus C, AZ (C-453) | 11,430 +/-395 | 14,439 - 12,554 |
| Locus C, AZ (C-345) | 10,150 +/-815, 10,670 +/-570 | 13,786 - 9554, 13,769 - 10,788 |
| Locus C, AZ (C-454) | 10,885 +/-665 | 14,680 - 10,794 |

* Combined samples from several arbitrary layers, all others are AMS

Sheridan Cave

Sheridan Cave in Ohio is an Early Paleoindian tool cache and small resource extraction site, well known for preserved bone projectile points. In association with Gainey Paleoindian tools, faunal remains have been identified of flat-headed peccary (*Platygonus compressus*), giant beaver (*Castoroides ohioensis*), common snapping turtle (*Chelydra serpentina*), caribou (*Rangifer tarandus*), and many other taxa (see Redmond and Tankersley 2005:512, Table 2). The bone points share many similarities to Upper Paleolithic osseous tools and were perhaps used for hunting caribou (Redmond and Tankersley 2005:523).

Holcombe

The Holcombe site in Michigan is interpreted to be a Late Paleoindian campsite of several families engaged in caribou hunting (see **Chapter 4**). The site is located on the shoreline of a glacial lake and the environment at the time of occupation was spruce parkland (Fitting et al. 1966). Several concentrated areas of finished stone tools are inferred to be dwellings around a central hearth which contained numerous burned chert fragments. A caribou phalanx and other burned bone fragments were recovered from a basin shaped pit feature (Fitting et al. 1966:14). This bone was originally published as belonging to the barren-ground ecotype of caribou (Cleland 1965), but this identification to subspecies has been debated (Spiess 1985:155).

Other Lines of Evidence

In addition to the five sites discussed above which have confirmed caribou remains, several other Paleoindian sites (e.g. Bull Brook, Whipple (Spiess et al. 1985), Sandy Ridge (Jackson 1990:133), Cummins (Jackson 1989; Julig 1985), and Udora (Storck and Spiess 1994)) are likely to contain caribou bones among long bone fragments which are difficult to distinguish between cervids (see Lemke 2015b).

At sites lacking faunal evidence, protein residue and topographic models are used as indirect support for caribou exploitation (Deller and Ellis 1992:215-262; Jackson and McKillop 1991:34; MacDonald 1968:116-134; Storck 1979:73-75). Caribou blood residue has been recovered on lithic tools dating to the Paleoindian period at the Nobles Pond site in Ohio, Cummins site in Ontario, Shoop in Pennsylvania, and Debert and Belmont Nova Scotia (Davis 1991; Hyland et al. 1990; Keenlyside 1991; Newman and Julig 1989; Seeman 1994) (**Figure 5.5**). In terms of topographic models, Debert is interpreted to be a central location of social aggregation and intercept hunting near caribou migration routes on a seasonal basis (Funk 1972; MacDonald 1968:134). Two additional Paleoindian sites in Maine, Vail and Adkins, are also considered to be caribou hunting sites due to their geographic locations (Gramly 1982, 1988). Vail in particular is considered to be an ambush locality for hunting caribou as they crossed a small stream near the site (Gramly 2010).

Significantly, similar to Late Glacial reindeer hunters in Europe, there are hints of built architecture related to caribou hunting in the Paleoindian period. For example, at Parkhill in Ontario and Debert in Nova Scotia, biface production and hunting preparation activities are positioned “up front” in facing valleys and likely represent game monitoring or hunting blinds (Ellis and Deller 2000:235; MacDonald 1968:133). At Parkhill, four loci of biface production are aligned along the Lake Algonquin shoreline and are assumed to be hunting stands where hunters

watched for caribou crossing along the shoreline. Five other loci with more diverse assemblages are located behind them further inland and are assumed to be the campsite area for these hunters. (Ellis and Deller 2000:226,246). Additionally, at the Paleo Crossing site in Ohio post molds are interpreted as the Paleoindian construction of temporary structures, such as wind blocks or lean-tos (Brose 1994), but may be remnants of a corral, snare, hunting blind, or other hunting structure. Lastly, a stone construction at the Adkins site, a large cluster of boulders arranged in a circular fashion, is interpreted to be meat cache (Gramly 1988:15).

The Evolution of Rangifer Hunting Strategies

Human populations have been interacting with *Rangifer* for millennia, and over this vast stretch of time a number of diverse strategies for their capture and exploitation can be documented (**Table 5.5**). It is clear from the above discussion that hunting strategies are not simply random, but are instead conditioned by the structure of ancient herds and paleoenvironment, as well as cultural and social factors. While there are some differences between modern *Rangifer* and their Pleistocene ancestors, certain aspects of their behavior can be taken as uniformitarian assumptions conditioning hunting strategies – primarily their peak condition in the Fall and their migratory behaviors. The conditioning effects of these anatomical realities and innate behaviors influence the success and elaboration of certain hunting techniques through time.

Throughout prehistory, four primary hunting strategies can be identified ⁵: 1) opportunistic 2) passive technologies (e.g. snares, pitfalls, etc.), 3) intercept hunting, and 4)

⁵ Hunting strategies are the primary focus of this discussion, but it should be noted that butchering, consumption, cooking, processing, and bone/antler tool making behaviors are extremely diverse and varied over time.

hunting with the use of built structures. This last strategy presents a fundamental shift in exploitation by actively modifying the hunting landscape and has vast social and economic implications (**Chapter 3**). Herd following is not included as a general strategy as it tends to be a highly specialized situation of historically circumscribed populations (see below).

Table 5.5. The antiquity of *Rangifer* hunting strategies.

| Time Period | Hunting and Exploitation Strategies |
|--|--|
| Lower Paleolithic (<i>H. erectus</i>) | Opportunistic, Local Hunting |
| Middle Paleolithic (<i>H. neanderthalensis</i>) | Migration Intercept Hunting Age/Sex Unselective Hunting (All ages/sex represented) Seasonally Selective Hunting (Autumn/Spring) Selective Processing (Adult animals, Higher Marrow Bones) |
| Upper Paleolithic | Migration Intercept Hunting Age/Sex Unselective Hunting (All ages/sex represented) Seasonally Selective Hunting (Autumn/Spring/Winter) Storage Meat Sharing Game Drives Social Aggregation/Cooperative Hunting Use of Passive Technologies (e.g. snares, pitfalls, etc.)? Use of Hunting Architecture? |
| Epipaleolithic | Intercept Hunting Seasonally Selective Hunting (focus on Autumn/Spring) Selective Processing (Adult animals, Higher Marrow Bones) Use of Hunting Architecture? |
| Paleoindian | Intercept Hunting Social Aggregation/Cooperative Hunting Use of Hunting Architecture? |

From these general strategies, a possible timeline of caribou hunting technique evolution emerges. Intercept hunting began in the Early Paleolithic, with pre-modern humans already understanding and predicting *Rangifer* migrations (*H. neanderthalensis*), and seasonally targeting these herds (*H. erectus*). Similar to anatomically modern humans in Upper Paleolithic and Paleoindian periods, at least a portion of Neanderthal settlement patterns reflect these strategic places on the landscape for interception. Intercept hunting was elaborated in later time

periods, with large campsites located at strategic locations for social aggregation and seasonal hunting that most likely resulted in surplus and shared resources for the coming months. Upper Paleolithic and Paleoindian hunters took advantage of Ice Age environments with large herds of these cold weather adapted species.

Passive Technologies

Passive technologies, such as snares, nets, and other traps, are inherently difficult to discuss in the prehistoric record given that they are often constructed of organic materials that do not preserve. Such hunting technologies are extremely common among ethnographic and historic hunter-gatherers across the globe and likely have a much greater time depth than the available evidence suggests (see Soffer and Adovasio 2010). Passive technologies were likely used by Upper Paleolithic hunters, specifically during the Magdalenian period. Spiess has interpreted the unique zooarchaeological record of reindeer at Abri Pataud site to be the result of passive technologies such as snares or traps, a faunal record with a small number of individuals of all ages suggest some sort of unselective strategy, but also one that does not generate a large number of animals (1979). Drives or corrals were ruled out since they often produce much larger numbers of animals. Likewise, opportunistic/random encounters can be ruled out since these animals were all taken during a single season/brief period of time. Snares and traps would produce an unselective pattern and such faunal assemblages are therefore used as indirect evidence of passive technologies as a hunting strategy – dating as least as early as the Upper Paleolithic.

Intercept Hunting

Intercept hunting of reindeer is a common strategy and has a long history dating back at least to Neanderthals. This strategy targets caribou during their migrations by selecting strategic places on the landscape to ambush large herds. This strategy depends on alternative resources that can be used between migrations and/or storage since caribou could be taken in large enough numbers that meat and bone grease could be stored for later use. It is well known that spring calving grounds and other areas such as water crossings are used consistently by caribou over centuries (e.g. Gordon 2003; Spiess 1979:64-65), providing predictable locations for interception. Early hunters took advantage of strategic landscape features and knowledge of animal behavior to hunt a large number of animals successfully and predictably. Intercept hunts could also be used to target large numbers of animals in their peak condition, specifically in the Fall. This strategy was used as early as the Middle Paleolithic and is well documented for the Upper Paleolithic and later times period (e.g. Carr 2012). The mass harvesting and surplus meat generated from these hunts would be necessary for social aggregations and important for growing hunter-gatherer populations over time. This type of hunting would also require larger number of cooperative individuals, and Blehr has stated that *Rangifer* is a poor prey choice unless they are being hunted with communal techniques (1990).

Hunting Architecture

The use of built hunting structures is an elaboration of intercept or ambush hunting in which humans modify the local environment to increase the yield and predictability of a kill ⁶.

⁶ Hunting architecture is in many ways an elaboration of natural traps, such as Stranska Skala IV, Morvaia (Thacker 1997:90) or Solutré – both natural traps for horses

Hunting architecture in the form of drive lanes, hunting blinds, funnels, or other structures is hypothesized to be used by Upper Paleolithic hunters in Eurasia and some Magdalenian artwork such as grid-like symbols may depict nets, corrals, or fences (Straus 1993:90). Likewise, strategic positions used by Ahrensburgian hunters to target reindeer and Paleoindian hunters targeting caribou were likely elaborated with hunting structures (Baales 1999:71, Figure 9 caption). Late Mesolithic rock art in Norway depicts hunting architecture although no physical remains of these features have been documented (Helskog 1977, 2012).

Hunting architecture was likely much more common in the past but these structures are prone to destruction by subsequent development (**Chapter 3**, Benedict 1996:2-4), likely explaining the absence of physical structures from these early time periods/their late occurrence (Gordon 1990:298). Similar structures, such as fishing weirs and other stationary gear such as branch fences, and basket traps date as far back as the Mesolithic and are only preserved because they are underwater (see **Chapter 6**, Fisher 1994, 1995a). Hunting architecture is the most common strategy for hunting *Rangifer* ethnographically and historically – and there is a wealth of information concerning these structures from such sources.

Ethnographic Cases of *Rangifer* Hunting Architecture

“In the old days it was only rarely that the people lived in a state of plenty. This happened only when they succeeded in driving a flock of caribou into a lake or river, so that they could be killed by the score. All other methods of hunting demanded great exertion, great perseverance, and never yielded anything much. Yet as a rule one could manage to live from hand to mouth if one lived at places where trout fishing and bird catching could be practised. Real depots of food could only be made in autumn”

Rasmussen 1930:41, interview with Igjugârjuk, Caribou Inuit

The arctic region has long captured the interest of the anthropologists. Arguably the harshest environment on the planet, the simple fact that people survive and thrive in the arctic has been a cause for research. Aside from Australia, the arctic is the only other region where wide-scale agriculture was never adopted, and consequently there is a wealth of ethnographic information concerning hunter-gatherers and their lifeways; perhaps more than any other geographic region on the planet.

Rangifer are one of the primary resources used by humans in the arctic prehistorically to the present day (e.g. Fitzhugh 1981:188) and therefore reindeer and caribou hunting practices have been well documented. Both caribou hunting and reindeer herding societies have been studied extensively by anthropologists (e.g. Anell 1969; Chard 1963; Gubser 1965; Hall 1989; Ingold 1980; Irimoto 1981; Krupnik 1993; Lips 1947; Lowie 1923; McClellan and Denniston 1981:337; Nelleman 1970; Simchenko 1976; Spencer 1959:29-30; Rogers and Smith 1981:131-132). Among this larger set of ethnographies, there are several that provide specific information on hunting strategies (**Table 5.6**).

Table 5.6. Ethnographic studies of caribou and reindeer hunters and hunting strategies.

| Geographic Region | Reference(s) |
|--------------------------|--|
| Point Barrow | Murdoch 1892 |
| North Alaska | Gubser 1965; Ingstad 1954; Spencer 1959; Stefansson 1914 |
| Central Arctic | Boas 1888; Balikci 1964, 1970 |
| Keewatin | Arima 1975; Birket-Smith 1929 |
| Greenland | Egede 1745; Nelleman 1970; Steensby 1910 |
| Ungava | Saladin d'Anglure and Vézinet 1977; Turner 1894 |
| Labrador | Taylor 1969; Turner 1894; Wheeler 1930 |

While there is a vast diversity in ethnographically documented *Rangifer* hunting techniques (see Blehr 1990:315; Spiess 1979:103-137), strategies adopting hunting architecture

are the most common. Communal hunts using drive lanes, hunting blinds, and other built features generally involved a large number of hunters and their families constructing stone, brush, or dirt structures to channel caribou into the water, into narrow lands or valleys, nets, or corrals (e.g. Gordon 1990; O’Shea et al. 2014; Riches 1982:33-39; Spiess 1979). Physical remains of hunting structures are well known from the North American arctic, used by late prehistoric Dorset, Thule, and Inuit populations in Alaska, Canada, and Greenland (see **Chapter 3**) and there has been a number of archaeological studies of the remains in these regions (e.g. Brink 2005; Freisen 2013; Grønnow 1986; Stewart et al. 2000, 2004). Ethnographic groups which used caribou fences/drive lanes are listed in **Table 5.7** and many are further elaborated in **Table 5.8**, see also **Figures 5.6-5.8**.

Table 5.7. Early accounts of ethnographic groups using caribou fences/drive lanes, (adapted from Birket-Smith 1929:254-255).

| Group or Locality | Reference(s) |
|--------------------------|--|
| East Greenland | Holm 1914:57; Thalbitzer 1914:405 f |
| West Greenland | Birket-Smith 1924:347 ff |
| Polar Eskimos | Freuchen 1912:145 |
| Baffin Island | Boas 1888:501, 509 |
| Iglulik Eskimos | Rae 1850:44; Hall 1879:248; Mathiassen 1928 c: 59 f |
| Southampton Island | Mathiassen 1927; I 278 |
| Caribou Eskimos | Tyrrell 1897:113 |
| Netsilik Eskimos | Ross 1835:186; Back 1836:341; King 1836: I 285; Simpson 1843:367; Klutschak 1881:119; Schwatka 1884b:543 f |
| Copper Eskimos | Franklin 1823:354; Simpson 1843:266; Stefansson 1914a:58; Jenness 1922:149 |
| Banks Island | Stefansson 1921:640 |
| Mackenzie Eskimos | Simpson 1843:114 f; Pullen 1852:37 |
| Colville Eskimos | Stefansson 1914:198; Rasmussen 1925-26; II 315 f |
| Point Barrow | Simpson 1843; 135 f; Murdoch 1982:265; Stefansson 1914; 385 f |
| Bering Strait | Dall 1870:147; Nelson 1899:119 |

| | |
|-------------------|---------------------|
| Koryak | de Lesseps 1790:260 |
| Upper Yukon River | Simeone 2007:318 |

Figure 5.6. Ethnographic groups listed in Table 5.7.



Table 5.8. Ethnographic descriptions of caribou hunting architecture in North America.

| Group | Hunting Architecture | Reference(s) |
|----------------------------|---|--|
| Tikkerarmiut, Point Barrow | Drive lane and snares: 1.6 km wide, 16 km long, 1 meter high, willow funnel, narrowed to a ride concealing snares, 200 cows, bulls, and calves were trapped, herd was not actively driven | Stefánsson 1914:385-386 |
| Inuit, West Alaska | Converging drive lanes, brush corral, central rope and suspended snares | Gordon 1990:282 |
| Nunamiut, Anaktuvuk | Stone and willow fences 1 meter high, 15-20 meters apart, up to 8 km long, ended in a lake, or a corral with snares; largest aggregations of hunters and animals during fall and spring migrations; corrals made of stone, moss, sod, willow, or ice depending on the season; U-shaped corrals, drive lanes covered with discarded clothing and bits of hides | Anell 1969:12; Gubser 1965:167; Spencer 1959:152 |
| Inuit, Mackenzie Delta | Rows of inuksuit, woman and children drove the herd between inuksuit to bowman and lancers in hunting blinds, or into water; in winter inuksuit rows were elaborated with snow blocks 20-40 meters apart to direct feeding caribou (not actively driven) | Anell 1969:11; Stefánsson 1914 |
| Netsilik | Innuksuit in the spring on ridges leading to lakes, beaters making wolf cries, drove past hunters; 3-5 km of inuksuit 50-100 meters apart | Balikci 1970:37-45; Gordon 1990:285 |
| Caribou Inuit, Keewatin | Single row inuksuit, 10-12 meters, leading to water crossings, made of 3-4 stones piled hip-high, covered with sod, gull skins/wings, and caribou scapulae waving on sticks, archers hidden | Rasmussen 1925:166,172; Birket-Smith 1927:94-95 |

| | | |
|------------------------------------|---|--|
| | between hidden; if caribou were down wind light fires to mask human smell | |
| Sadlermiut, Southampton Is. | Single row inuksuit to drive the herd to hunters, up-ended flat stones for 500 meters to a small lake, early July- early October, hunters in converging inuksuit | Anell 1969: 9; Comer 1910:89 |
| Chandalar and Peel Kutchin | Permanent fall and winter corrals of logs and brush, funnel entrance made of post set 2.5 m apart with twisted and braided rawhide snares, could take up to 400 caribou in one drive | Anell 1969:18; McKennan 1965:31-32 |
| Tanana, central Alaska | Brush and log converging fences into a corral with snares, late Spring and early Fall, snared corrals along migration routes | McKenna 1969:100-101; Whympers 1868:187-188; 214-215 |
| Koyukon (Tena), Yukon River | v-shaped drive lanes with snares, 32 meter long, brush hunting blinds, willows, posts, and windfalls, with snares, drive lane block several mountain ravines where herds migrated in fall and spring | Osgood 1958:38-39 |
| Tanaina, Upper Cook Inlet | Sturdy corrals with snares, horizontal 2.4 meter long poles, placed 40 cm apart, 16 km long drive lanes, converging to 6.4 km, these very large fences may related to poorly defined migration routes and dispersed herds | Anell 1969:22; Spiess 1979:118 |
| Tahltan, Northern British Columbia | Drive lanes with snares along game trails, drive lane leading to the shore/corral on a frozen lake | Gordon 1990:288 |
| Kaska | Drive lanes ending in a corral, 16 meters in diameter, hidden snares, attracted caribou using willow-framed | Honigmann 1954 |

| | | |
|---|--|--|
| | caribou skins on lake ice as decoys | |
| Mountain Indians | Long drive lanes below the timber line to direct caribou in to openings set with snares | Gillespie 1981:332 |
| Mackenzie Flats Kutchin, Northwest Territories | Long drive lanes along the lake shore with snares | Petitot 1899:192 |
| Yellowknife, between Great Slave and Great Bear Lakes | Converging rows of stakes and turf sods leading to a corral with twisted tendon snares, inuksuit, and hunting blinds near natural declivities into which herds were driven by women and children (likely used in late fall); also built tree and brush corrals in the winter, several meters to 2 km in diameter, with narrow entrance, near the entrance fence 15-20 meters apart diverge outward for 3-5 km, herds are actively driven into this corral by an arc of hunters | Blanchet 1964:37; Franklin 1823:8-9; King 1836:155-156 |
| Chipewyan | In the forest, late July, 1.6 km diameter brush corral, in the fall and winter, smaller groups drove herds into converging 2-5 km long brush fences, with snares/poles 15-20 meters apart leading to brush corral, on the tundra, funnel-shaped drive lane with sticks set 15-20 meters apart, women and boys circled behind the herd to drive it into the funnel/toward hidden archers, animals were kept as living larder in corrals south of the tree line and feed 300-400 people during the winter months | Hearne 1795; 1958:121, 206-207, 252-256; Morrison 1981:171-185 |
| Attawapiskat Cree, near James Bay Ontario | Hourglass-shaped corrals for bidirectional caribou drives over March/April snow, | Anell 1969:63 |

| | | |
|-----------------------|---|------------------------------------|
| | willow or spruce funnels 4 meters high for summer and midwinter drives | |
| Abitibi Cree | Drove caribou into water in the fall, and into tree and pole corrals in the summer and winter when the ground was solid | Gordon 1990:290 |
| Beothuk, Newfoundland | Water drives during spring and fall, converging fences leading to lakes and tree and brush corrals at other times, meat and fat storage building near the drive lanes, each 16 m ² , on both sides of the river, fences 1-2 km long, 1 meter high hunting blinds | Howley 1915:30-31; Spiess 1979:124 |
| Netsilik | <i>Taalun</i> , stone constructed hunting blind, a few stones in a line or half circle | Balikci 1964:14-15 |
| Norway | Stone drive lanes 25-50 cm high, stone blinds 60-80 meters high, stone pits | Gordon 1990:292 |

Figure 5.7. Sketch of caribou hunting architecture by Copper Inuit Ikpakhuak, (adapted from Jenness 1922:151). A caribou is being driven toward three archers waiting in hunting blinds, dots and lines represent stone cairns, some elaborated with skin, bird wings, or caribou scapulae.

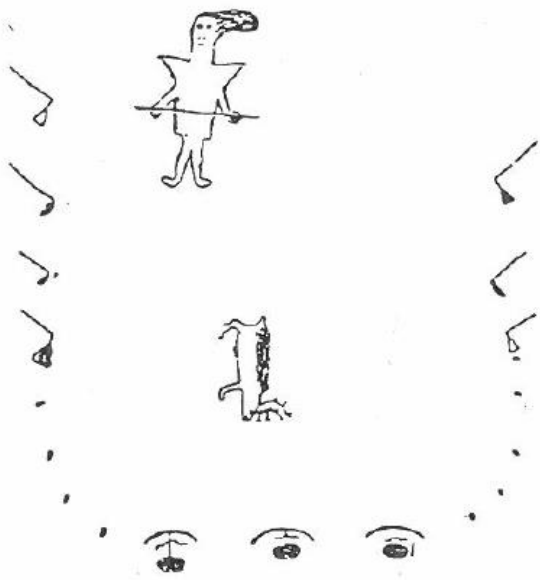
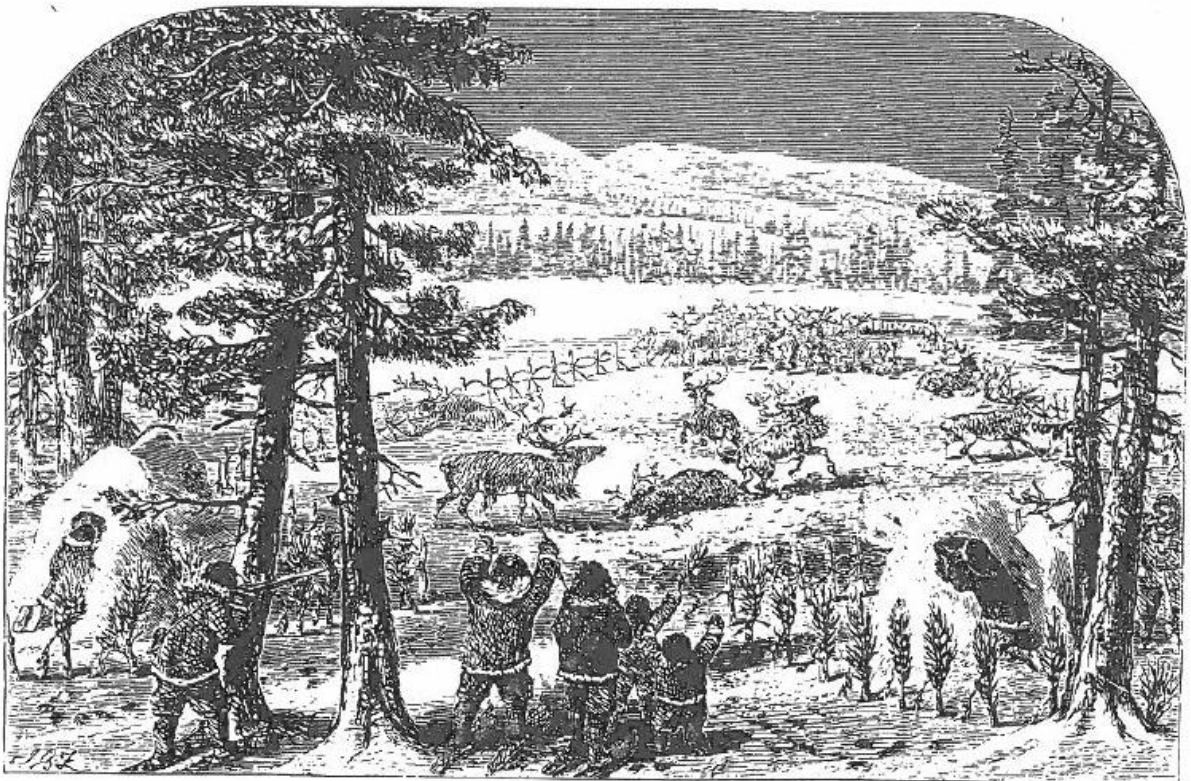


Figure 5.8. A Koyukon caribou drive in 1866. “A kind of corral, or enclosure, elliptical in form, and open at one end, is made on deer-trail, generally near the outlet of a wood. The further end of the enclosed space is barricaded; the sides are built of stakes, with slip-nooses or loops between them. Herds of deer are driven in from the woods, and, trying to break from the trap, generally run their heads into the noose, tighten them, and so get caught, or are shot, whilst still bewildered, and running from side to side” (Wymper 1868:187-188).

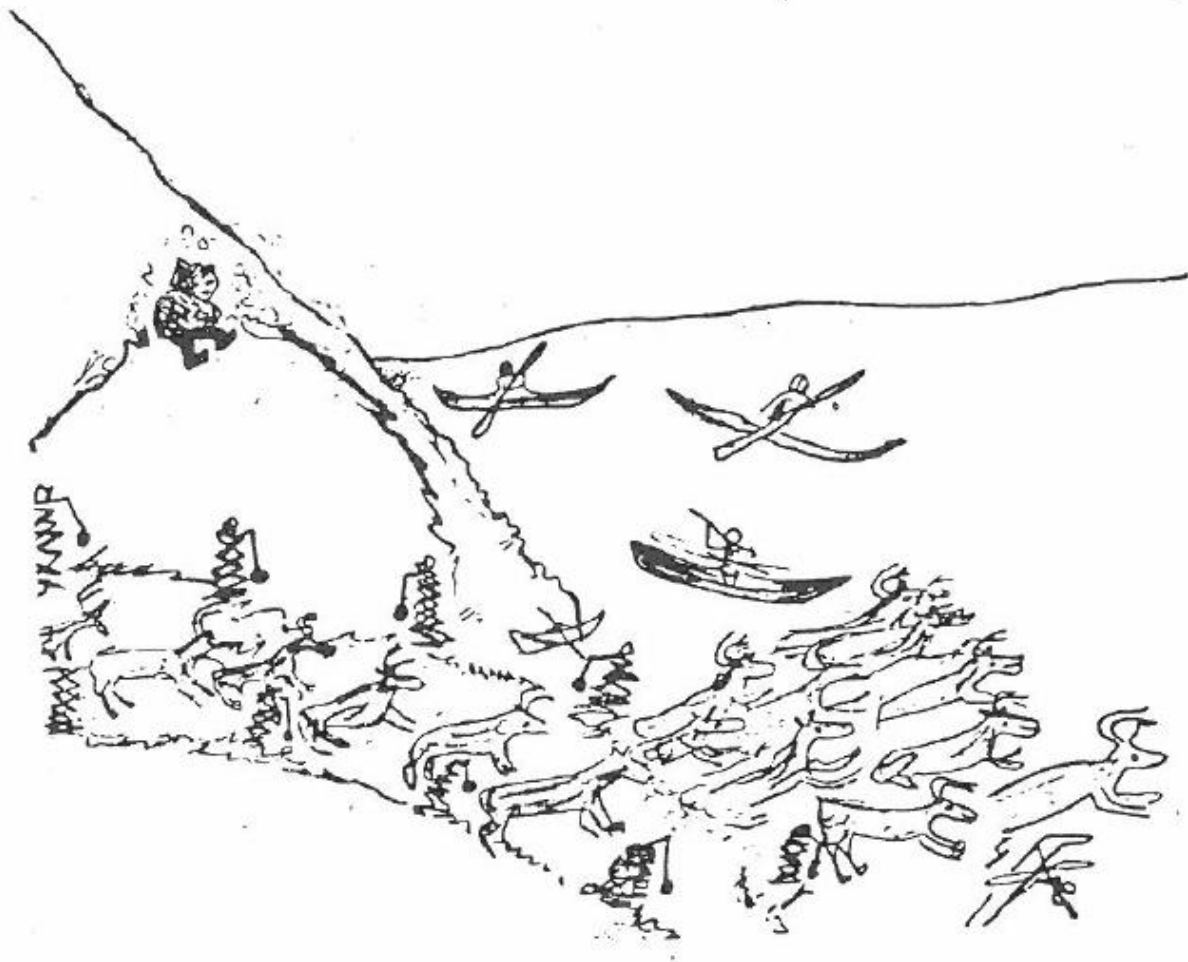


Water Crossings

Across North America from Alaska to Greenland, ethnographically the most productive and successful hunts were at water crossings on fall and spring migration routes (Gordon 1990:282). This strategy was very successful due to the fact that caribou will attempt to escape wolves by entering lakes or rivers, and this innate tendency was exploited by caribou hunters. *Rangifer* were actively driven toward these crossings with women and children chasing them and making wolf sounds (Balikci 1970:45; Birket-Smith 1929:111; Jenness 1922; Stefansson

1914:163). Hunting from boats was efficient as carcasses float, and once swimming caribou could be “herded” towards campsites, e.g. “The hunter calmly drives the herd through the water as the shepherd does his flock on land” (Turner 1894:250). Many water crossings were elaborated with drive lanes and rows of cairns which led into bodies of water, creating “artificial crossings” at strategic locations (Blehr 1990:313; Gordon 1990) (Figure 5.9).

Figure 5.9. A communal caribou drive at an artificial crossing place drawn by Inuit artist Talirurnilik (Saladin D’Anglure and Vezinet 1977).



Materials and Topographic Setting

Most ethnographic cases of hunting architecture reveal similar structure types regardless of the materials used to construct these features. This general plan has been characterized to include drive lanes, an area of channeling, an area of concentrating, and an area of trapping and/or killing (see **Figure 3.24**).

Variability in size and materials is related to the environmental context and topographic setting. In general, stone is the preferred construction material for areas with limited trees and brush, including the Alaskan and Canadian tundra and Greenland (e.g. Blehr 1990:313; Barth 1971; Mølmen 1976:178-179; Vorren 1958:9-16). Wooden and brush fences are the most common in the subarctic, near the treeline between the tundra and taiga. Similar to hunting architecture sites in other regions (see **Chapter 3**), caribou hunting structures made use of natural topography for communal drives such as narrow valleys with steep slopes (Boas 1888:501).

Ethnographic Analogy and the Archaeology of *Rangifer* Hunters

Due to the long standing anthropological interest in the arctic and *Rangifer* hunting adaptations, archaeological interpretations of *Rangifer* hunters – from the Middle Paleolithic to the Iron Age – are deeply influenced by ethnographic accounts. However, the extant historical and ethnographic records cannot stand as a surrogate for prehistoric hunting strategies or choices and cannot be expected to reflect the vast diversity of caribou hunting adaptations known only in the deep past. This overreliance on ethnographic analogy for describing prehistoric hunter-gatherers is problematic (see **Chapter 2**) and it is particularly rampant in the archeology of

caribou and reindeer hunters given the rich ethnographic and historical records for such groups (Conkey 1991; Kenyon 1997:9; Levine 1997, see also Arkush 1986 for a similar critique of communal pronghorn hunting).

Examples of ethnographic analogy in prehistoric *Rangifer* hunting are numerous and varied, and they dominate interpretations of archaeological cases as far back as the Middle Paleolithic. For example, in their critique of Neanderthal hunting strategies, Munson and Marean state, “An unintended corollary of their [Gaudinski and Roebroeks 2000] argument is that the kind of hunting they envision (i.e., an emphasis on late middle-age animals) has no analogues among either modern hunters or anatomically modern Upper Paleolithic reindeer hunters” (2003:271, brackets added). Here, Munson and Marean argue that the absence of analogy makes the archaeological interpretation unlikely. However, there is no *a priori* reason to assume that Neanderthal hunting strategies would look anything like contemporary hunter-gatherers or Upper Paleolithic hunters.

Reference to modern caribou/reindeer hunters is even more prevalent in discussions of anatomically and behaviorally modern *Rangifer* hunters. After the discovery of well-preserved faunal remains from Late Glacial sites in Germany, interpretations began with “observations of recent circumpolar hunter-gatherer peoples with a specialized reindeer-hunting economy” (Baales 1999:64, see also Burch 1972). In North America, Spiess connected large and long-term Paleoindian occupation sites in the Northeast to caribou drive hunting activities based on ethnographic analogy to inland caribou hunters (1984:282). Concerning the nature of social aggregation at the Paleoindian site Bull Brook, Robinson et al. list different types of social gatherings of the subarctic Montagnais and settlement patterns of the Gwich/in of the Yukon Territory (2009:429-430). Freisen compares Chipewyan Dene and Caribou Inuit settlement

patterns to form alternative models of caribou hunting – however, both of these cases reflect a period after major population decline in the animals, and a complete territorial circumscription of the hunters (2004). These are only a few examples of the wide use of ethnographic analogy to explain prehistoric caribou hunting (see Levine 1997).

Despite the details provided by the ethnographic and historic records, the limitations of these analogs are strikingly obvious. These analogies are inadequate, primarily due to the simple fact that prehistoric caribou hunting took place in social and environmental contexts that have no modern analogs. For example:

1. **Prehistoric environments were very different**, particularly in the Pleistocene. These paleoenvironments have no modern equivalent as they are characterized by disharmonious and diverse floral and faunal communities during the late Glacial (e.g. Semken et al. 2010; Sommer and Nadachowski 2006; **Chapter 4**).
2. **Prehistoric *Rangifer* herds were different** despite general similarities and uniformity in *Rangifer* behavior. Populations were much larger in the Pleistocene and their geographic ranges were much bigger (**Figures 5.2 and 5.5**) (Geist 1998:335; see also Wakelyn 1999:3). For example, between 21,000 – 6,000 cal yr BP there was a demographic decline in caribou in North America, and the global range of *Rangifer* declined by 84% (Lorenzen et al. 2011). There are many other regional declines, such as the caribou population crash in Greenland circa AD 1750 (Cuyler 2007:24; Grønnow et al. 1983:9; Meldgaard 1986:24; Nellemann 1970:150), the Fortymile caribou herd crash due to overhunting in the mid-1970s (Simeone 2007:318), and a substantial decline of caribou after the 1920s more generally (Bergerud et al. 2008:10, Table 1). In contrast, it is

estimated that as many as 80,000 individuals aggregated in the Late Pleistocene (Cohen 1997:246). Additionally prehistoric herd composition and structure was different. In modern populations there is at least one male for every five females (Nowak 1999) a lower proportion than the fossil record where there are often two males for every five females (Rivals et al. 2004:31). Moreover, the diet and teeth of recent *Rangifer* have also changed from the typical diet of caribou in the past (e.g. Croitor 2010; Rivals and Solounias 2007). For all these reasons, prehistoric populations are much more favorably compared to each other than either is to historic or modern herds.

3. **Human demography is different**, as there have been substantial changes in human population size, structure, density, and territoriality. For example, there was an increase in Greenland's population from 6,000 in 1800 to 12,000 in 1900 (Hamilton and Rasmussen 2010:46), which significantly impacted subsistence practices. In addition to general growth and the associated subsistence demands, increasing populations would limit hunting territories by population in-filling, having a significant impact on hunting strategies and mobility regimes of prehistoric hunter-gatherers (see below).

4. **Colonial encounters significantly altered lifeways**, and ethnographies and historic accounts in the arctic often deal with groups that had already suffered substantial devastation from contact with explorers, fur traders, whalers, and missionaries (Kenyon 1997:9; see also Cranz 1995:567,769,926; Gulløv 1985). For example, the combination of trading posts in the interior of Canada and the smallpox epidemic of 1781-1782 significantly impacted Chipewyan lifeways and traditional hunting strategies (e.g. Hearne

1958:115, footnote; Morrison 1981:183; Rich 1967:163-185; Gillespie 1975, 1976).

Furthermore, culture change after contact could occur very quickly (e.g. Kenyon 1997:9; Beck 2013). For example, as early as the turn of the twentieth century, Steffansson documented that drastic changes had already taken place as hunter-gatherers occupying the Mackenzie River Delta no longer hunted using traditional drives (1919). “In fact, they thought it rather a tremendous effort because they possessed hunting rifles and could, in a more relaxed manner, shoot caribou from behind blinds, harvesting sufficient numbers with considerable less effort and at any time it was convenient” (Kenyon 1997:10).

- a. **Integration into the world system radically changed economies.** For example, while the historic Yukon Kutchin groups practiced caribou hunting using drive lanes and fences for subsistence, at the same time a large part of their economy was focused on the extraction of furs for market. Historical settlement patterns and communities are were largely determined by this dual economy (Mcfee 1981:161).

- b. **Technological change** significantly impacted hunting behavior. Technologies for capture and mobility (e.g. rifles and snowmobiles) changed dramatically in historic era, impacting hunting strategies and *Rangifer* populations. The sudden and widespread use of firearms devastated caribou herds within 10 years in the central Canadian arctic, forcing Victoria Island Eskimo groups to move to the mainland (Manning 1960:8-10). The introduction of the flinklock gun in the second half of the 18th century, and the breech-loading rifle in the 19th century rapidly altered caribou hunting strategies in Greenland and Canada from large communal hunts to individual

stalking (Birket-Smith 1918:9, 1924:343; Dahl 2000:166; Grønnow et al. 1983:31; Nellesmann 1970:151; Mcfee 1981; Petersen 2003:54, 141). Similarly, the combination of the flinklock gun and the fur trade altered caribou migration routes in Ungava (Elton 1942:16). Snowmobiles significantly altered mobility and hunting strategies (Pelto 1973). A classic example of these technological changes includes the use of planes by Nunamiut hunters to locate caribou herds (Binford 1978b: 141-142). All of these changes can be traced through a single example – caribou hunting in Greenland between 2500 BCE and 1950.

Caribou have existed in Greenland at least since 6000 BC and the country is the easternmost habitat for caribou today (Meldgaard 1986; Pasada 2014). The archaeological and ethnohistorical records of caribou hunting in Greenland document tremendous variability in caribou hunting strategies between the earliest occupation (Paleoeskimo Period, locally known as Saqqaq) and colonial times.

In the context of fluctuating caribou populations, and contact with Dutch whalers, administrators, missionaries, and other social groups (e.g. Norse) – caribou hunting ranged from communal strategies using large and elaborate drive lanes next to summer camps, to small groups of hunters and many smaller drive lanes far away from summer camps, to summer hunting by mobile foragers, as well as stone-built hunting systems in alpine areas, communal hunting with stone built structures, and hunting from kayaks (Pasda 2014) (**Table 5.9**).

Table 5.9. Time periods and caribou hunting in Greenland, (adapted from Pasda 2014).

| Cultural Period | Years | Hunting Strategies |
|------------------------|---------------|---|
| Saqqaq | 2500 – 80 BCE | Wooden arrows, lithic points, spear-throwers and bows |
| Greenlandic Dorset | | Lances |

| | | |
|----------|--------------------|--|
| Thule | ca. AD 1200 – 1720 | <p>Early: Winter settlements near fjords (Gulløv 1998, 2007)</p> <p>Late: Summer camps, Caribou hunting carried out by 3-4 closely related households, 5-6 persons each (Birket-Smith 1924:142-143; Dahl 2000:166; Gulløv 1997:358; Müller 1907:396; Møbjerg 1983:37; Petersen 1963:37, 2000:86); umiak hunting</p> |
| Colonial | AD 1720 – 1950 | <p>Large scale communal drives at Aasivissuit (Grønnow 2006), rows of cairns, shooting blinds and walls</p> <p>Kayak hunting (AD 1800 - 1930s)</p> <p>1720-1750: Caribou population high (Cuyler 2007:24), communal hunting with drives (Egede 1925:335), men, women, and children (Israel 1969:69), fall, winter, and summer</p> <p>1750-1790s: Caribou scarce, introduction of guns, interior caribou hunting by small groups for 3-12 days (Birket-Smith 1918:9; Giesecke 1910:144, 254-259; Grønnow et al. 1983:31; Nellemann 1970:151; Petersen 2003:54, 141), missions and colonial administration halt long distance travel</p> <p>1820-1850: Caribou hunting becomes important again</p> |

| | | |
|--|--|--|
| | | (Meldgaard 1986), small groups for limited periods of time |
|--|--|--|

The Greenland case demonstrates that hunting strategies and general lifeways changed rapidly post contact, and “Thus, *discontinuity* is the key word for the utilization of caribou in West Greenland as it is all over the arctic” (Grønnow 2006:202 original emphasis). Further examples highlight how single ethnographic cases come to be used as normative models for all caribou hunters.

The impact of these significant differences between the historic and prehistoric contexts of *Rangifer* hunting can be further highlighted by two cases in point – specialization and herd following. These two models have been proposed as general *Rangifer* hunting adaptations despite the fact that these behaviors are far from viable or generalizable strategies, and instead are the result of pushing models derived from historically contingent cases back into the past.

Specialization

While specialized hunting has several definitions (e.g. Gardeisen 1999; Rivals et al. 2004), it generally refers to a focus on one prey species, which dominates the zooarchaeological assemblage. Traditional characterizations of prehistoric reindeer and caribou hunters assumed economic specialization based on large amounts of reindeer bone, but overall interpretations were largely drawn from ethnographic analogies (e.g. Bouchard 1966; Cohen 1997; Fainberg 1991; Leroi-Gourham and Brezillion 1972; Sturdy 1975; Zaliznyak 1989). In these models, specialized reindeer hunting is considered to be a deliberate economic choice, but the classic examples of specialized reindeer hunters documented in the ethnographic record reveal that this “adaptation” is most likely due to extended historical contingency. Ethnographic occurrences of

specialization occur under a limited set of circumstances. Similar to the concept to herd following groups, specialization only occurs when there are no other available resources (see below).

The focus on caribou hunting by the Nunamiut, long held as a standard prototype of reindeer specialists for archaeologists primarily due to Binford's extensive and influential ethnoarchaeological work (e.g. 1978a,b, 1991), largely resulted from the scarcity of other exploitable resources within the environment (Burch 1972, 1991; Meltzer and Smith 1986). The Nunamiut are also an example of changing hunter-gatherer populations effected by contact, disease, and new technologies. The group that Binford worked with had recently moved back to the interior to relearn traditional lifeways after living on the coast with limited caribou hunting for generations and now had rifles, snowmobiles, and planes for hunting aids (Campbell 2004).

Despite these limited circumstances, specialization is a common economic model for prehistoric hunter-gatherers (see above), although it is not the only explanation for archaeological sites dominated by a single taxon. This pattern may only reflect fluctuations in the environment and/or available species (Thacker 1997:92) as opposed to human hunting strategies targeting a single taxon. Likewise, differential preservation between the bones of large and small animals often skew zooarchaeological assemblages in favor of the larger species, creating "dominated" assemblages. Furthermore it may be difficult to distinguish between "obligate" and "deliberate" specialization in archaeological sites (Costamagno et al. 2006). Focal resource use may also be related to a single season or time of year. Overall, specialization as a subsistence strategy is likely a product of interpretations rather than a strategically viable choice for hunter-gatherers (Costamagno 1999; Loring 1997; Speth 2004).

Herd Following

Another behavior, “herd following,” has also been held to be a general model for prehistoric reindeer hunting (e.g. Burch and Blehr 1991; Gordon 1988). Yet the model is actually based on a handful of post-European contact populations including the Ethen-eldèli/Chipewyan (caribou-eaters, Smith 1981), Gwich’in, and Caribou Inuit groups, and to a lesser extent, the Naskapi and Nunamiut. It has been suggested that these groups attempt to follow caribou during the bi-annual migrations and move with the herd rather than strategically intercept the fast moving groups of animals.

It is unlikely that any human groups attempt to keep up with any group of animals, instead some may choose to move to different seasonal locations to keep within broad ranges of a *Rangifer* population (Burch 1972, 1991; Heuer 2008; Thacker 1997:87). Indeed, it is physically impossible for humans without mechanized transport to keep up with a herd of long distance migrating caribou (Burch 1972). Additionally, major population shifts, i.e. herds emigrating to new areas, may happen every 30-50 years, or 1-2 human generations (Spiess 1979:66) make the concept of herd following even more problematic, if not impossible. In fact, ethnographic hunter-gatherer groups claiming to follow herds did not qualitatively differ from other hunter-gatherers in their interaction with and exposure to prey species. Even the Chipewyan groups, that represent the closest candidate for “herd followers,” did not consistently encounter caribou year round (Blehr 1991:444), rather they followed the herds throughout their range but did not physically accompany them (Gordon 1990:298). Some ecotypes of *Rangifer*, such as woodland or mountain herds, do have shorter migrations and smaller ranges, and these types of herds might be followed if human groups were forced to be solely dependent on them (Spiess 1979:65). However, even in regions where prehistoric migrations were shorter such as Southwestern France (e.g. Spiess

1979), Magdalenian hunters situated themselves to intercept these herds and did not follow them. Indeed, herd following as a strategy is not represented in the archaeological record in either western or central Europe (Burch 1991; Burke and Pike-Tay 1997; Thacker 1997; White 1989).

It is clear that behavior approximating herd following only happens under very specific conditions, primarily in areas where other resources are limited (i.e. no food to fall back on the rest of the year in between migrations, land locked populations with no/limited access to marine resources (Gordon 1990:298)), and examples include the Canadian high arctic (Gordon 1975), and Scandinavia before domestication (Blehr 1990). Under these conditions, ethnographic accounts have documented massive starvation of herd following groups (Mowat 1962; Tester and Kulchyski 1994). Additionally, ethnographic groups that formed the ideal of herd followers participated in this behavior due to territorial circumscription. Caribou Inuit groups, specifically the Harvaqtuurmiut and Ahiarmiut (Burch 1986:109) occupied inland areas year round, but this year round interior occupation did not happen until the mid 19th century, prior to this they occupied coastal regions at least part of the year (Freisen 2004:301). In the late 18th century, Chipewyan/Dene moved south to participate in the fur trade and as a response to epidemic diseases (Smith and Burch 1979:83). For all these reasons, this “adaptation” is only a rare historical circumstance, not a generalizable model or a viable strategy that can be expected to be representative of prehistoric adaptations – although it often has been for southwest France (Gordon 1974, 1988, 2003).

Given all these differences, particularly changes in the social and natural environment over thousands of years, it is frankly amazing that the historic and ethnographic records are as useful as they are. While not to suggest the Kalahari debate be revisited (e.g. Lee and Guenther 1993; Wilmsen 1983, 1989; Wilmsen and Denbow 1990), there is no reason to presuppose

prehistoric hunter-gatherers looked anything like historic or ethnographic foragers. This is even more true in the deep past concerning human ancestors that were clearly very different sorts of foragers (e.g. Kuhn and Stiner 2001; Kuhn and Stiner 2015) (e.g. Neanderthal reindeer hunters). While some ideas can be generalized to model hunter-gatherer behavior (e.g. Binford 1976, 1978b, 1980, 1981, 1982) – this is primarily due to the conditioning behavioral effects of the animals themselves. The extant historic and ethnographic record cannot stand as a surrogate for prehistoric hunting strategies or choices, particularly since there is always the possibility that prehistoric hunting techniques for caribou and reindeer are “simply unknown to ethnographers” (Spiess 1979:185). There has been a tendency among archaeologists to ignore these differences (e.g. between caribou hunting peoples, diversity in hunter-gatherers more generally, and between ethnographic and archaeological foragers) – or explain them away (**Chapter 2**), and adequacy of prior work is compromised accordingly.

For the regional case study examined in this dissertation – a model of foraging lifeways of Great Lakes caribou hunters will be generated from the general theory of hunting architecture (**Chapter 3**), the archaeological and ethnographic cases of caribou hunters presented above, and prior research on the AAR (**Chapter 7**). First, the following chapter will review the evolution of submerged site archaeology in order to contextualize the AAR research within this broader setting.

Chapter 6

The Evolution of Submerged Site Archaeology

Introduction

Some of the most pivotal questions in human prehistory require the investigation of archaeological sites and landscapes that are now underwater. Due to global changes in sea level and deglaciation throughout the last two million years (Lambeck et al. 2002), large areas of land particularly on the continental shelf (e.g. Evans et al. 2014) and in many large inland lakes (e.g. O'Shea and Meadows 2009) were exposed and available for human occupation. Continuing fluctuation of water levels during and after the last ice age drowned these areas and their accompanying archaeological records or, in cases where isostatic rebound outpaced water levels, uplifted ancient coastal sites miles inland from modern shorelines (Gusick and Faught 2011). Archaeological evidence on these submerged landscapes dates to critical time periods in human evolution, migration, and early coastal adaptations across the globe. Therefore questions as diverse as the origins of human culture, global human expansion, and the nature and timing of early maritime adaptations, all hinge on evidence that is underwater.

Following close on the heels of nautical and maritime archaeology and advances in scuba and subsea technologies, systematic research into prehistoric submerged sites began in the late 1970s although individual finds were known from the nineteenth century or earlier. Large-scale publication and research emerged during the 1980s – 1990s and the field continued to grow

throughout the 2000s leading Gusick and Faught to classify it as a nascent subdiscipline in 2011. Since then submerged site archaeology has flourished and indeed, the last 5 years have shown a remarkable increase in awareness and research in underwater *prehistoric* archaeology, as indicated by the publication of several edited volumes, *Submerged Prehistory* (Benjamin et al. 2011), *Trekking the Shore: Changing Coastlines and the Antiquity of Coastal Settlement* (Bicho et al. 2011), and *Prehistoric Archaeology on the Continental Shelf: A Global Review* (Evans et al. 2014).

Despite early criticisms suggesting that high energy water action during and after inundation would have destroyed intact archaeological sites, and that the extreme cost of working underwater would outweigh any potential data that may be found, research by a handful of dedicated archaeologists has demonstrated that submerged prehistoric archaeological investigations are worth the effort (e.g. Bailey 2014; Benjamin et al. 2011; Evans et al. 2014; Gusick and Faught 2011). These criticisms were largely addressed by landmark discoveries of intact stratigraphy at the submerged Middle Paleolithic site of Fermanville off the coast of France (Scuvée and Verague 1988), extensive underwater excavation of Mesolithic sites in the Danish North Sea (e.g. Anderson 2013; Fischer 1995a,b), Neolithic and Bronze Age villages in Swiss Lakes (Egloff 1988; Stickel and Garrison 1988), and most recently, a 12,000 year old skeleton named Naia found in a Mexican cenote with preserved ancient DNA (Chatters et al. 2014). While these discoveries have largely put criticisms concerning the value and potential of prehistoric underwater archaeology to rest (Bailey 2014), a third criticism remains which suggests that these investigations are doing little in the way of addressing larger research questions (Bailey 2014). How are submerged sites contributing to broader questions such as the origins of human culture and the peopling of the Americas?

This chapter will first explore the history of working underwater in general and the history of underwater archaeology more specifically, and then discuss the investigation of submerged sites and how they are different from more traditional underwater investigations of shipwrecks, and finally present the importance and contributions of this type of research.

History of Archaeology Underwater

The history of underwater archaeology can be organized into four chronological and developmental stages: 1) the 1600s – 1900s, Salvaged Treasure; 2) 1960 – the present, Shipwrecks; 3) 1970s – 1990s, Submerged Sites; and 4) 1990s – the present, Deep Prehistory. The first period marks the earliest examples of salvage from shipwrecks and other artifacts recovered from underwater contexts. The second phase marks the first systematic archaeological research underwater by George Bass, and subsequently the birth of both nautical and maritime archaeologies (Bass 1966; Muckelroy 1978). During the third phase submerged prehistoric sites were systematically excavated for the first time, and lastly, the fourth phase marks the deepest and earliest known artifacts to have been recovered from underwater contexts (see below). These stages are defined both chronologically and developmentally as each phase had significant methodological leaps and theoretical insights concerning archaeology underwater (See Broadwater 2002 for detailed timeline of individual events).

Before describing each developmental stage in more detail it is essential to note that the history of underwater archaeology is intimately connected with the history of subsea research and technology in general (Broadwater 2002:17). It parallels trends in scuba diving, bathymetric mapping, sonar technologies, and other improvements and draws extensively from them. Beginning with breath holding and then use of diving bells and enclosed barrels in the 17th and

18th centuries, it wasn't until the 20th century that the most well-known and common underwater breathing technique, scuba with self-contained gas was used extensively. While vessel salvage using breath holding, diving bells, and surface supplied air dates back centuries, the invention of the Aqualung in 1943, the first scuba system by Jacques-Yves Cousteau and Emile Ganan, revolutionized research underwater. Indeed, the emergence of underwater archaeology coincides with scuba becoming generally affordable in the 1960s and 1970s. Additionally the large scale commercial development of sonar and other subsea equipment for accurate mapping led to the incorporation of these technologies into archaeological research (e.g. side scan sonar, magnetometer, sub-bottom profiler, multibeam sonar, fathometer, global positioning systems, etc.). Both the history of diving and subsea mapping technologies greatly influenced the development of underwater archaeology, and the gradual incorporation of this equipment is discussed below.

1600s – 1900s: Salvaged Treasure

Pioneering efforts to recover archaeological artifacts, (as opposed to simple salvage which dates back many years further), from under water happened at least as early as the 17th century when divers using a bell recovered a cannon from the *Wasa* warship in Sweden (1663). Other salvage operations also used open diving bells to salvage shipwrecks in the Caribbean Sea (1685) (Broadwater 2002:23). Similar operations during the 18th century in Italy and England using diving bells and metal helmets meet with minimal success but included the first underwater excavation in the Tiber River near Rome (Broadwater 2002). In the 19th century, it was discovered that sites other than shipwrecks were submerged beneath the Baltic Sea, as numerous Mesolithic artifacts were recovered and reported off the coast of Denmark (Müller 1897:18-23).

Early in the 20th century salvage became more common and more successful. For example, in 1900, surface supplied helmet divers recovered statuary from a Roman shipwreck in 180 feet of water, and many famous shipwrecks such as the Antikythera were discovered in the early 1900s by sponge divers in the Mediterranean (Muckelroy 1978:12). Additionally, a carved wooden figure was recovered from an ancient cenote at Chichén Itzá by lowering a steel bucket in 1909 (Coggins and Shane 1984:23), and numerous pile dwellings dating to the Neolithic and Bronze Ages were discovered in Swiss lakes in 1927 in early aerial photographs (Stickel and Garrison 1988:71). These early finds indicated that different types of archaeological sites were underwater, including ritual deposits where artifacts were intentionally sunk such as the gold, jade, and wooden figures in the Chichén Itzá cenote (Coggins and Shane 1984) and Bronze Age river offerings in the Thames (York 2002); shipwrecks where some catastrophe sank a vessel; and lastly, intact submerged sites. Prior to the invention of the Aqualung and large-scale and affordable scuba gear, these incidental discoveries of underwater finds remained the extent of underwater archaeological research until 1960.

1960 – The Present: Shipwrecks

Systematic underwater archaeology emerged in the 1960s with a nautical focus on identifying, mapping, photographing, and excavating shipwrecks in Mediterranean (Bass 1966, Bass et al. 1967; Throckmorton 1970). Earlier campaigns include Jacques Cousteau efforts to excavate the Mahdia shipwreck off the coast of Tunisia in 1948 where the aqualung and airlifts were first used, and the raising of the Swedish warship the *Wasa* from 110 feet of water (Broadwater 2002). This latter event which took place during 1957-1961 is still considered one of the most successful raisings of a shipwreck. In addition to these early efforts, Bass'

investigation of a 4th century Byzantine shipwreck at Yassi Ada, Turkey is considered the first controlled excavation of a underwater site, with careful mapping of each artifact *in situ* and excavations in controlled natural layers, removing the cargo down through the hull planking. Underwater excavation techniques were invented throughout the course of this project as the crew had to deal with some unforeseen challenges of working in an underwater environment. For example, each wooden piece of the vessel had to be secured to the sea floor using bicycle spokes so that each plank could be mapped before floating away. This early work established that controlled excavation was possible in underwater contexts using scuba gear that allowed archaeologists the flexibility they needed, and that intact shipwrecks as well as scattered wreck sites could yield valuable data to historians, classicists, and archaeologists (Bass 1967; Gould 2000; Muckelroy 1978, 1980).

With this first systematic excavation of a shipwreck, and the many that soon followed, both nautical and maritime archaeologies were born. While Bass was pioneering nautical archaeology as a method of documenting ship manufacturing and technology (1966, 1972, 1988 Bass and Van Doorninck 1982), Muckelroy a few years later developed the broader concept of maritime archaeology (1978). Maritime activities have played a large role in the human past – since boats and ships were arguably the most complex technology in pre-industrial societies from the at least the early Upper Paleolithic to the 19th century, and they played significant economic and social roles in these cultures (Muckelroy 1978:3). Beyond Bass’ nautical archaeology then, which is primarily concerned with ships themselves and the economic processes of construction and shipping largely in complex societies – maritime archaeology emerged with a broader range of interests, including ships, shipbuilding, and their economic roles, but also the long history of maritime adaptations dating back to hunter-gatherer societies, and a more anthropological

understanding of seafaring and fishing lifeways and “sub-cultures” (1978:3). Muckelroy also presented the first systematic discussion concerning post-depositional processes and their effect on shipwreck sites (1978). Since these landmark studies, maritime archaeology, of which nautical archaeology is a large component (See Muckelroy 1978:9, Fig.1.1), has continued to grow, primarily in the historic and classical disciplines, with the procedures and standards created by Bass and his colleagues remaining as the model for systematic archaeological research underwater.

This period marks many of the most important technological leaps for conducting archaeology underwater including the use of aqualungs for flexible diving, the airlift for controlled excavations, the development of underwater photography and mapping techniques pioneered by Bass, and lastly, the first use of side-scan sonar to locate a shipwreck in 1963. Although submerged sites and shipwrecks were known for centuries, it wasn't until the culminating advent of all these tools, that archaeological research could be conducted underwater to the same standards as it was conducted on land (see also O'Shea 2004).

1970s – 1990s: Submerged Sites

Following close on the heels of the pioneering research of shipwrecks, archaeological sites which have been submerged due to changing water levels known from at least the nineteenth century (e.g. Müller 1897:18-23) came to be systematically investigated for the first time in the 1970s. While limited excavations took place in the early 1970s in the south sea of Funen, Denmark (Skaarup 1983, 1993), the first systematic, large-scale excavation of a submerged prehistoric site occurred from 1978-1988 at the site of Tybrind Vig (Andersen 2013). Tybrind Vig is located 300 meters off the Danish coast in 3 meters of water and is an extensive

Late Mesolithic-Ertebølle cultural settlement with a radiocarbon date from a human burial dating the occupation to 6400 cal yr BP. Mesolithic artifacts near the site (about 500 meters south) were first located in 1957 by amateur archaeologists/scuba divers (Albrechtsen 1959), and in the early 1970s when scuba equipment became generally affordable, systematic excavations were carried out in 1x1 meter squares. Of the material remains excavated, close to 60% are organic, including a wickerwork fishing trap, components of fishing wiers, fish hooks made of red deer bone (one with piece of a line attached), wooden fishing spear tines, textiles, three wooden dugout boats made of limewood, and wooden paddles made of ash, four of which are decorated (Andersen 2013; Malm 1995:393, Fig. 12).

Following Tybrind Vig, large scale publication and research emerged throughout the 1980s and 1990s with the completion of a series of edited volumes drawing the small, but diverse set of scholars who were interested in the topic together (e.g. Bailey and Parkington 1988; Hoyt et al. 1990; Masters and Flemming 1983; Purdy 1988). Investigations included systematic survey and excavation of additional submerged sites in the Baltic and in the Mediterranean. Early survey with the help of a simple predictive model located additional submerged Mesolithic sites preserved in the slow moving and shallow waters of the Baltic Sea off the coast of Denmark (Andersen 1980, 1987; Fischer 1995a). Similar to Tybrind Vig, these well-preserved sites have produced a wide array of architecture and artifacts including domestic structures, wooden objects, and textiles (Fischer 1995a,b). Predictive topographic models were derived from interviews with local fisherman concerning the best places for fishing with stationary equipment, as fishing practices using weirs, fences, and baskets were common during the Mesolithic. Underwater archaeological survey targeting locations predicted by the model located many sites, often two or three a day, following general geographic rules for the best

fishing spots (Fischer 1993a, 1993b, 1997). The discovery of so many sites dating to this time period reflects dramatic sea level rise during the Mesolithic, giving archaeologists a unique case study for understanding human decision making during water level changes. Mesolithic foraging societies needed to adapt to new areas and environments while old hunting grounds were being flooded over the course of individual lifetimes (Fischer 1995).

Additionally, in the Mediterranean, underwater site survey and limited excavation took place off the Carmel coast of Israel. Sites here are 250 meters off the coast in 1-12 meters of water, and are well preserved under sand. Occasional industrial dredging and intense storms exposed these sites anywhere from a few days to a few months and six were identified early on during these periods of exposure and surveyed (Wienstein-Evron and Galili 1985). These include Late Neolithic-Chalcolithic stone structures such as rectangular house floors, hearths, storage pits, and silos (dated to 6830 +/- 60 B.P.) with lithic artifacts, basalt grinding slabs, ceramic sherds, limestone bowls, and bone fragments (Wienstein-Evron and Galili 1985).

The earliest prehistoric site which was found and explored in this period was Fermanville, a Middle Paleolithic occupation discovered in 1968, and excavated periodically during the 1970s – 1980s. Originally discovered by petroleum geologists conducting geomorphological survey, over 2,500 Mousterian lithic artifacts have been recovered near the base of a submerged granite cliff north of Cherbourg, France. This site has preserved stratigraphy and demonstrates that Neanderthals were living 20 meters (or 65 feet) below present sea level at least 45,000 years ago (the site has been relatively dated based on geological evidence to 40 – 90,000 cal yr BP). Fermanville seems to present an ideal place for occupation, as Neanderthals living there could take advantage of the proximity to both terrestrial and marine resources, as well as local lithic raw materials (Scuvée and Verague 1988). The antiquity of Fermanville was

particularly important since it was the first submerged site dating to before Last Glacial Maximum (LGM) – demonstrating that archaeological sites and stratigraphy could survive first inundation, then fully glacial conditions, and subsequent transgressions (Scuvée and Verague 1988).

This early period demonstrated that the same techniques first developed in terrestrial settings and then applied to shipwrecks, could be used to excavate prehistoric sites underwater as well. The use of predictive models occurred very early in submerged site investigations and these models continue to play a pivotal role in this type of research (e.g. Davis et al. 2009; Garrison 2000; Fogarty et al. 2015). In addition to full scale excavations, early geophysical surveys to locate inundated archaeological materials also took place. Although surveys in this period lacked adequate bathymetric maps, global positioning systems (GPS), and geographic information systems (GIS), they demonstrated the potential for using remote sensing techniques such as side scan sonar, sub-bottom profilers, and proton magnetometers which had been used to locate shipwrecks for locating submerged prehistoric archaeological sites. Examples include Dixon's 1979 survey in the Bering Sea, and surveys to locate submerged pile dwellings in Swiss lakes (e.g. Stickel and Garrison 1988).

1990s – The Present: Deep Prehistory

Following the demonstrated ability to conduct submerged prehistoric site discovery, excavation, and survey, the 1990s to the present have shown a dramatic growth in terms of the geographic range and time depth represented by submerged prehistoric projects. Additionally, methods have been continuously developed to better understand these sites and their associated paleolandscapes. To date, the deepest artifact recovered is from a depth of 145 meters (a

retouched flake from a core in the North Sea (Long et al. 1986)) and the oldest artifacts to be found underwater are Acheulean handaxes off the coast of South Africa (Werz and Flemming 2001). These handaxes were found at a depth of 7-8 meters and all three seem to be close to their *in situ* positions, showing little or no evidence of abrasion or other wear from traveling significant distances. These are undoubtedly the oldest archaeological materials to be recovered from submerged contexts thus far as Acheulean technology was developed and used between 300,000 and 1.4 million years ago. Therefore the geographic and temporal scope of prehistoric archaeology available underwater covers over 1 million years and extends to the edge of the continental shelf, and thus, all of the once available dry land (Bailey and Flemming 2008:2160).

In addition to these early finds from South Africa, long term projects in the Mediterranean and Baltic Seas continue (e.g. Galili and Arenson 2015; Fisher 1995 a,b), and new investigations have emerged along both the Pacific and Atlantic coasts of the Americas to further understand submerged landscapes on the continental shelf and assess their archaeological potential. On the Pacific coast continental shelf, projects are as far north as the Alexander Archipelago (Monteleone and Dixon 2013) in Alaska and Haida Gwaii, Canada (Fedje et al. 2004; Fedje and Josenhans 2000; Josenhans et al. 1995, 1997) where a lithic artifact was recovered from 53 meters (174 feet) of water and dates to an estimated 10,000 years ago; and range as far south as Chile, where numerous extinct faunal remains have been recovered which may show signs of human made cutmarks at the site GNL Quintero 1 (Carabias et al. 2014). Between these sites sediment sampling, coring, and water dredge excavations have taken place in the Gulf of California (Gusick and Davis 2010a, 2010b) and Montague Harbour in BC, Canada (Easton and Moore 1991), and geoarchaeological investigations have been done to build

predictive models of site locations off the Oregon coast (Davis et al. 2009) and the Northern Channel Islands (Garrison 2000).

On the Atlantic continental shelf, survey and excavations have taken place in the Gulf of Mexico with sub-bottom profilers, side scan sonar, and coring to locate sites dating the Paleoindian and Archaic periods (e.g. Adovasio and Hemmings 2009; Evans et al. 2007; Pearson et al. 2014). Many have been located and excavated, primarily off the coast of Florida such as the J&J Hunt site (e.g. Faught 2008). Indeed, karstic sinkholes and rivers on the Florida peninsula as well as the underwater continental shelf along its coast have produced more recorded inundated prehistoric sites and artifacts than any other state in the United States, the majority of which are late Pleistocene-Early Holocene in age (Clausen et al. 1975, 1979; Dunbar 1991; Faught 1988, 2004; Goodyear and Warren 1972; Ruppe 1980; Stright 1990, 1995; Webb 2006). These sites are providing classes of data, such as bone and ivory rods that are extremely limited in the terrestrial Paleoindian record. Further south, the site of La Olla off the coast of Argentina is an Early-Middle Holocene occupation ~8200 – 7300 cal yr BP (7400 – 6480 ¹⁴C yr BP) (Bayón and Politis 2014; Blasi et al. 2013) and is the only known pre-Hispanic submerged site thus far, although there have been a few isolated finds from submerged contexts in the area, such as a wooden fishhook recovered from the North Patagonian Coast (Gómez Otero 2007). La Olla has intact deposits and exceptional preservation of organic remains which include animal bones, plant materials, and wooden technology. It has been investigated four separate times when local tides have been abnormally low and the site was exposed. Due to the brief interval of exposure, no large scale excavations were done, instead rescue operations consisted of mapping artifacts in three dimensions and the collection of sediment samples for paleoenvironmental analysis and chronometric dating (Bayón and Politis 2014).

In addition to these projects targeting the continental shelf, inland submerged prehistory has also appeared, targeting fresh water rivers, sinkholes, and lakes. Such projects range geographically from Europe to Japan to North America, and date from the Middle Pleistocene to the late Holocene. The earliest artifact known from an inland underwater site is a wooden point was recovered from the Ljubljanica River in Slovenia which was dated $\sim 43,000$ cal yr BP ($38,490 \pm 330$ ^{14}C yr BP). Only five archaeological sites including this find from a river have produced wooden hunting tools from the Paleolithic (the others are Clacton-on-Sea, Lehringen, Schöningen, and Mannheim) (Gaspari et al. 2011). Although the wooden point was not *in situ* and seems to have eroded from older sediments into the river, the anaerobic underwater environment preserved this rare organic artifact. Submerged Neolithic sites have been excavated in lakes including a late Neolithic fishing fence which was preserved in Lake Arendsee, Germany (Leineweber et al. 2011), and Neolithic pile dwellings excavated in shallow water lakes in Northwest Russia (Mazurkevich and Dolbunova 2011). Furthermore, large scale cultural resource management work has located and excavated many Jomon period submerged archaeological sites in Japan, many of which may be ritual deposits into scared waters (Hayashida et al. 2014). In North America, projects looking for submerged prehistoric sites have taken place in rivers, sinkholes, and the Great Lakes. For example, testing for shell middens has been done the Damariscotta River in Maine (Leach and Belknap 2007), and as previously mentioned, inundated prehistoric sites are fairly common in the karstic sinkholes of inland Florida where Pleistocene fossils and archaeological materials have been recovered by avocational scuba divers and archaeologists for over 40 years (see above). Lastly, archaeological research in the Great Lakes has discovered numerous submerged caribou hunting structures

(O'Shea and Meadows 2009; O'Shea et al. 2013; O'Shea et al. 2014; Sonnenburg et al. 2015) – the case study which is evaluated throughout this dissertation.

This most recent time period marks a rapid increase in research projects due to continuing methods development. Advances in technology include 1) more accurate bathymetric mapping to understanding regional topography and fluctuating water levels over time, 2) the wide spread use of GPS to accurately locate and map sites at sea, 3) the continued use and improvement of subsea geophysical instruments including side scan sonar and sub-bottom profilers to conduct archaeological survey, 4) the inclusion of autonomous underwater vehicles (AUVs) to conduct archaeological surveys (the first of which was in 2000), 5) advances in coring and sediment sampling procedures, and 6) the combination of all these methods to accurately model the paleolandscape and survey for prehistoric submerged sites (Bailey and Flemming 2008). Furthermore, given the widespread geographic and temporal spread of archaeological materials recovered from underwater, it is obvious that submerged sites are critical for understanding broader questions such as early maritime adaptations and the dispersal of hominids along coastlines. Submerged sites represent an important and unique portion of the archaeological record and the investigation of such sites is unique as well.

The Investigation of Submerged Sites

Looking at the history of underwater archaeological research it is clear that shipwrecks were the primary focus of investigations. The transition from chance finds, to systematic shipwreck research to submerged sites was necessary for developing general underwater archaeological techniques but does not account for the some of the very real differences within

the archaeological record underwater – specifically the diversity of site types, from shipwrecks to submerged sites.

These two site types are different first in terms of the formation processes which were responsible for these sites becoming part of the archaeological record; a catastrophic event in the former, and sea level rise in the latter. As Muckelroy acknowledges, most voyages never become part of the archaeological record (1978:7). While only a small portion of ships become wrecks, entire landscapes and their accompanying archaeological sites have been submerged. Thus, while shipwrecks represent a single target, submerged sites are part of an entire landscape which can be investigated. These site types also vary in terms of archaeological visibility. Compared to historic shipwrecks and large scale architecture known from later periods, the archaeological records of hunter-gatherers prior to 10,000 years ago, when portions of the continental shelf and inland lakes were dry land, are extremely ephemeral.

These differences between site types in terms of formation processes and visibility have led to different approaches in their investigation. First, the nature of these targets requires different survey strategies. When investigating a shipwreck the search is for a known target. Survey for submerged sites on the other hand requires a much more extensive search in which the number and character of what the sites may look like is not known *a priori*. In addition to the targets themselves, the scale of survey must be much greater for submerged sites since the surrounding topography and bottom conditions are also part of the past occupied landscape. A complete understanding of the landscape requires reconstruction of the paleoenvironment from the background sediments, and is critical for creating predictive models for where sites may be located. In contrast, for shipwreck investigations, these features are largely incidental to discovery and essentially irrelevant.

Lastly, the availability of funds for underwater research can be contrasted between shipwreck investigations and those of submerged sites. Although all underwater research can be expensive, most often there are large scale public and private funding opportunities for shipwrecks, particularly those that are well known such as the Titanic and the Queen Anne's Revenge. For submerged site research, there are limited public funds and projects must be designed that fit the confines established by terrestrial archaeology, leaving these types of projects conducting "Big Ocean Science on a Bathtub Budget" (O'Shea et al. 2015).

In order to conduct submerged site survey and excavation then, these very real differences between shipwrecks and inundated hunter-gatherer archaeological records need to be accounted for. Research designs and methods for submerged sites must draw on the history and development of underwater archaeology in general while being continuously adapted to broader questions and earlier and more ephemeral archaeological records (See **Chapters 7 and 9** for specific methods of submerged site archaeology in Lake Huron).

The Importance of Submerged Sites

While the investigation of submerged sites may present technological challenges, research on submerged landscapes is extremely important, and these challenges are beginning to be overcome. Throughout its fairly short history, underwater archaeology has faced and resolved a number of criticisms as it continues to find its place within archaeology more generally. Early on, underwater archaeology was criticized by opponents suggesting that nothing would survive first inundation, and then subsequent marine reworking and that any archaeological materials would have been significantly disturbed. It was also suggested that given the extreme expense of working underwater and given the limited amount of funds for archaeology in general that

underwater research was not worth the effort. Investigations throughout the 1960s to today have largely addressed and done away with these first two criticisms concerning preservation and expense (Bailey 2014). Generally, as illustrated above, underwater sites are noted for their excellent preservation given the oxygen free environment which tends to preserve organic materials much better than terrestrial soils. Taking just one site, Tybrind Vig, as an example, over 60% of the assemblage was organic, including many artifacts and entire classes of data that have never been found in terrestrial Mesolithic sites (Andersen 2013). Interconnected to this, in terms of cost efficiency, many sites have been systematically excavated at low costs (e.g. Tybrind Vig, Malm 1995), and methods are being constantly improved in order to complete underwater research on terrestrial archaeological budgets – primarily through the use of smaller research vessels and hand deployable assets (O’Shea 2015a).

Perhaps the longest lasting criticism of all underwater research concerns the role it plays in contributing to larger anthropological, historical, and archaeological questions. The strongest critics suggests that submerged site archaeology is doing little in the way of contributing to broader questions (Bailey 2014). In part, this is simply a function of the short historical trajectory of underwater archaeology as it is suffering from many of the same criticisms that archaeology more generally has already dealt with (e.g. the transition from culture-historical archaeology to “new” archaeology). But beyond theoretical development, submerged sites are an important component of the global archaeological record, and as such are critical for addressing some of the most important questions in human history.

Submerged sites are extremely important for a number of reasons. First, they are largely undisturbed from subsequent human activity and development. Since these landscapes are now underwater they have been relatively well protected. Like terrestrial archaeological sites, sites

underwater are also subject to formation processes ranging from geological to cultural which effect the spatial distribution, preservation, and deposition of archaeological materials. Some of these formation processes are unique to underwater environments, such as the initial submergence of these areas, wave action, and disturbance by marine animals (e.g. octopi in South Africa are known to decorate their dens with artifacts from shipwrecks (King and Mollema 2015; see also O’Shea 2002). Disturbance may also include scour marks, anchor drags, and dredging operations, (although some of the latter have actually been responsible for the discovery of many prehistoric submerged sites (e.g. Hublin et al. 2009; Stanford et al. 2014)). However, despite these post-depositional processes, compared to many places on land the disturbance from subsequent construction and human habitation has been much less. Additionally underwater landscapes preserve not just archaeological materials but the background sediments and topography as well which reflect the past occupied landscape. Paleoenvironments can be reconstructed from preserved pollen, trees, and other environmental indicators to put archaeological sites in a broader context – creating pristine archaeological records and essentially a Pompeii-like scenario underwater.

Second, submerged sites have unique preservation making them qualitatively different from terrestrial sites. Submerged landscapes offer tremendous preservation of organic remains due to the anaerobic environment, as archaeological materials including lithic artifacts, human and animal bones, and wooden objects have been recovered from diverse underwater settings, both high energy coastlines and low energy environments in open sea, and in shallow as well as deep water (Bailey 2014). These landscapes have also revealed patterns of settlement, subsistence, and lifeways that are unknown on land (Bailey and Flemming 2008:2162). For example, submerged Mesolithic sites off the Danish coast are large settlements which reveal a

more socially complex culture than evidence from terrestrial archaeological sites seemed to indicate (e.g. Anderssen 2013; Fischer 1995b). Additionally, although it was assumed that Great Lakes hunter-gatherers at the end of the Pleistocene were targeting caribou, little evidence was found on land to support these claims but research beneath Lake Huron has confirmed these hypotheses (e.g. O'Shea and Meadows 2009; O'Shea et al. 2014).

Third, submerged sites are part of vast landscapes that date to a critical periods in human prehistory. Global sea level rose 120-130 meters as the ice sheets from the Last Glacial Maximum (LGM) retreated (Fairbanks 1989; Lambeck et al. 2002) and the areas of land which were exposed prior to global sea level rise were extremely vast. The Patagonian region in Argentina for example was almost double its present size (Guilderson et al. 2000; Zárte in Flegenheimer 2007:44-45). The last two million years during which sea levels fluctuated and drown the continental shelf correspond to the long period in human prehistory during which many significant changes occurred. This time period in fact encapsulates the entire trajectory from the origins of modern humans and their migration across the planet to the development of agriculture. Therefore, these now submerged landscapes are rich in archaeological potential.

Finally, landscapes that are now submerged would have been the best places on the landscape for hunting and gathering, fishing, and early farming societies. When dry land, these areas would have been very attractive to prehistoric societies since coastlines are extremely productive and are ecotones between the sea and land where a wide variety of resources are available. These areas therefore probably housed some of the highest population densities, making them crucial landscapes for the spread of people and ideas between different regions, and ultimately around the globe (e.g. Bailey 2011; Galili and Rosen 2011; Fischer 1995b, 2011;

Flemming 2004, 2011; Johnson and Stright 1992; Masters and Flemming 1989; Westley et al. 2011).

Bigger Questions

While submerged sites and landscapes largely represent a pristine archaeological record, have excellent preservation, and are were some of most attractive geographic areas dating to the critical time periods in human prehistory – how can they contribute to broader questions? Some of the most relevant areas for submerged site research include the origin of human culture, global human expansion, and early maritime adaptations.

Concerning the origins of human culture, one of the principle geographic areas that is critical to answering this question since it appears to be the homeland of modern humans is southern Africa. Given the number and nature of early archaeological sites along the South African coast which are providing the earliest evidence of modern human behavior (e.g. Blombos, Klasies River etc.), the continental shelf which would have been dry land for much of this critical period in human evolution is an obvious place to look for even earlier, better preserved and/or *different* adaptations. Most likely, the three Acheulean handaxes recovered from Table Bay (Werz and Flemming 2001) are just the tip of the iceberg in terms of submerged sites in this area.

Outside of Africa the question of early hominid evolution and dispersal is also reliant on underwater evidence due the same process of sea level rise, and many areas which may have been critical corridors for early hominid movement are now under water. A handful of recent discoveries are demonstrating that underwater sites in these areas have preserved early human

skeletal remains. For example, a Neandertal frontal bone was recovered from the bottom of the North Sea, 15 km off the coast of the Netherlands in less than 50 meters of water (Hublin et al. 2009). This small frontal fragment retained diagnostic features to confidently assign it to Neandertals and this specimen, along with those from Salzgitter-Lebenstedt in Germany (Hublin 1984) and Pontnewydd in the UK (Green et al. 1981) represent the northernmost Neandertal remains in Europe, all close to 52 degrees north latitude (Hublin et al. 2009), expanding our knowledge about Neanderthal adaptive plasticity. Additionally, a jaw bone recovered by a fisherman off the coast of Taiwan is the only early human remain from that country (Chang et al. 2015). Indeed, the entire process of human dispersal out of Africa may have involved new adaptations to coastal resources and maritime lifeways, and sea food and travel routes provided along the coastlines may have resulted in rapid dispersal rates out of Africa across the Red Sea and around the Indian Ocean (Bailey and Flemming 2008), leaving these now submerged areas crucial for understanding peopling processes.

Another component of global human expansion problem is the peopling of the Americas, an additional research venue where underwater investigations are imperative. Many of the primary hypotheses concerning how humans first occupied the Americas involve coastal migrations and maritime adaptations. In fact, the peopling question is the primary focus of most underwater prehistoric archaeology in the Americas (e.g. Adovasio and Hemmings 2009; Evans et al. 2007; Fedje and Christensen 1999; Fedje and Josenhans 1999; Faught 2002, 2004; Gusick and Davis 2010a, 2010b; Josenhans et al. 1995; Pearson et al. 1986). Long term projects on Haida Gwaii, inland Florida, the Gulf of Mexico, and southern California are all seeking evidence of the earliest inhabitants with some success locating intact sites on the Pacific continental shelf and the Gulf of Mexico (Faught 2004; Fedje and Josenhans 2000). More recent

discoveries are also contributing vast amounts of new data to the problem of the peopling of the Americas, such as the skeleton Naia from the Mexican cenote that shows genetic similarities to all native Americas (Chatters et al. 2014). Additionally, many potential early sites are being investigated on the Atlantic continental shelf where Pleistocene faunal remains of mammoth, mastodon, and walrus have been recovered by fisherman and during dredging operations at least as early as the 1960s (Edwards and Merrill 1977; Whitmore et al. 1967). One such incident in 1974 dredged up a mastodon skull and a large bifacially flaked knife made out of rhyolite, referred to as the Cinmar biface and was just recently reported (Stanford et al. 2014). Additionally, GNL Quintero 1 may represent another early human occupation site in Southern South America (Carabias et al. 2014).

Lastly, early maritime adaptations and seafaring represent yet another area where submerged archaeological sites could drastically change our understanding. Over thirty years ago, Bass appropriately questioned why so much attention was given to the “urban revolution” rather than a “seafaring revolution”, particularly given that early seafaring and river travel predate the emergence of agriculture, metallurgy, and urbanization and that these nautical technological advances would have played a significant role in the movement of goods, people, and ideas for thousands of years (1983:92). Our understanding of early seafaring and the time depth of these technologies and adaptations has increased significantly since Bass’s comments – particularly with the colonization of Australia which required some type of seafaring technology at least 40,000 years ago (O’Connell and Allen 2004), and colonization off of Japan 33,000 years ago (Ikawa-Smith 2004). Due to the same processes of sea level rise, most early coastlines are underwater – and while searching for the “oldest” or first coastal adaptation is not an adequate

research design, exploring these questions underwater can help better understand the patterns and process of early seafaring and maritime lifeways (Simmons 2014:16).

Finally, it is important to note that even if underwater surveys in these areas do not locate any archaeological sites, until systematic research has been done these regions cannot be ruled out, and the submerged records will be either ignored or exaggerated for pet theories as it suits them (Bailey 2014). Through this brief discussion it is clear that underwater research is critical for addressing larger questions, and as it continues to evolve, it certainly will. The future of submerged site archaeology will benefit from an anthropological perspective, with big questions in mind and the frame of reference to understand hunter-gatherer archaeological records. The case study presented in this dissertation seeks to exemplify such an approach.

Conclusion

The following chapters will discuss the particular case study in detail, prehistoric submerged site research on the Alpena-Amberley Ridge (AAR) in Lake Huron. **Chapter 7** documents prior interdisciplinary investigations on the AAR. **Chapter 8** presents of a model of hunter-gatherer lifeways on the AAR, and **Chapter 9** present the methods that were used to test this model and the results of the study. Together, these chapters present specific techniques and methods for prehistoric site discovery and sampling which were either elaborated or newly developed in Lake Huron, and which can be applied to wide range of underwater settings for addressing similar and other anthropologically relevant questions of the submerged prehistoric archaeological record.

Chapter 7

Interdisciplinary Investigations on the Alpena-Amberley Ridge

Introduction

The Alpena-Amberley Ridge (AAR) is a rocky limestone and dolomite outcrop that runs across the Lake Huron basin from Alpena in Michigan to Amberley in Ontario (see **Figure 4.1** and below). This land bridge is currently ~25-36 meters (80-120 feet) underwater and would have been dryland during the Lake Stanley phase of Great Lakes prehistory when water levels dropped over 100 meters (~10,500-8300 cal yr BP) (Lewis, Blasco, and Gareau 2005) (see **Chapter 4**). During Lake Stanley, over 250,000 hectares of new land were exposed including the AAR, and this narrow landform (on average 10-15 km wide) divided the modern Lake Huron basin into two distinct lakes, with a third lake north in Georgian Bay (Lake Hough) (**Chapter 4**).

Interdisciplinary investigations on the now submerged AAR have demonstrated that it retained a periglacial sub-arctic type environment much longer than surrounding areas on the mainland; providing a refugium for cold-adapted animals such as a caribou. Additionally, previous research has generated evidence of prehistoric hunter-gatherers using this land corridor by building stone hunting architecture to hunt animals at strategic locations.

The Study Context

It has long been acknowledged that there were very shallow areas in the middle of Lake Huron. Historically, a portion of the AAR has been noted on nautical charts as Six Fathom Shoal (11 meters deep, 1 fathom = 6 feet, 6 fathoms= 36 feet, or 11 meters); but following new detailed bathymetric mapping by NOAA in 2008, it was realized that Six Fathom Shoal was part of a continuous and extensive outcrop that ran across the entire Huron basin (See **Figure 4.5**). With the most recent water level reconstructions of Lake Stanley, it became clear that the AAR would have been a dry land bridge connecting Northern Michigan to Southern Ontario.

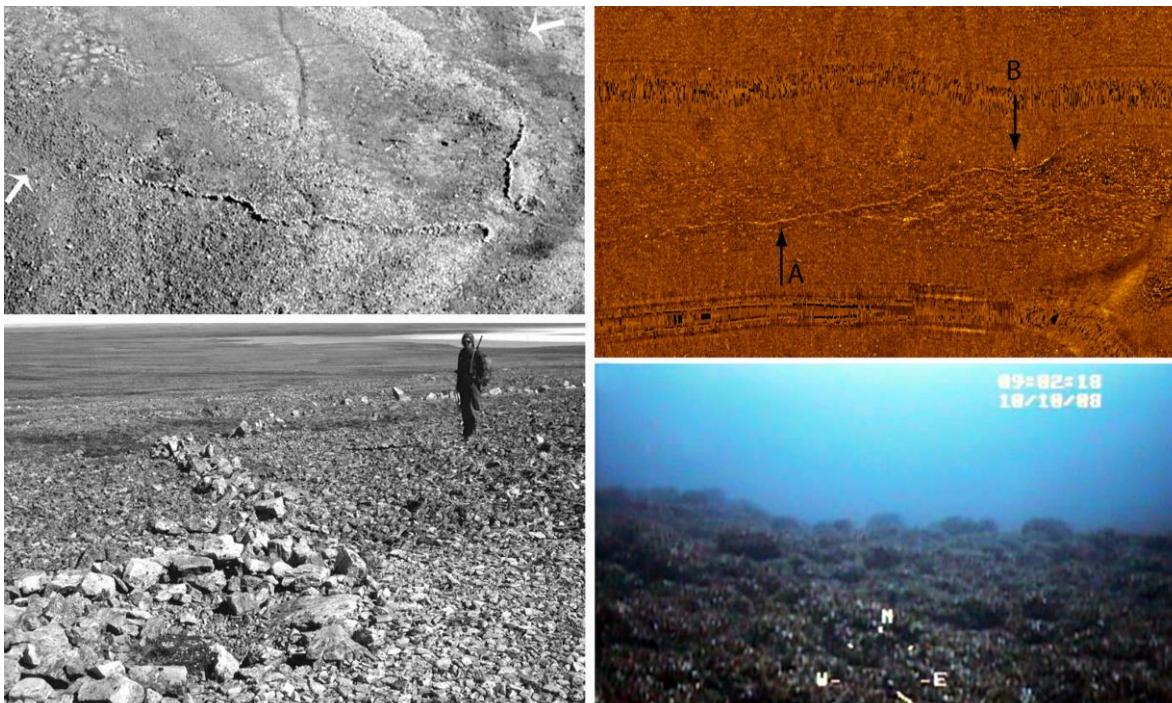
Archaeologists have suspected that sites belonging to the Late Paleoindian and Early Archaic periods would have been submerged beneath the modern Great Lakes (**Chapter 4**). However it was thought that these sites would have been destroyed during inundation by Lake Nipissing, or would be deeply buried. The discovery of a preserved submerged forest in Southern Lake Huron (Hunter et al. 2006) suggested that sites may have survived, and opened the door for archaeological investigations.

Only recently has submerged prehistoric archaeology and underwater technology been available to make searching for prehistoric submerged sites feasible (both methodologically and financially) (see **Chapter 6**). The timing of all these factors: the discovery the land bridge, a better understanding of the Lake Stanley low water stand, and the feasibility of prehistoric underwater archaeological research, converged and an interdisciplinary project at the University of Michigan was initiated.

First Discovery

Early investigations on the AAR consisted of acoustic and video survey. These first surveys were conducted in two research areas (Areas 1 and 3, see below), and revealed an absence of major sediment cover on the AAR. Large quantities of rock, with boulder fields, outcropping strata, and intact bedrock surfaces were detected, as well as some areas of shallow sand which appeared to represent ancient water ways. These bottom conditions on the AAR confirmed that side scan sonar and remote operated vehicles would be appropriate survey tools since sites would not be deeply buried (i.e. a subbottom profiler was not necessary in this context). These initial surveys located several features of interest that were then investigated using a remote operated vehicle (ROV). These features looked remarkably similar to stone constructed caribou hunting features known historically and ethnographically from the North American arctic (O'Shea and Meadows 2009) (**Figure 7.1**).

Figure 7.1. Caribou drive lanes on Victoria Island, Canada (*left*), and similar structure under Lake Huron (*right*). Top right: linear drive lane feature is indicated on side scan sonar by A, hunting blinds indicated by B, (adapted from O'Shea and Meadows 2009:10121, Figure 2).



Research Design

These preliminary results indicated that the AAR likely preserved a prehistoric landscape and evidence of ancient hunters intercepting caribou. A research design was developed in order to continue investigations of these hunting features with scuba divers to collect samples for archaeological and paleoenvironmental analysis. An additional unique facet of the AAR research design was the incorporation of an Artificial Intelligence/Agent-Based Model to predict the location of submerged archaeological sites (**Figure 7.2**).

Research Areas

To date, research has only been conducted on the United States portion of the AAR, which is essentially divided in half by the United States-Canada border. Three areas were selected for detailed investigations on this half of the ridge based on the reconstructed land surface (**Figure 7.3**).

Figure 7.2. Schematic diagram of the research design for investigating the Alpena-Amberley Ridge. The research design is nested and recursive – dashed lined reflect new information that is fed back into the computer simulation (O’Shea et al. 2013, Figure 2).

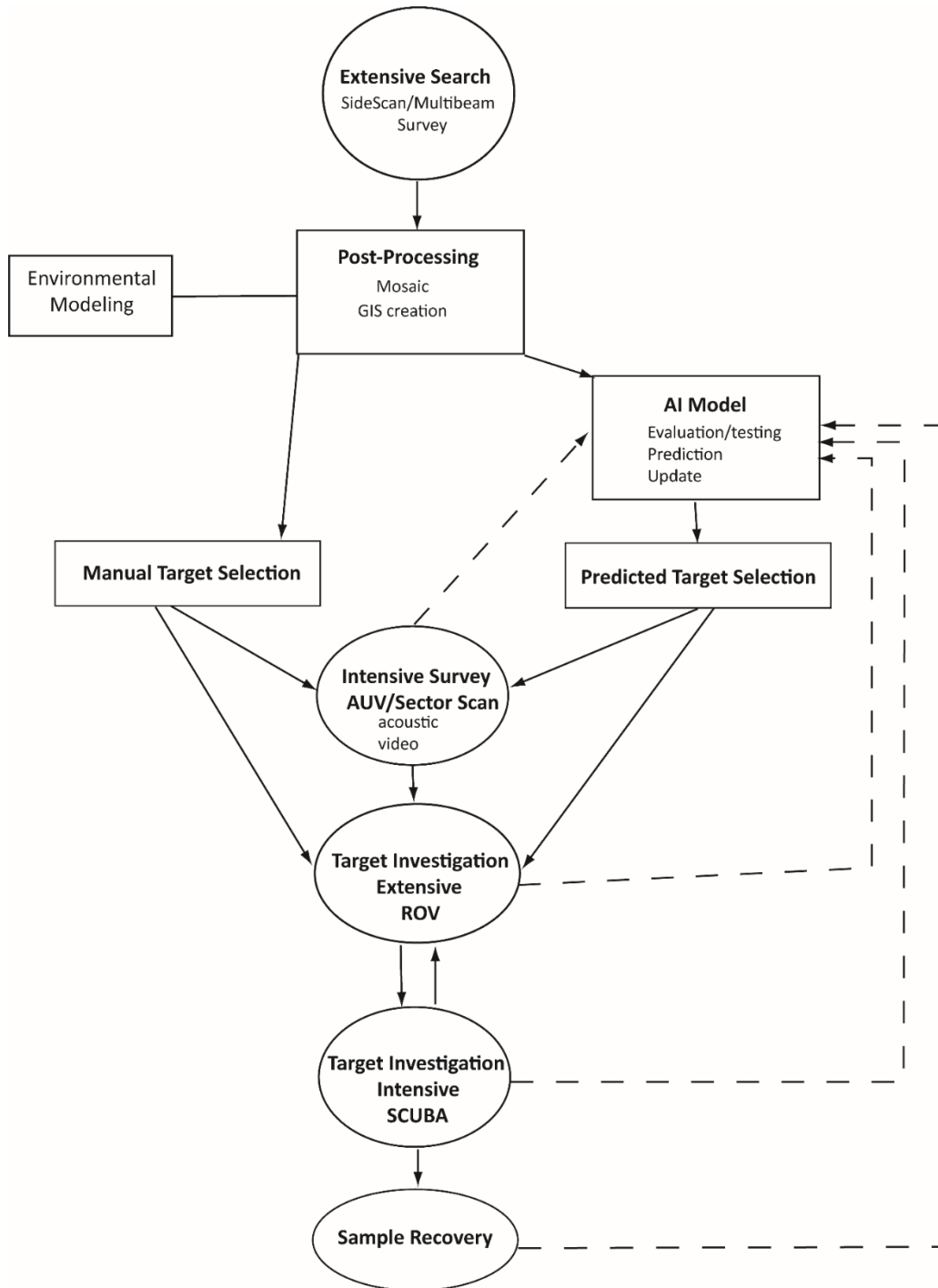
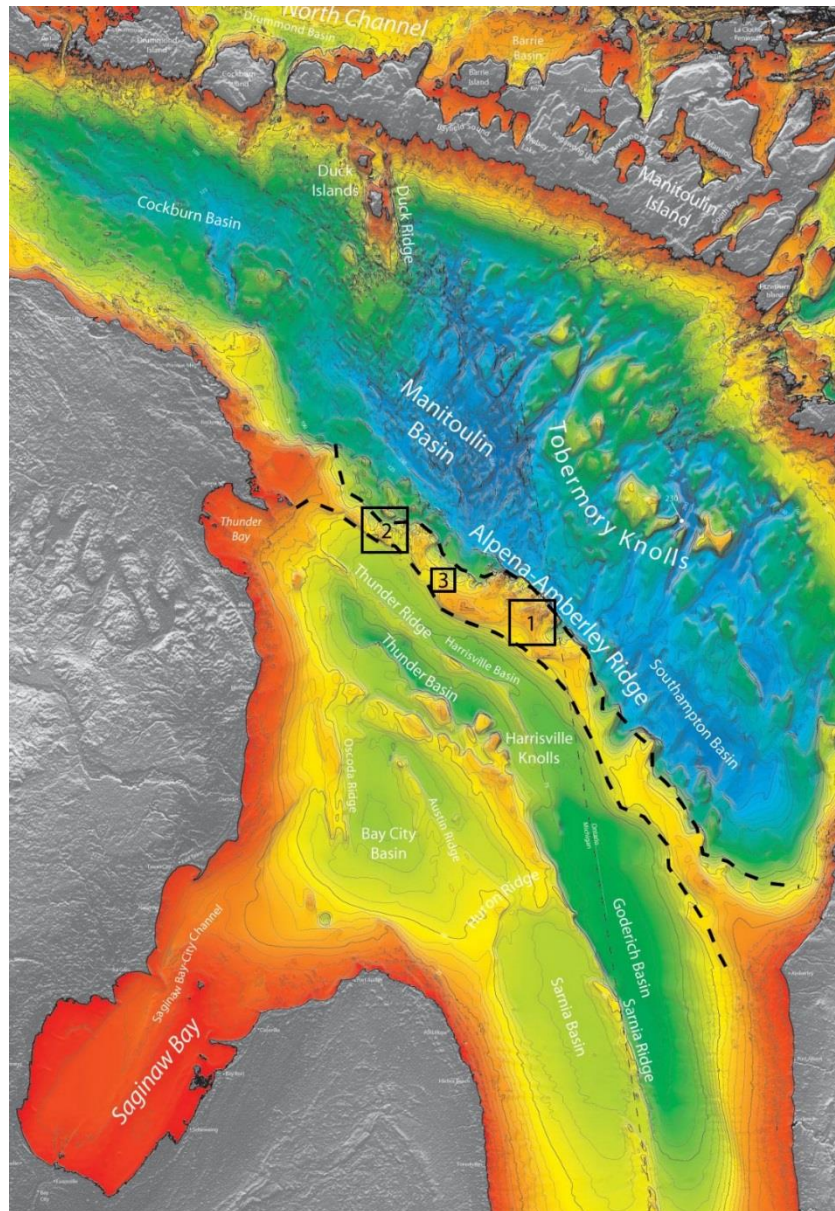


Figure 7.3. Research Areas on the AAR.



Area 1 is the largest research area covering 56 km². It is the most varied topographically and has the highest elevation on the AAR. This area was selected since these higher elevations would have the potential for containing intact archaeological remains dating to the latest Lake Stanley lowstand. Additionally Area 1 is dominated by a long linear bedrock outcrop that may include outcropping chert layers.

Area 2 was selected since it contained a potential water crossing, areas that are well known as prime locations for hunting caribou (see **Chapter 5**). While Area 2 is the closest to shore, it contains some of the deepest portions of the AAR. Area 2 is intermediate in size between Areas 1 and 3 covering 49 km². Topographically, Area 2 has both low elevations and areas with higher relief that may have served as lookout areas for hunters. It also has narrow channeling features that likely would have influenced caribou movement. This area of the AAR would have been the first to be submerged with rising water levels, and as such is likely to contain some of the earliest evidence of prehistoric peoples using the AAR corresponding to the lowest levels of Lake Stanley.

Area 3 is the smallest (17 km²) and is a location where the AAR narrows considerably forming a narrow corridor through which migrating caribou would have to pass. This narrow neck of land formed an upward trending ridge leading to a relatively large open meadow. This crest of the ridge would have been an ideal lookout area for hunter-gatherers waiting for migrating caribou.

Each area has been the focus of systematic mapping using side-scan sonar; both Areas 1 and 3 were completely surveyed, and a smaller portion of Area 2 was mapped most recently (**Figures 7.4-7.6**). Area 1 has additional multibeam sonar coverage (**Figure 7.7**). Overall, the majority of the research to date has been conducted in Areas 1 and 3. Area 1 is where the first hunting structures were located (O'Shea and Meadows 2009) and has been the focus of further intensive research. The side-scan sonar mosaic of Area 3 indicated long glacial eskers as well as an overlooking rise which would have offered promising topography for hunting caribou, and many potential stone constructions were present; for these reasons Area 3 has also been studied extensively. For more practical and logistical reasons, Area 2 has seen the least amount of

research. While this research area is the closest to shore, it is intersected by north and southbound shipping lanes used by Great Lakes freighters (**Figure 7.8**). The high volume of marine traffic in this area limits the ability to anchor the research vessel for long periods of time over targets of interest.

Figure 7.4. Area 1 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between 20 and 30 meters. Each swath is 200 meters wide. Dark areas on the mosaic indicate areas of sand.

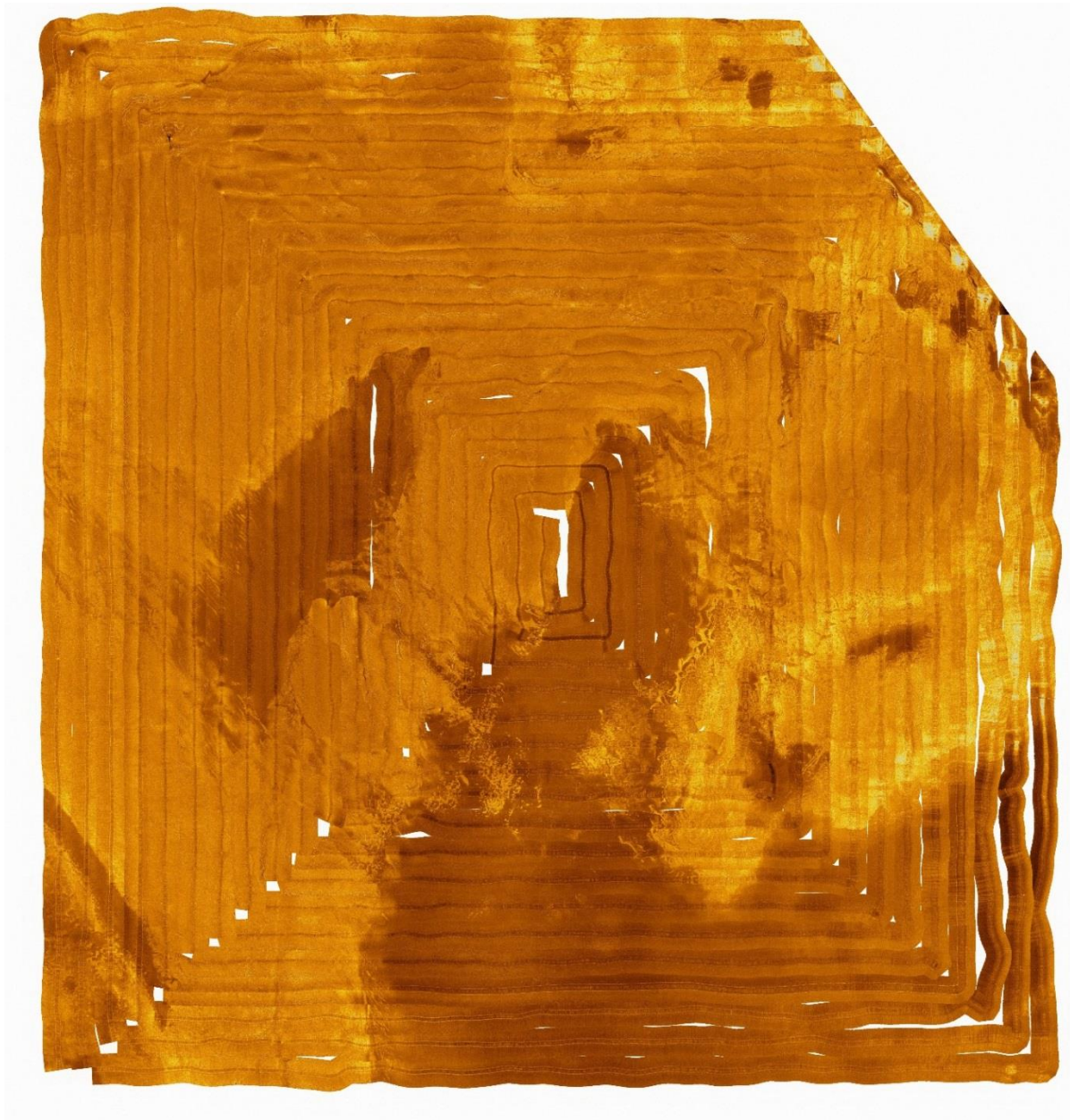


Figure 7.5. Area 2 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between ~30 and 40 meters. Each swath is 150 meters wide. Dark areas on the mosaic indicate areas of sand.

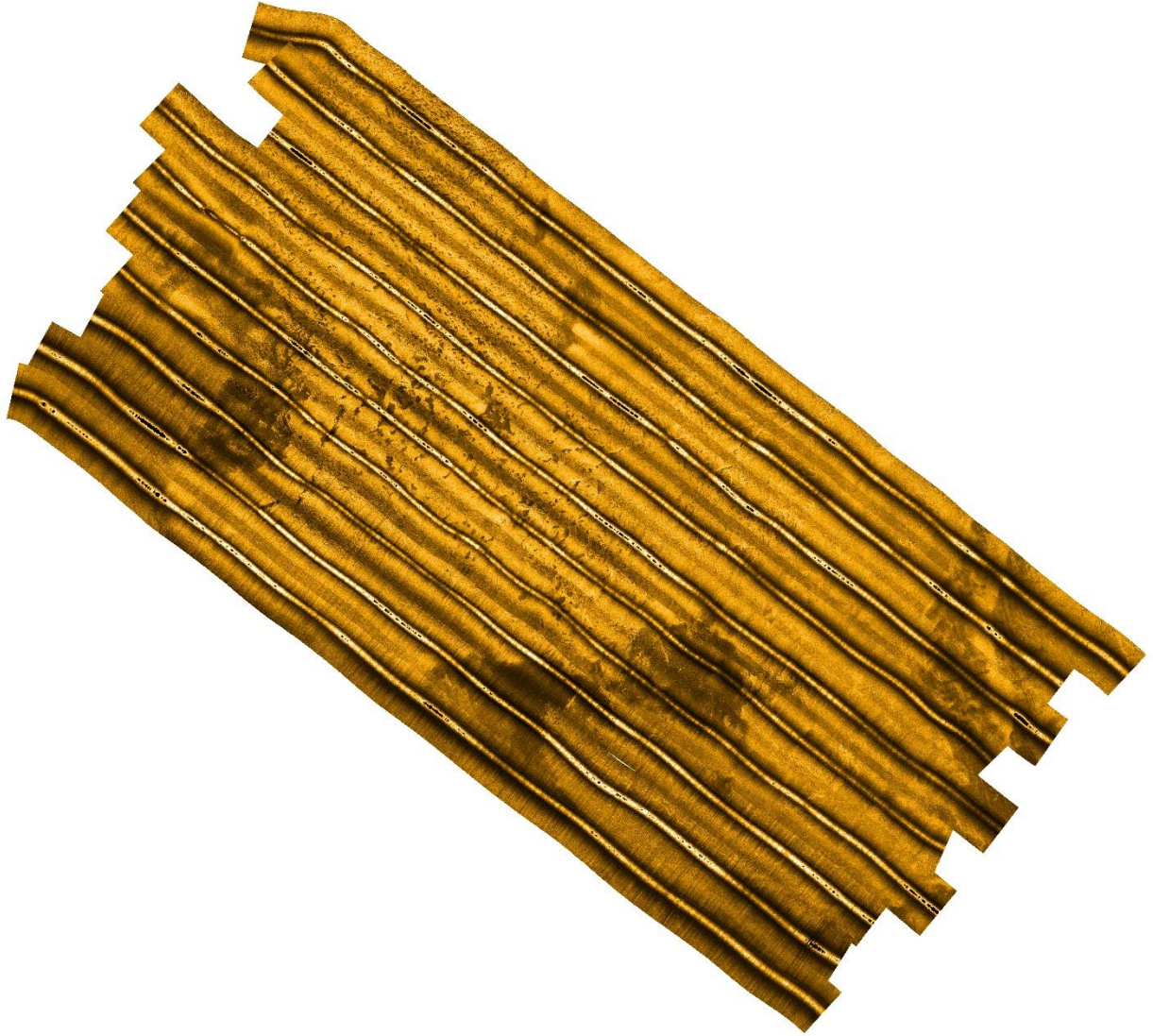


Figure 7.6. Area 3 Side Scan Mosaic. Survey was conducted with a digital Imagenex side scan sonar towfish at a frequency of 330kHz at depths between 20 and 30 meters. Each swath is 200 meters wide. Dark areas on the mosaic indicate areas of sand.

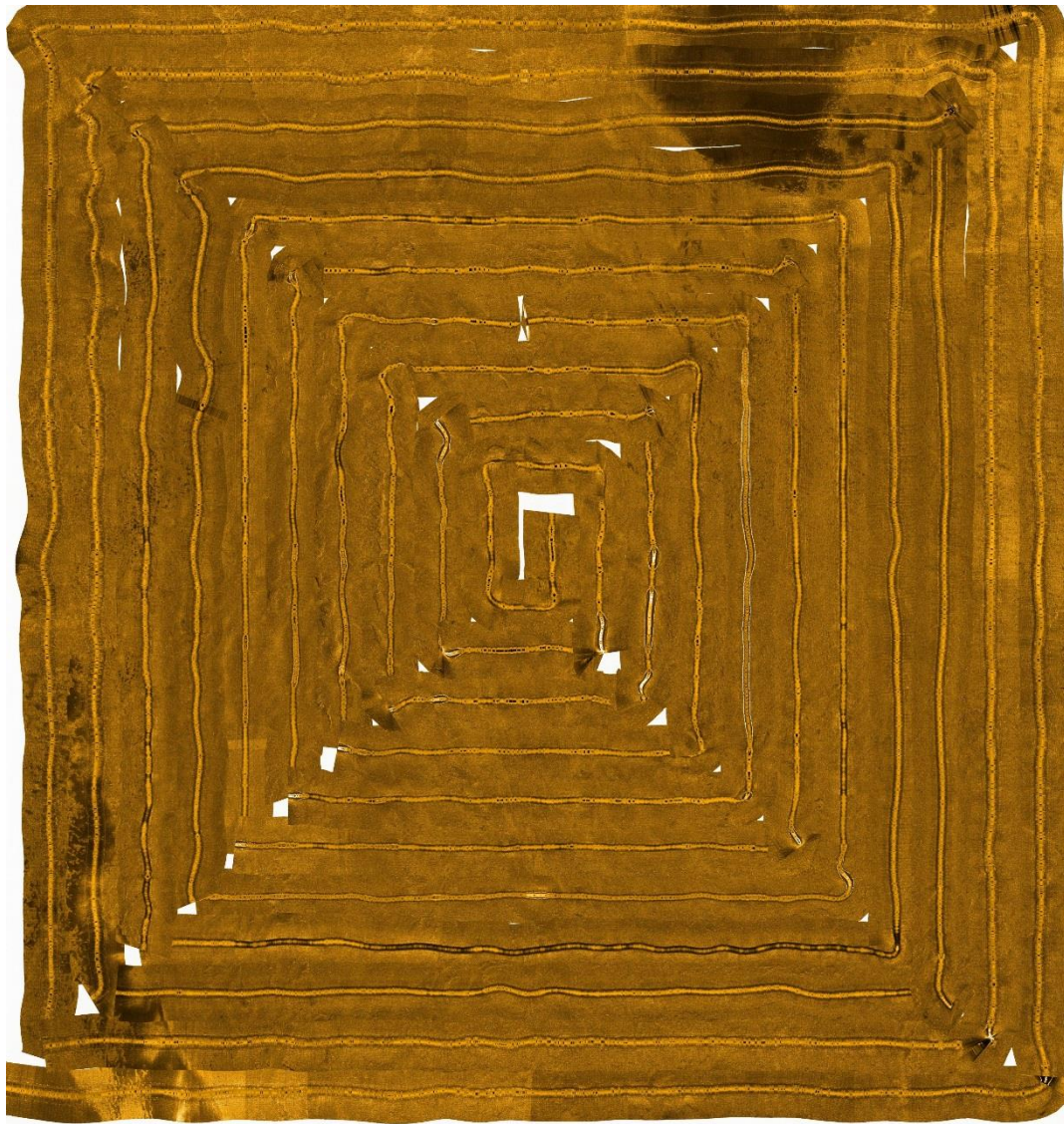


Figure 7.7. Area 1 Multibeam Moasic, 115 km². Survey was conducted with a digital hull-mounted RS Sonic 2024 multibeam echosounder with a F180 vessel attitude and position unit.

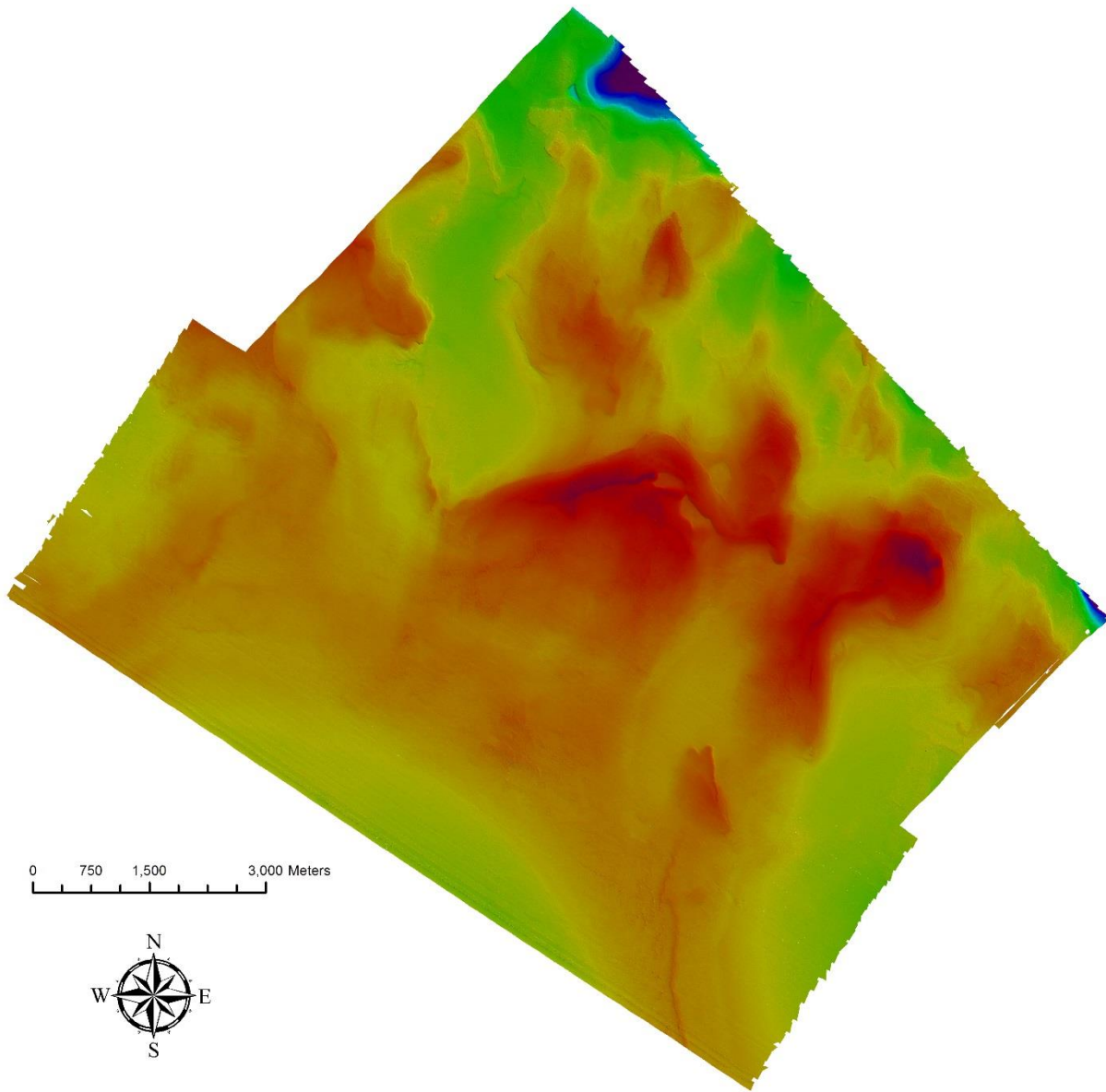


Figure 7.8. Freighter near marker buoy.

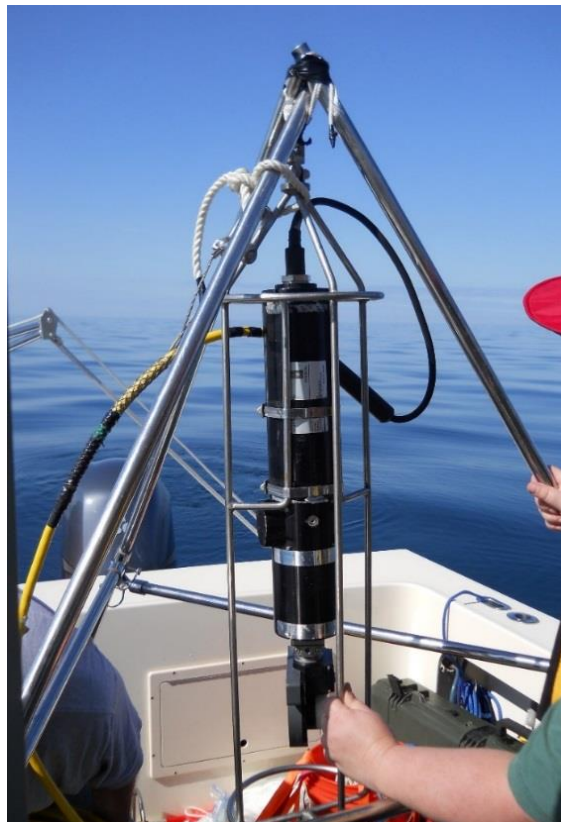


Targets of interest on the sonar mosaics for Areas 1 and 3 were selected for further examination using a remote operated vehicle (ROV) (**Figure 7.9**) and confirmed archaeological structures were selected for finer scale mapping using a scanning sonar (**Figure 7.10**) (See *Recognizing Human Constructed Features* below). [An autonomous underwater vehicle (AUV) was also used for meso-scale surveying for this dissertation (see **Chapter 9**)]. Intensive target investigation and sample recovery was completed at archaeological sites and features via scuba divers and a ponar geological sampler. These research methods have documented archaeological sites and their paleoenvironmental context in both research Areas 1 and 3 (Sonnenburg et al. 2015a).

Figure 7.9. Remote Operated Vehicle used on the AAR project. “Jake” Outland 1000 ROV, Depth rating of 1000 feet.



Figure 7.10. Scanning Sonar used on the AAR project. Kongsburg MS1000 unit (model 1171), dual frequency.



Opportunities and Challenges of Research on the AAR

Initial evaluations of the AAR characterized the landform as an ideal research venue for investigating prehistoric submerged landscapes and archaeological sites. First, given the limited amount of time that the AAR would have been dryland, i.e. ~3000 years between 11,200-8,300 cal yr BP (**Chapter 4**), there is inherent chronological control. Essentially, this is a long enough period of time that repeated patterns in human behavior can be recognized, but a short enough period of time that these patterns are fairly free of “noise” from post-depositional disturbances or later occupations.

Second, the AAR offers ideal depositional conditions for environmental modeling. Given its mid-lake location (Areas 1 and 3 are 50 and 35 miles offshore respectively), there is no source of modern sediment that reaches the ridge. This lack of sedimentation results in archaeological sites that are not deeply buried but offers sufficient ancient sediment for conducting geoarchaeological and paleoenvironmental analyses.

Furthermore, the cold, fresh waters of the Great Lakes provide excellent preservation of organics, including intact rooted 9,000-year-old trees (see below). The AAR also provides a fairly low energy environment over much of its surface, in contrast to the reworking of sediments in near shore and marine contexts due to tidal action and substantial currents. While there is a low energy environment *now*, it was also a low environment *then*, as inundation was relatively rapid, but gentle enough that there appears to have been minimal post-depositional disturbances, exemplified by trees left rooted in place. All these factors contribute to an intact ancient landscape, both environmentally and culturally.

However, there are also limitations to working on the AAR. First, invasive zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussel species attach to all the hard

surfaces in Lake Huron. These mussels cover all the stone constructed hunting structures with layers of shells up to a few inches thick. While large boulder constructions are still obvious, these mussels significantly limit the visibility of smaller artifacts. Bulk sediment samples, and screening on both the lake bottom and the surface vessel have been implemented to recover artifacts made invisible below the surface due to adhering mussels. Secondly, given the extreme conditions of underwater research, specifically working 50 miles offshore, weather conditions severely impact the number of research days in a given year. In the Great Lakes, ice cover is abundant for much of the year, and active research can only take place between April and October. Water clarity and overall visibility is also variable throughout these months, with both the early and late season experiencing cloudy conditions.

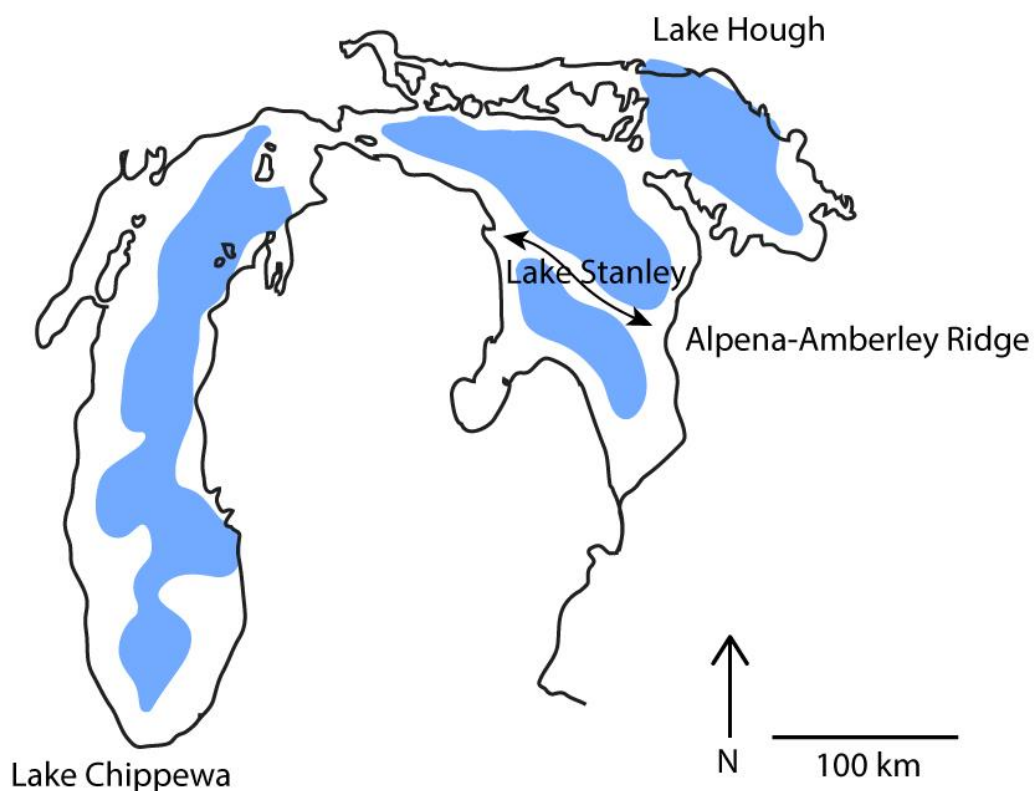
With these issues as general background, what follows is a detailed discussion of the three primary realms of research on the AAR: (1) Environmental Modeling, (2) Agent-Based Computer Simulation, and (3) Archaeological Research. This rest of this chapter will present what was known about the prehistoric environment and archaeological sites on the AAR prior to new research presented in the several following chapters (8-9).

Environmental Modeling: Geoarchaeological and Paleoenvironmental Research

Geoarchaeological and paleoenvironmental reconstruction has been a significant portion of the AAR project. Understanding the background environment and the biota it would have supported is essential for understanding prehistoric hunter-gatherer use of the landscape and the resources which would have been available to them. As is often the case with ancient environments, the paleoenvironment on the AAR was distinctive and has no modern equivalent. The AAR itself is a result of unique glacial and geological processes in the Lake Huron basin,

specifically that the hard and substantial dolomite and limestone ridge withstood erosion from glacial action and remained an intact landform across the basin in post-glacial times. During the Lake Stanley lowstand, the AAR would have separated two distinct lakes, with a third hydrologically closed lake to the north in Georgian Bay, Lake Hough (Figure 7.11, See Chapter 4). Due to this setting, the paleoenvironment of the AAR was different from inland environments.

Figure 7.11. The AAR and associated Paleolakes, including Lake Hough.

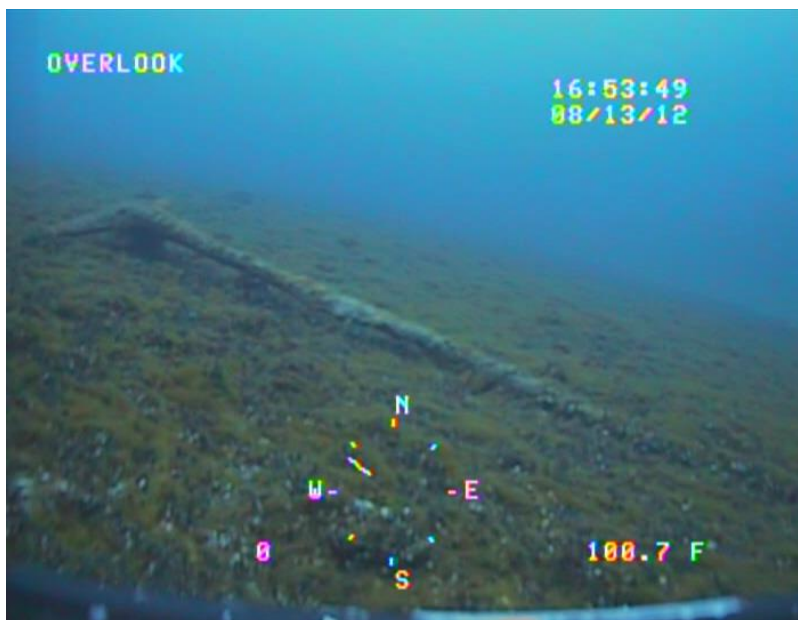


The general picture of paleoenvironments in the Great Lakes is outlined in Chapter 4 and reveals that changes across the region were punctuated and variable. Most significantly, the traditional view of wide spread and rapid shift from spruce to pine dominance at the end of Lake Algonquin ~12,000 cal yr BP (10,600 ¹⁴C yr BP) has been problematized. Rather, on mainland

Ontario, it appears that open parkland with pine, but also spruce, oak, etc. represented an intermediate environment between glacial tundra and closed woodlands, similar to the subarctic today. These peri-glacial environments which existed well into Lake Stanley should not be surprising given the close proximity of the Laurentide ice sheet (See **Figure 4.4**). This glacial ice slowed the Holocene warming of climates and environments which do not appear in the Great Lakes until 7500 cal yr BP (**Chapter 4**). The specific paleoenvironment of the AAR echoes this subarctic setting but also presents its own unique climatic attributes.

Preserved ancient sediment on the AAR have been sampled and analyzed for a range of paleoenvironmental indicators including microfossils (i.e. pollen, testate amoebae), and geoarchaeological analyses of particle material, shape, size and sorting have been conducted (Sonnenburg 2015). In addition, numerous preserved wood fragments and one case of an *in situ* rooted tree have been recovered (**Figure 7.12**).

Figure 7.12. *In situ* rooted spruce tree.



The density of ancient sediment across the AAR is variable, with some higher elevations of exposed bedrock having little to no sediment as a result of scouring, while other localities have up to 25 centimeters of sediment. These latter areas are primarily ancient lakes and beach ridges from when the AAR was dryland. For example, backscatter imagery generated during multibeam investigations in Area 1 clearly shows areas of ancient sand contrasted with rocky areas on the AAR (**Figure 7.13**). Within this area there are two paleo lakes which are connected by a river channel (**Figure 7.14**). ROV and scuba investigations in these areas have documented these sand ripples (**Figures 7.15-7.16**).

Figure 7.13. Backscatter imagery of Area 1. Lighter areas indicated sand.

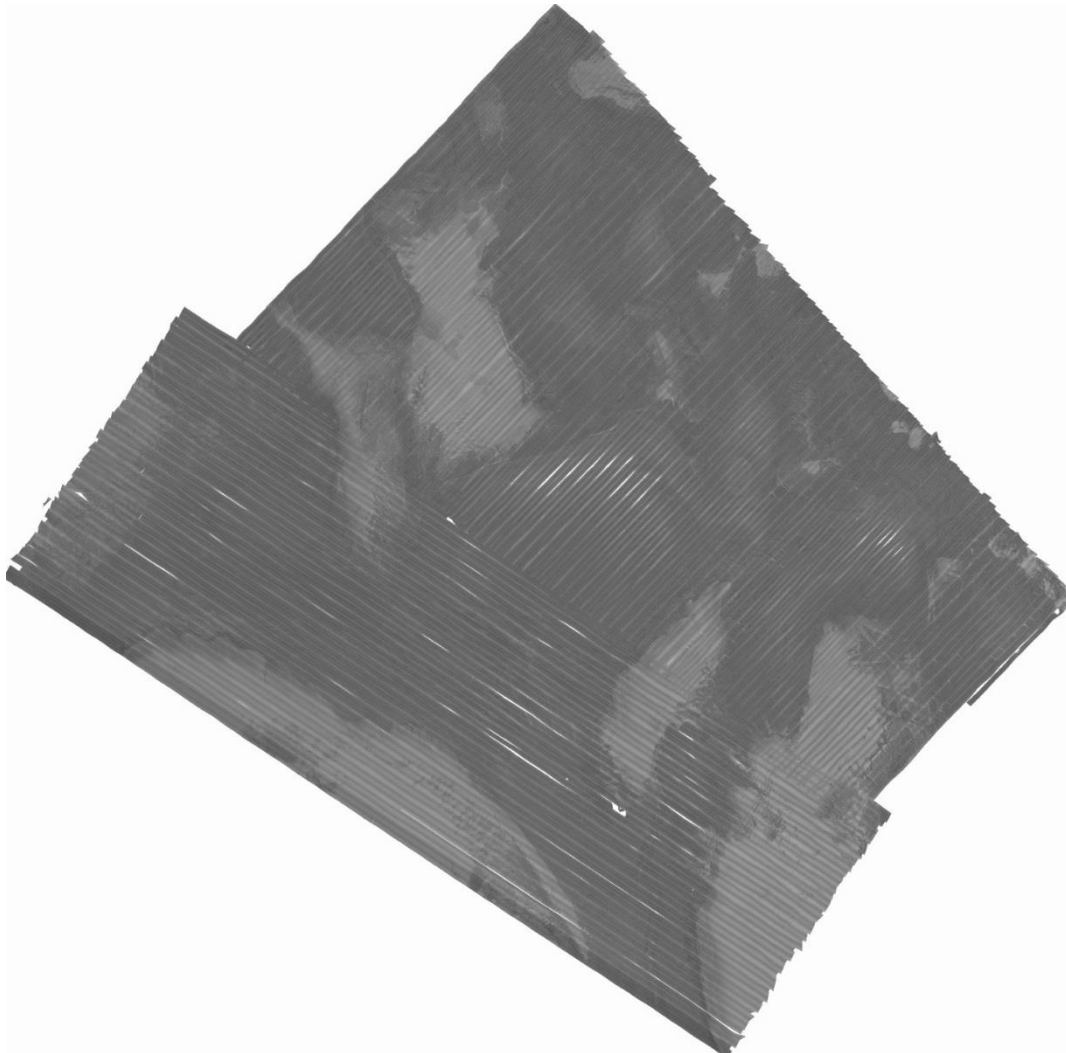


Figure 7.14. Area 1 side scan mosaic with major waterways colored in, and areas of marsh are indicated by thin dashes.

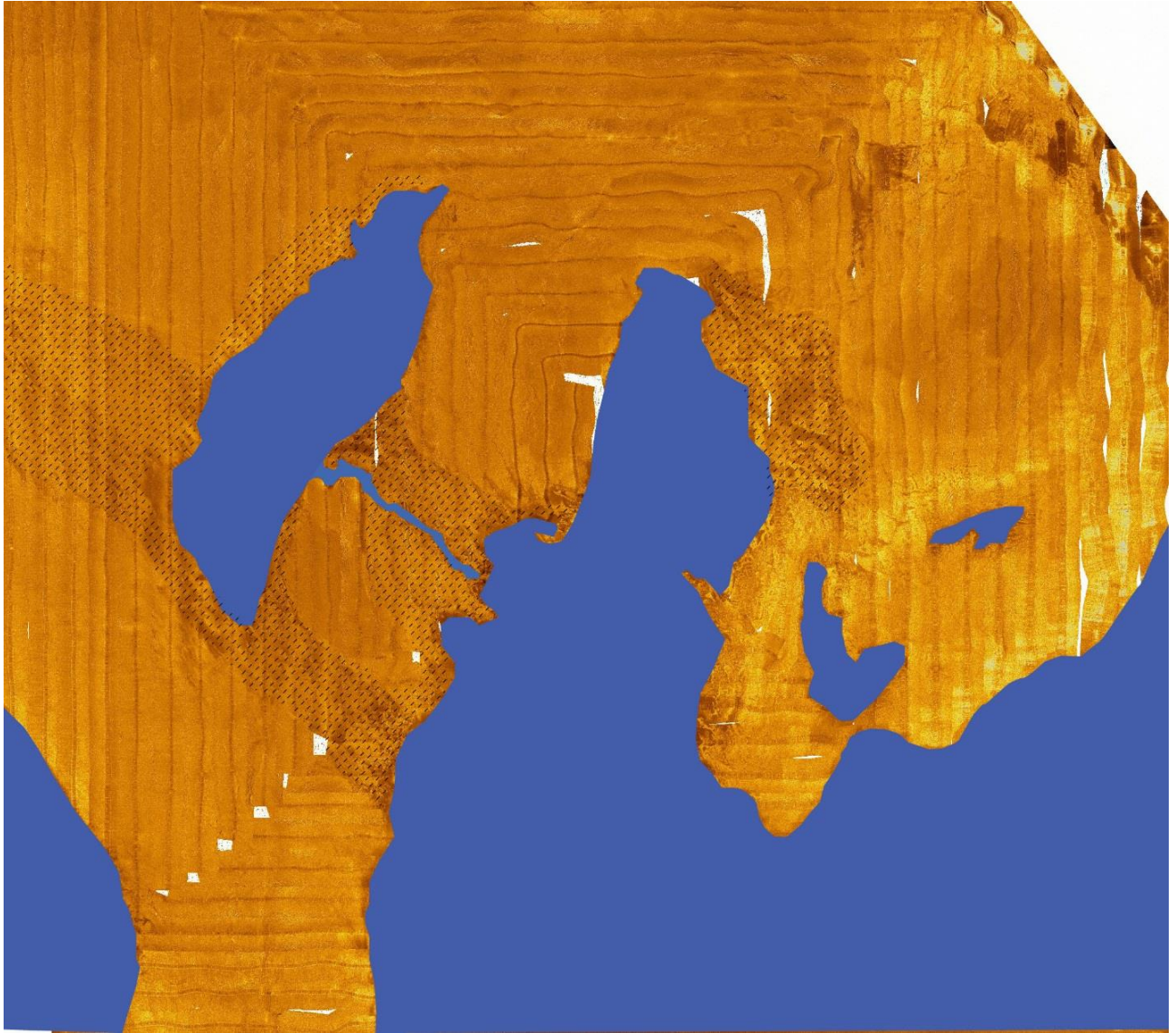


Figure 7.15. ROV image of sand ripples and the ancient lake shore with preserved wood across the boundary.

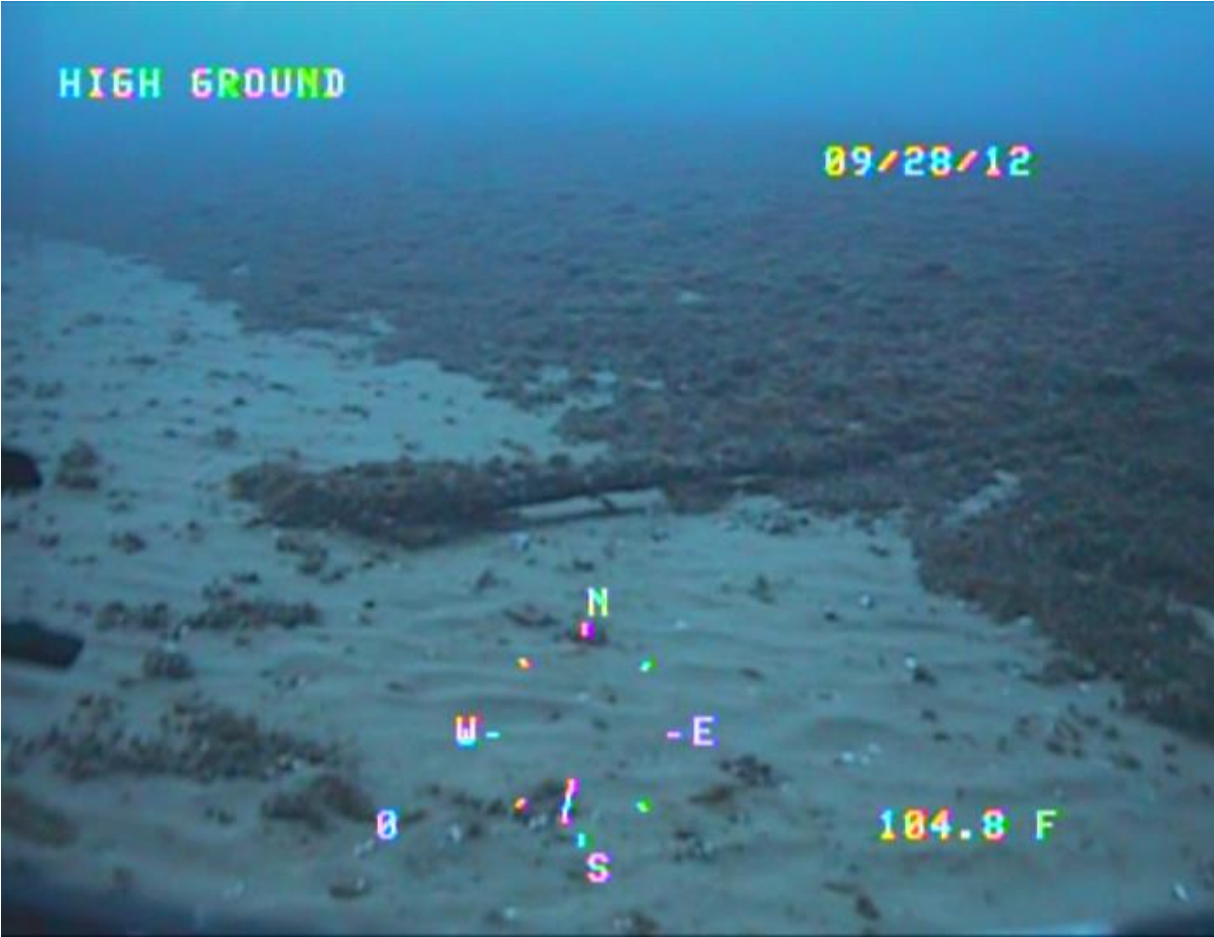


Figure 7.16. Scuba divers measuring and sampling sand ripples.



In general, preserved macrofossils from the AAR indicate a variety of microenvironments within Areas 1 and 3. Testate amoebae are protist organisms that are characterized by a test, or hard shell, which preserves after the organism has died. These amoebae survive at the sediment-water interface and are environmentally sensitive; they also react more quickly to shifts in water levels and climate than pollen (McCarthy et al. 1995). Therefore different species are indicative of specific local paleoenvironments. Testate amoebae from the AAR are representative of fens, sphagnum moss bogs, and inland lakes (See Sonnenburg 2015). Particle size indicates an absence of deep lake sediments which are normally composed of silts and clays, and instead an abundance of sand on the AAR indicates different sedimentary regimes and preservation of ancient sediments. Less well sorted samples are common and indicate a lack of post-depositional transport. Particle shape shows a distinct absence of rounded particles, further supporting intact sediments, a lack of post-depositional movement, and an absence of any modern or mainland sediment (Sonnenburg 2015). Particle material in both Areas 1 and 3 is primarily composed of quartz, followed by chert, and other materials (O’Shea et al. 2014). Finally, preserved wood fragments from the AAR have been identified as spruce, tamarack, and pine and samples of the first two species have been directly dated to Lake Stanley (**Tables 7.1-7.2, Figure 7.17**).

Table 7.1. Summary of general paleoenvironmental results from the AAR, (adapted from O’Shea et al. 2014, Table S1).

| Analysis | Summary of Results |
|--|--|
| Testate Amoebae (Dominant or indicator species) | 6 distinct assemblages based on cluster analysis: Oligotrophic Pond (<i>Diffflugia bologna</i>) Kettle Hole Mire (<i>Centropyxids</i>) Sphagnum Fen (<i>Cyphoderia ampulla</i>) Sphagnum Bog (<i>Hyalosphenia papilio</i>) Spruce/Tamarack Swamp (<i>Diffflugia globulus</i>) Eutropic Pond (<i>Curcurbitella tricuspis</i>) |
| Pollen | Spruce (<i>Picea</i>) Moss spores |
| Particle Size | Sand – 66.16% |

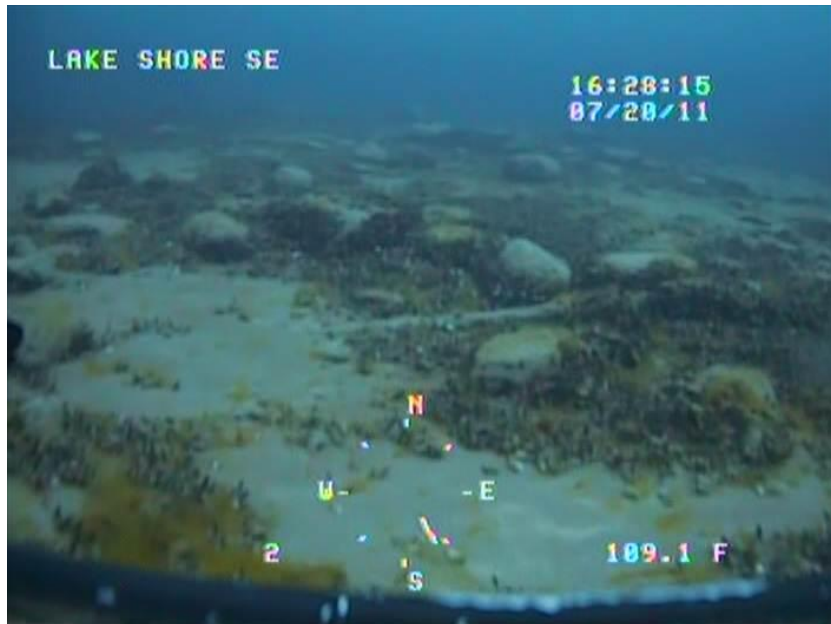
| | |
|---|--|
| Percentage of total Samples | Silt – 23.09% Mud – 10.77% |
| Particle Sorting Percentage of total Samples | Well-sorted – 1.54% Moderately well-sorted – 21.54% Moderately sorted – 26.15 % Poorly sorted – 35.38% Very poorly sorted – 15.38% |
| Particle Shape Percentage of total Samples | Very angular to subangular – 70% Subrounded to well-rounded – 30% |
| Particle Source Percentage of total Samples | Area 1: Quartz, 65%; Chert, 12%; other, 23% Area 3: Quartz 50%; Chert 25%;, other 25% |

Table 7.2. Preserved wood Samples from the AAR and their associated radiocarbon dates (when available), last date was run on charcoal recovered from the middle of a stone ring. Dates from Lake Stanley/AAR dryland are bold.

| Lab No. | Sample No. | Area | Species | ¹⁴ C yr BP | Average | Cal yr BP |
|---------|----------------|------|---------------------------|---|-----------|-----------|
| 221 | AA95226/Wood 1 | 1 | Spruce (<i>Picea</i>) | 8038 ± 46 8102 ± 26 8061 ± 26 | 8067 ± 33 | 8935 |
| 222 | Wood 2 | 1 | Pine (<i>Pinus</i>) | 140 ± 25 88 ± 21 115 ± 21 | | |
| 223 | Wood 3 | 1 | Pine (<i>Pinus</i>) | 115 ± 25 110 ± 21 161 ± 21 | | |
| 224 | Wood 4 | 1 | Spruce (<i>Picea</i>) | 7960 ± 55 | | 8829 |
| 225 | Wood 5 | 1 | Tamarack (<i>Larix</i>) | 7840 ± 40 8102 ± 26 8051 ± 26 8218 ± 27 8230 ± 28 | 8808 ± 29 | 9050 |
| 226 | Wood 6 | 3 | | 111 ± 22 116 ± 23 | | |
| 229 | Wood 7 | 3 | | 612 ± 21 579 ± 21 | | |
| 230 | Wood 8 | 2 | | - 772 ± 27 | | |
| | Wood 9 | 1 | | 8124 ± 28 8201 ± 29 | 8163 ± 29 | 9131 |
| | Wood 10 | 1 | | 111 ± 22 103 ± 22 | | |
| | HG RNG 1 | 1 | | 8432 ± 27 | 8370 ± 35 | 9379 |

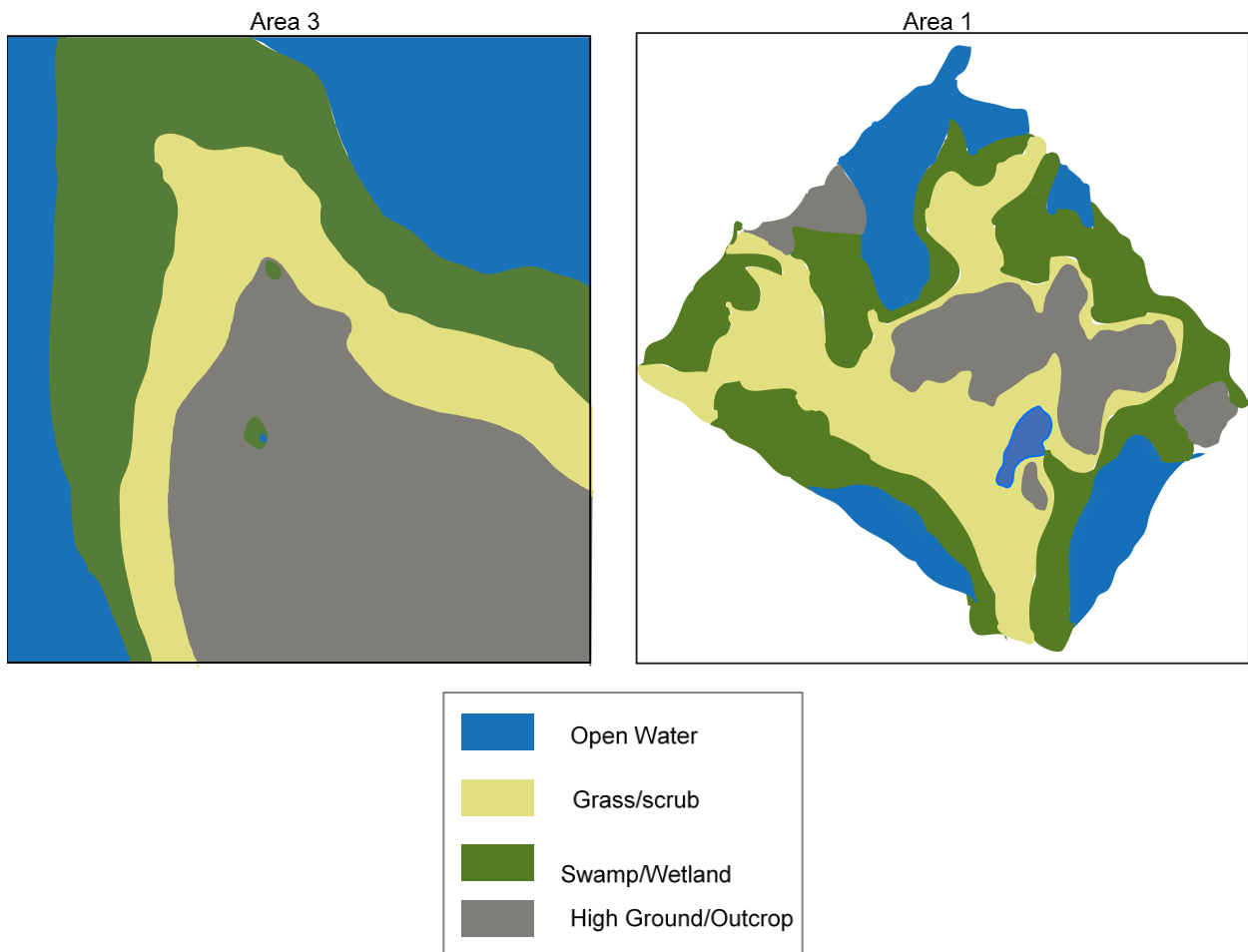
| | | | | | | |
|--|----------------------------------|----------|--|--------------------------------|------------------|-------------|
| | | | | 8311 ± 29 | | |
| | HG_RNG 2 uncarbonized | 1 | | 8163 ± 26 7780 ± 31 | 7971 ± 29 | 8828 |
| | HG_RNG 2 Carbonized | 1 | | 8797 ± 27 8536 ± 27 | 8667 ± 27 | 8828 |
| | 92912F Charcoal | 1 | | 8080 ± 35 | | 9020 |

Figure 7.17a-b. Wood 1 *in situ*.



More specifically, testate amoebae assemblages and pollen recovered from the AAR indicate that Area 1 had a mosaic of shallow lakes and depressions, as well as spruce and tamarack swamps and sphagnum moss bogs (Sonnenburg et al. 2015a). Area 3 is more uniform in terms of its paleoenvironment, with areas of small ponds and sphagnum moss. Forested swamps similar to Area 1 are also found in Area 3 (Sonnenburg 2015) (**Figure 7.18**).

Figure 7.18. Paleogeographic reconstruction of Areas 1 and 3 indicating primary microenvironments, (adapted from Sonnenburg 2015:160, Figure 12.8). (Note: large area in grey indicated “High Ground/Outcrop” in Area 3 has received limited sampling, and areas of bare outcrop are likely overrepresented in this diagram).



These multiple independent lines of evidence indicate that the AAR had intermittent tamarack and spruce tree stands, marshy areas with sphagnum moss, and smaller lakes and

rivers. This type of subarctic environment fits well with the mid-lake location of the AAR as an area that would have likely remained much cooler than the mainland. Additionally, the landform itself likely channeled wind and waves creating cooler temperatures (McCarthy et al. 2015). These cooler temperatures account for the paleoenvironment differences between mainland Ontario and the AAR.

The AAR represents one part of a mosaic of paleoenvironments across the Great Lakes Basin at this time, i.e. closing woodlands in Ontario and Southern Michigan, hardwood forests further south in Ohio and Indiana, and the sedge swamps on the old Algonquin lake bed in Northern Michigan (**Chapter 4**). Compared to some of these environments, specifically the forests on the mainland, the AAR would have been a productive environment for certain species of plants and animals. As the AAR presented a very different set of environmental conditions compared to adjacent areas, it would have been particularly attractive to cold adapted plant and animal species characteristic of the Pleistocene.

These areas would have been natural magnets for ungulates with more open grazing areas. In addition to swamps and spruce trees, on AAR cold lake waters and winds along the ridge kept this landform cooler with likely fewer insects than the mainland. These combined factors: productive forage for ungulates, cooler climates, and general subarctic paleoenvironment would have made the AAR an ideal habitat for migrating caribou – particularly given the species' unique ability to quickly expand into newly available territories (**Chapter 5**). Furthermore, the AAR periglacial environment would have been more productive than contemporary subarctic environments as given its lower latitude, more sunlight likely reached the AAR; resulting in longer growing seasons, more forage, and larger caribou populations.

Therefore, given this environmental reconstruction, the AAR was likely a refugium for cold adapted species such as sedges, mosses, and caribou.

While caribou bones are rarely found in archaeological sites in the region due to highly acidic soils (**Chapter 5**), paleontological specimens from the Pleistocene-Holocene transition indicate that these animals were much more common in the Great Lakes than traditionally assumed (Lemke 2015b). The AAR was an ideal habitat for these relict caribou populations in the Great Lakes at the beginning of the Holocene. It has been hypothesized the caribou inhabited other areas of the Lake Huron basin which are now submerged, such as Georgian Bay north of Tobermory and the AAR (Janusas et al. 2004:12; Lemke 2015b), and caribou remains from lakes and bogs are fairly common in Michigan (**Figures 7.19-7.20**) (Lemke 2015b)¹. It is clear that the substantial morphological and behavioral variation in *Rangifer* is mediated by local environments (**Chapter 5**), therefore it is likely that the caribou inhabiting the AAR would have migrated to winter and summer ranges in this subarctic environment that likely had significant seasonality.

¹ Given these anaerobic depositional environments, these remains likely contain ancient DNA that could be used to better understand prehistoric caribou populations, isolation of certain herds, and patterns of movement (e.g Røed 2005). Additionally, isotopic studies would be useful for determining if these ancient herds migrated similar to prehistoric herds in Eurasia (i.e. strontium studies conducted by Britton et al. 2011).

Figure 7.19. Dated *Rangifer* remains from the Great Lakes Basin and ancient water levels. Curved line represents generalized high water and low water stands across the entire basin. The absence of dated remains during Lake Stanley indicates that a portion of archaeological and paleontological records from this time period are underwater (Lemke 2015b:279, Figure 3).

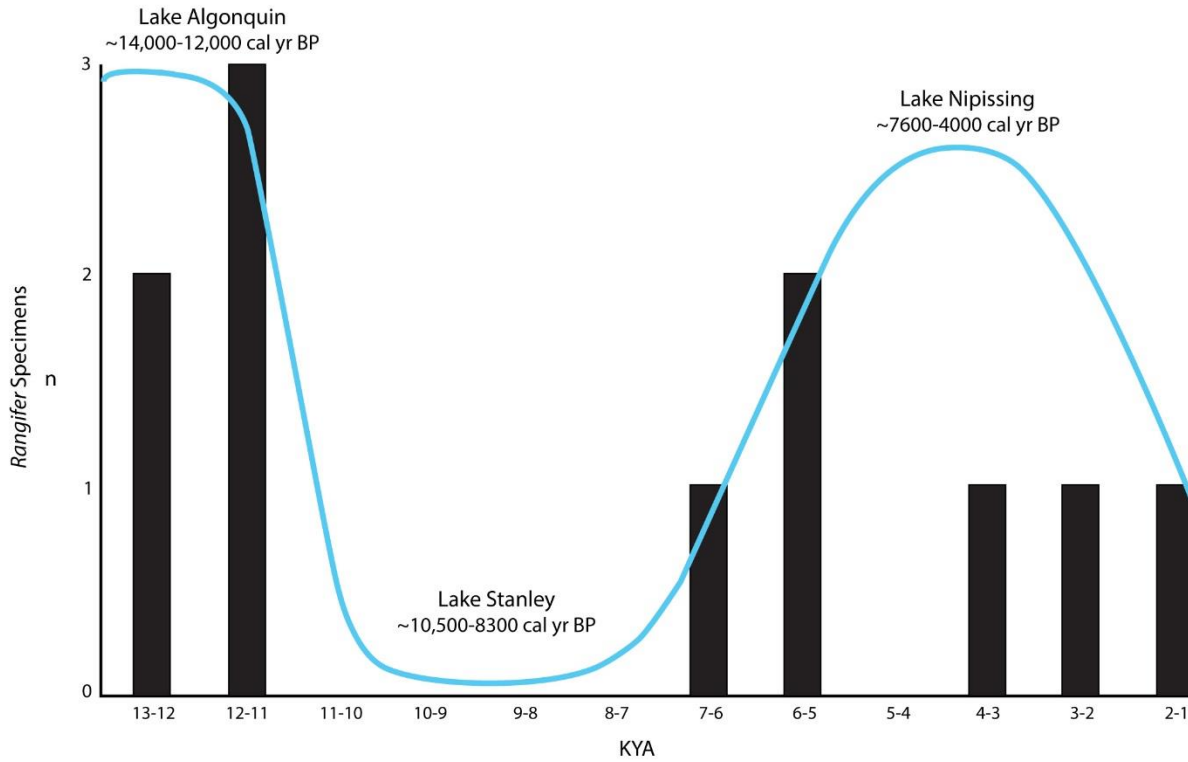
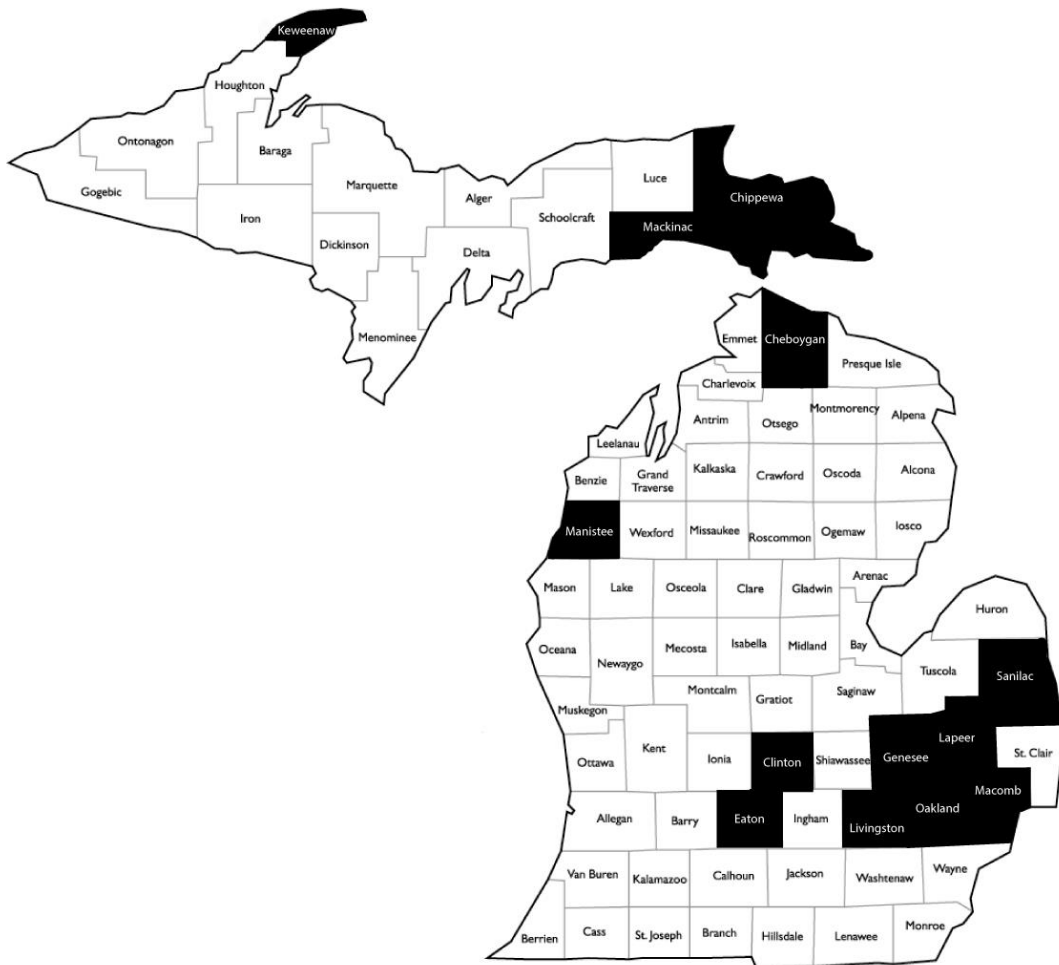


Figure 7.20. Geographic distribution of *Rangifer* remains by county in Michigan (Lemke 2015b:277, Figure 1).



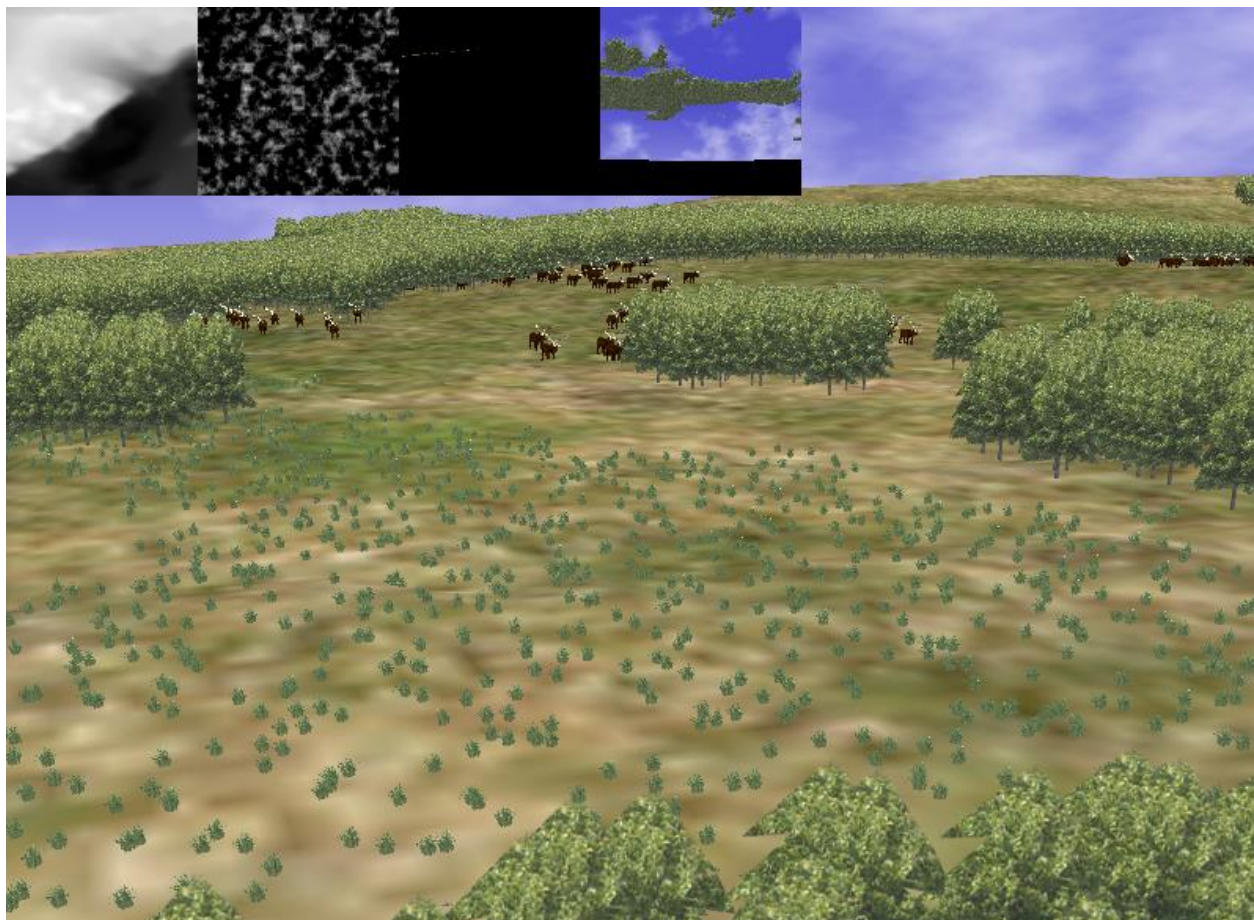
Agent-Based Computer Simulation

A secondary realm of research concerning the AAR is the implementation of a virtual world model of the land bridge. Given the constraints of underwater research, specifically the cost and large research areas – a computer simulation was designed to create a model of the prehistoric landscape. This simulation was created to, (1) incorporate new paleoenvironmental data into a reconstructed environment, (2) run an agent-based model of caribou migrations across

the AAR to predict common routes, and finally, (3) use all this information to predict likely locations for archaeological sites related to caribou hunting (Fogarty et al. 2015).

Using the detailed bathymetry and side-scan sonar mosaics of Lake Huron and the AAR, this virtual world depicts the topography of the AAR when it was dryland, down to a 1 meter square resolution. All new environmental data collected from the AAR is relayed to the computer simulation and added to the virtual world to continuously update the model and create a more accurate picture of what the ancient environment would have looked like (**Figure 7.21**).

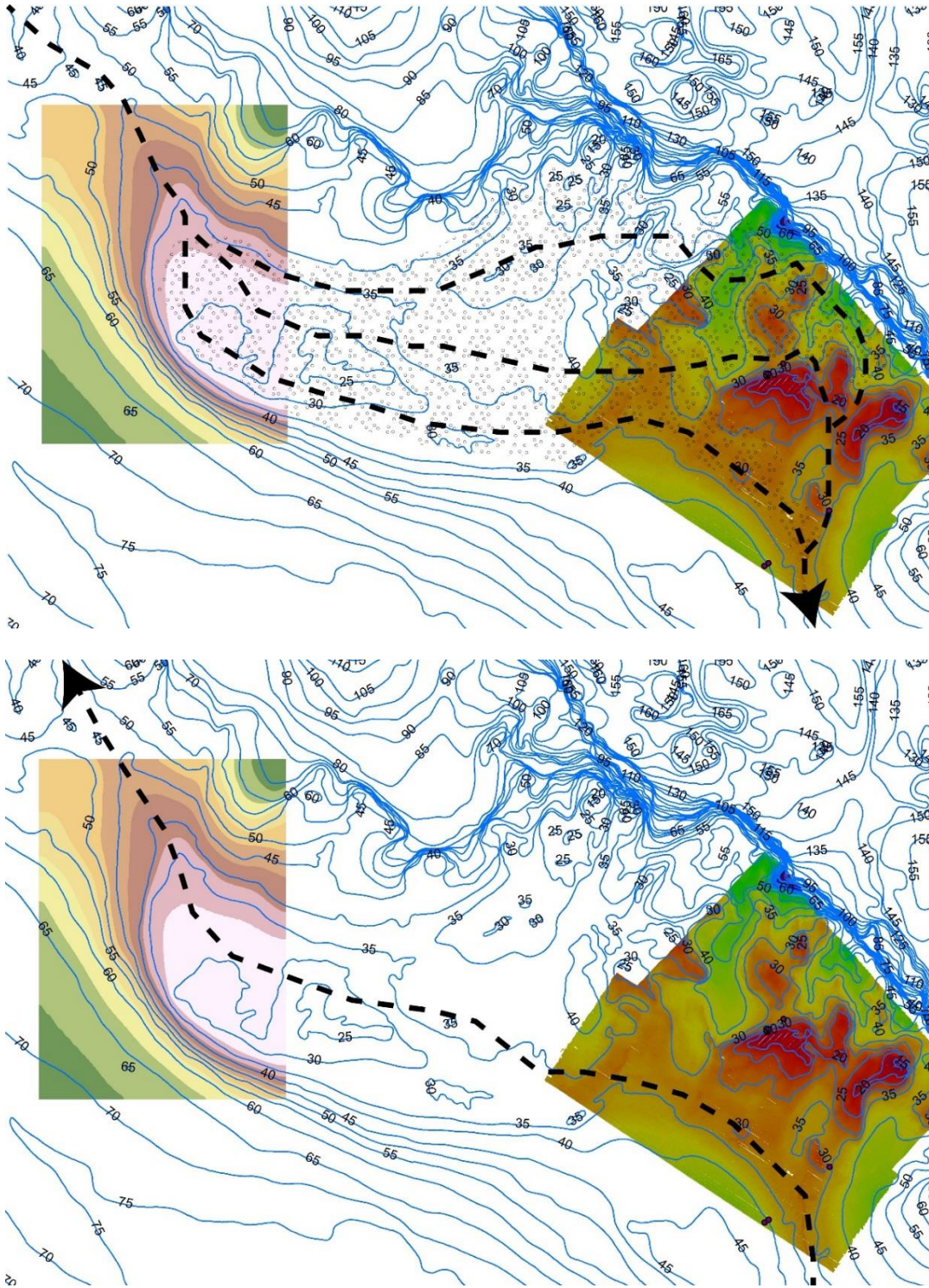
Figure 7.21. Screen shot of the AAR virtual world with simulated environment and caribou.



Once a virtual world model of the AAR was completed, caribou were added. The agent caribou were instilled with learning capabilities as they become more familiar with the environment and learn ideal paths across the AAR (Fogarty et al. 2015). These individual agent caribou in the computer simulation were given particular constraints and goals and were then allowed to traverse the virtual AAR thousands of times. These constraints include basic needs such as forage and water, as well as a herding algorithm that mimics herd movement during large scale migrations. These rules for caribou movement have been refined using ecological literature concerning caribou migratory behaviors – for example, those listed in **Chapter 5**, such as their tendency to follow ridges, rivers, and other linear features for some time before crossing them.

From these iterative runs of the computer simulation, the most common migration paths taken by the agent caribou during both the fall and spring have been distilled. The simulation supports general patterns of caribou migration patterns from biological literature which often differ in the fall and spring. For example, the rate and timing of fall migrations is variable and largely weather dependent; as large herds move south to more temperate areas they stop frequently to forage. Fall migration routes are therefore less direct and the rate can be fairly slow but are the largest concentration of animals as males and females migrate together. In contrast, spring migrations to the calving grounds are led by pregnant females and tend to be quick and direct (see **Chapter 5**). The patterns of migration routes which emerged from the simulation match these general patterns, with several primary routes in the fall, and one very direct path in the spring (**Figure 7.22a-b**).

Figure 7.22. Caribou migration routes across the central portion of the AAR as predicted by the computer simulation. North is up, contour interval is 5m, and colored/grayscale areas represent larger research areas (see Figure 7.3) which have been mapped using side scan and multibeam sonars. a. Fall migration routes. b. Spring migration routes.



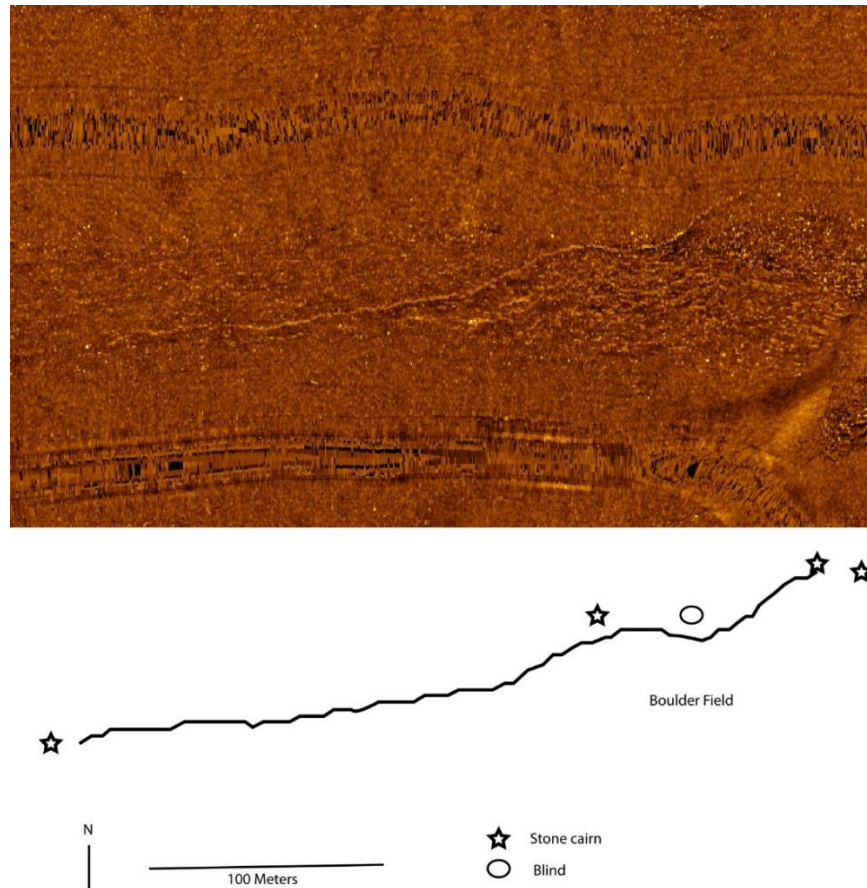
These simulated migration routes are helpful for predicting chokepoints on the AAR where caribou were likely to pass during both migrations and which would have been ideal locations for hunting sites. First, the caribou migration routes are partly a function of general AAR topography. For example, there are several areas where the AAR is narrow and migrations would have had to pass through these areas in both seasons out of necessity. Additionally, a vital component of hunting architecture is the strategic use of the local topography in order to have the most hunting success, i.e. high ridges for good visibility, places where the structures are mostly concealed, near migration routes or water sources, etc. (**Chapter 3**). Given the simulation routes and detailed topography, certain places are more likely than others to have been chosen as hunting sites.

The computer simulation has therefore narrowed the larger research areas on the AAR to specific locations that are likely to have been traversed by caribou during both seasons and likewise are probable areas for hunting sites. The research conducted specifically for this dissertation compares two such areas on the AAR. Both are narrow chokepoints where agent caribou migrated during both seasons. One of these chokepoints, in Area 3, has been the location of prior research – an area where one of the most complex archaeological sites and hunting structures located on the AAR has been located (see O’Shea et al. 2014 and below). Additional fieldwork was conducted in this area as well as in an entirely new area to further assess the computer simulation results, and to test a general model of hunting on the AAR (See **Chapters 8-9**).

Archaeological Research

Archaeological research on the AAR has consisted primarily of investigating targets of interest on the sonar mosaics as potential sites. After the discovery of hunting structures, specifically the Dragon drive lane and hunting blind (the first reported structures) (O’Shea and Meadows 2009, **Figure 7.23**), it was clear that stone constructed features could be detected with side scan sonar as hard rocks provide a clear acoustic signature, i.e. a bright reflection. Once a target of interest has been selected from the sonar, the site is visited by a remote operated vehicle (ROV) to collect and record live video of the lake bottom to determine if the stone structures appear to be human modified (e.g. O’Shea 2015a).

Figure 7.23. Dragon Drive Lane and hunting blind on side scan sonar with schematic.



Recognizing Human Constructed Features

The recognition of human constructed features on the AAR follows a layered search process and confirmation system. As these features are constructed out of the locally abundant stone resources on the ridge – a system of determination for anthropogenic versus geological processes was developed. Overall, this system follows the same guidelines for identifying stone constructed hunting features used on land:

“It has to be emphasized that stone-built caribou-hunting systems are sometimes difficult to identify in the terrain (Blehr 1990:311; Gordon 1990:281; Grønnow 2009:206) as in each case single-stone *inussak* has to be differentiated from natural boulders, e.g. from erratics left by glaciers (French 1996:156-157; Humlum 1988) or by ice rafting at lake shores (Barnes et al. 1994; Dionne 1979).” (Pasda 2014:69, Endnote)

Even when working in a terrestrial setting archaeologists must train their eyes to locate such structures as they are often very ephemeral on the landscape – and the use of native informants has greatly enhanced survey for such features in Canada (Stewart et al. 2000; Stewart 2015). For example, west of Hudson Bay, analogous stone constructed features to those on the AAR were used by the Caribou or Inland Inuit since 1800. For the Inland Inuit, the archaeological record is supplemented by oral history and a detailed historical record (e.g. Andrews and Zoe 1997; Freisen 2002; Janes 1983; Lyons et al. 2010; Stopp 1994, 2002). Consequently, for this region stone facilities have been located and the circumstances of their construction and use has been recorded (e.g. **Figures 7.24-7.25**; Stewart 2015). Comparison between these known forms helps discriminate between cultural and natural features under Lake Huron (Stewart 2015).

Figure 7.24. Wall ring hunting blind facing caribou trails, (adapted from Stewart 2015:91, Figure 8.9).



Figure 7.25. Hunting blind facing a river crossing, (adapted from Stewart 2015:94, Figure 8.11).



The first layer of research is the large scale mapping using side-scan and multibeam sonar to locate potential features. The resulting sonar mosaics are then used to select targets of interest that do not appear to be natural features such as moraines, ice thrusts, etc. At this stage, potential targets are selected if they appear to be linear, rectangular, circular, or form other non-random patterns. During this phase, and subsequent video investigation with the ROV, potential structures are compared to other rock formations within each region, across the AAR, and to known terrestrial hunting features (e.g. Stewart 2015). Potential targets differ a great deal in scale and shape from natural features, i.e. glacial eskers and moraines are much larger and uniform than stone constructed features.

The overall position on the landscape for each potential structure is also evaluated. For example, none of the hunting structures identified on the AAR are very close to the edge of the landform, where ice rafts could conceivably create linear features. In addition to these considerations and comparisons, the environmental context, position on the local topography (i.e. up on a high ridge, in narrow valley etc.), and presence of associated cultural material is also evaluated for each potential structure. Significantly, all of the hunting structures identified on the AAR are where they would be expected to be, i.e. no features have been located in/under ancient lakes on the AAR and many are located on high ridges, in narrow valleys, or adjacent to river crossings, exactly where such sites are known on land (**Chapters 3 and 5**). Importantly, given the restrictions on underwater research, to date all the areas which have been investigated were specifically selected because they were the most likely places for hunting architecture. Therefore, prior research is not comparable to a random test. Investigations conducted specifically for this dissertation begin to approximate such a test (**Chapter 8**).

Once potential targets have been confirmed as human modified from these methods, the final phase involves scuba diving to collect paleoenvironmental data for each site and to recover archaeological materials. These operations have proved successful for reconstructing the specific paleoenvironments of Areas 1 and 3 (see above) and in locating archaeological materials (lithic, faunal, organic), in or near the hunting structures themselves. The very presence of artifacts provides independent and direct support for the human modification of the AAR landscape and the construction of stone hunting features.

Stone-Constructed Features

Ethnographic (Stewart et al. 2000; Stewart 2015) and archaeological (e.g. Brink 2005; Grønnow et al. 1983) descriptions of caribou hunting structures characterize them as relatively simple constructions that take advantage of the local topography and available materials. These same features describe the AAR structures. All of the AAR constructions are made from the locally abundant stone on the ridge, and all have been identified using the strategy outlined above. Previous research on the AAR has identified 74 probable human constructed features (O’Shea 2015b) (**Table 7.3**).

Table 7.3. Types of stone constructions on the AAR and number of occurrences in each research area, (adapted from O’Shea 2015b:132, Table 10.1).

| Type | Area 1 | Area 3 | Total | Percent |
|-------------------------|--------|--------|-------|---------|
| Stack/Cluster of Stones | 15 | 10 | 25 | 34 |
| V | 3 | 14 | 17 | 23 |
| Line | 9 | 8 | 17 | 23 |
| Circle/Ring | 3 | 1 | 4 | 5 |
| Pile | 1 | 3 | 4 | 5 |

| | | | | |
|----------------------|-----------|-----------|-----------|------------|
| Rectangle | 1 | 3 | 4 | 5 |
| Complex Construction | 2 | 1 | 3 | 4 |
| Upright Stone | 0 | 1 | 1 | 1 |
| <i>Total</i> | <i>34</i> | <i>41</i> | <i>74</i> | <i>100</i> |

The majority of these structures cluster into four localities (**Table 7.4**). Each of the localities represents a topographic setting on the AAR which fits expectations drawn from terrestrial hunting architecture sites (**Chapter 3**). For example, the majority of AAR structures are found on high, overlooking ridges as represented by the Dragon and Overlook Localities (**Figures 7.26-7.27**), adjacent to river crossings such as the Crossing Locality (**Figure 7.28**), or are situated in narrow valleys such as the Gap Locality (**Figure 7.29**). All of these areas are near migration routes predicted by the computer simulation (seen also O’Shea 2015b; Lemke and O’Shea 2015).

Table 7.4. Four primarily localities with hunting architecture on the AAR.

| Area | Locality | Geographic Setting | Depth (m) | Structures (n) |
|-------------|-----------------|---------------------------|------------------|-----------------------|
| 1 | Crossing | River crossing | 37 | 21 |
| 1 | Dragon | Ridge top | 20 | 5 |
| 3 | Gap | Natural funnel | 32 | 29 |
| 3 | Overlook | Ridge top | 37-41 | 6 |

Figure 7.26. The Dragon Locality in Area 1 with hunting architecture sites indicated. The distribution of structures is overlain on the multibeam sonar mosaic of depth. The contour interval is 5 meters reported in depth below surface. The location labeled “complex line” is the Funnel site.

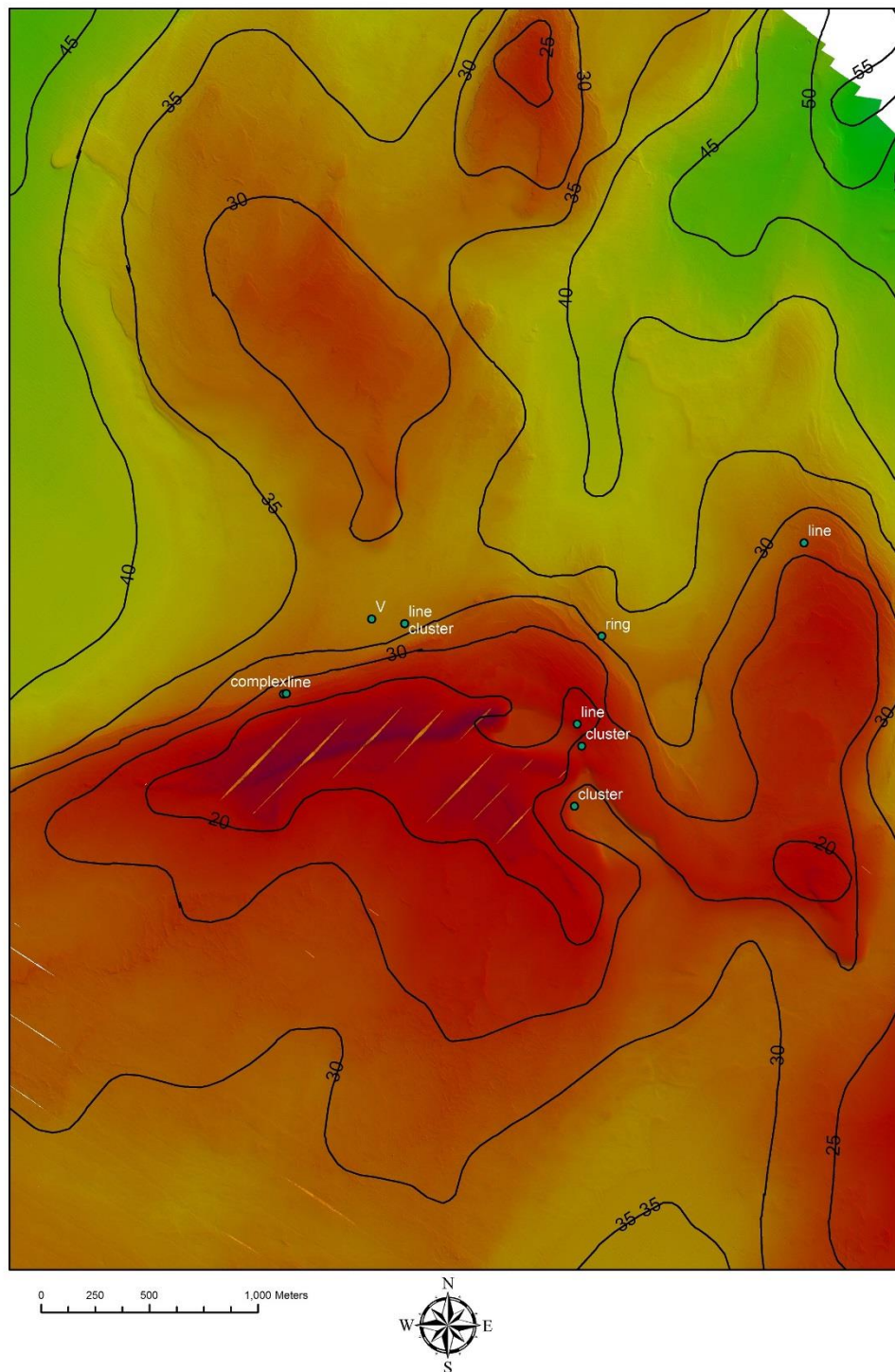


Figure 7.27. The Overlook Locality in Area 3 hunting architecture sites indicated. The distribution of structures is overlain on the side scan sonar mosaic. The contour interval is 5 meters reported in depth below surface.

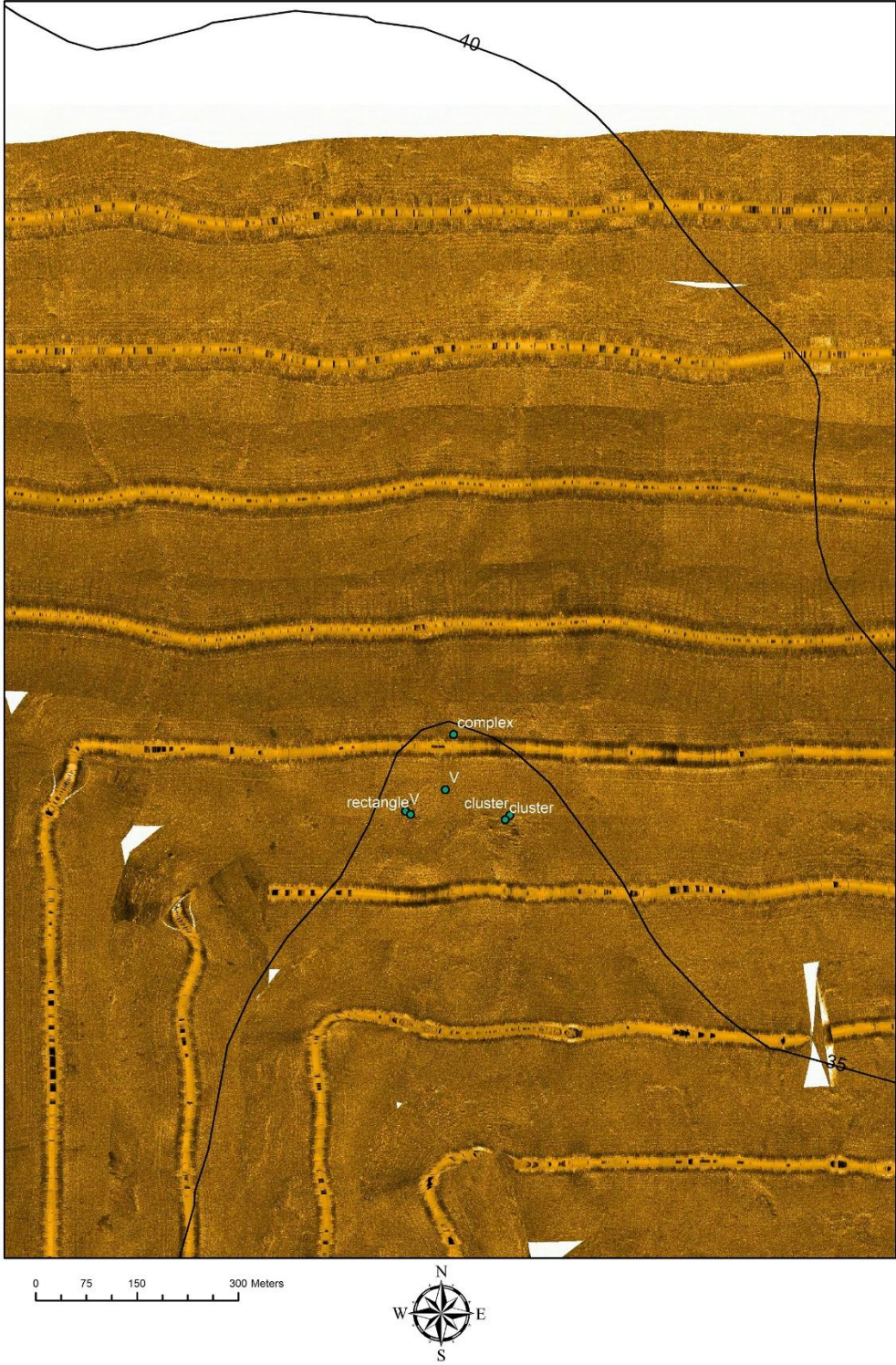


Figure 7.29. The Gap Locality in Area 3 hunting architecture sites indicated. The distribution of structures is overlain on the side scan sonar mosaic. The contour interval is 5 meters reported in depth below surface. The majority of structures are placed within channeling glacial deposits.



The AAR structures can be grouped into two broad categories: simple and complex. Simple structures are defined as single features that take a variety of shapes: open or V structures, enclosed, linear, as well as small rings and circles, stone piles, stacked stones, and upright stones. In the following sections, a representative sample of each structure type will be described. Complex structures are defined as sites containing more than one simple structure that function together.

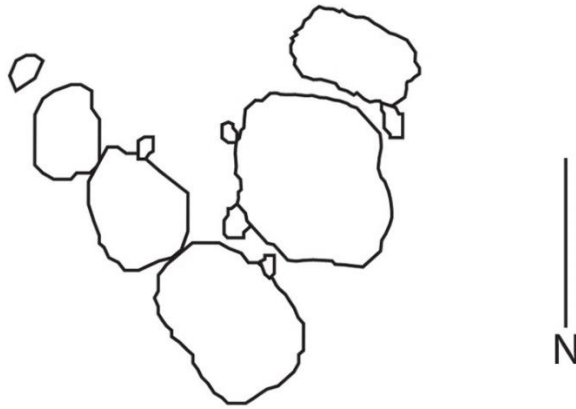
Open or V-Structures

Open or v-shaped structures are the simplest form of modification found on the AAR (**Table 7.5**). These structures likely served as hunting blinds as their open form makes them unsuitable for use as a cache or for other functions, although they may have been used a shelter or a windbreak. Most likely these structures were multifunctional and served as both hunting blinds and windbreaks. V structures are typically constructed with a single large stone that forms the apex of a “v” shape, with two lines of smaller stones forming the arms of the “v” (**Figure 7.30a-b**). These lines of the arms of the “v” are sometimes extended after a small gap. The size of stones used to construct v structures are variable, although the apex stones are typically larger, i.e. a meter across and 60-110 cm high. The total width of the interior main v is an average of 3-4 meters. Given their open form, their orientation provides a clear indicator of the direction in which the animals would approach these structures. In this way, they are *directionally-dependent* in that they would only adequately conceal the hunters in the animals were coming from one specific direction (O’Shea et al. 2013).

Figure 7.30a-b. V-shaped hunting blind. Depth 105 feet (32 meters), a. ROV captured image of the structure, b. schematic of the same structures.



V Structure
Lake Huron



Depth = 105 feet/ 32 meters
8/19/2011

—
One Meter

Table 7.5. Representative sample of Open or V-shaped structures on the AAR.

| Name of Structure | Area and Locality | Size | Orientation |
|-------------------|----------------------|--|-------------|
| V-Structure | Area 3, Gap Locality | 5 boulders, arms form a 50 degree angle, each arm is 3 meters long | North |

| | | | |
|------------------------------|---------------------------|--|-------|
| Ash-Gap V | Area 3, Gap Locality | Length 4 meters, width 3.5 m | North |
| V with rectangular structure | Area 3, Gap Locality | | North |
| Overlook Blind | Area 3, Overlook Locality | Apex very large boulder (2.2 m long, 0.8 m high), rocks that comprise arms are 24 cm | East |

Enclosed Structures

Enclosed structures are similar to v-structures but rather than having a large opening, these structures are closed (**Table 7.6**). The first such structure identified was the Dragon Blind, named due to the long sinuous line of rocks that is associated with this structure. The Dragon Blind is composed of 3 flat topped boulders that are 90 centimeters high. The main structure is triangular and the interior space measures 2.5 by 2 meters (**Figure 7.31**). The Dragon Blind is a representative of enclosed structures but as it is also associated with a long drive lane and it is part of a complex structure – the Dragon Drive Lane (see below). Another enclosed structure is the T-V blind that also likely functioned as a hunting blind. It is overall v-shaped and therefore has a measurable orientation but it is more closed than other v structures (**Figure 7.32**). The west v blind is actually a rectangular structure (**Figure 7.33**). Following ethnographic parallels (*cf* Stewart 2014, Fig. 13, (**Figure 7.34**) this structure may have been used as a cache.

Table 7.6. Representative sample of Enclosed Structures on the AAR.

| Name of Structure | Area | Size | Orientation |
|--------------------------|---------------------------|-----------------------------------|--------------------|
| Dragon Blind | Area 3, Gap Locality | 90 cm high, 2.5 by 2 meters | N/A |
| T-V Blind | Area 3, Gap Locality | 3 large boulders. 2.5 by 2 meters | Northeast |
| West V Blind | Area 1, Overlook Locality | Rectangle, 305 by 3 meters | N/A |

Figure 7.31. The Dragon Blind.



Figure 7.32. T-V Blind.

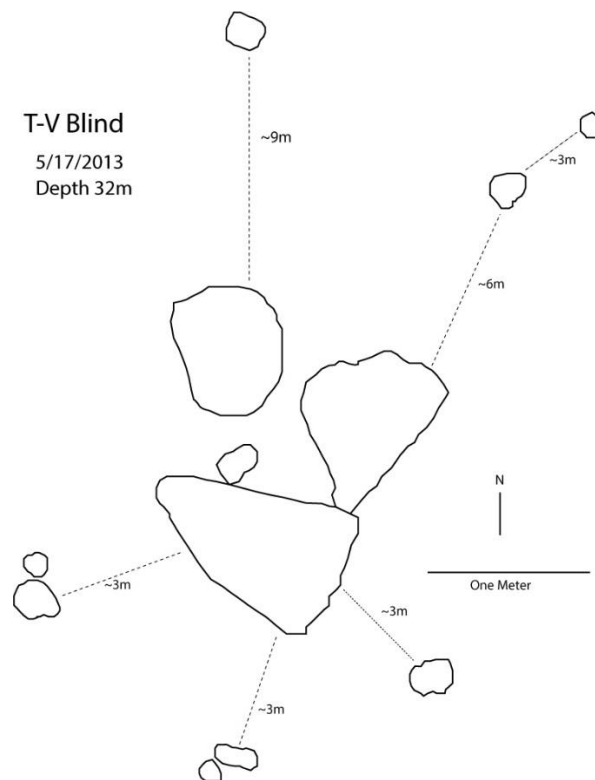


Figure 7.33. Rectangular structure on the AAR, likely a meat cache. Depth 116 feet (35 meters).

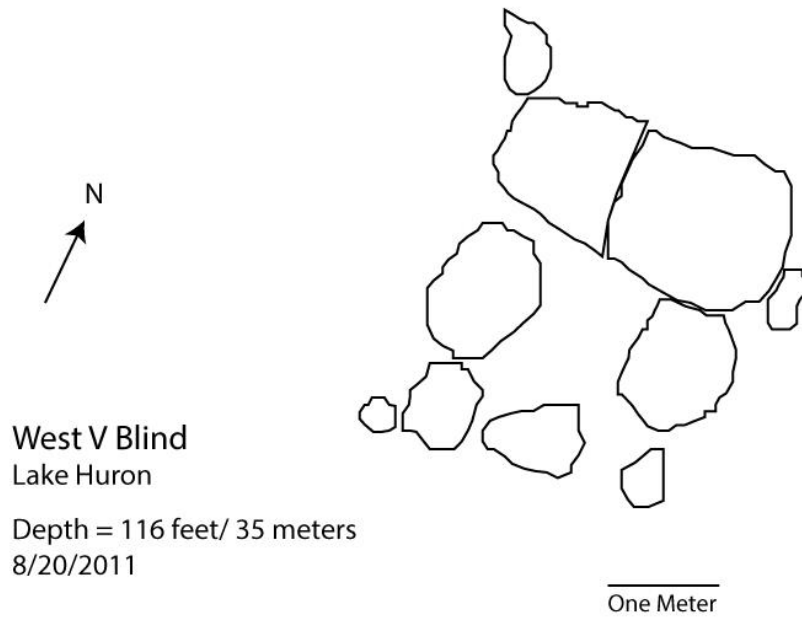


Figure 7.34. Rectangular structure along the Kazan River, Canada (*foreground*), standing stone inuksuit in the background (Stewart 2015:89, Figure 8.7b).



Linear Structures

Lines of stones are one of the principle elements of many caribou drive lanes (Brink 2005; Stewart et al. 2000; Friesen 2013). Terrestrially these linear formations are often found in combination with other lines, hunting blinds, and stone piles or cairns (i.e. *inuksuit*). While isolated lines found on the AAR are difficult to distinguish between human constructed or natural alignments, two lines on the AAR are in close association with other hunting features which lends weight to their human construction. Similar to the Dragon Blind, these lines therefore form part of complex structures discussed below (**Table 7.7**).

Table 7.7. Representative sample of Linear Structures on the AAR.

| Name of Structure | Area | Size | Orientation |
|--------------------------|-------------------------|-------------|-------------------------------------|
| Dragon Drive Lane | Area 1, Dragon Locality | 365 m long | Southwest to northeast running line |
| New Gap Line | Area 3, Gap Locality | 12 m long | North –South |

Other Constructed Features

Several other kinds of structures have been recorded on the AAR that are similar to caribou hunting sites on land, including small rings, circular structures, stone piles, stacked stones, and upright stones. The archaeological recognition of these less regular constructions is difficult given the pervasive covering of all hard surfaces with mussels and algae, as well as the uncertainty in distinguishing true cultural modification from natural occurrences. Therefore, the number of these types of structures is likely *under-representative* of what was actually used by prehistoric hunters on the AAR.

A number of small rings have been identified that average 1 meter across. These are constructed with small stones that resemble fire rings in both shape and size. One such circle has been directly sampled via scuba diving, and while the surrounding stones did not appear to be fire cracked, a core sample taken in the center of the circle revealed a layer of oxidized sediment and charcoal which yielded a radiocarbon date of 9020 cal yr BP (8080 ± 35 ^{14}C yr BP) (see **Table 7.2**).

Rock piles, stacked stones, and upright stones often function as guiding or marking features (e.g. Stewart et al. 2000). As many natural processes can produce rock piles and stacked stones, great caution must be exercised when declaring one a cultural feature (see O'Shea 2015b:125, and Pasda quote above). Similar to linear features, stacked stones and piles have been found associated with other constructed features and are therefore inferred to be cultural in this context. One incident of a standing stone has been recorded on the AAR (**Figure 7.35**).

Figure 7.35. Standing stone on AAR.



Complex Structures

Complex constructions are composed of more than one simple structure – and three such sites have been identified on the AAR: The Dragon Drive Lane and the Funnel in Area 1, and Drop 45 in Area 3. These three features are seen as being an order of magnitude more complex than any of the structures discussed so far. They are considered complex as they are comprised of multiple simple structures which function together, and because they would have required more people to successfully operate them. While sharing these general properties, each of the three complex sites are distinct in their construction and operation.

Dragon

The Dragon site was the first to be recorded in early surveys, and was quickly identified on the side-scan sonar mosaic due to its fortuitous linear alignment with the sonar transects. This site has a long stone line, associated hunting blinds, and one standing stone at the end of the line (**Figures 7.36-7.38**) (O’Shea and Meadows 2009). The Dragon Blind is located in a distinct dip in the drive lane. There are also four stone cairns/stacked stones associated with this drive lane, all of which are visible the side scan mosaic of this feature ².

² In prior publications the Dragon Drive Lane has been listed as a simple construction (O’Shea 2015b), and generally not included in discussions of “complex structures” on the AAR (O’Shea et al. 2014). Here, the dragon is included under the definition of complex structure, as similar to both Funnel and Drop 45, the site consists of several, simple constructions (e.g. linear features, hunting blinds, stacked stones) which are associated and likely operated together by a larger number of people. As the Dragon was discovered first, it was not until the discovery of these other complex structures that a pattern became clear.

Figure 7.36. Dragon drive lane schematic.

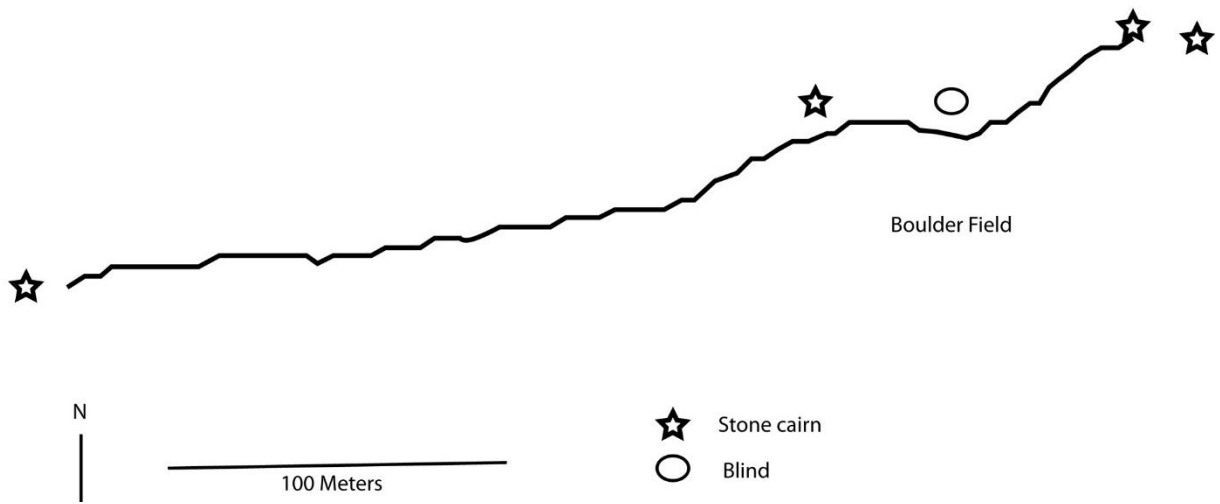


Figure 7.37. Scuba diver mapping the Dragon Blind. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary.



Figure 7.38. The Dragon blind and Jake the ROV. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary.



Funnel

The Funnel is a large site with some of the most substantial architecture on the AAR, with large stones forming two lines of a funnel shape, with several hunting blinds (**Figure 7.39**) (see O'Shea et al. 2013). The Funnel was the first feature on the AAR to be mapped with scanning sonar technology (**Figure 7.40**). This feature is located near the high limestone ridge/Dragon Locality in Area 1. The immediate kill area is approximately 150 m², while the total area of the feature is roughly 900 m² (0.09 ha). The central portion of the funnel is formed by a tightly set line of six boulders (on average less than 1 meter in width) on one side and an equally solid but more complex line opposite. This latter line appears to have functioned as both a block and a large hunting blind. These two lines converge creating a gap 5 meters wide

although a large stone is placed in the middle of this gap creating two smaller funnels, with 2.5 meter gaps each (**Figure 7.41**). There are two additional hunting blinds placed at the east end of one line and opposite the gap in the central portion of the structure. Behind this latter blind is a large stone that likely originally stood upright.

The orientation of the funnel would favor animals moving toward the north and west. The topographic placement of the funnel drive indicated that it was situated to take advantage of two natural features – an irregular boulder field to the southwest and a 1 meter drop off to the northeast produced by naturally outcropping limestone bedrock. These two features would have channeled the movement of animals along the level bedrock surface that the funnel effectively blocks. A discontinuous line which runs from the interior wall out to the edge of the boulder field is similar to terrestrial drive lanes, serving the function of channeling animals into the funnel/range of the hunting blinds. Furthermore, the funnel is situated between a high ridge and marsh (as indicated by distinct testate amoebae, Sonnenburg et al. 2015a) and it is likely that occasionally the structure was used to actively drive browsing animals into the funnel from the marshy area below as caribou tend to run upslope when frightened (**Chapter 5**).

Figure 7.39. Schematic of Funnel.

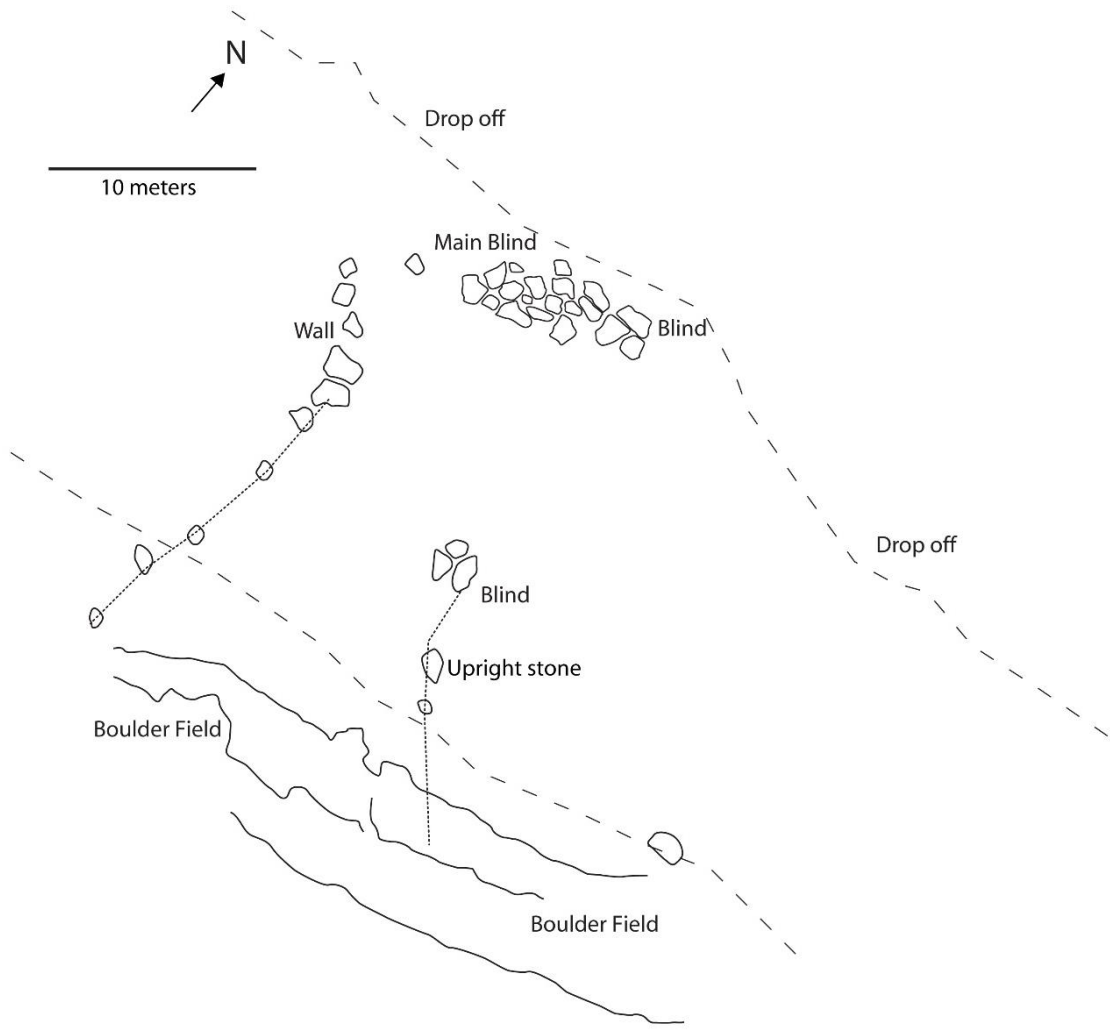


Figure 7.40. Scanning sonar image of the Funnel site.

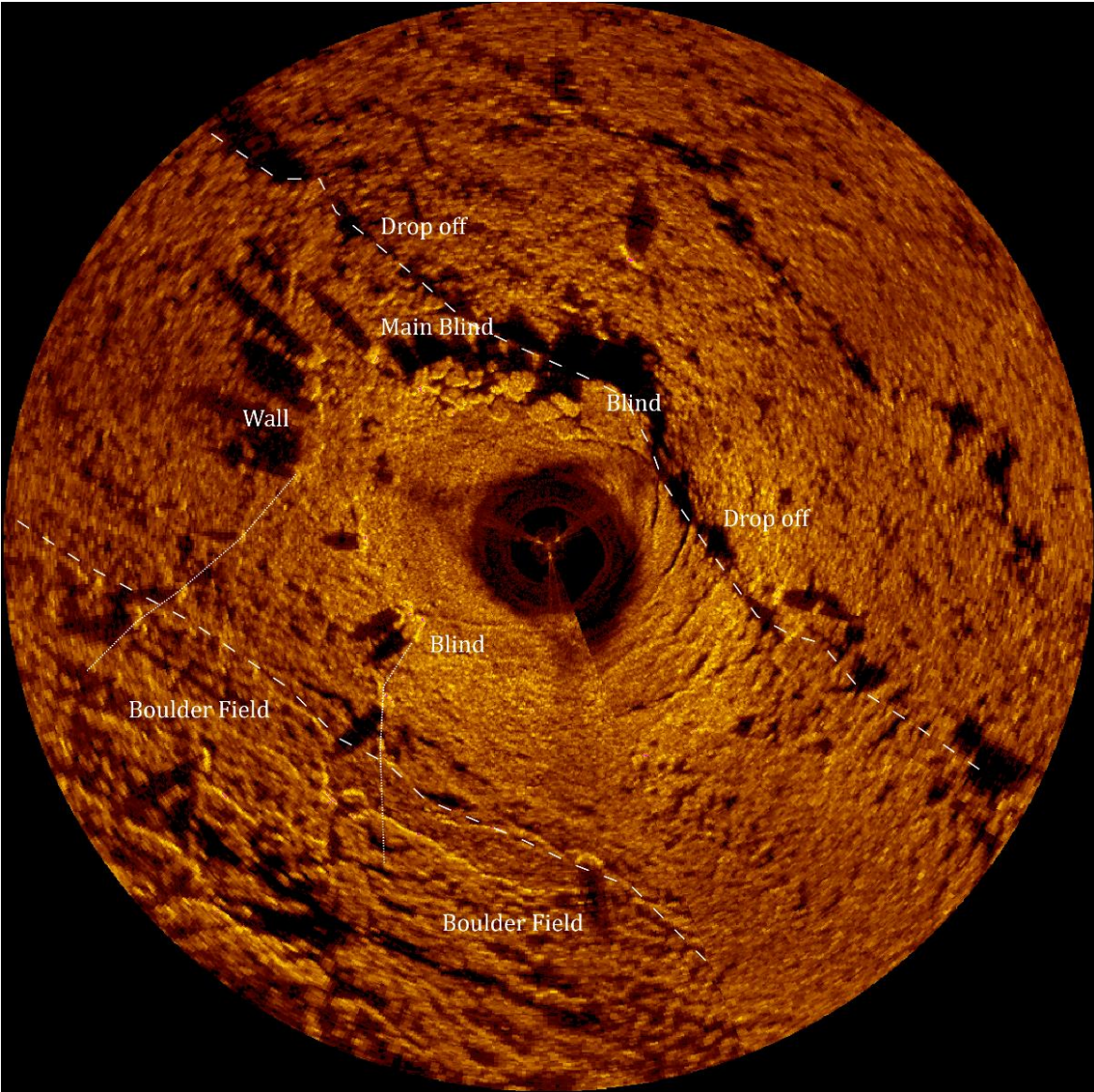
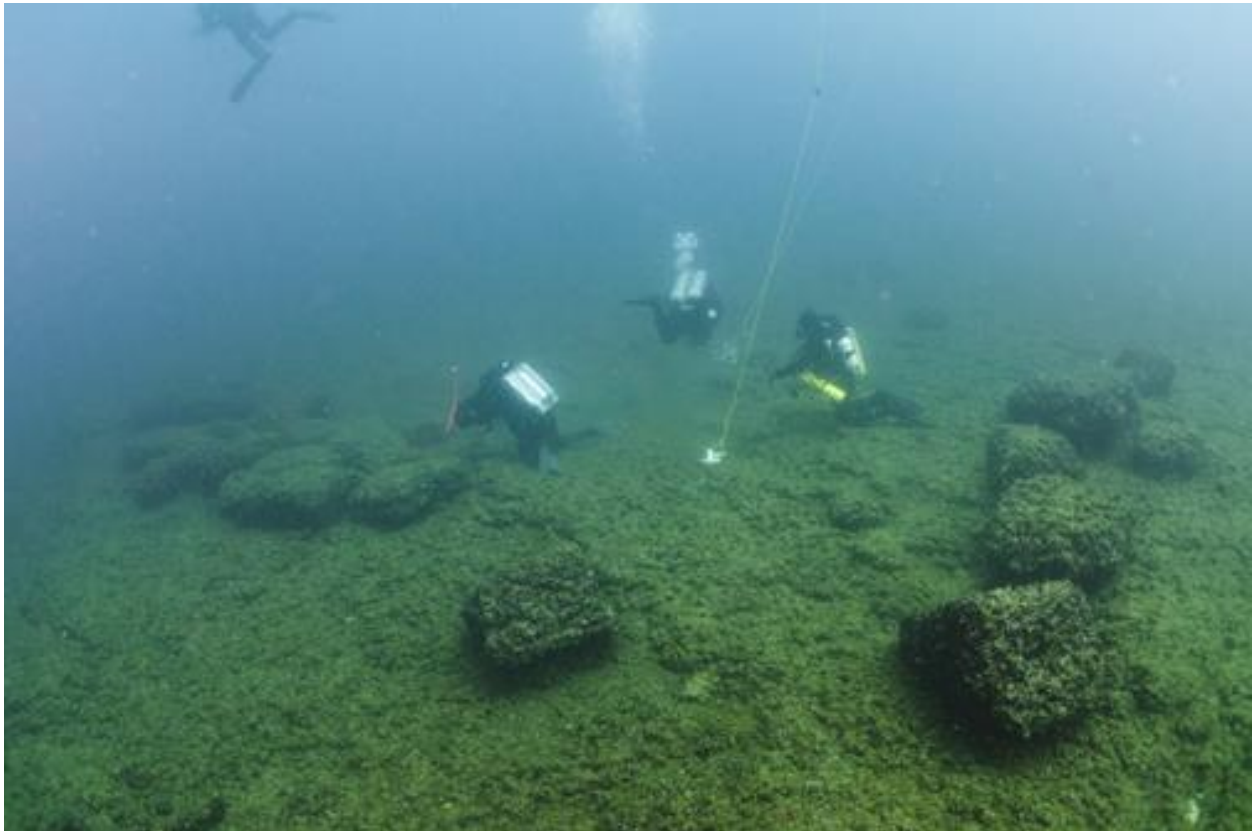


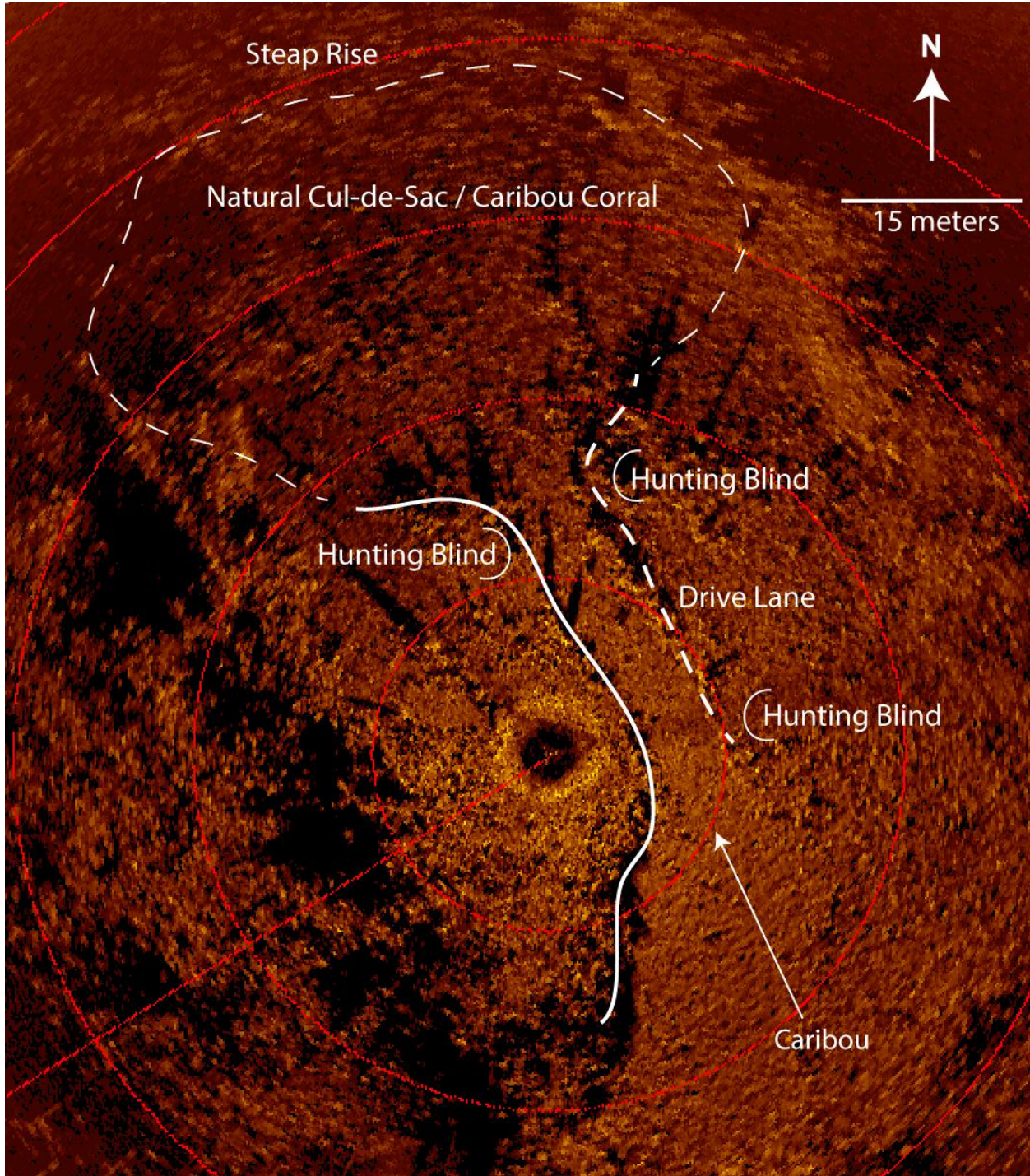
Figure 7.41. Divers within the Funnel. Photograph courtesy of Tane Casserley, National Oceanic and Atmospheric Administration, Thunder Bay National Marine Sanctuary.



Drop 45

The third complex site is Drop 45, which is located in 37 meters of water in the Overlook Locality in Area 3 (see O’Shea et al. 2014). The feature is constructed on limestone bedrock and is composed of two parallel lines creating a drive lane leading to a naturally formed cul-de-sac created by a raised cobble pavement. This stone lane is 8 meters wide by 30 meters long and is bounded to the west by the natural raised cobbles, and to the east by a boggy area (as indicated by distinct testate amoebae). Incorporated into the drive lane are four enclosed blinds, two placed at the entrance of the drive lane and two at the end. The total area of the site is 100 meters long by 28 meters wide, or 0.34 ha (**Figure 7.42**).

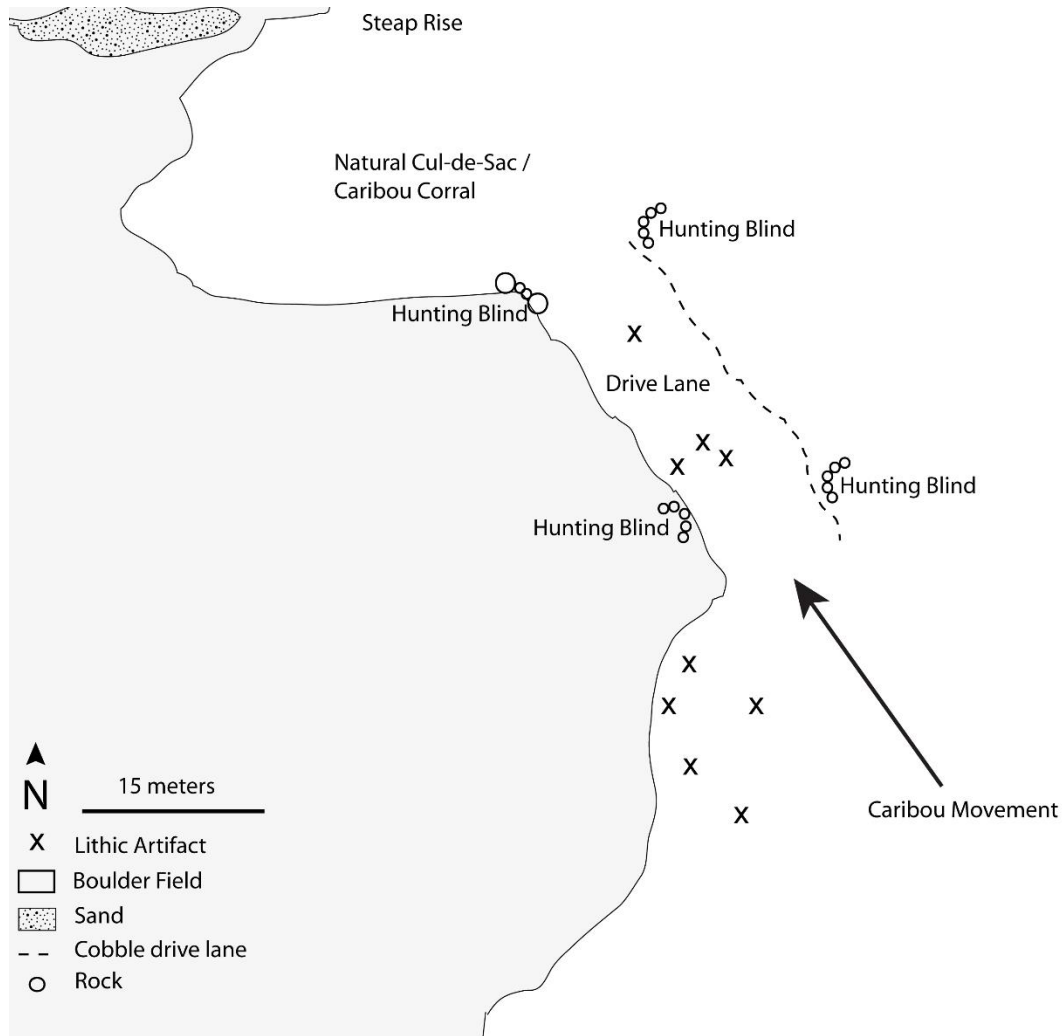
Figure 7.42. Schematic of Drop 45 site overlain on scanning sonar image.



The interior of the drive lane is covered by discontinuous shallow layer of sand, on average 6 centimeters thick on top of the limestone bedrock. Systematic sampling along

transects, within the hunting blinds, and 1 x 1 meter units in the interior drive lane have produced 13 chert flakes and 1 thumbnail scraper (see **Figure 7.43**, and below).

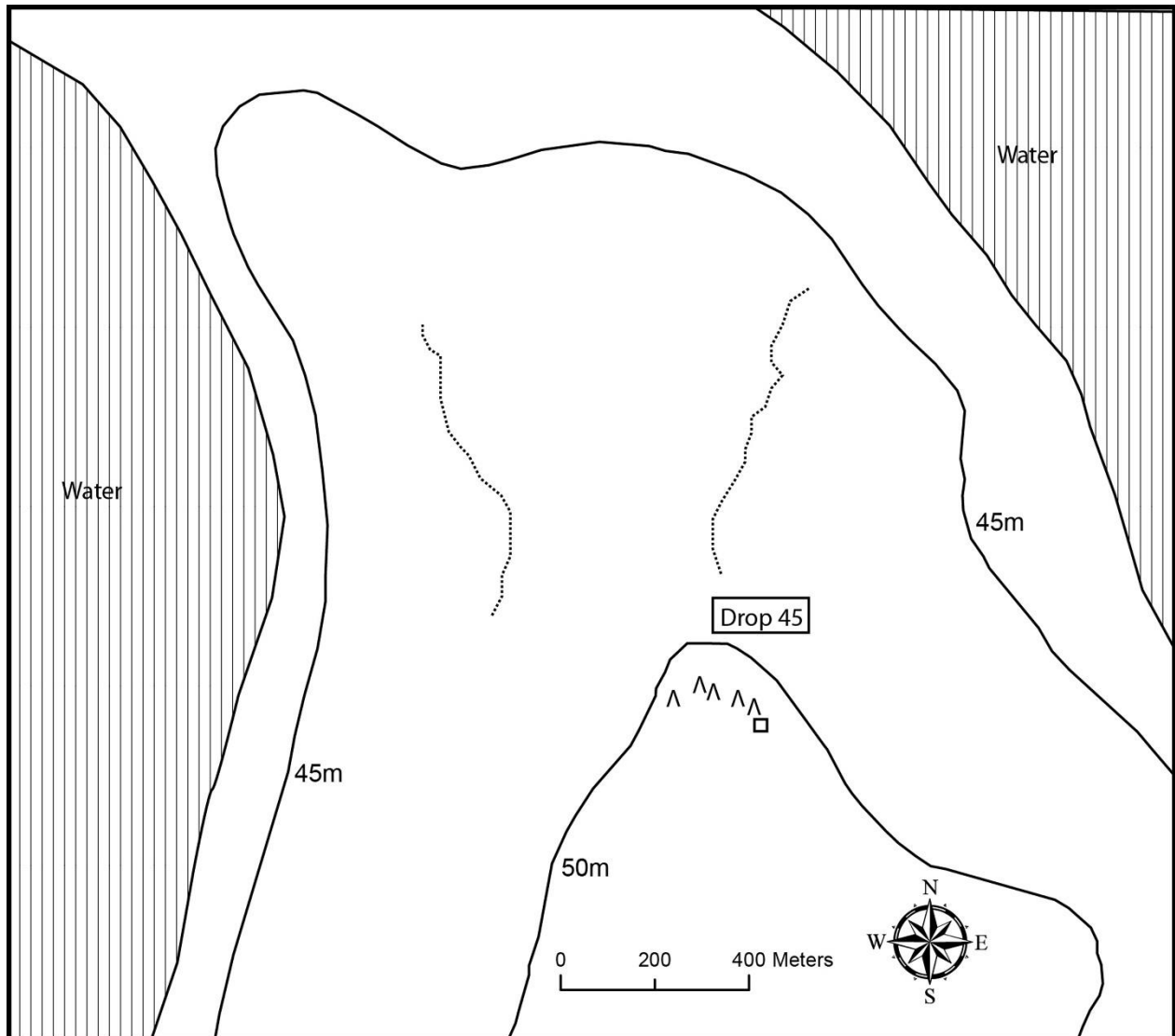
Figure 7.43. Schematic of the Drop 45 site indicating location of lithic artifacts.



The topographic placement of Drop 45 within the Overlook Locality was made to take advantage of the high ground. Drop 45 is located near the base of the slope and is orientated with its broad opening toward the southeast. The Overlook Locality is a narrow (less than 2 km) southeast to northwest sloping isthmus which contains a number of structures in addition to Drop 45. To the north, two long converging stone lines narrow to a gap of ~400 meters and lead to the overlooking hill and directly to the Drop 45 opening. Near the crest of this slope are at least 5

simple constructions, including numerous v-shaped hunting blinds and the West V Blind rectangular feature. In contrast, the v blinds on top of the high ridge are orientated north and northwest (O'Shea 2015b:113) (**Figure 7.44**). Therefore the multiple structures in this small locality seem to be oriented for animals moving both northwest and southeast, i.e. during both the fall and spring migrations across the ridge. As suggested by O'Shea et al. 2014, the explanation for this concentration of hunting architecture in this area, and their association with different directions of animal movement, may reflect the locality's status as a "choke point" in animal migrations, in which the predictability of the animal's passage through this very narrow area, and thus the hunters' ability to intercept them, is maximized. This model of a small locality acting as a bottleneck on caribou migrations used by prehistoric hunters during both seasons was specifically tested for this dissertation (**Chapters 8-9**).

Figure 7.44. The Overlook Locality in Area 3, showing the topographic setting of the V blinds and the Drop 45 Drive Lane and associated features. Contour interval is 5 m and is reported in meters above mean sea level (modern Lake Huron datum is 176 m amsl). Hatching reflects areas believed to be underwater at time the locality was in use, (adapted from O'Shea 2015b:132, Figure 10.18).



Archaeological Materials

In addition to mapping the hunting structures themselves, 31 separate localities/sites have been archaeologically sampled by scuba divers (**Table 7.8a-b**). This number excludes samples

taken during the research conducted specifically for this dissertation (presented in **Chapter 9**), and sites where only environmental samples were taken.

Table 7.8a. Localities on the AAR in Area 1 which have been tested for archaeological materials (n=12) (These do not include areas where only environmental samples were taken by a ponar geological sampler).

| Anchor Point | No. of Samples |
|---------------------|-----------------------|
| Dragon | 8 |
| Funnel | 19 |
| High Ground | 13 |
| Lakeshore NW | 2 |
| Outcrop | 8 |
| Overlook | 5 |
| River | 5 |
| Spruce | 17 |
| Stone Line | 3 |
| The Gap | 11 |
| Top_HT | 8 |
| Wood 6 | 2 |

Table 7.8b. Localities on the AAR in Area 3 which have been tested for archaeological materials (n=19) (These do not include areas where only environmental samples were taken by a ponar geological sampler).

| Anchor Point | No. of Samples |
|---------------------|-----------------------|
| Ash Gap | 3 |
| ASH1 | 6 |
| BF-1PT | 5 |
| Circle | 5 |
| D45_NW | 5 |
| Depression | 3 |
| Drop 45 | 43 |
| Drop 50 | 3 |
| FCR | 5 |
| HDO Gap | 1 |
| HG_RNG | 1 |
| LRockC | 1 |
| New Gap | 5 |
| New Fun | 1 |
| Scenic Overlook | 6 |
| Stone Line | 3 |

| | |
|-----------|----|
| The Gap | 11 |
| V | 8 |
| V Cluster | 4 |

Archaeological sampling has been conducted using three methods: bulk sediment sampling, screening on the lake bottom, and using an airlift. Bulk sediment is collected in 4-5 liter ziplock bags. These samples are usually taken in areas where the sediment is relatively shallow, and where sediment can be collected all the way down to bedrock in a small area, i.e. ~30 x 30 centimeters. Screen samples are most often taken in transects and are akin to shovel tests in terrestrial archaeology. Sediment in ~ 30 x 30 centimeter areas is scooped into #3 one-quarter-inch (6.3mm) scientific sieves. All the sediment collected in the sieves are bagged and labeled. Each screen sample also has an associated vial sample collected in a 100 mL clear EPA plastic tube in order that the light fraction which is lost during screening can be recorded and analyzed. Finally, the use of an airlift for excavating 1 x 1 meter squares has been implemented. Sediments collected via the airlift are transported through PVC pipe into a 5 gallon plastic collection bucket which is then lifted to the surface. Onboard the surface vessel sediments are screened through nested one-half-inch, and one-quarter inch screens. Each airlift sample also has an associated vial sample collected in a 100 mL clear EPA plastic tube in order to preserve the light fraction. Each of these sample types has an associated marker and unique identifier number that is left on the lake bottom. These markers have floats with the sample number which are tied with flagging tape to a fishing weight so that they are left *in situ* where the sample was taken. After the sample is taken, the ROV which is equipped with a locating sonar/pinger (TriTech MicroNav 100 USBL (ultra-short base line) Tacking Sonar) hovers above the sample location to record its exact coordinates.

To date, 19 lithic artifacts have been recovered from three areas on the AAR (**Table 7.9**), these artifacts are mostly flakes and debitage and one formal artifact – a scraper. The flakes are small with average length, width, thickness, and weight of 9.34 mm, 5.72 mm, 2.30 mm, 0.20 g respectively. The thumbnail scraper is larger, with a maximum length, width, thickness, and weight of 9.15 mm, 7.97 mm, 3.48 mm, and 0.20 grams. In **Table 7.9**, a type is listed for each lithic artifact. Flakes are defined as thin, angular specimens that had one or more diagnostic features of lithic manufacture, i.e. bulb of percussion, intact platform, or feathering/ripples from impact force (n=9). Debitage is defined as specimens that are thin, angular and were easily distinguished from background sediments (i.e. rounded, thick, natural sediments and pebbles) (n=9). This debitage category is similar to specimens from terrestrial archaeological sites created during lithic flaking where bulbs and/or platforms may be sheared off, are diagnostic of bi-polar shatter, or are flake fragments. All the artifacts are made on chert and four main raw materials are represented, (1) gray-brown cherts which are common in the local Devonian Age Traverse formation (Hough 1958) (n=11), (2) a black and orange glacial chert (n=4), (3) a high-quality black semi-translucent chert (n=2), and (4) Bayport chert, which outcrops around Saginaw Bay which was used to make the scraper (**Figures 7.45-7.49**).

Table 7.9. Lithic artifacts from submerged sites on the AAR, (update to Lemke 2015c).

| Spec. No. | Site or Locality | Material | Type | Length (mm) | Width (mm) | Thickness (mm) | Weight (g) |
|------------------|-------------------------|-----------------|-------------|--------------------|-------------------|-----------------------|-------------------|
| DE-1a | Crossing | Chert | Debitage | 6.08 | 1.16 | 3.20 | 0.08 |
| Vial 1a | Crossing | Chert | Flake | 7.88 | 5.55 | 1.92 | 0.13 |
| DF-1 | Crossing | Chert | Debitage | 8.75 | 5.18 | 1.84 | 0.06 |
| DA-1a | Gap | Chert | Flake | 7.31 | 6.50 | 1.64 | 0.07 |
| DA-1b | Gap | Chert | Debitage | 2.30 | 2.93 | 0.42 | 0.01 |
| DP-1-1a | Drop 45 | Chert | Debitage | 15 | 8 | 2.61 | 0.27 |
| DP-1-1b | Drop 45 | Chert | Debitage | 6 | 5.50 | 3.05 | 0.12 |

| | | | | | | | |
|---------|---------|---------|----------------|-------|------|------|------|
| FE-1-2a | Drop 45 | Chert | Flake | 11 | 10 | 2.11 | 0.26 |
| FE-1-2b | Drop 45 | Chert | Debitage | 6 | 5 | 2.61 | 0.08 |
| EG-1-2a | Drop 45 | Chert | Debitage | 14 | 6 | 1.17 | 0.13 |
| EG-1-2b | Drop 45 | Chert | Debitage | 15 | 7 | 4.05 | 0.44 |
| FA-1-2a | Drop 45 | Chert | Flake | 10 | 6 | 1.80 | 0.10 |
| EZ-1a | Drop 45 | Chert | Flake | 6.50 | 5 | 1.32 | 0.05 |
| EO-1-2a | Drop 45 | Chert | Debitage | 17 | 7 | 2.26 | 0.16 |
| EO-1-2b | Drop 45 | Chert | Flake | 6 | 5 | 1.79 | 0.87 |
| FB-1-1a | Drop 45 | Chert | Cortical Flake | 11 | 4 | 4.14 | 0.21 |
| Unit 1a | Drop 45 | Chert | Flake | 8.43 | 3.26 | 1.60 | 0.06 |
| Unit 3a | Drop 45 | Bayport | Scraper | 9.15 | 7.97 | 3.48 | 0.20 |
| Unit 8a | Drop 45 | Chert | Cortical Flake | 10.15 | 7.64 | 2.75 | 0.50 |

Figure 7.45. Flakes and debitage from the Drop 45 site. *Top row* (left to right), specimen numbers DP-1-1a, EG-1-2b, EG-1-2a, EO-1-2a, FA-1-2a, FB-1-1a, *Bottom row* (left to right), specimen numbers DP-1-1b, Unit 1a, EZ-1a, EO-1-2b, FE-1-2b, FE-1-2a, Unit 8a. Scale bar is in centimeters.



Figure 7.46. DE-1a flake from Crossing Locality, Area 1. Scale bar is in centimeters.



Figure 7.47. Vial 1a flake from Crossing Locality, Area 1. Scale bar is in centimeters.



Figure 7.48. DA-1-1a and DA-1-1b flakes from the Gap Locality, Area 3. Scale bar is in centimeters.



Figure 7.49. Thumbnail scraper on Bayport chert from the Drop 45 site. Scale bar is in centimeters.



The presence of a thumbnail scraper made on Bayport chert is particularly significant. Bayport Chert outcrops south the AAR on the Michigan “thumb” (85 km as the crow flies).

Given the geographic position of these chert outcrops, this material could not have been deposited on the ridge by natural processes and therefore had to have been brought by humans. Bayport is also a very common raw material choice in this region and time period (**Chapter 4**). It is so common in terrestrial sites that the use of Bayport by AAR hunters and its likely presence on the ridge was anticipated by Fox et al. (2015) a year before the artifact was recovered. In addition, this type of thumbnail scraper is fairly common in Paleoindian aged sites. Use-wear analysis on similar endscrapers from Paleoindian sites in the Eastern North America indicate that these artifacts were used to work hides, wood, antler, and bone (Loebel 2013).

All of these lithic artifacts are within close spatial association of stone constructed features and come from three sites/localities: the Crossing Locality in Area 1, the Gap Locality in Area 3, and the Drop 45 site in Area 3 (See Lemke 2015c). Significantly, background sampling has been done, both within sites and in other areas far from stone features and these additional samples have not produced any lithic materials. Therefore, the human presence on the AAR and human manufacture of stone features is not just confirmed by where lithic artifacts *are*, but also where they are *not*.

Both the nature of the lithic assemblage and the spatial pattern of lithic artifacts matches the expectations for such sites drawn from the terrestrial record (**Chapter 3**; Lemke 2015c). Terrestrial hunting sites often have very few artifacts as a limited range of activities take place at these locations (i.e. procurement, limited butchering) and they are often kept clean in order to be reused. The narrow range of activities and frequent cleaning produces small and limited archaeological assemblages, primarily flakes from tool preparation and maintenance. In terms of spatial patterns, artifacts are generally found inside or very near hunting blinds (LaBelle and Pelton 2013). In these ways, the AAR lithic assemblage is consistent with patterns known at the

other hunting architecture sites. These issues will be discussed in further detail in the following chapter.

In addition to these lithic artifacts, one fragment of a cervid tooth was recovered during archaeological sampling. This sample was of bulk sediment inside the Dragon hunting blind (**Figures 7.50**). While too small to be identified to species, surface textures on the tooth fragment are indicative of the cervid family which consists of deer, elk, and caribou (See Lemke 2015b).

Figure 7.50. Cervid tooth fragment.



Conclusion

Prior research on the Alpena-Amberley Ridge has provided a general picture of the paleoenvironment on this submerged landscape as a subarctic environment that likely supported large numbers of caribou. The AAR archaeological record is consistent with this picture and

provides evidence of ice age-adapted hunter-gatherers targeting cold-adapted animals in a refugium.

While the refugium concept traditionally concerns areas that resisted glaciation, the use of refugium here is the exact opposite, and refers to an isolated area that retained ice age characteristics during the general warming trends of the Pleistocene-Holocene transition. In the Great Lakes, the succession from open subarctic environments to closed pine and hardwood forests limited productive grazing ground for many foraging ungulates. In this region where ice age adapted species had thrived for millennia (e.g. mastodon, muskox, caribou), warming climates and closing forests significantly impacted floral and faunal communities (**Chapter 4**). Refugia, such as the AAR which retained ice age characteristics, were better suited for caribou, and would have created exploitable niches for hunter-gatherers. Prior research supplies direct evidence of caribou hunting by prehistoric hunter-gatherers and the earliest evidence of caribou hunting architecture.

In order to give anthropological meaning to the raw archaeological data recovered thus far from the Alpena-Amberley Ridge, the next chapter situates the AAR data with general expectations for hunting architecture sites. The middle range theory constructed in **Chapter 3** will be applied to the AAR case to characterize hunting and human occupation across a number of interrelated variables including prey species, number of animals hunted, state of the animals, hunting technology, seasonality, group size, and hunting goals. When analyzed with the AAR archaeological data and combined, these variables provide the basis for a model of prehistoric hunter-gatherer lifeways on the AAR (**Chapter 8**). This model is evaluated with new field research conducted for this dissertation presented in **Chapter 9**.

Chapter 8

A Model of Foraging Lifeways on the Alpena-Amberley Ridge

Introduction

Preliminary research on the AAR hints at interesting patterns in hunting architecture sites, such as the dual seasonal use and an abundance of hunting architecture sites clustered in small areas exemplified by the Overlook Locality. In order to further characterize the nature of human activity on the AAR, this chapter generates a model of hunter-gatherer lifeways on the ridge by drawing on previous archaeological research and a general theory of hunting architecture. Specifically, this chapter applies the middle range theory of hunting architecture developed in **Chapter 3** to the AAR data presented in **Chapter 7**. Analyzing the AAR data using specific archaeological expectations provides a model of human activity on the ridge across several interrelated social and economic variables. This model is then evaluated in **Chapter 9** in light of new research conducted as part of this dissertation.

Hunting Architecture and Material Correlates on the AAR

Prior research on the AAR has demonstrated that caribou hunting architecture sites are preserved on this inundated landform. These hunting features vary in size and complexity, from simple one-person hunting blinds to complex structures with multiple components. As presented

in **Chapter 3**, the formal attributes of such structures can be used to infer a range of interrelated social and economic variables. Additional archaeological expectations can be generated for the material culture expected at hunting architecture sites given each variable's inferred value.

For each state of these core variables, a series of archaeological expectations has been generated, first for hunting architecture, second for other related facilities, and finally for associated material remains such as such as lithic tools, debris, and fauna (**Table 8.1**).

Table 8.1. Interrelated social and economic variables of hunter-gatherer lifeways utilizing hunting architecture. Archaeological expectations have been generated for each variable based on a global comparison of hunting architecture presented in Chapter 3.

| Variable <i>variable state</i> | Archaeological Expectations/Material Correlates | | | |
|--|---|------------------|-----------------------------|--|
| | Hunting Architecture | Other Facilities | Associated Material Culture | |
| | | | Tools/Lithics | Fauna |
| PREY SPECIES | | | | |
| <i>Large-bodied (e.g. bison)</i> | Taller (> 1 meter), Thicker (2-5 meters), continuous, substantial walls | N/A | Dense | Butchered at kill site; Large bone beds, burning |
| <i>Medium-Bodied (e.g. caribou)</i> | Intermediate | N/A | Light | Limited butchering at the kill site, secondary butchering elsewhere; Limited bone, head/foot dominated assemblage, portions of carcass cached nearby |
| <i>Small-bodied (e.g. gazelle, antelope)</i> | Shorter (< 1 meter), thinner (>1-2 meters), discontinuous, walls | N/A | Minimal-None | Removed whole from kill site, butchered elsewhere; No faunal remains at kill site |
| NUMBER OF ANIMALS HUNTED/SIZE OF | | | | |

| | | | | |
|---------------------------------------|--|-----|---|---------------|
| HERD | | | | |
| <i>Few</i> | Narrow gaps between funneling features/drive lanes | N/A | None-Minimal | None-Minimal |
| <i>Many</i> | Wide gaps between funneling features/drive lanes | N/A | Light – Dense | Light – Dense |
| STATE OF THE ANIMALS | | | | |
| <i>Panicked, i.e. actively driven</i> | Robust continuous lines, narrow gaps between lines (avg. 4.5 m), substantial, continuously walled hunting blinds | N/A | N/A | N/A |
| <i>Bothered, Not Panicked</i> | Diffuse, discontinuous lines, wide gaps between lines (~30 m), shallow blinds in or behind the gap | N/A | N/A | N/A |
| HUNTING TECHNOLOGY | | | | |
| <i>Bow and Arrow</i> | Diffuse, discontinuous lines, wide gaps between lines (~30 m), shallow blinds in or behind the gap | | Small projectile points, impact damage, found within range of hunting blinds, ~11-20 m radius | |
| <i>Atlatl/Dart</i> | Intermediate ? | | Large lanceolate points, impact damage, found within range of hunting blinds, x meters | |
| <i>Lance/Thrusting Spear</i> | Robust continuous lines, narrow gaps between lines (avg. 4.5 m), substantial, | | Fire harden, lithic, or ivory/bone tipped wooden spears | |

| | | | | |
|-----------------------------------|------------------------------------|--|---|---|
| | continuously walled hunting blinds | | | |
| SEASON OF USE/ HUNTING CONTEXT | Hunting Architecture | | Other Facilities | |
| | Orientation | Location | | |
| <i>Fall – Migratory</i> | Northwest | Topographic bottlenecks along migration route | N/A | |
| <i>Spring – Migratory</i> | Southeast | Topographic bottlenecks along migration route | N/A | |
| <i>Non-Migration</i> | Opportunistic | Near game trails, grazing areas, fresh water | N/A | |
| GROUP SIZE | | | | |
| <i>Individual</i> | Simple, if any | Minimal | Minimal | |
| <i>Pair/Small Group</i> | Small, Simple Structures | Small number of temporary dwellings | Light | |
| <i>Cooperative Group</i> | Complex Structures | Large, multiple dwellings, with evidence of re-use | Dense | |
| HUNTING GOALS | | | | |
| <i>Immediate Consumption</i> | Present | Hearths | Limited range of tools, primarily those related to kill and kill processing | Expedient processing, full representation of bone elements |
| <i>Delayed Consumption</i> | Present | Caches, Drying racks, Hearths/boiling pits | Greater representation of processing tools and debris | Multi-stage processing, absence of bones associated with high ranked elements |
| <i>Raw Material Acquisition</i> | Present | | Specialized maintenance tool kit | Absence of antler, metapodials, cutmarks indicative of hide processing/tool manufacture |
| <i>Social Solidarity/Exchange</i> | Present | Social architecture | Exotic raw materials, mixed styles of projectile points, etc. | Feasting consumption remains |

The previously collected AAR data presented in **Chapter 7** is analyzed below for each variable in order to characterize hunting and human occupation on the AAR.

Prey Species

Determining the targeted prey species of many hunting architecture sites is difficult due to a lack faunal remains which would provide direct evidence of the animals hunted (**Chapter 3**). Therefore, comparisons between hunting architecture sites without faunal remains to those with a known target species are often used as a line of inference. *A priori* it seems likely that caribou were the targeted species of hunting architecture on the AAR given their comparison to terrestrial caribou hunting structures (O'Shea and Meadows 2009; Sonnenburg et al. 2015b, **Chapter 7**). This assertion is in good agreement with the long-held view from terrestrial archaeology that caribou were a primary prey species exploited by Paleoindians during this time period in the Great Lakes and Northeast (Lemke 2015b, **Chapter 4**).

Archaeological expectations for medium-bodied prey such as caribou, include hunting architecture sites that are intermediate between tall (> 1 meter), thick (i.e. 2-5 meters), substantial and continuous walled structures targeting larger-bodied animals such as bison, and those that have shorter (<1 meter), thinner (<1-2 meters), and discontinuous walls for smaller-bodied animals such as gazelle and antelope (Nadel et al. 2013:151). On the AAR this intermediate expectation is met by structures that vary between substantial walls, such as the Funnel structure with its 1 meter thick walled blind, and others that have thinner, discontinuous lines such as extended arms of the v structures. The AAR constructions therefore fit the expectations for hunting architecture targeting a medium-bodied prey species.

In terms of the archaeological expectations for associated material culture, medium-bodied animals are often only minimally butchered at the kill site resulting in a light

concentration of tool debris and faunal remains. This pattern is also intermediate between large bison kills with dense bone beds and numerous processing tools, and the minimal tools and faunal remains left at kill sites of smaller-bodied game, where carcasses are often removed whole. The AAR presents the intermediate pattern, with a light presence of lithic debris (n=19), and thus far, an admittedly small faunal assemblage that matches expectations for limited butchering at kill sites, i.e. a head and foot dominated assemblage – as exemplified by the cervid tooth fragment recovered from inside the Dragon hunting blind.

Number of Animals Hunted

The relative size and concentration of the herds hunted with hunting architecture varies between small relatively isolated numbers of individuals to very large and concentrated numbers of animals. Larger numbers are encountered when structures are built to intercept migrations, while some hunting architecture sites serve to round up smaller numbers of animals. When many animals are targeted, gaps between funneling structures are wider to allow larger number of animals to pass between them. In contrast, narrow gaps are used to tightly corral smaller numbers of animals.

On the AAR, there are both narrow and wide gaps within the complex structures. For example, the Funnel site has a 5 meter gap that is divided by a large, centrally placed boulder, into two narrow 2.5 meter funnels. The drive lane at Drop 45 has an intermediate gap of 8 meters, which would allow larger groups of animals to pass through the lane. Therefore, the archaeological expectations for both large and small groups of animals being hunted are met on the AAR as there are structures with both narrow and wider gaps. Gaps also occur on the AAR in between hunting structures that are not associated with drives. For example, several hunting structures are near one another in the Gap Locality between two lines of natural, glacial eskers.

These natural features create a wide gap of ~50 meters and hunting structures are in the middle of these features which produces a functional gap of 25 meters between them. Overall, this implies the movement of very large numbers of animals between eskers and the hunting structures.

Expectations for the associated material culture for both large and small groups of animals range from minimal to dense as more processing tools and debris may be associated with the processing of larger numbers of animals, and less debris with smaller numbers. Importantly these patterns are also dependent on prey species as material remains tend to be denser the larger the animal as transport costs to move the carcass from the kill site are higher, (i.e. a large number of bison will result in dense accumulations of both tools and faunal remains, such as the Head-Smashed-In site (Brink 2008)). Overall, associated material culture on the AAR analyzed for the number of animals, similar to prey species, can be characterized as “minimal-none”. However, preliminary investigations can characterize the assemblage at Drop 45 as “light”, as 15 artifacts have been found at that single site. This is consistent with the interpretation of Drop 45 targeting a large group of animals inferred by the gap between drive lanes. In terms of other structures however, sampling limitations cannot be discounted; as Drop 45 has been systematically sampled while most others on the AAR have not. The difference in group sizes of animals likely correspond to seasonal hunting patterns since herd size and composition is seasonally variable (see below and **Chapter 5**).

State of the Animals

Terrestrial studies of hunting architecture have used the formal characteristics of the structures to determine whether the animals were actively driven, and thus panicked, as opposed

to more passively channeled and only bothered (specifically Friesen 2013). These various states are significant as it is likely more people would be needed to panic herds, and panicked herds can be driven closer to hunting blinds. Following this, animal state can also correlate with hunting technology as different weapons require a closer range (see next section).

The specific archaeological expectations for animal state include robust, continuous lines with narrow gaps (4.5 m average), with substantial continuous walled hunting blinds for targeting panicked animals, and diffuse, discontinuous lines, with wide gaps up to 30 meters, and shallow hunting blinds indicating bothered animals.

When comparing the AAR structures to these attributes, different structures meet some or all of the expectations for both animal states. For example, the Funnel site unequivocally meets the expectations for panicked animals, as it has robust and continuous lines, with one narrow 5 meter gap, and it has the most substantial architecture on the AAR with its dense, continuous walled hunting blind (see **Figures 7.39-7.41**). The Drop 45 site also meets these expectations for panicked animals, as similar to funnel is has slightly larger gap (8 meters), robust and continuous lines, and incorporated continuously walled hunting blinds. The Dragon site meets some of expectations for panicked animals as it has a continuous, robust drive lane, and a substantial, walled hunting blind, but this site does not have a measurable gap.

Other hunting architecture types on the AAR present a mix of attributes corresponding with both panicked and bothered animals. Closed hunting blinds and v-shaped blinds have gaps either between each other, or gaps that are created by the natural landscape, such as glacial eskers in the Gap Locality (see above, **Chapter 7, Figure 7.29**). Closed blinds on the AAR are fairly substantial with diffuse, but continuous lines, with an intermediate gap (9 m) between them. V-blinds are also fairly substantial with diffuse lines, but wider gaps (avg. 25 m) (see

O'Shea et al. 2013). In this case, while the hunting blinds on the AAR are more substantial than the shallow hunting pits which were used in Freisen's original study (2013), they most closely match the expectations for bothered, i.e. not panicked animals, particularly since these hunting blinds are less substantial than the walled blind at Funnel. Therefore, the two most complex AAR structures, Funnel and Drop 45, meet expectations for panicked and actively driven animals, and other AAR structures such as closed and v-shaped hunting blinds likely meet expectations for bothered animals.

Hunting Technology

Hunting technology has been associated with the state of the animals as different types of weapons have different effective ranges. Some weapons require the animals to be close to hunting blinds (e.g. thrusting spears or lances), while other technologies such as atlatls/darts, and bows and arrows have longer ranges and do not require such close proximity. On purely chronological grounds, none of the hunting structures on the AAR should be associated with bow hunting, as bow and arrow technology was introduced much later in the Great Lakes region (Blitz 1988). For the Pleistocene-Holocene transition AAR structures (~9380-8830 cal yr BP) (**Chapters 4 and 7**) the likely weaponry was either atlatl/darts tipped with large lithic lanceolate points, and/or wooden lances either fire-hardened, stone tipped, or tipped with other organic materials such as bone, antler, or ivory, or composite micro-blade tips.

It is difficult to differentiate between these two technologies with the AAR data. Expectations of hunting architecture for lances match those for panicked animals: robust continuous lines, narrow gaps, and substantial hunting blinds. These channeling features serve to keep the animals in close contact with the built structures, and thus, closer to the lance-armed hunters. While the Funnel and Drop 45 sites match these expectations, other structures on the

AAR do not. The expectations for hunting architecture sites with atlatls is likely intermediate between the long range of arrows and the shorter range of lances, but the exact numbers cannot be certain as most known hunting architecture sites did not utilize this technology. Therefore, while atlatls cannot be ruled out, the current evidence is inconclusive. A complete understanding of the weaponry used by AAR hunters will have to await further *in situ* recovery of these implements.

Season of Use/Hunting Context

Seasonality is a critical variable for understanding caribou exploitation (Enloe and David 1997:53) since it determines the availability, predictability, and quality of the animals (Bouchud 1953, 1966; Burch 1972; Gordon 1988; Spiess 1979). Seasonality has been inferred at terrestrial hunting architecture sites by associating the orientation of the structures with the inferred direction of ungulate migration. Structures have openings that are oriented to the direction of animal movement, i.e. if animals migrate *north* in the spring, hunting architecture sites will have their openings to the *south* to intercept them.

Due to the strict patterns of movement during migrations across the narrow AAR landform, the orientation of the hunting structures can be used to infer if they were used for fall or spring hunting (O'Shea et al. 2013, 2014). As the AAR runs northwest to southeast across the Lake Huron basin, prehistoric herds likely traveled southeast in the fall to more southerly rutting grounds, and northwest in the spring to calving grounds (see also **Chapter 5**). Therefore, seasonality can be inferred for the AAR structures: a north-northwest orientation indicates use during the fall, and a south-southeast orientation indicates use during the spring. Structures with other orientations likely indicate non-migration hunting activities. The orientations of AAR structures presented in **Chapter 7** are outlined in **Table 8.2**.

Table 8.2. AAR hunting architecture and inferred season of use.

| Structure Name | Orientation | Season/Hunting Context | Setting |
|---|--------------------|-------------------------------|--|
| <i>Complex Structures</i> | | | |
| Dragon | ~Southeast | Spring, Non-migration | High ridge, near grazing area |
| Funnel | Southeast | Spring | High ridge, near grazing area |
| Drop 45 | Southeast | Spring | Topographic bottleneck along migration route |
| <i>Simple Structures</i> ¹ | | | |
| V-Structure | North | Fall | Topographic bottleneck along migration route |
| Ash-Gap V | North | Fall | Topographic bottleneck along migration route |
| V with Rectangular Structure | North | Fall | Topographic bottleneck along migration route |
| Other “V” blinds in the Overlook Locality (Figure 7.44) n=3 | North | Fall (n=3) | Topographic bottleneck along migration route |
| Overlook Blind (Chapter 7) | East | Non-migration | Topographic bottleneck along migration route |
| T-V Blind | Northeast | Non-migration | Topographic bottleneck along migration route |
| New Gap Line | North – South | Fall and Spring | Topographic bottleneck along migration route |

AAR structures meet the orientation expectations for all three hunting seasons/contexts – fall migration hunting, spring migration hunting, and non-migration hunting. In addition, the topographic placement of each structure meets corresponding expectations for migration and non-migrating hunting, as all hunting architecture on the AAR recorded to date are either in topographic bottlenecks along migrations routes, or near grazing and fresh water areas. These

¹ While there are many more simple structures on the AAR, these few which were discussed in detail in **Chapter 7** have been the focus of intensive investigations and are used here as representation sample.

results indicate that hunting architecture on the AAR was used for diverse hunting contexts, during both migrations as well as during other seasons.

Group Size

Hunting architecture sites can be constructed, operated, and re-used by different numbers of people. While most terrestrial studies have suggested large groups operating complex structures, ethnographic and historic cases indicate that both large and small groups use built structures (**Chapter 3**). Archaeological expectations can be made for three different sizes of groups: individual, pair/small group, and cooperative groups (Grønnow et al. 1983). An individual is likely to use simple built structures, if any; have minimal other facilities, and leave minimal associated tools or faunal remains. Pairs or small groups would use small, simple hunting structures, likely construct or use a small number of temporary dwellings, and leave a light pattern of associated material items. Lastly, cooperative groups would be necessary to operate very complex hunting structures, and these larger groups would also leave traces of large, multiple dwellings and create dense patterning of artifacts.

In terms of the expectations for hunting architecture, there are AAR examples that fit each of the group size three categories; corresponding to the simple and complex structures. The AAR suggest a functional correlation between larger groups of people operating the more complex hunting structures such as Funnel, Drop 45, and Dragon, and smaller groups (either individuals or pairs/small groups) utilizing the simpler hunting blinds. This interpretation fits the physical properties of the hunting blinds such as the numerous v-shaped blinds that are only large enough to conceal 1-2 hunters, with groups of hunting blinds such as the cluster at the Overlook Locality likely being used by up to 10-12 hunters.

Archaeological expectations for other facilities are difficult to evaluate with the previously recorded AAR data. While there are a number of other types of structures, such as the rectangular caches and a fire ring suggestive of a temporary camp (see below), other constructions such as stone clusters which may represent temporary or permanent dwellings have not been systematically tested. In terms of associated material culture, AAR sites can be characterized as “minimal-light”, meeting the expectations for individual and small groups, although these patterns are still likely a function of limited sampling.

Hunting Goals

The final variable, hunting goals, presents archaeological expectations for various goals, including immediate consumption, delayed consumption, raw material acquisition, and social solidarity/exchange. The expectations are largely drawn from the Grønnow et al. study of caribou hunting sites on Greenland (1983), and are therefore particularly relevant for application to the AAR data. Hunting architecture is expected to be present for each of the goals, but the expectations vary greatly in terms of other associated facilities. In cases of immediate consumption, hearths would be expected. For delayed consumption more facilities would be expected including caches, drying racks, as well as hearths and boiling pits. No other facilities are associated with the goal of raw material acquisition, and lastly, if social solidarity/exchange was the primary hunting goal, social architecture, as defined as dwellings, larger campsites, or communal buildings would likely occur. The expectations also vary for tools and faunal remains for each goal and these are summarized in the discussion below.

As hunting architecture sites are present on the AAR, they meet this first and simple expectation for all four goals. Furthermore, as other facilities such as the caches and one example of stone ring hearth (from which the charcoal dating to 9020 cal yr BP was recovered, **Chapter**

7) have been identified on the AAR, there is further support for both delayed and immediate consumption. As mentioned previously, the presence social architecture (i.e. habitation sites) cannot yet be evaluated. In terms of lithic tools and debris, the AAR data meet expectations for immediate consumption, as there is a limited range of tools primarily related to the kill and kill processing, flakes from resharpening or otherwise maintaining tools. This lithic assemblage also meets expectations for delayed consumption as the single thumbnail scraper was likely used for hide-processing and thus represents a broader range of tools. Furthermore, it is likely that most of the processing of medium sized game happened away from the kill site and was transported to camps or caches for delayed consumption (see *Prey Species* section above). Focused raw material acquisition is not likely as there is no evidence of specialized maintenance tool kit, although raw materials such as hides were likely collected. Lastly, the small lithic assemblage meets one expectation for social solidarity or exchange as there are exotic materials present, specifically the Bayport chert thumbnail scraper that outcrops south of the AAR on the Michigan “thumb”.

While these disparate hunting goals generate detailed expectations for faunal remains, generally these parameters are difficult to test with the AAR data due to issues of equifinality, i.e. at this stage it is not possible to determine if the limited faunal data recovered is due to taphonomic and sampling issues, or rather if it represents a real archaeological pattern such as an absence of high-ranked elements. Overall then, the AAR data support the goals of immediate and delayed consumption, as well as providing evidence for social solidarity and/or exchange.

Discussion and the Creation of a Model

Throughout this chapter, a middle range theory of hunting architecture has been applied to infer human behaviors from stone hunting architecture and its associated archaeological materials on the AAR. When the results across each variable are combined, a general model of human hunting and occupation on the ridge can be created (**Table 8.3**).

Table 8.3. Interrelated social and economic variables of hunter-gatherer lifeways utilizing hunting architecture. Dark shading indicates the expectations met by the AAR data, lighter shading indicates the expectations minimally supported by the AAR data.

| Variable | Archaeological Expectations/Material Correlates | | | |
|--|--|------------------|-----------------------------|--|
| | Hunting Architecture | Other Facilities | Associated Material Culture | |
| | | | Tools/Lithics | Fauna |
| PREY SPECIES | | | | |
| <i>Medium-Bodied</i> (e.g. caribou) | Intermediate | N/A | Light | Limited butchering at the kill site, secondary butchering elsewhere; Limited bone, head/foot dominated assemblage, portions of carcass cached nearby |
| NUMBER OF ANIMALS HUNTED | | | | |
| <i>Few</i> | Narrow gaps between funneling features/drive lanes | N/A | None-Minimal | None-Minimal |
| <i>Many</i> | Wide gaps between funneling features/drive lanes | N/A | Light – Dense | Light – Dense |
| STATE OF THE ANIMALS | | | | |

| | | | | |
|---|--|---|--|-----|
| <i>Panicked, i.e. actively driven</i> | Robust continuous lines, narrow gaps between lines (avg. 4.5 m), substantial, continuously walled hunting blinds | N/A | N/A | N/A |
| <i>Bothered, Not Panicked</i> | Diffuse, discontinuous lines, wide gaps between lines (~30 m), shallow blinds in or behind the gap | N/A | N/A | N/A |
| HUNTING TECHNOLOGY | | | | |
| <i>Atlatl/Dart</i> | Intermediate? | | Large lanceolate points, impact damage, found within range of hunting blinds, x meters | |
| <i>Lance/Thrusting Spear</i> | Robust continuous lines, narrow gaps between lines (avg. 4.5 m), substantial, continuously walled hunting blinds | | Fire harden, lithic, or ivory/bone tipped wooden spears | |
| SEASON OF USE/ HUNTING CONTEXT | Hunting Architecture | | Other Facilities | |
| | Orientation | Location | | |
| <i>Fall – Migratory</i> | Northwest | Topographic bottlenecks along migration route | N/A | |
| <i>Spring – Migratory</i> | Southeast | Topographic bottlenecks along migration route | N/A | |
| <i>Non-Migration</i> | Opportunistic | Near game trails, grazing areas, fresh water | N/A | |
| GROUP SIZE | | | | |
| <i>Individual</i> | Simple, if any | Minimal ? | Minimal | |
| <i>Pair/Small Group</i> | Small, Simple Structures | Small number of temporary dwellings ? | Light | |
| <i>Cooperative Group</i> | Complex | Large, multiple | Dense | |

| | | | | |
|-----------------------------------|------------|--|---|---|
| | Structures | dwelling, with evidence of re-use ? | | |
| HUNTING GOALS | | | | |
| <i>Immediate Consumption</i> | Present | Hearths | Limited range of tools, primarily those related to kill and kill processing | Expedient processing, full representation of bone elements |
| <i>Delayed Consumption</i> | Present | Caches, Drying racks, Hearths/boiling pits | Greater representation of processing tools and debris | Multi-stage processing, absence of bones associated with high ranked elements |
| <i>Raw Material Acquisition</i> | Present | | Specialized maintenance tool kit | Absence of antler, metapodials, cutmarks indicative of hide processing/tool manufacture |
| <i>Social Solidarity/Exchange</i> | Present | Social architecture ? | Exotic raw materials, mixed styles of projectile points, etc. | Feasting consumption remains |

Given the AAR results, there are some instances where the evidence suggest more than one value for a particular variable including number of animals hunted, state of the animals, season of use, group size, and hunting goals (and to a lesser extent, hunting technology). Furthermore, there are obvious correlations among variable states. For example, prey species and prey size are correlated with each other as well as specific butchering expectations. Furthermore, herd size, composition, and animal quality are all seasonally variable. While each variable was presented individually above, here the discussion will focus on how these variables group together.

Looking at **Table 8.3** both large and small groups of animals were the target of hunting structures, and both panicked and non-panicked animals were likely hunted. The diversity

present here in both the number and state of the animal is likely related to different hunting patterns associated with different seasons. The majority of structures that are most closely associated with non-panicked animals are simple hunting blinds (closed and v-blinds) and the majority of these (n=6) are associated with fall migration hunting (see summary of seasonality data below). In contrast, the two most complex structures, Funnel and Drop 45 match expectations for panicked animals, and both of these sites were used in the spring. Given these patterns, it is likely that during the fall, migration herd sizes were sufficiently large that they were not actively driven toward the hunting blinds. This is consistent with the data that herds were simply larger in prehistory before firearms, snowmobiles, and human expansion decimated caribou populations, as well as the fact that fall migrations have the largest concentration of animals and males and females migrate together (Petersen and Johansen 1991:27-28, **Chapter 5**). In contrast, some spring herds were actively driven into complex hunting architecture sites – indicating that spring herd sizes were smaller and/or that these animals were migrating more directly and needed to be actively channeled toward hunting architecture sites. This interpretation is also consistent with caribou ethology which indicates that spring migrations are less concentrated as males and females migrate separately, and as pregnant females lead the spring migration to calving grounds these routes tend to be very direct. Furthermore, when migrating caribou are less intent on their surroundings and are easier to frighten (**Chapter 5**).

In terms of hunting technology, either the atlatl/dart or lances/thrusting spears were likely utilized by AAR hunters. To date, no definitive weaponry has been recovered, although given the extensive sampling at Drop 45 in and around hunting blinds, the weight of the evidence currently supports wooden lances or spears, as no projectile points or fragments have been found. Overall, the specific hunting weaponry on the AAR is likely to have been one of these options, and

further sampling will confirm which. Fortunately, the unique submerged environment of the AAR has preserved several pieces of ancient wood (**Chapter 7**) and provides the necessary depositional environment for recovering organic weaponry.

An analysis of orientation of the AAR structures demonstrates that hunting architecture was used during both the fall and spring migrations as well as for non-migration hunting. The majority of hunting architecture sites on the AAR have a fall orientation (n=7, **Table 8.2**). The emphasis on autumn hunting is not surprising as animals are in the best quality, with maximum body weight and fat, and their hides and sinews are at their most desirable (Blehr 1990:320; Enloe 2003:24; O’Shea et al. 2013, 2014; Reimers and Ringberg 1983; Steffansson 1951:337). Furthermore, autumn migration routes also typically lead to relatively predictable winter ranges (Calef 1981:129). For all these reasons, hunting in the autumn for hides and surplus meat for winter is commonly documented among caribou hunters (Brink 2005:16). Significantly, the two most complex hunting architecture sites located the AAR, Funnel and Drop 45, are oriented for spring. Hunting during the spring migration is likely associated with immediate consumption as food stores and resources are low at the end of winter. As these complex sites require large groups of people to operate, spring communal hunting provides the feedback between group aggregation to operate complex structures and complex structures generating enough food to support these larger groups (**Chapter 3**).

Similarly, a range of different types of hunting took place on the AAR in terms of group size and hunting goals, which makes sense as these variables are all interrelated. The AAR data support hunting by individuals, pairs/small groups, as well as larger cooperative groups. The expectations are also met for the hunting goals of immediate and delayed consumption as well as social solidarity and exchange. The diversity in group size makes good sense with the range of

hunting goals exhibited on the AAR. It is easy to imagine how variable states are interrelated. For example, small groups traversing the AAR, utilizing simple hunting structures for immediate consumption; or larger groups cooperating to operate complex structures to generate surplus meat for delayed consumption and exchange.

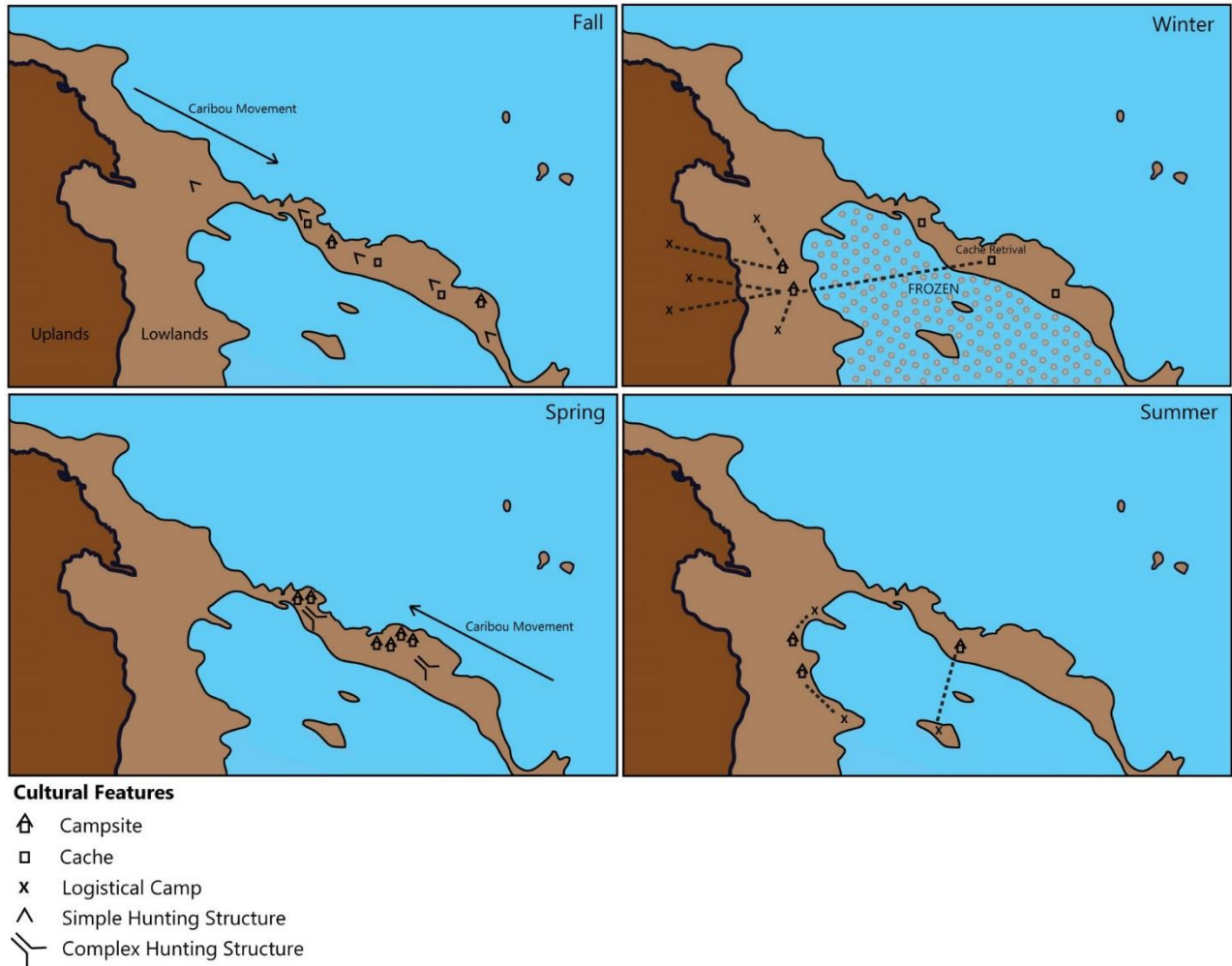
Along these lines, the most interesting pattern that emerges from the AAR data reflect correspondence across the variables of seasonality and group size. Specifically, there is a strong correlation between *structure type* (simple or complex), *season of use*, and *population size*. Specifically, the most complex structures on the AAR are associated with spring migration hunting and the operation of these complex structures required larger, cooperative groups of people. Likewise, the majority of simple structures are oriented for fall migration hunting and these simple structures correspond to smaller groups of hunters.

Therefore, a model can be proposed that *caribou hunting on the AAR was organized with simple hunting blinds operated by small groups in the fall, and larger numbers of hunters and their families aggregated in the spring to construct and operate the more complex structures* (Lemke and O'Shea 2015; O'Shea et al. 2014) with more ephemeral use of the AAR in other seasons to pursue in non-migration hunting. Furthermore, these different hunting strategies were likely driven by a number of shifting and complementary goals including both immediate and delayed consumption, as well as social solidarity and/or exchange all structured by season (**Table 8.4**). This model of seasonal occupations on the AAR has implications for the complete seasonal round of AAR foragers which is illustrated in **Figure 8.1**. This model can be used to infer likely economic patterns for the winter and summer non-migration seasons, as well as specific expectations for what types of sites may be found on terrestrially on mainland Michigan, such as logical winter camps (**Chapter 10**, Lemke and O'Shea 2015).

Table 8.4. Generalized model of human occupation and caribou hunting on the AAR.

| Season/ Hunting Context | Structure Type | Number and State of the Animals | Group Size | Hunting Goals |
|--|---------------------------|--|---|---|
| Fall | Simple | Large, Bothered | Individual, Pair/Small Group | Delayed consumption |
| Spring | Complex | Panicked | Cooperative Group | Immediate consumption; Social Solidarity/Exchange |
| Non-Migration | Simple and Complex | Bothered, Panicked | Individual, Pair/Small Group, Cooperative Group | Delayed, and Immediate consumption, Social solidarity/exchange |

Figure 8.1. Schematic of seasonal occupations on the American portion of the AAR. Darkest color indicates modern land surface, lighter color indicates additional land surfaces that would have been dry land during Lake Stanley (see Chapter 4), (adapted from Lemke and O’Shea 2015: 175, Figure 14.1).



This analysis of the previous collected AAR data using the middle range theory developed in **Chapter 3** provides a testable model of human occupation and caribou hunting. Over time, the variable states which compose the model would create a palimpsest of hunting architecture sites, other facilities, and their associated material culture; ultimately resulting in a complex, engineered environment that was used across seasons and generations. In order to formally characterize this engineered landscape and test the general model proposed here, new research was undertaken (**Chapter 9**).

Chapter 9

Testing the Model: Alpena-Amberley Ridge Results

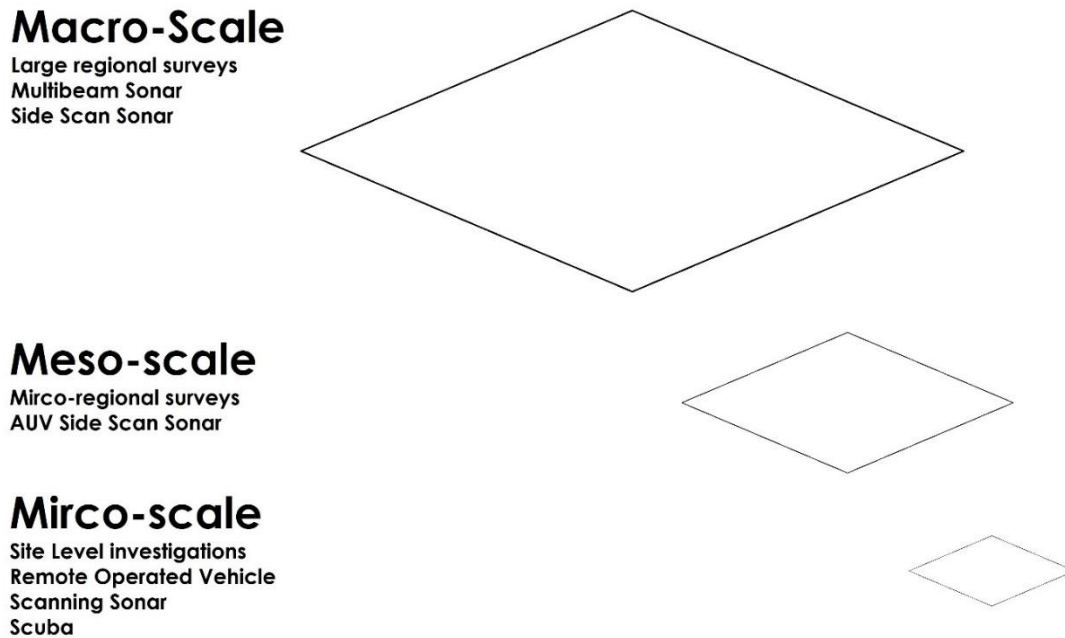
Introduction

Previous research on the AAR is extremely informative concerning the range of ways prehistoric foragers used this landform (**Chapter 7**). Given the nature of underwater investigations (**Chapter 6**), prior research has focused primarily on proof of concept by surveying large regions, or investigating individual hunting structures at the site level. What is fundamentally missing from this prior research is the critical meso-scale (**Figure 9.1**). Meso-scale investigations, those intermediate between large regional surveys and individual site level research, are necessary to formally characterize the culturally engineered landscape on the AAR.

Similar to terrestrial approaches, landscape archaeology underwater is by necessity a multi-scaler endeavor. While investigations tend to focus on single targets, such as shipwrecks, or on large-scale landscapes, the meso-scale is often overlooked in submerged research. Surveys at a meso-scale, around 1-10 square kilometers, are large enough that they can be used to understand spatial relationships between hunting architecture and other facilities, but fine enough that individual constructed features can still be identified and understood. Such investigations take particular advantage of the unique preservational environment of the AAR in which these meso-scale landscapes are preserved intact. In order to test the general model of hunter-gatherer

lifeways developed in **Chapter 8**, a meso-scale approach is required. As such, new research was undertaken to compare two localities on the AAR.

Figure 9.1. Scales of research on the AAR.



New Research

Prior investigations on the AAR suggest that caribou exploitation strategies and social aggregation/dispersal are structured by season and hunting context. A model was proposed which characterized caribou hunting as small groups using simple hunting blinds in the fall, and larger, cooperative groups gathering in the spring to construct and operate complex structures. Additionally, the AAR was likely used to for non-migration hunting, but to a lesser extent than

hunts targeting migrating caribou, with winter and summer occupations on both the AAR and the mainland having distinctive characters (**Chapter 8**).

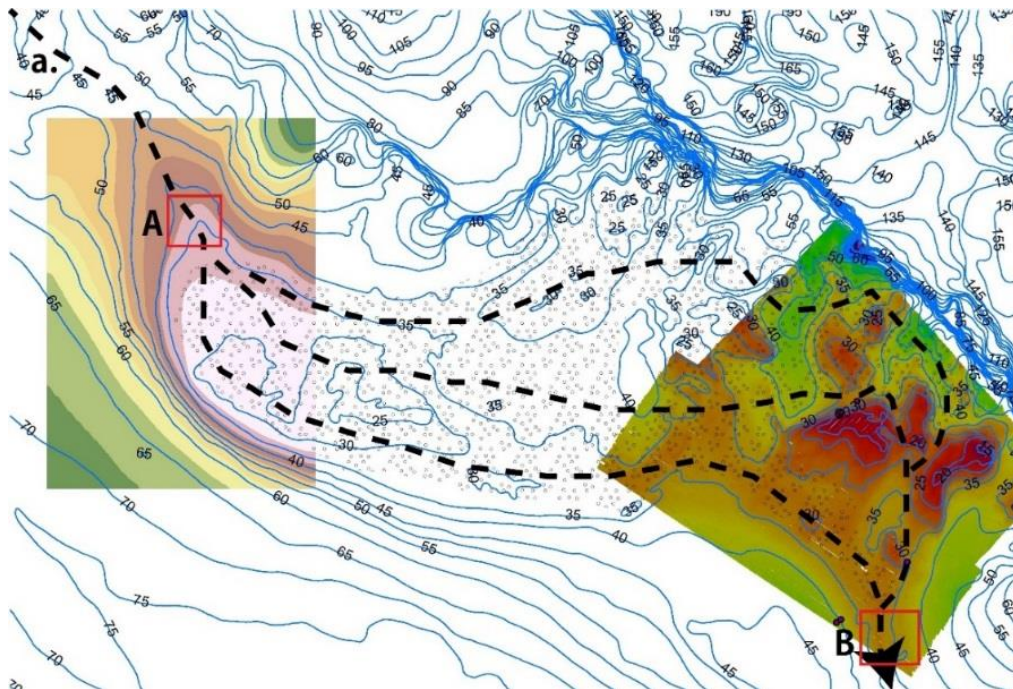
Preliminary studies in the Overlook Locality played a large role in the formation of this model of human hunting and occupation on the AAR – as the interrelated variables of seasonality, group size, and structure type play out in this small region. As mentioned in **Chapter 7**, the AAR landform narrows considerably and forms a natural and unavoidable bottleneck for migration in this area (**labeled “A” on Figure 9.2**). Furthermore, there is overlooking high ground which would serve as an ideal lookout for hunters watching for migrating herds coming south in the fall. While this area was selected for research because of its topographic setting, its function as a bottleneck for migrations has been supported by both hunting architecture sites and the computer simulation (**Chapter 7**, O’Shea et al. 2014). Hunting architecture sites indicate that hunters exploited this location during both migrations; as the spring complex site Drop 45 rests on the downward slope, and upslope on the overlooking high ground there are the several V-shaped blinds orientated for fall hunting near a rectangular cache. Additionally, there are two large stone lines that served to funnel migrating animals toward the overlook and the hunting blinds (see **Figure 7.44**).

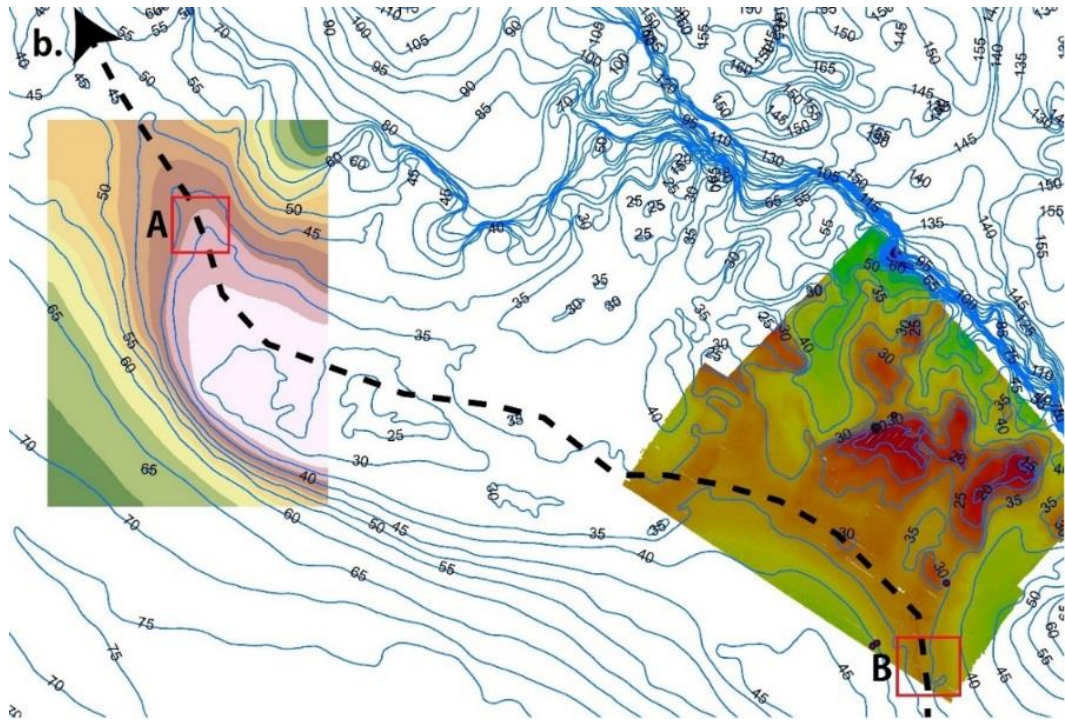
The Overlook Locality approximates a meso-scale area – intermediate in size between large topographic regions and individual sites. The patterns of hunting architecture and other facilities previously identified in this locality illustrate the importance of meso-scale investigations, as different forms of hunting architecture sites are part of an actively modified (i.e. niche constructed), re-used, multi-purpose landscape. Regional expectations for settlement patterns include different types and configurations of hunting features, camps and habitation sites that are some distance away from hunting architecture, and the likely presence of rock art or

other kinds of social architecture (**Chapter 3**). Expanding investigations at a meso-scale is necessary for characterizing such patterns, and for quantifying the density of, and spatial relationships between, elements of hunting architecture.

The computer simulation identified a second, heretofore uninvestigated, area that presents a similar topographic situation to the Overlook Locality – another narrow part of the AAR that caribou were likely to have transited during both seasons (**labeled “B” on Figure 9.2**). It is hypothesized that similar to the Overlook Locality, this second area on the AAR would be also be modified with hunting architecture to intercept caribou during both the fall and spring migrations and would show similar correlations between season of use, structure type, and group size. This second narrow “bottleneck” or chokepoint presented an ideal area to evaluate the proposed model, and was selected for the comparative research undertaken for this dissertation.

Figure 9.2a. Computer simulated caribou migration routes across the AAR in the fall (*top*) and b. spring (*bottom*). The Overlook Locality is labeled A, the second bottleneck where caribou would have passed in both seasons is labeled B.





The meso-scale research area for this second bottleneck was selected to partially overlap previously collected multibeam sonar data of the larger Area 1 (**Chapter 7**). The multibeam survey documented a portion of a large nearly north-south running geological feature, seen as the orange line in **Figure 7.7**. This feature is most likely a glacial esker, and would have looked similar to **Figures 9.3a-b** when the AAR was dry land. This feature dominates the landscape in this local area and runs through the middle of this narrow portion of the ridge (both localities are ~2 km across).

This esker would have presented an ideal topographic feature for hunting, as the slightly elevated landform would provide high ground for monitoring game movement, as well as a harder surface to traverse than the adjacent marshy flatlands (see *Paleoenvironmental Context* below). Furthermore, caribou migrations often follow along such topographic features (see **Chapter 5**). For all these reasons, this specific area on a narrow portion of the AAR which had to be traversed by caribou in both seasons, presented an ideal location for prehistoric hunters to

predictably intercept caribou; and an ideal location a new survey. Throughout the rest of this discussion this area is referred to as the Esker Locality.

Figure 9.3a. Glacial esker in Canada.
(http://sis.agr.gc.ca/cansis/taxa/landscape/locsf/level_nta.jpg).



Figure 9.3b. Glacial esker in Canada.
(http://farm4.staticflickr.com/3303/3475078644_b1d5059f19.jpg).



Methods for Evaluating the Model

New investigations in both the Overlook and Esker Localities were conducted to test the general model developed in **Chapter 8**. There are two essential elements of the model: (1) that the AAR was used in both the fall and spring and, (2) that there is a link between season and type of hunting structure, from which other variables, i.e. group size, number and state of the animals, and hunting goals, can be inferred (see **Chapters 3 and 8**). New investigations in both localities permit an assessment of the model based on the presence or absence of these essential elements. In **Table 9.1** H_1 is the model originally derived from earlier research. H_0 is the null hypothesis that there is no correlation between season and structure type in the Esker Locality, or that there are no human made constructions there at all.

Table 9.1. Alternative hypotheses for the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR.

Essential Elements of the Model

| <i>Hypotheses</i> | AAR is used during Both Seasons | Linkage between Season and Type of Structure |
|--------------------------|--|---|
| H₀ | - | - |
| H₁ | + | + |
| H_{2a} | - | + |
| H_{2b...} | + | - |

If both elements are present, the seasonal model proposed for the AAR will be strongly supported. In this scenario groups of hunters travel to the Esker Locality in both the fall and the spring to intercept caribou during their migrations. Group size will most likely vary between these two seasons, with small groups operating simple hunting structures in the fall, and larger groups aggregating for communal hunts utilizing more complex drive lane features in the spring.

If only one element is present, the underlying model should be revised in light of new results. For example, the Esker Locality may have been used during both seasons by just small groups or just large groups, or it may have been used during a single season, or for non-migration hunting, with either large or small groups.

If neither element is present, the proposed model as a general construct for the AAR must be rejected. For example, the Esker Locality may have been used in a single season with a variety of different hunting structures, and thus represent a very different land use strategy than then current model proposes. Alternatively, the Esker Locality may have features that were not used for hunting, such as caches, campsites, fire pits, etc. or may have no structures of any kind suggesting, a) that people did not travel to the Esker Locality, or b) their activities there did not include constructing stone hunting architecture.

Lines of Evidence

Similar to the generation of the model in **Chapter 8**, the formal attributes of the structures and their associated archaeological materials will serve as the evidence for supporting or rejecting these hypotheses. The interpretation of the formal attributes of new hunting architecture will follow these guidelines for key variables: (1) in terms of *orientation*, north-northwest will indicate use during the fall, and south-southeast will indicate use during the spring, other orientations may indicate non-migration hunting activities; (2) in terms of *structure type*, simple structures like individual v-shaped hunting blinds indicate operation by small groups of people, while more complex structures such as drive lanes and hunting blinds indicate use by a larger number of individuals carrying out different tasks.

In addition, given the unique nature of the new meso-scale survey, spatial relationships can be measured between different types of hunting structures and may reveal seasonal variability in land use strategies and mobility regimes in each research locality. Therefore, (3) in terms of *density*, a smaller number of structures placed far apart will indicate a more ephemeral use of the choke points and/or a smaller number of individual hunting events, while a higher density will indicate larger groups of people, or aggregation from continued seasonal reuse. Density of sites has played an important role in terrestrial caribou hunting investigations as greater densities of hunting architecture sites have been found at certain locations such as water crossings, indicating that such areas were frequently used (Stewart 2015:81). Furthermore, density of different kinds of structures indicates land use and settlement patterns that involve built structures not only for hunting, but also trapping, fishing, and/or commemoration (Stewart 2015).

One important proviso for these alternative organizational scenarios is the implicit assumption that the AAR structures are contemporaneous. While the tightly bounded chronology of the AAR limits change over time (see **Chapter 7**), there is a possibility that some hunting features were constructed later than others. Modeling the details of lake level fluctuations and final inundation of the AAR is difficult and complex, but elevations can provide a rough estimate of which portions of the AAR were submerged first, i.e. lower elevations provide a *terminus ante quem*. Within the Esker Locality there is relatively little difference in elevation (average depths are between 100-115 feet), providing a strong argument that the structures in this area will be contemporary. There is a greater amount of difference among the structures in the Overlook Locality (depths between 90-130 feet), which might make an assumption of contemporaneity more tenuous.

Autonomous Underwater Vehicles and Survey Methods

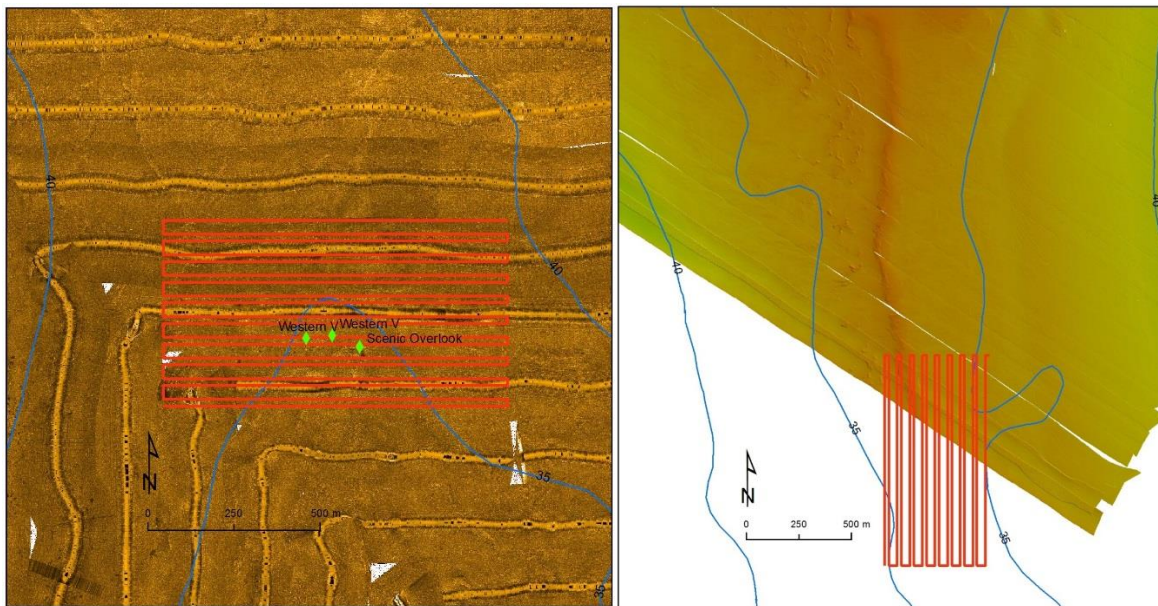
In order to test the proposed model of seasonal land use and social aggregation on the AAR, meso-scale mapping of hunting structures and sites is critical. Recording new features and their spatial relationships in high-resolution with an Autonomous Underwater Vehicle (AUV) proved to be well suited to this task. Both localities were surveyed using an AUV equipped with side-scan sonar to create high resolution maps of the meso-scale relationships between known (and newly discovered) hunting structures in the Overlook Locality, and to identify and map any new structures in the Esker Locality. Although Overlook was targeted for preliminary research, detailed meso-scale maps did not exist for this area, and therefore AUV mapping was done to create comparable maps of both locations.

An AUV has great potential for mapping the meso-scale since it can fly close enough to the bottom to create high resolution images with both side-scan sonar and still photographs taken straight down every 1 second. Both the acoustic and still images can be mosaicked to give an accurate representation of the lake bottom and any archaeological sites in the survey areas. Side-scan sonar is particularly useful for this type of investigation since it provides detailed representations of three-dimensional objects on the sea floor. The use of AUVs for detailed mapping was pioneered during shipwreck explorations such as the Titanic (e.g. Murray 2012) but these vehicles have only recently been applied to prehistoric research (see Mackie et al. 2015). The real advantage of AUVs is that they are autonomous, that is, in contrast to traditional side-scan sonar towfish which are connected to the surface vessel via a cable, AUVs are untethered. This autonomy allows the AUV to travel unrestricted, in contrast to towed side-scan

sonars which are subject to the motion of the boat, and are hindered from flying too close to the lake bottom by cable length and catenary effects.

An Iver3 AUV was used to map both research localities with side-scan sonar. The survey patterns for each research area were designed using a Mines and Countermeasures (MCM) efficient search pattern (Atherton 2011; Fish and Carr 1990). A 4.5 km² east-west oriented survey was completed in the Overlook Locality, and a 5.4 km² north-south oriented survey was completed in the Esker Locality. In both areas the side scan sonar was set at a 50 meter range, with a 50% (or 25 meter) overlap, and flew at a set altitude of 10 meters above the lake floor. The survey pattern for each locality is displayed in **Figure 9.4**.

Figure 9.4. AUV survey transects in the Overlook (*left*) and Esker (*right*) Localities.



The survey block for the Overlook Locality was designed to cover the slope of the ridge up the hill to beyond the crest. This specific area was selected so that the AUV would overlap the Drop 45 complex site as well as the several v-shaped hunting blinds and the rectangular structure near the crest. The survey block also extends in all four directions around this cluster of

structures in order to record any others that may not have been identified. The survey block for the Esker Locality was designed to partially overlap the previously collected multibeam data and to follow the length of the esker south.

Results

Sonar data was processed using SonarWiz version 6 (Chesapeake Technologies Inc.) to produce mosaics of both survey areas (**Figures 9.5-9.6**). In a few places in each locality, the AUV tracked off course, as indicated by zig-zigs in the otherwise straight survey transects. Several factors contributed to these navigational errors.

The particular AUV used for this study was a new model with new inertial navigation software. Once launched, the GPS receiver on the AUV communicates to several satellites in order to locate itself in real time, before driving to the beginning of the transect line and then diving below the surface. Once under the surface, the AUV no longer has GPS communication, and thus relies on the inertial navigation system to estimate its course. Weather conditions on the day of the AUV survey were not ideal as rough seas built throughout the day. As such, the AUV's ability to get reliable GPS fixes at the end of each survey transect was limited, with it often only communicating with 2-3 satellites instead of the typical 4-5. Furthermore, this was also only the second mission ever flown with this AUV, the first tight pattern survey without a visible baseline, and its longest time running on a single battery. These reasons likely account for the deviations in the Overlook Locality survey. Deviations are more numerous, as well as more varied in terms of where along the transect they occurred in the Esker Locality. This is likely due to the orientation of the survey. As opposed to the east-west orientation of the Overlook locality survey, the Esker Locality's north-south survey transects were perpendicular to prevailing winds,

waves, and currents on that particular day. While these conditions were likely responsible for the AUV navigation deviations, these same conditions would have made traditional side scan sonar collection with a towfish connected to the boat impossible.

Figure 9.5. AUV mosaicked for the Overlook Locality.

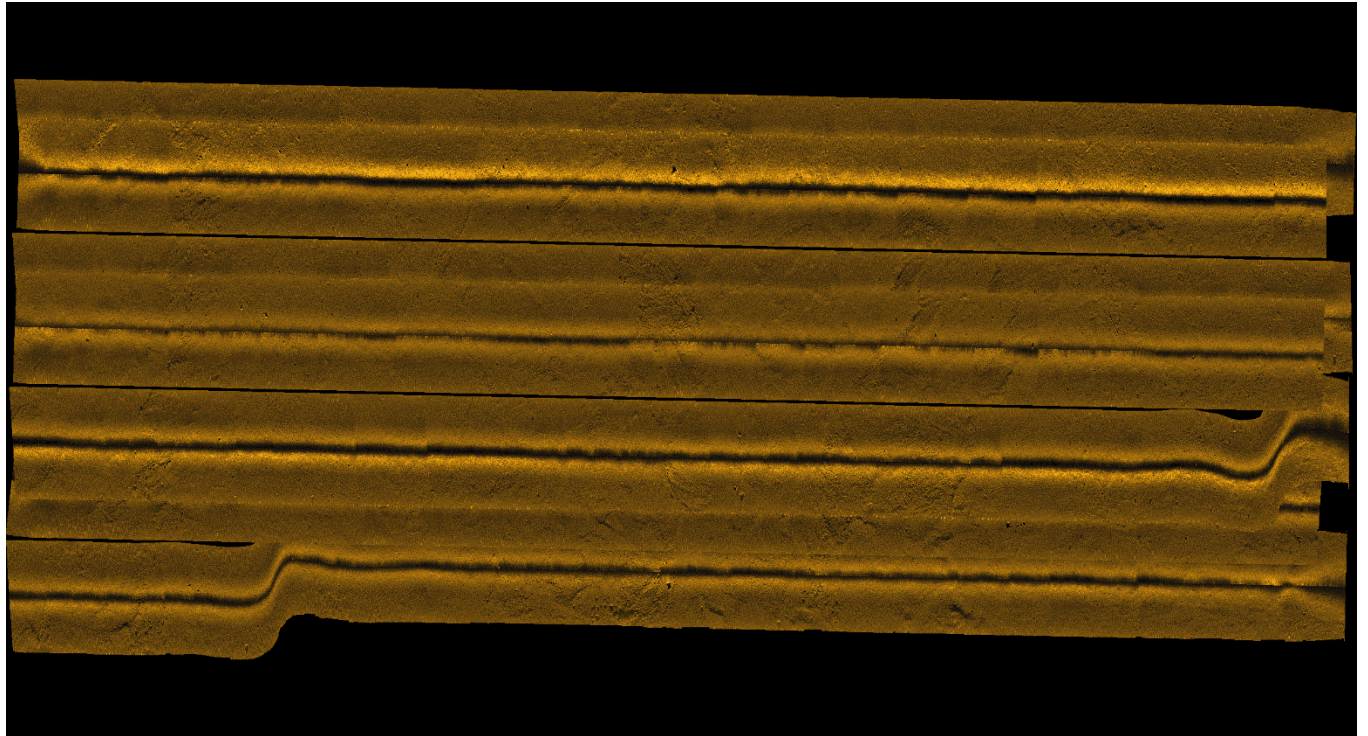


Figure 9.6. AUV mosaicked for the Esker Locality.



Despite navigational issues, the AUV completed both survey blocks with high resolution sonar imagery of the lake bottom. The acoustic images produced by the AUV flying close to the

lake bottom are particularly striking when overlain on the mosaic of the larger survey of Area 3 conducted with traditional side scan (**Figure 9.7**). While this initial survey was necessary to characterize the overall landscape of Area 3, i.e. at a macro-scale, it is clear that meso-scale surveys with AUVs can produce higher quality images of potential structures.

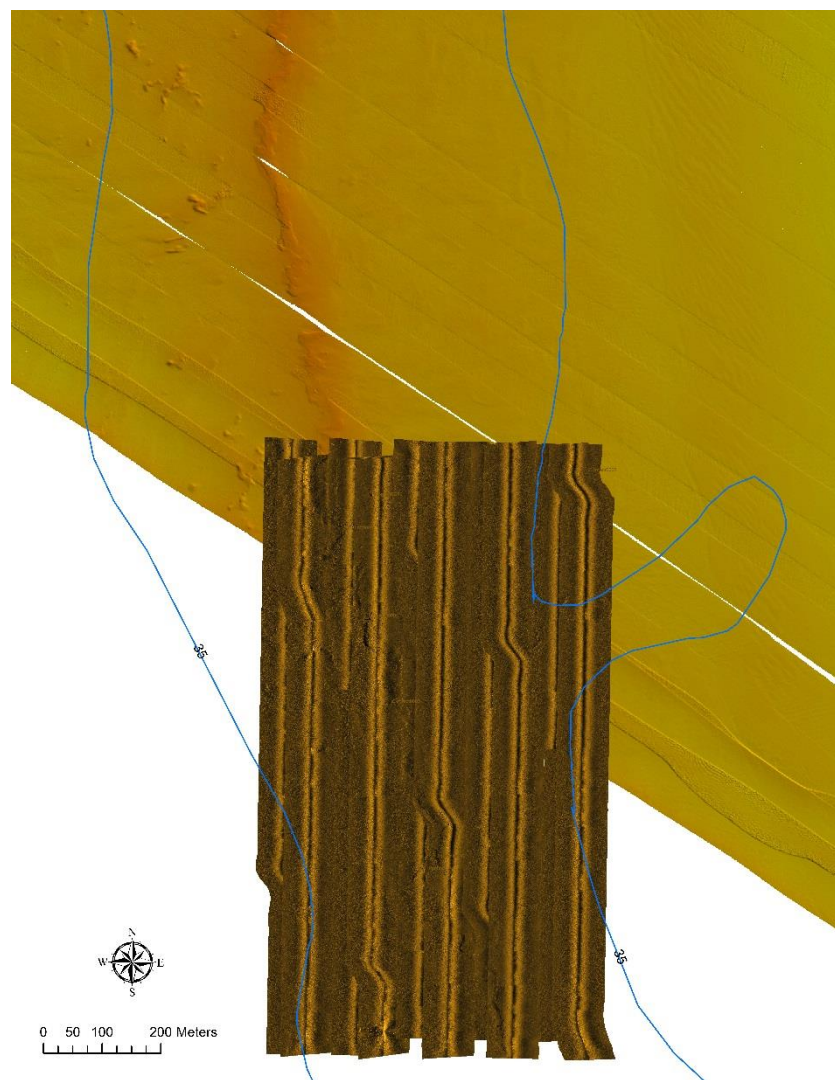
Figure 9.7. AUV mosaic of the Overlook Locality placed over the SSS of Area 3.



For the Esker Locality overlapping the AUV imagery on top of the previously collected multibeam data demonstrates how complementary these different scales and methods of mapping are; as the multibeam produces unparalleled imagery of elevations and 3-D features on the lakebed, while the AUV provides a higher resolution picture of smaller features (**Figure 9.8**).

The AUV survey resulted in the discovery of new potential structures in both areas. Several of these new discoveries were selected for further investigation with a remote operated vehicle and scuba divers; following the research design outlined in **Chapter 7**.

Figure 9.8. AUV mosaic of the Esker Locality placed over multibeam coverage of Area 1.



Structures

Potential targets were selected in both localities based on their scale, appearance, and overall likelihood of human modification. One new target was selected for further investigation in the Overlook Locality, and nine were selected in the Esker Locality. The Overlook Locality will be discussed first, but it must be stressed that the primary focus of research was the Esker Locality, as it had not previously been investigated. As with all structures on the AAR, conservatism is practiced in promoting a target to a potential human modified feature. Decisions are made on a case by case basis in reference to non-random patterning, topographic placement, presence of artifacts, etc. as discussed below and in **Chapter 7**.

Overlook Locality

On the AUV survey, Contact 1 was selected as it presented at least two, and possibly three connected rectangular structures (**Figures 9.9-9.10**). These rectangular configurations of stones are very different from other features seen thus far on the AAR. This feature contrasts markedly with the previously identified rectangular structures which are much smaller in overall size/interior space, but are made with larger stones (see *Contact 12* below). The central rectangular structure is ~10 by 10 meters, and both the shape and size of this feature are comparable to stone tent foundations known throughout the arctic (**Figures 9.11-9.13a-b**). An ROV survey of the target supported the inference that this configuration of stones was human modified as opposed to a natural feature as there was no evidence that this feature was made by

geologic processes. Therefore, scuba diving operations were undertaken to collect archaeological and paleoenvironmental samples (see below).

Figure 9.9. Overlook Locality, Contact 1 (North is up).

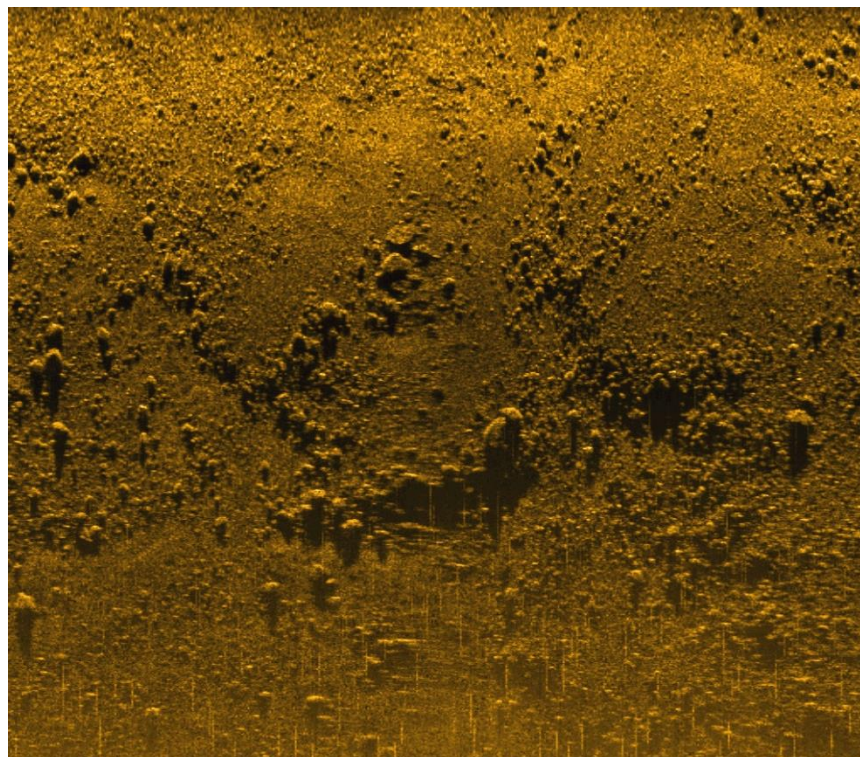


Figure 9.10. Schematic drawing of the Overlook Locality, Contact 01.



Figure 9.11. Ariel view of a Dorset longhouse on Victoria Island (Friesen 2007:201).

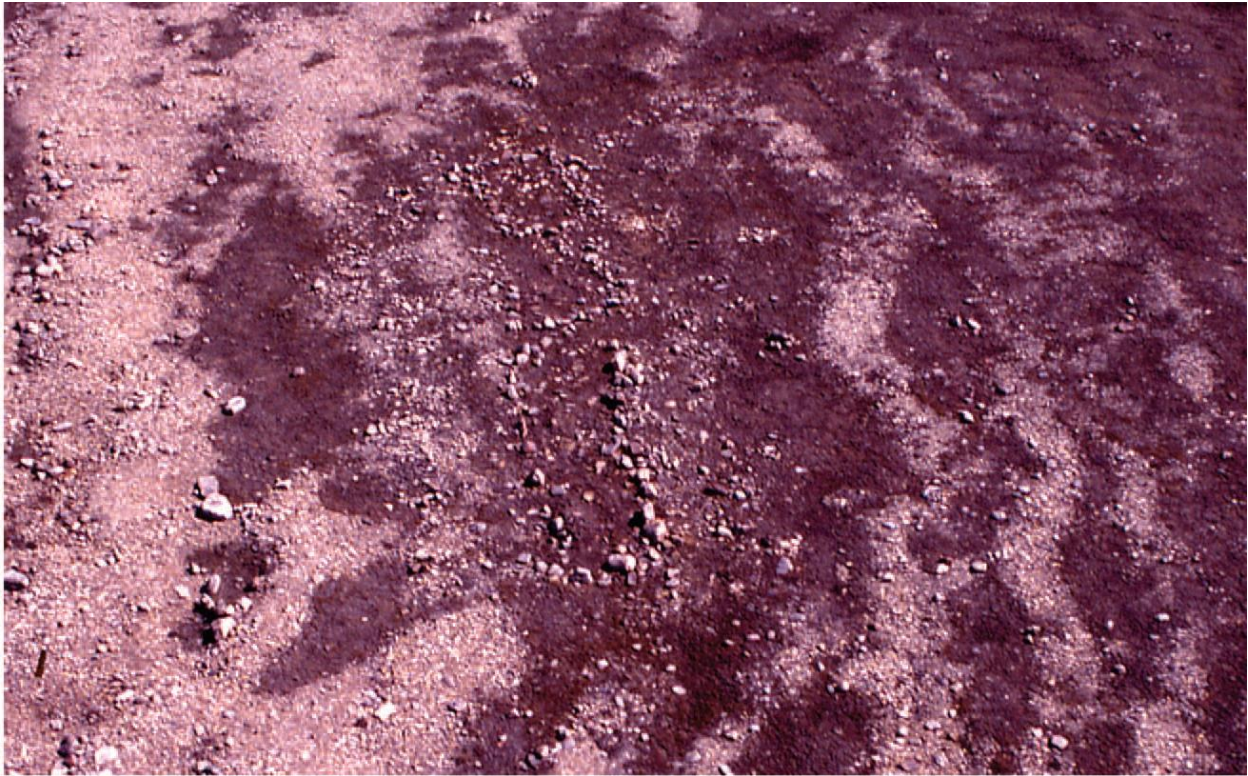


Figure 9.12. Caribou hunters' tent ring west of Hudson Bay positioned on an outcropping of bedrock and a shallow gravel substrate, with additional tent rings in the background (Stewart 2014:88, Figure 8.6).



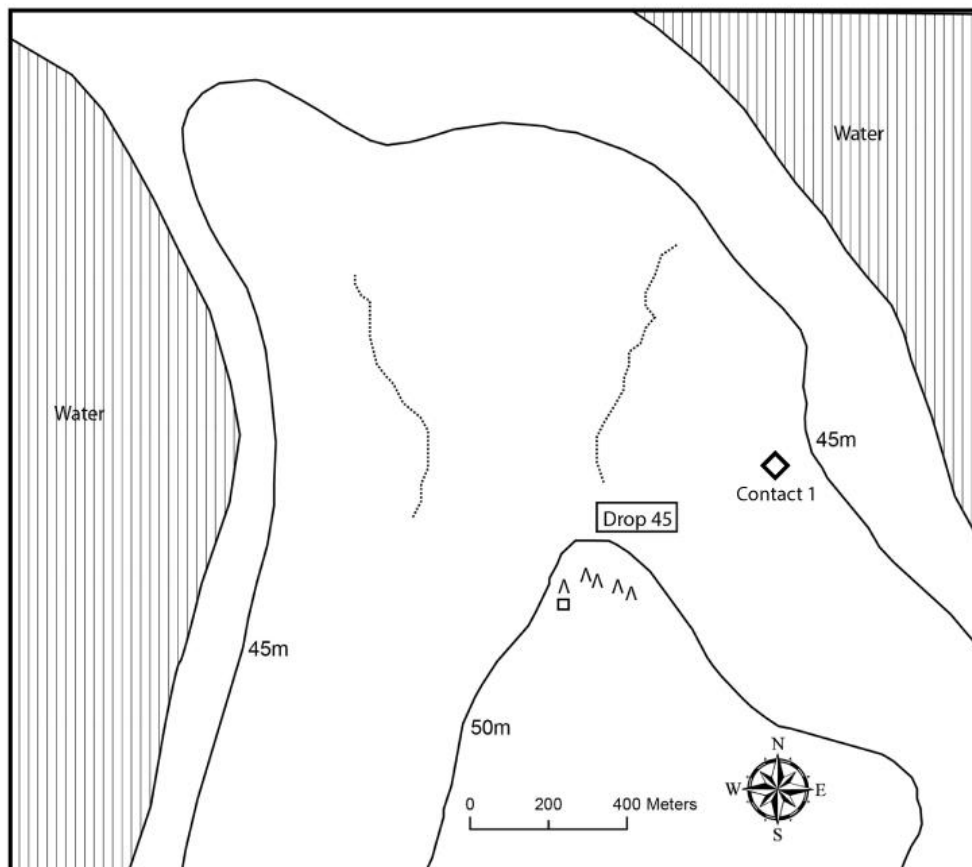
Figure 9.13a-b. Harvaqtuurmiut tent ring and camp site overlooking Thirty Mile Lake, lower Kazan River (Stewart 2014, Figure 19).



When this new structure is added to the meso-scale map of the Overlook Locality, it is clear that the topographic location of Contact 1 is consistent with its interpretation as a dwelling.

For example, the placement of this campsite is ideal as it is far enough away from the hunting architecture features that smells and sounds from habitation would not spook the animals, but close enough that it would be an easy walk to either Drop 45 (half a kilometer) or the top of the ridge near the v hunting blinds to watch for caribou (1 kilometer) (**Figure 9.14**).

Figure 9.14. Overlook Locality with Contact 1, the dwelling. Dashed lines indicate two large stone lines that likely acted as a funneling feature.



Overall, in addition to the identification of what is likely a habitation site, the most striking result of the AUV survey in the Overlook Locality is that previously identified structures, including Drop 45, the smaller v-shaped hunting blinds, and the large stone lines to the north, are not immediately apparent on the AUV sonar. One explanation is that the east-west orientation of the transects, in combination with navigation issues, obscured these features on the

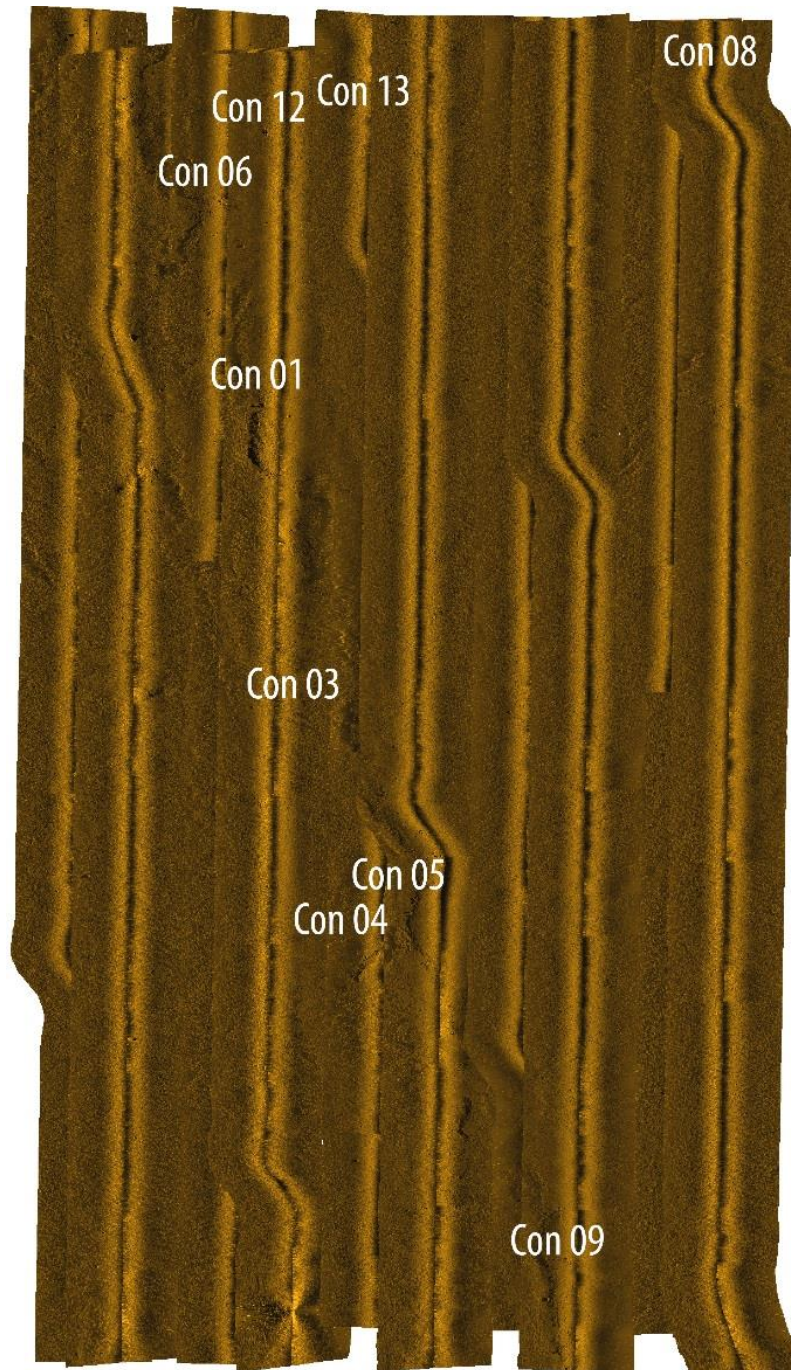
sonar. Oftentimes, there is a fortuitous alignment of features on the lake/ocean beds with the side scan transects that allow some features to be extremely visible, such as the Dragon drive lane in the very first sonar surveys of the ridge (**Figure 7.23**). This phenomenon has been documented by other underwater research and consulting projects (Faught 2015) – suggesting that given unlimited time, funding, and weather, a cross hatched survey pattern is likely the most effective for revealing all potential features. However, the east-west block and north-south blocks of the same area are likely better examined side by side rather than being overlapped in sonar processing programs as this creates a situation of too much overlap – which also obscures potential targets.

Esker Locality

Nine targets in the Esker Locality were investigated as potential human made constructions (Contacts 1, 3-6, 7, 8-9, 12-13) ¹. Of these Contacts, 4-6, 8, and 12 were further investigated using the remote operated vehicle, and of these, scuba operations were conducted at Contacts 6 and 12, where samples were taken from both sites. Contacts 4 and 12 were also mapped with a scanning sonar (**Figure 9.15**).

¹ Contacts 2, 10, and 11 were marked during the original survey but did not warrant further review once the side scan sonar was mosaicked.

Figure 9.15. The spatial organization of all investigated contacts in the Esker Locality.



Contact 1 appears to be a natural opening in the long linear esker that runs through this locality that may have been elaborated with stones lines and by the selective removal of specific

rocks. There is a cluster of several larger rocks that is likely a hunting blind (**Figure 9.16**). Due to time restraints, Contact was 1 was not investigated with the ROV, but as it bears close similarity to other blinds on the AAR it likely served a similar function. The interior space measures 2.5 by 2.5 meters, and the rocks which form this structure are on average 1.5 meters wide. Given its overall v-shape, this hunting blind would only work in one direction (**Figure 9.17**).

Figure 9.16. Esker Locality, Contact 1 (North is up).

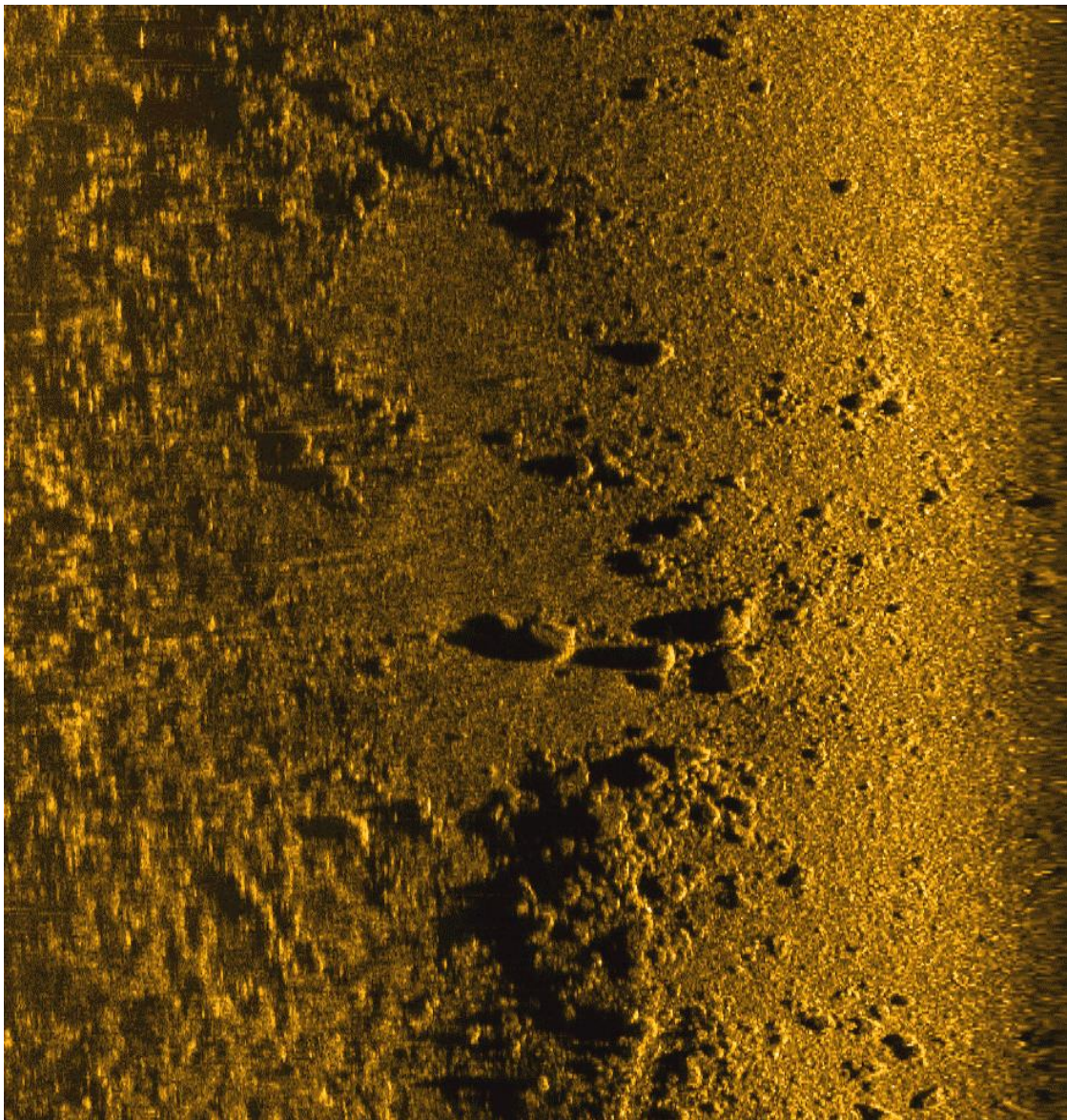
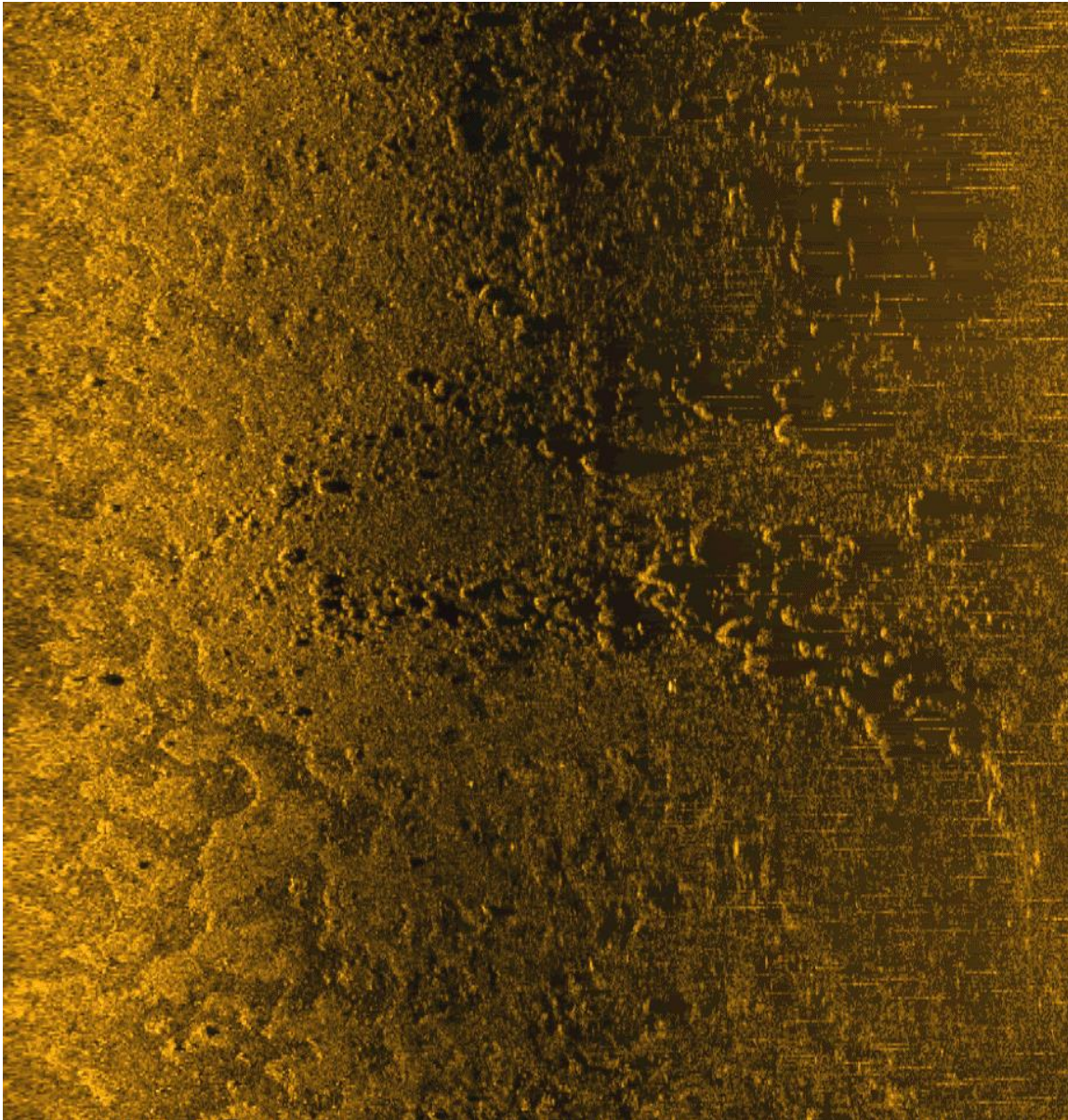


Figure 9.17. Schematic drawing of Contact 1, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement.



Contact 3 was selected as a potential target as it presents two lines perpendicular to the esker feature (**Figure 9.18**). It is still uncertain if these lines are natural deposits of clusters of smaller stones or if these stones were arranged in this pattern to create a type of corral structure. Contact 3 will be further investigated in the future with the remote operated vehicle.

Figure 9.18. Esker Locality, Contact 3 (North is up).



Contact 4 is a discontinuous circle of large stones, which when investigated with the ROV, was found to bear close resemblance to closed blinds known from other areas on the AAR. This circle has an interior space measuring 2.6 meters north-south, and 1.9 meters east-west, with large gaps between some stones that could easily accommodate one or several hunters exiting the blind (**Figures 9.19-9.21**).

Figure 9.19. Esker Locality, Contact 4 (North is up).

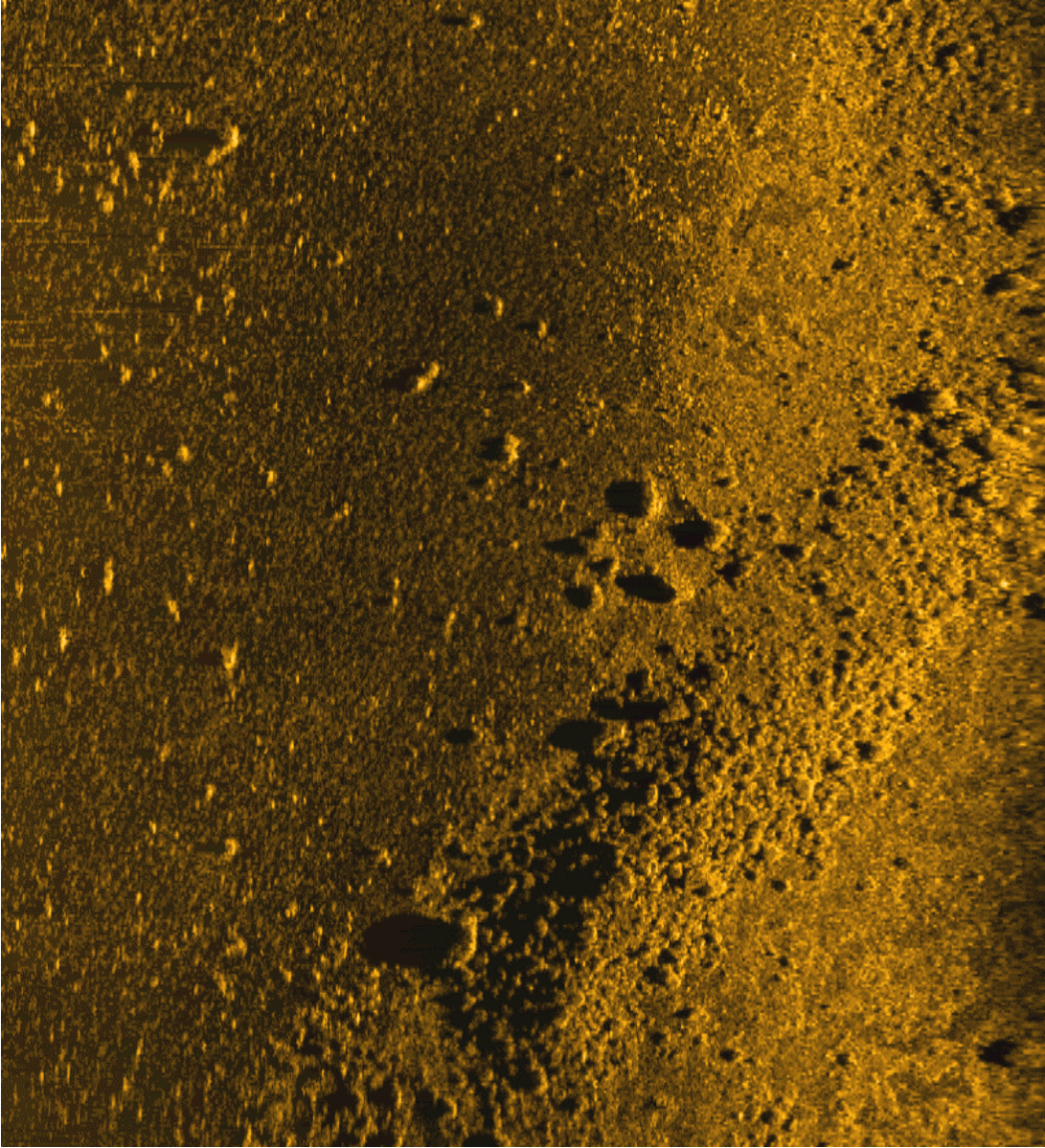


Figure 9.20. Schematic drawing of Contact 4, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement.

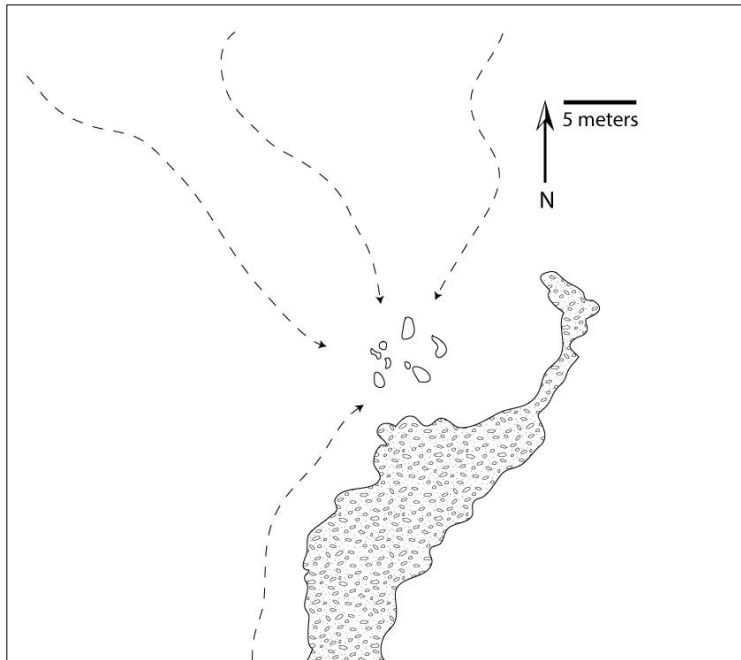
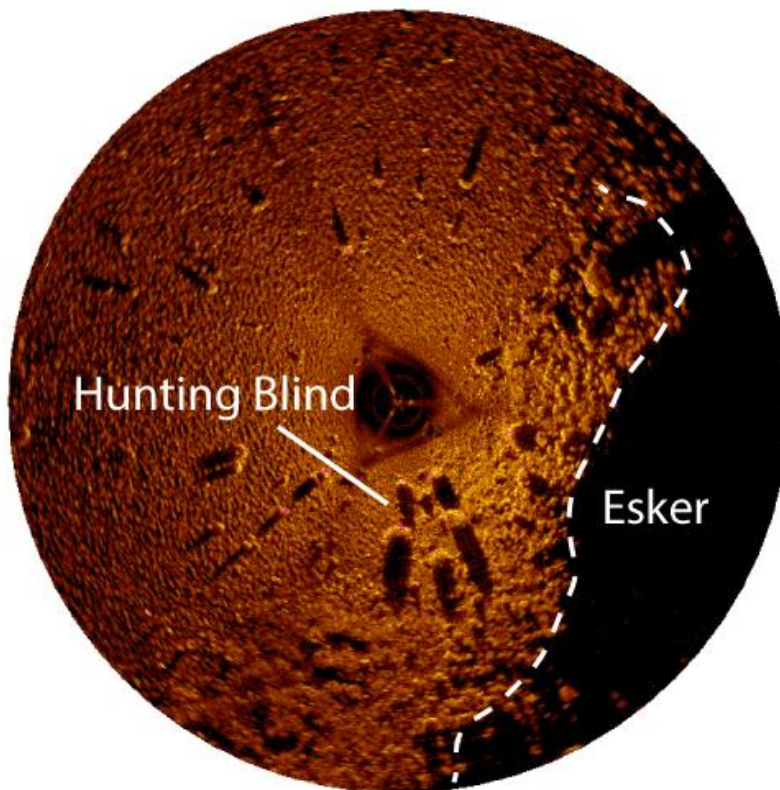
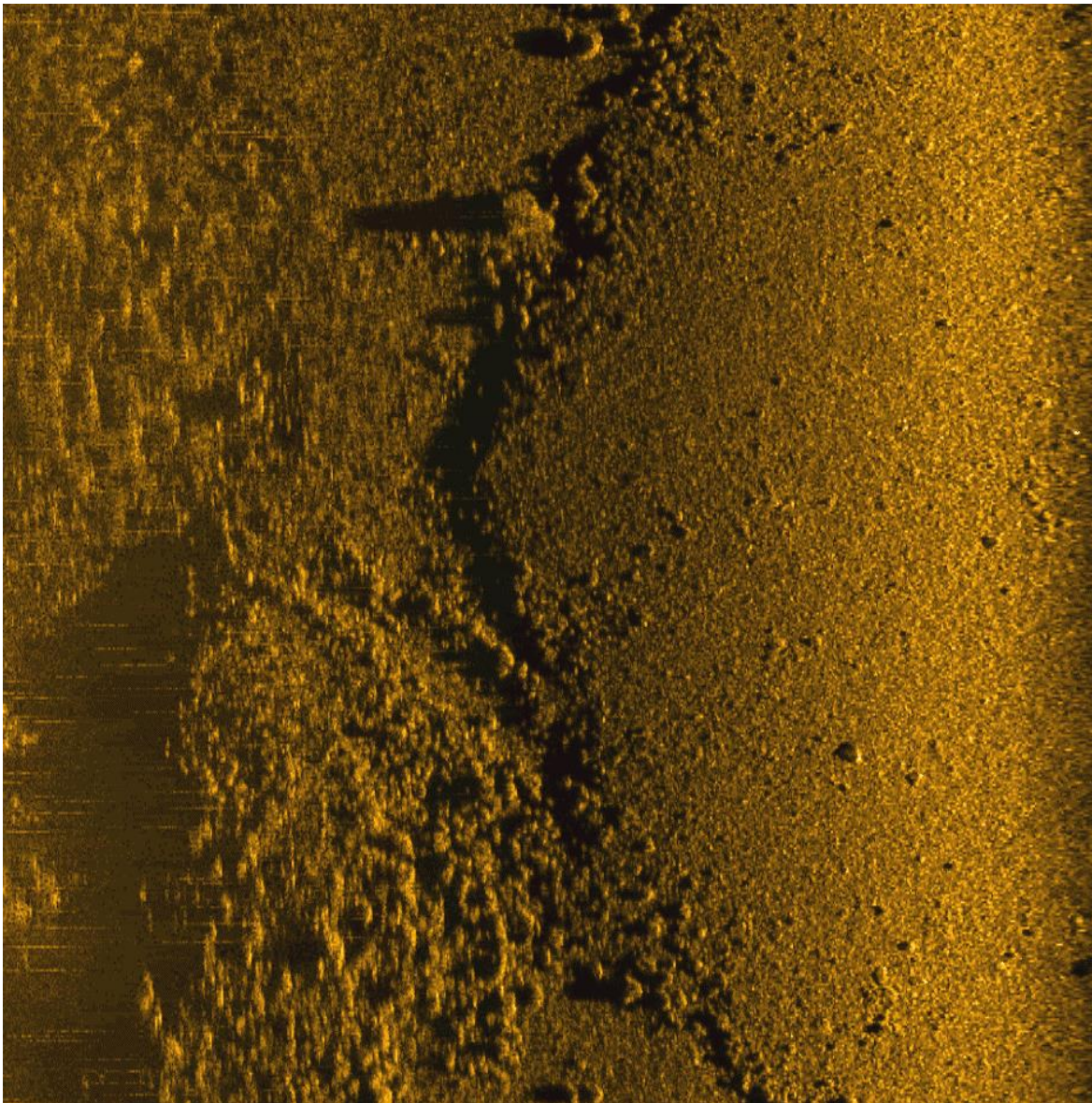


Figure 9.21. Scanning sonar of Contact 04, 20 meter range (i.e. diameter is 40 meters).



Contact 5 was selected as a potential target as it appeared a rock line which may have been constructed off the natural north-south running esker (**Figure 9.22**). ROV investigations of Contact 05 investigated these two linear lines of stones but they appeared to be natural.

Figure 9.22. Esker Locality, Contact 5 (North is up).



Contact 6 is a natural gap in esker that appears to have been modified by two continuous lines of stones (**Figure 9.23**). Contact 6 was further investigated with ROV, and scuba divers. In contrast to the two linear lines in Contact 5 that appear natural, the two lines at Contact 6 are

likely human modified. Similar to Drop 45, there appear to be two hunting blinds built into the end of the both lines, with a third circular cluster of stones outside the drive lane that is likely a blind (**Figure 9.24**). Also similar to Drop 45, the gap between the drive lanes is fairly narrow, ~6 meters, suggesting that animals may have been actively driven and panicked (**Chapter 8**). The drive lane is much shorter than Drop 45 however which is 30 meters long, and Contact 6 is 10 meters. Through scuba investigations, it was documented that the interior of the drive lane is covered with a very thin layer of sediment on bedrock with the side and exterior of the lane having numerous deep pockets of sediment. Future work at Contact 6 will sample these deeper areas of sand for optically stimulated luminescence (OSL) dating. Archaeological and paleoenvironmental samples were taken at Contact 6 and will be discussed below.

Figure 9.23. Esker Locality, Contact 6 (North is up).

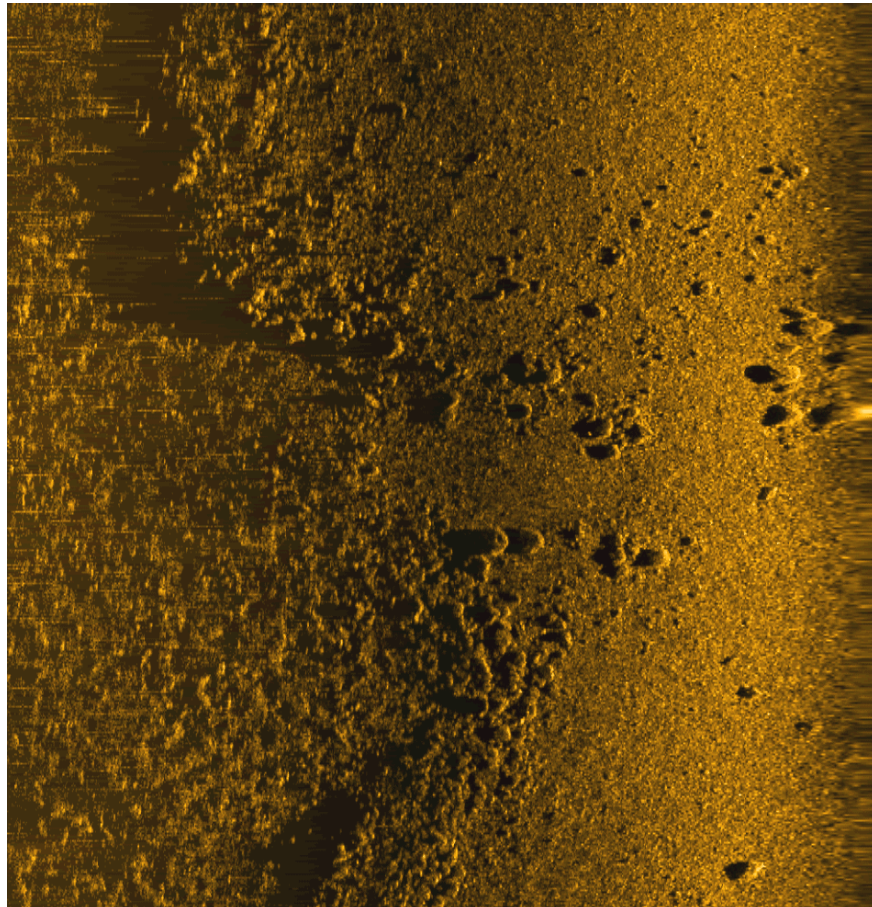
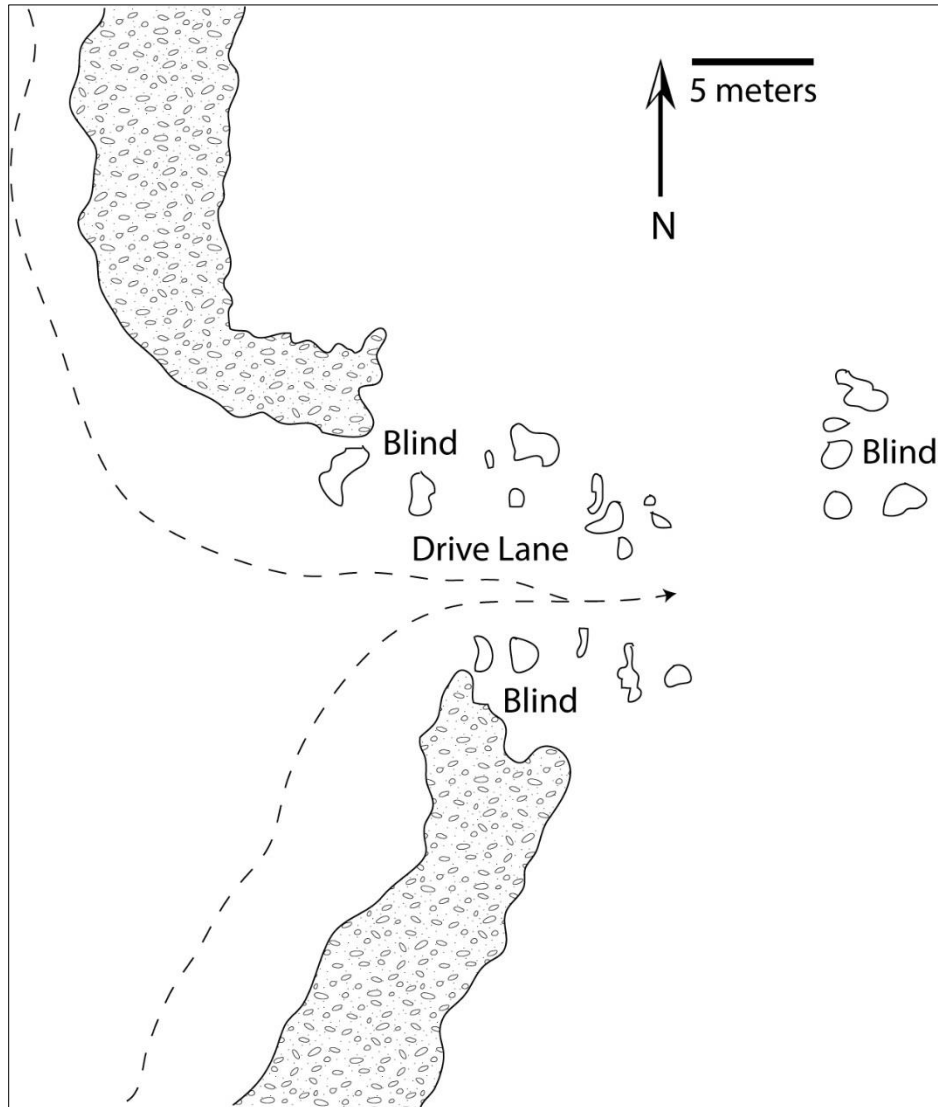
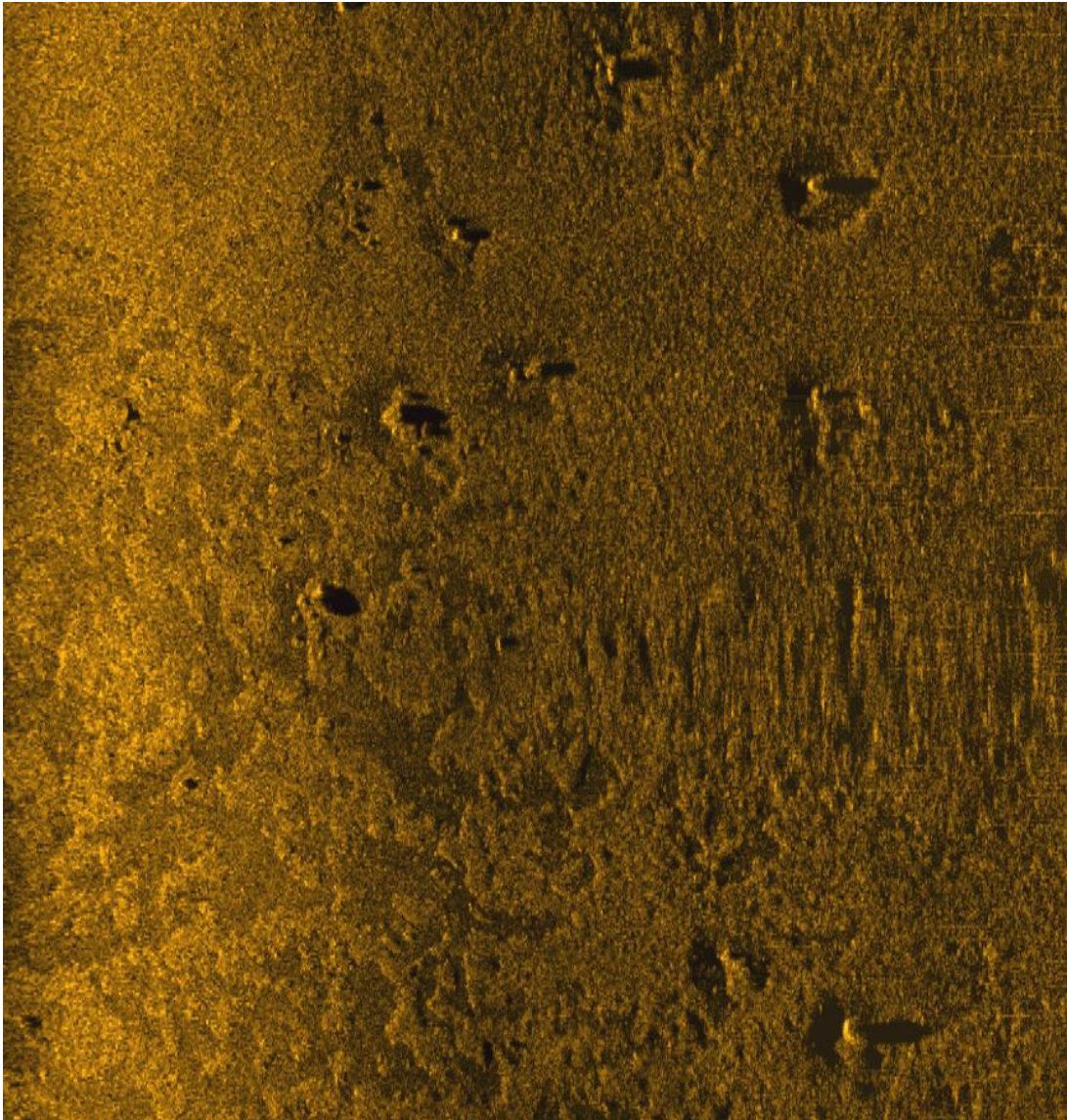


Figure 9.24. Schematic drawing of Contact 6, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement.



Contact 8 was selected as the side scan sonar indicated several tall targets that were within circular indentations in the surrounding sandy sediment (**Figure 9.25**). It was believed that these targets might be intact tree stumps similar to those located closer to shore in Lake Huron to the south and west of the AAR (see **Chapter 4**). When investigated with the ROV however, these targets were found to be large stones where the surrounding sediment had been scoured out around them.

Figure 9.25. Esker Locality, Contact 8 (North is up).



Contact 9 was not investigated with the ROV, but bears strong similarity to Contact 6 in terms of two lines forming a channel away from the linear esker (**Figure 9.26**). Two clusters of stones, again at the end of the both lines appear to be hunting blinds similar to both Contact 6 and Drop 45 (**Figure 9.27**). Also similar to both of these complex structures, the gap is fairly narrow at Contact 9, at 8 meters, suggesting that animals were actively driven into the drive lane. Both the drive lanes at Contacts 6 and 9 are 10 meters long.

Figure 9.26. Esker Locality, Contact 9 (North is up).

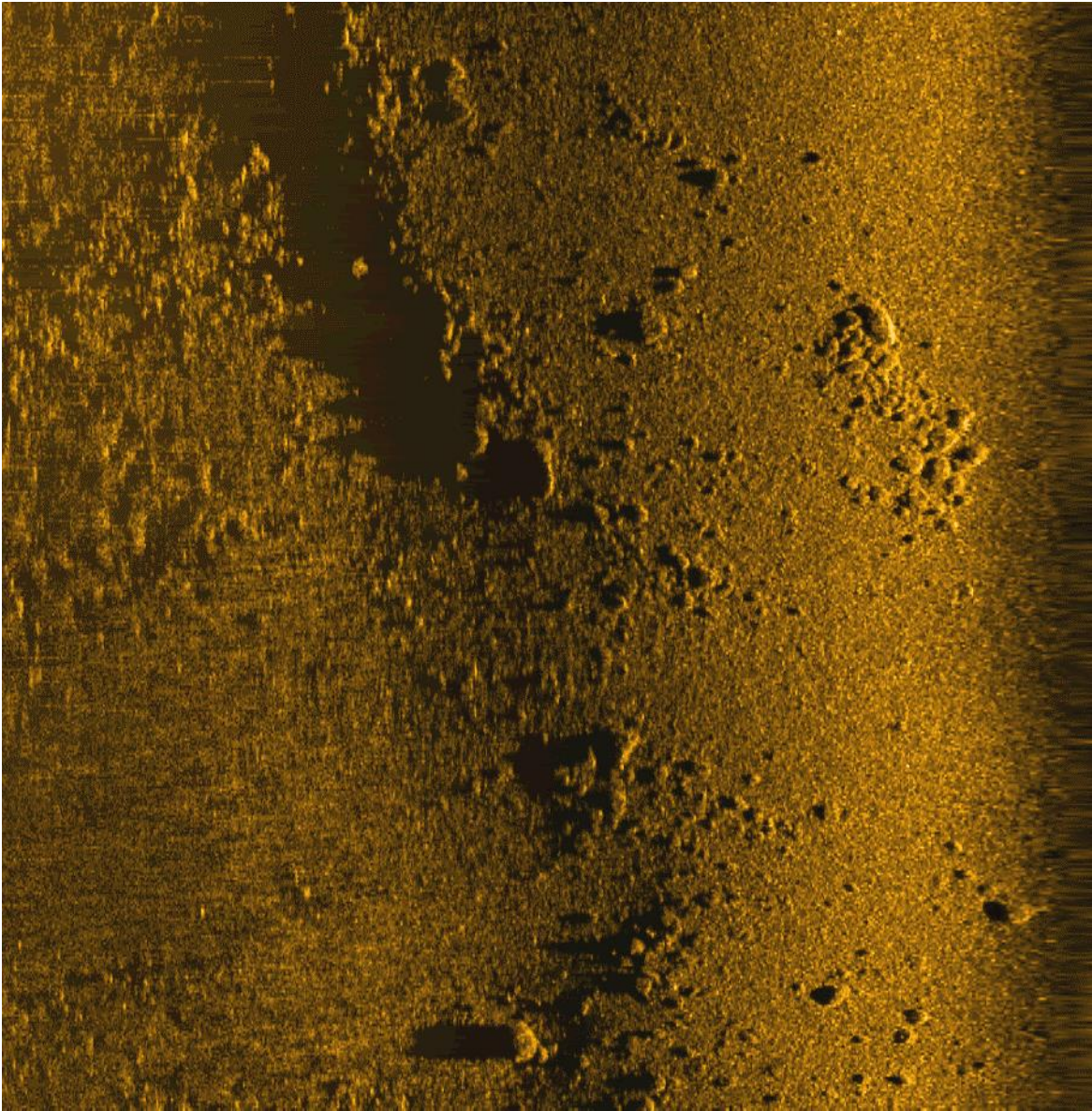
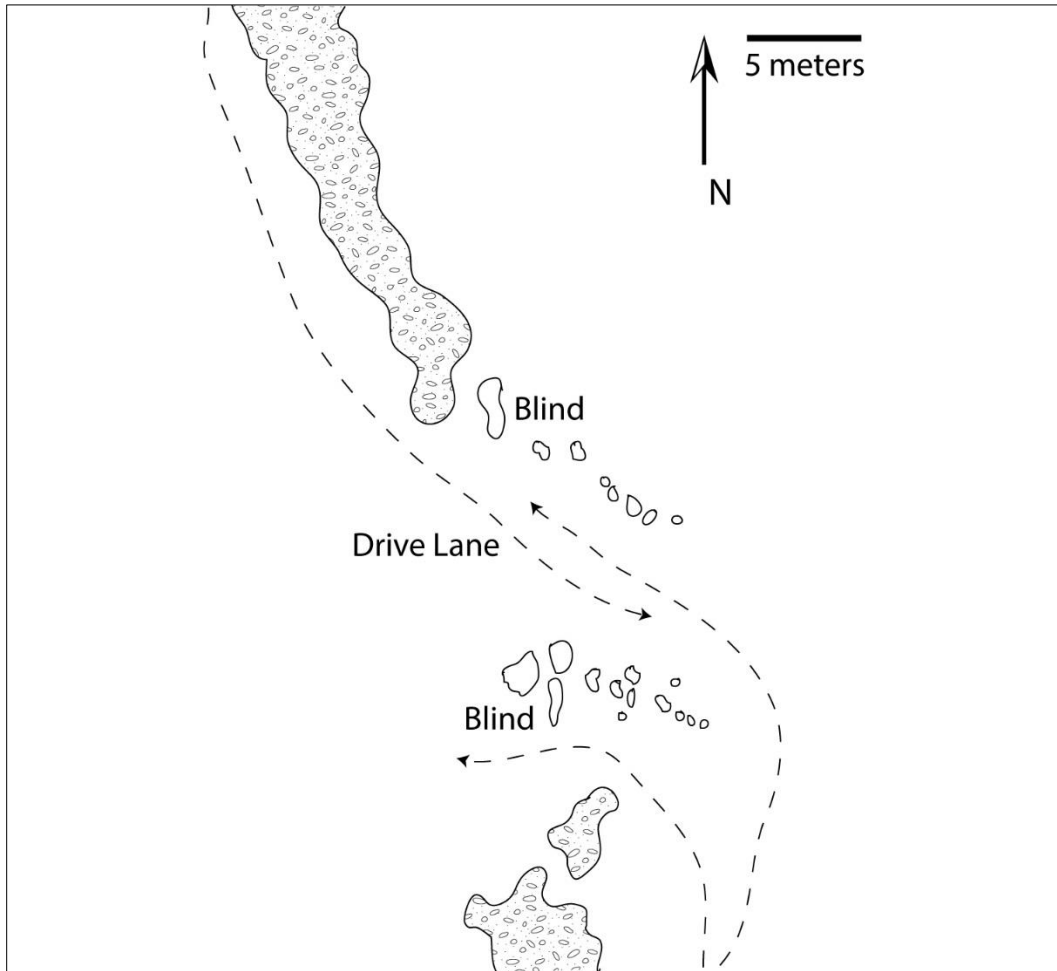


Figure 9.27. Schematic drawing of Contact 9, textured fill indicates the natural esker, dashed lines with arrows indicate likely routes of caribou movement.



Contact 12 was a rectangular structure visible in the AUV imagery (**Figure 9.28**). This rectangular structure is very similar in shape and size to the previously identified small rectangular cache behind the v-shaped hunting blinds in the Overlook Locality. This structure was investigated with the ROV, scanning sonar, and scuba divers (**Figures 9.29-9.31**). The interior space measures 2 meters by 1 meter and given ethnographic parallels this structures is also likely a meat cache.

Figure 9.28. Esker Locality, Contact 12 (North is up).

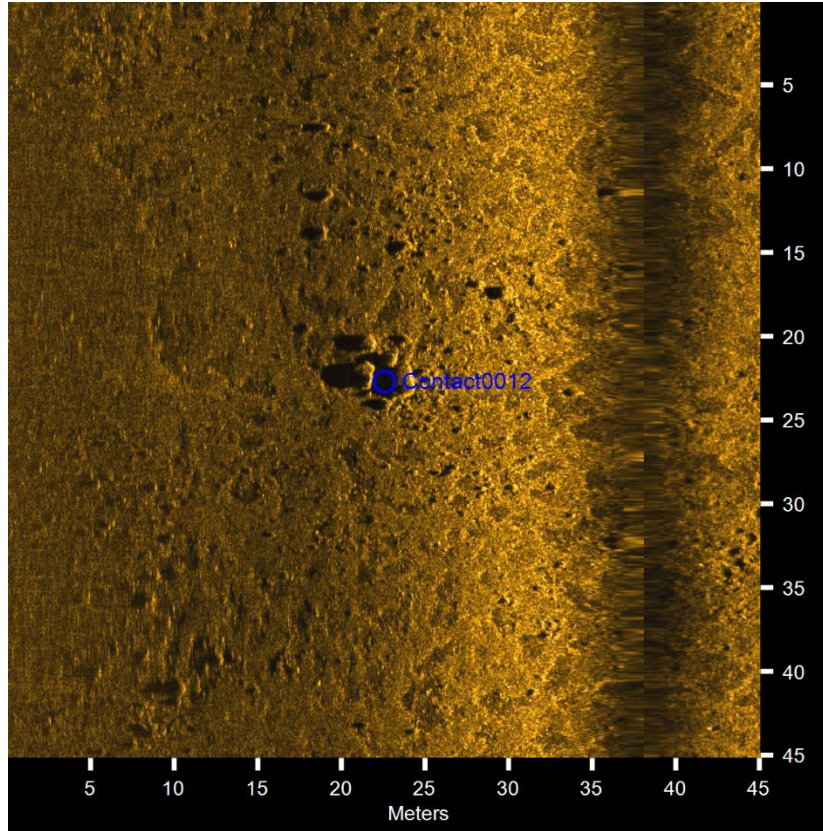


Figure 9.29. Scuba driver drawn plan map of Contact 12.

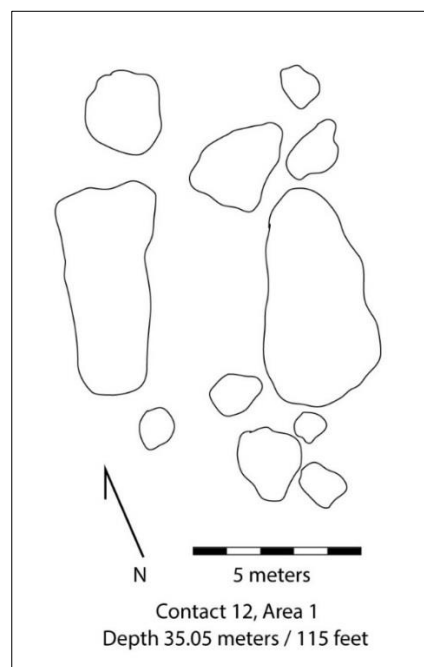


Figure 9.30. Scanning sonar of Contact 12.

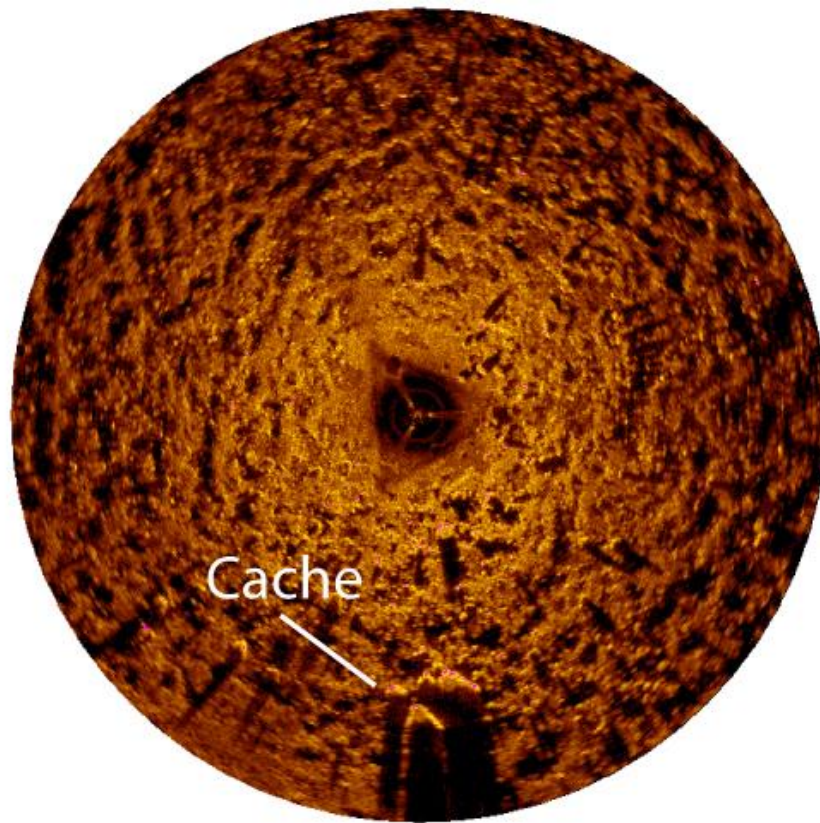
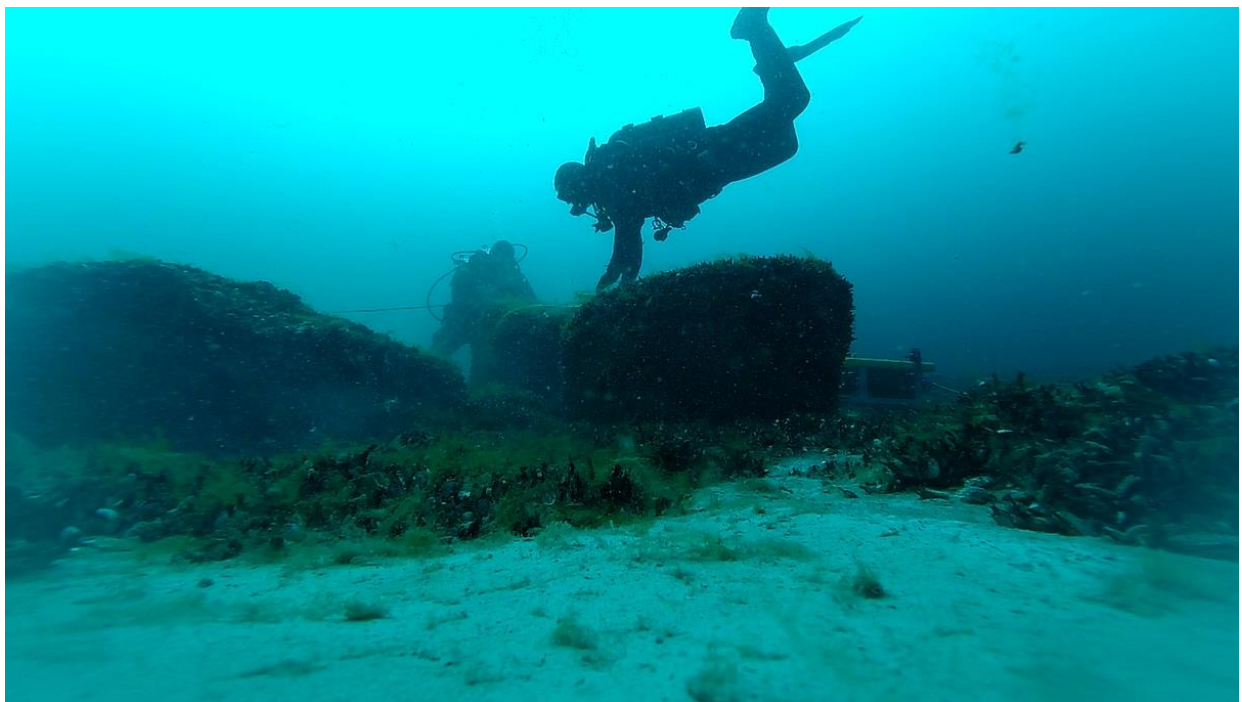
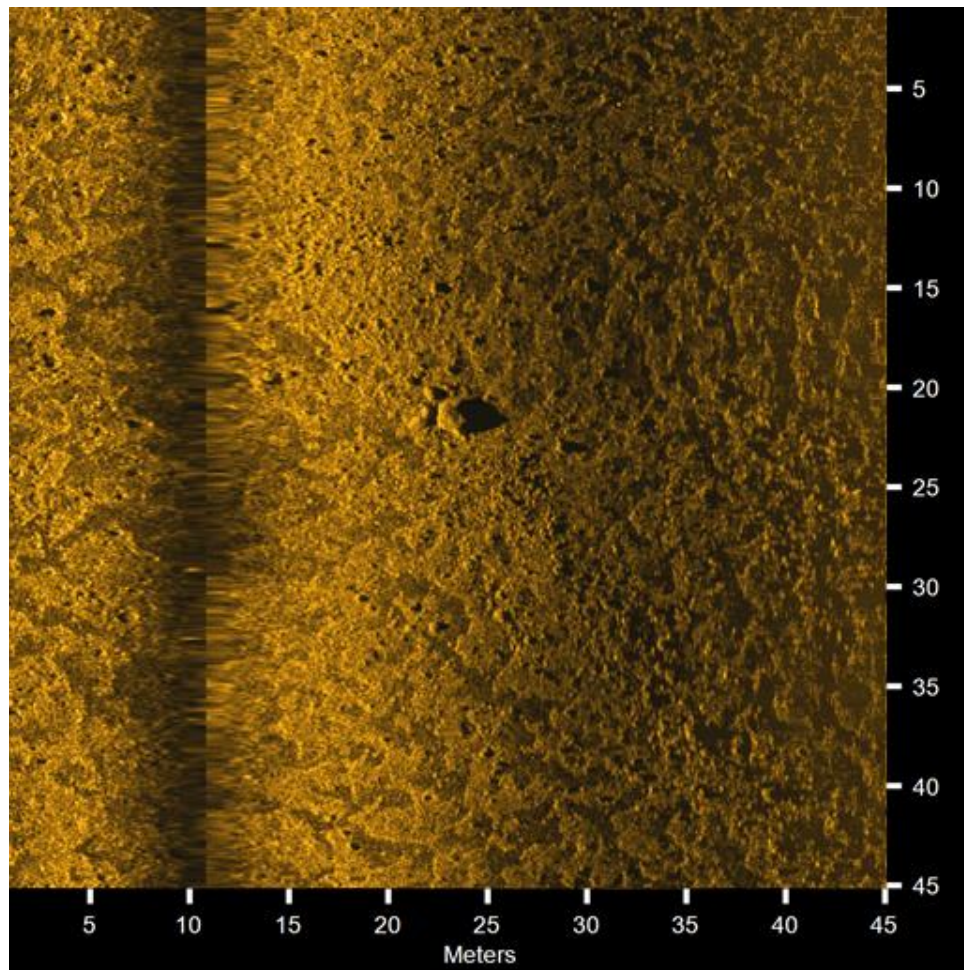


Figure 9.31. Scuba divers sampling at Contact 12.



Contact 13 is a cluster of two large stones and one small stone on the side scan sonar imagery (**Figure 9.32**). This cluster of stones, similar to Contact 12, is in an otherwise empty local landscape (i.e. the flat open plain on the east side of the esker) and these stones were therefore likely brought there by prehistoric peoples. While Contact 13 resembles three rock hunting blinds from other areas of the AAR, these three stones are too close together to offer an interior space for hunters. Contact 13 may have acted as a cairn to mark the location of the cache (Contact 12) and the complex drive lane (Contact 6) that are close by (70, and 140 meters respectively), or alternatively it functioned similar to an arctic *inuksuk* to attract caribou from grazing grounds to Contact 6.

Figure 9.32. Esker Locality, Contact 13 (North is up).



To summarize results in the Esker Locality, of the nine targets investigated, 6 appear to be human constructions. These results are summarized in **Table 9.2**. Contacts 1 and 4 are hunting blinds, while 6 and 9 present pairs of linear features that create drive lanes with associated hunting blinds. Contact 12 is a rectangular structure that is consistent with being a cache, and Contact 13 is consistent with arctic cairns. All of the confirmed human constructions in the Esker Locality are displayed in **Figure 9.33**, and all the constructions from both localities are summarized in **Table 9.3**.

Table 9.2. Targets in the Esker Locality and their interpretation.

| Contact | General Description | Structure Interpretation |
|----------------|--|--|
| 1 | Line of large rocks/ cluster in gap in esker | Blind |
| 3 | Pair of lines | Likely natural |
| 4 | Circle of large rocks | Closed Blind |
| 5 | Pair of lines | Likely natural |
| 6 | Natural gap in esker, elaborated with two continuous lines, circle of stones | Drive lines and associated hunting blind(s) |
| 8 | Bright reflectors in the sonar with circular scours | Large natural rocks |
| 9 | Pair of lines | Drive lane with associated hunting blind(s)? |
| 12 | Rectangular structure | Cache |
| 13 | Cluster of stones | Cairn |

Figure 9.33. Placement of human constructed features overlain on the multibeam imagery in the Esker Locality. Solid line indicates the edge of the AAR landform, dashed lines indicate 35 meter elevation contour, and diagonal lines indicate the esker.

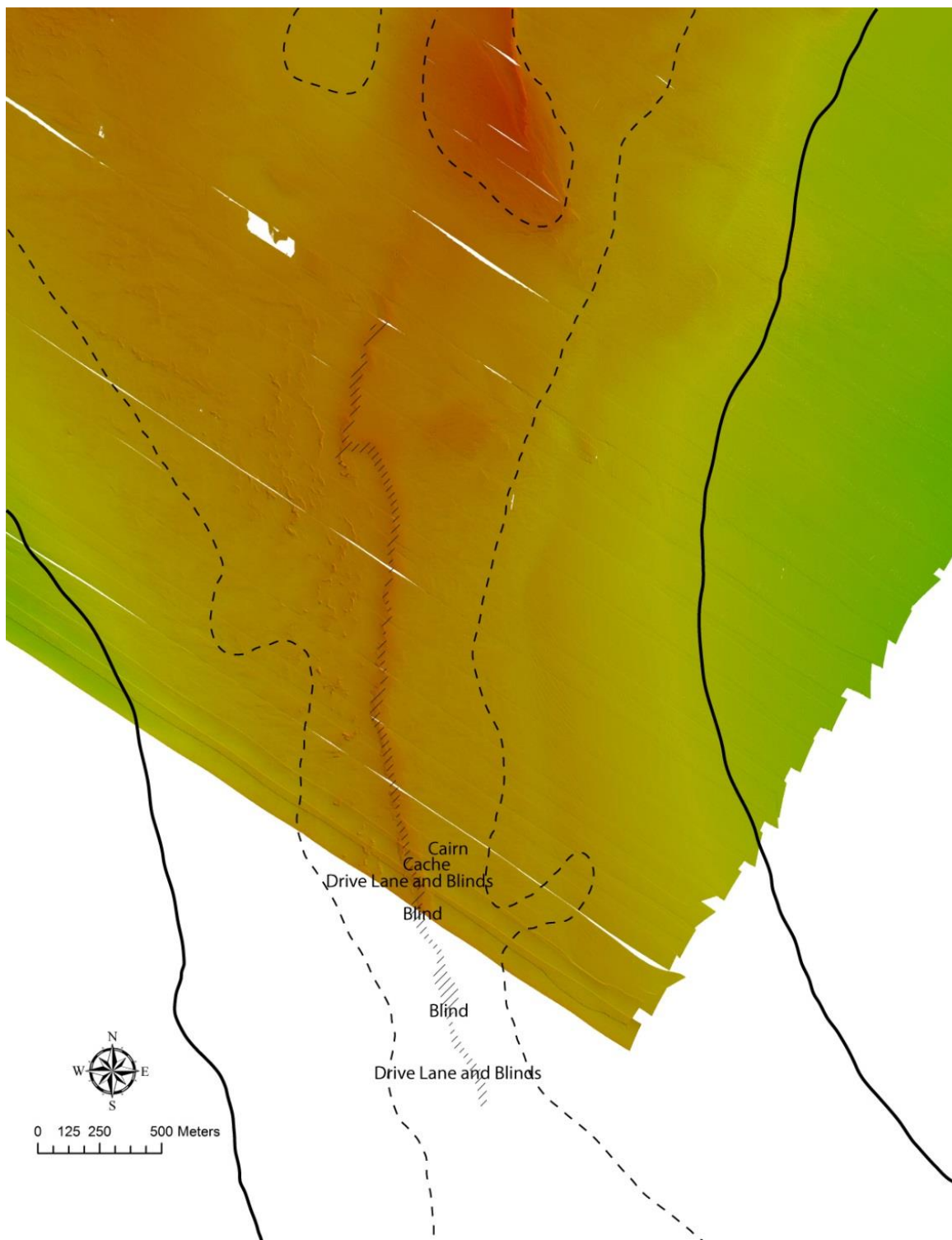


Table 9.3. Newly discovered human modified structures in the Overlook and Esker Localities.

| Contact | Structure Interpretation | Depth (ft) | Metrics (Meters) | Location |
|--------------------------|--|-------------------|--|--|
| <i>Overlook Locality</i> | | | | |
| 1 | Dwelling | 103 | ~10 x 10 m rectangle with additional rectangular structure | 0.5 km from Drop 45, 1 km from v-blinds and cache |
| <i>Esker Locality</i> | | | | |
| 1 | Blind | 105 | Rocks average 1.5 m wide, Interior space: 2.5 m x 2.5 m | Within a natural break in the esker |
| 4 | Closed Blind | 114 | Interior space: 2.6 m x 1.9 m | Within a natural break and bend in the esker |
| 6 | Drive lines and associated hunting blind(s) | 109 | Drive lane is 6 m wide, 10 m long | Perpendicular to and within a natural break in the esker |
| 9 | Drive lane with associated hunting blind(s)? | 105 | Drive lane is 8 m wide, 10 m long | Perpendicular to and within a natural break in the esker |
| 12 | Cache | 107 | Interior space: 2 m x 1 m | 70 m NE of Contact 6, on the plain E of the esker |
| 13 | Cairn | 118 | 1.5 m x 2 m | 70 m NE of Contact 12, on the plain E of the esker |

Paleoenvironmental Context

In addition to mapping, systematic sampling of targets in both areas was completed by scuba trained archaeologists to collect paleoenvironmental and archaeological materials.

Sampling methods followed the established protocol for the AAR project (**Chapter 7**). A total of

fourteen samples were collected from both localities, from Contacts 4 (n=1), 6 (n=6), and 12 (n=3) in the Esker Locality, and Contact 1 (n=4) in the Overlook locality (**Table 9.4**).

Table 9.4. Samples collected.

| Site | Sample No. | Date Collected | Collection Method | Latitude | Longitude | Depth (ft) | Context |
|------------------------------|-----------------|----------------|-------------------|------------|------------|------------|--|
| <i>The Esker Locality</i> | | | | | | | |
| Contact 4 | CONTACT4 ** | 9/25/14 | Ponar | 44 45.1634 | 82 28.5564 | 110 | Sandy area near structure |
| Contact 6 | JJ-1 | 9/26/14 | Vial | 44 45.4587 | 82 28.6579 | 110 | In the middle of lines |
| | JJ-1-1 | 9/26/14 | Sieve | 44 45.4587 | 82 28.6579 | 110 | “ ” |
| | JQ-1 *, ** | 9/26/14 | Vial | 44 45.4599 | 82 28.6628 | 110 | Other side of lines in sandy area |
| | JQ-1-1 | 9/26/14 | Sieve | 44 45.4599 | 82 28.6628 | 110 | “ ” |
| | KB-1 * | 9/26/14 | Vial | 44 45.4557 | 82 28.6660 | 110 | 10 m west of JQ-1 |
| | KB-1-1 | 9/26/14 | Sieve | 44 45.4557 | 82 28.6660 | 110 | “ ” |
| Contact 12 | JG-1 | 9/26/14 | Vial | 44 45.5074 | 82 28.6199 | 107 | Inside structure |
| | JG-1-1 | 9/26/14 | Sieve | 44 45.5074 | 82 28.6199 | 107 | “ ” |
| | JM-1 | 9/26/14 | Sieve | 44 45.5074 | 82 28.6199 | 107 | Outside edge of structure, under rocks |
| <i>The Overlook Locality</i> | | | | | | | |
| Contact 1 | CONTACT1 Unit 1 | 9/28/14 | Airlift | 44 52.454 | 82 44.313 | 130 | Inside structures with stacked stones |
| | KI-1 * | 9/28/14 | Vial | 44 52.454 | 82 44.313 | 130 | “ ” |
| | CONTACT1 Unit 2 | 9/28/14 | Bucket | 44 52.448 | 82 44.3093 | 130 | 5 m SW of Unit 1 in sandy area |
| | JE-1 ** | 9/28/14 | Vial | 44 52.448 | 82 44.3093 | 130 | “ ” |

* Samples which produced cultural material

** Samples which produced environmental data, i.e. testate amoebae

Three samples contained testate amoebae which can be used as a paleoenvironmental indicator. Testate amoebae analysis has taken place on previously collected samples on the AAR and has been informative, along with other lines of evidence including pollen and preserved

wood, for paleoenvironmental reconstruction (**Chapter 7**). These animals live at the sediment-water interface in fresh water, and individual species occur under limited environmental conditions. In contrast to pollen, testate amoebae results represent the immediate vicinity sampled and thus reflect the localized environment of the sites tested.

Distinct testate amoebae assemblages were recovered from near the Contact 4 hunting blind, as well as the complex drive lane feature Contact 6 in the Esker Locality. At Contact 4, two different species of testate amoebae indicate an area of sphagnum and other mosses (**Table 9.5a**). At Contact 6, four different species of testate amoebae were recovered, indicating a local paleoenvironment with a fresh water pond or bog with sphagnum and other mosses (**Table 9.5b**). Finally, a sample from the dwelling in the Overlook Locality, contained a distinct assemblage indicating a fresh water pond or bog, with mosses, and standing water (**Table 9.6c**).

Table 9.5a. Testate amoebae and paleoenvironmental summary, Contact 4.

| Sample | Testate amoebae | n | % of Sample | Ecology |
|------------------------|---|-----------|-------------|--|
| Contact 4 Ponar | <i>C. aculeata 'spinosa'</i> | 48 | 96 | Sphagnum, other mosses, in the ooze of ditches and lakes |
| | <i>Centropyxis Contactstricta 'aerophila'</i> | 2 | 4 | Mosses and sphagnum |
| | Total | 50 | 100 | Paleoenvironment Summary |
| | | | | Sphagnum/mossy area |

Table 9.5b. Testate amoebae and paleoenvironmental summary, Contact 6.

| Sample | Testate amoebae | n | % of Sample | Ecology |
|------------------|------------------------------|----------|-------------|---|
| Contact 6 | <i>C. aculeata 'spinosa'</i> | 5 | 62.5 | Sphagnum, other mosses, in the ooze of ditches and lakes |
| | <i>Diffugia glans</i> | 2 | 25 | Sediments of fresh water ponds, ditches, and bogs, also in moist soil |
| | <i>Diffugia oblonga</i> | 1 | 12.5 | Sediments of fresh water ponds, ditches, and bogs, also in moist soil |
| | Total | 8 | 100 | Paleoenvironment Summary |
| | | | | Sphagnum/mossy fresh water pond/bog |

Table 9.5c. Testate amoebae and paleoenvironmental summary, Overlook Locality, Contact 1.

| Sample | Testate amoebae | n | % of Sample | Ecology |
|-------------------------------------|--|-----------|--------------------|--|
| Overlook Locality, Contact 1 | <i>Diffflugia oblonga</i> | 5 | 45.5 | Sediments of fresh water ponds, ditches, and bogs, also in moist soil |
| | <i>Diffflugia glans</i> | 4 | 36.5 | Sediments of fresh water ponds, ditches, and bogs, also in moist soil |
| | <i>C. aculeate</i> ' <i>spinosa</i> ' | 1 | 9 | Sphagnum, other mosses, in the ooze of ditches and lakes |
| | <i>Arcella vulgaris</i> | 1 | 9 | In the ooze and vegetation in stagnant water and also in soil among algae and other plants |
| | Total | 11 | 100 | Paleoenvironment Summary |
| | | | | Fresh water pond/bog with mosses and standing water |

These local paleoenvironmental results fit well with the general characteristics of the AAR as a subarctic-like environment, with intermittent spruce and tamarack stands, mossy bogs, and fresh water streams and small lakes (**Chapter 7**). The immediate environment around Drop 45 is swamp/wetland (**Figure 7.43**) and is similar to the settings of both Contact 6 and Contact 4 - likely indicating that hunting structures on the AAR were strategically placed not only near migration routes, but near areas of abundant forage as well (see also Sonnenburg et al. 2015a).

Archaeological Materials

Cultural material was recovered from two sites, one in each locality (**Table 9.6**). Four potential lithic artifacts were recovered from the complex structure, Contact 6 in the Esker Locality. Two pieces of quartzite microdebitage (**Figure 9.34**) were recovered from samples taken just outside the drive lane. Microdebitage is defined as the very small (often microscopic), angular, flakes which result during stone tool maintenance or creation. For every large flake

removal there are dozens of pieces of microdebitage which create a “cloud” around the flintknapper. As microdebitage is more numerous, and has a wider spatial distribution than flakes, it has been used as a means of locating submerged archaeological sites (see Sonnenburg et al. 2011). Two additional pieces of quartzite microdebitage were recovered from a sample taken on the outside edge of the opposite drive lane, 10 meters east of the other samples (**Figure 9.35**). From the newly discovered dwelling structure in the Overlook Locality, two chert microdebitage flakes were recovered from a single sample taken from inside the structure near a pile of stacked stones (**Figure 9.36**). These materials lend further support for the human modification of these structures and demonstrate potential for additional archaeological sampling.

Table 9.6. Cultural material.

| Site | Sample No. | Cultural Material |
|------------------------------|-------------------|--------------------------|
| Esker Locality Contact 06 | KB-1 | Microdebitage (n=2) |
| | JQ-1 | Microdebitage (n=2) |
| Overlook Locality Contact 01 | KI-1 | Microdebitage (n=2) |

Figure 9.34. Esker Locality, Contact 6, complex structure sample KB-1 microdebitage.



Figure 9.35. Esker Locality, Contact 6, complex structure sample JQ-1 microdebitage.



Figure 9.36. Overlook Locality, Contact 1, dwelling sample KI-1 microdebitage.



Evaluating the Model

New investigations conducted in both the Overlook and Esker Localities permit assessment of the generalized model of foraging lifeways on the AAR. In order to evaluate this model, the following discussion analyzes structure type, orientation, and density of the new structures to characterize human occupation and caribou hunting in the Overlook and Esker Localities. This description will then be compared to the model generated from previous research in light of its two essential elements to formally test the hypotheses outlined above (**Table 9.1**).

Structure Types and Orientation

The AUV survey in the Overlook Locality did not record an abundance of new constructed features on the AAR. This is likely due to two sampling issues, as research was primarily directed at the Esker Locality, and it is likely that the east-west orientation of the survey transects in combination with navigational errors may have obscured additional structures. However, while only one new structure was located and investigated in the Overlook Locality, this new feature is one of the most unique structures identified on the AAR to date. The rectangular construction is very similar to light tent rings and other stone foundations of caribou hunting peoples in the Canadian arctic. Furthermore, its large size and short stones make it unlikely to be a hunting blind or cache feature, and it is more likely a dwelling. As Contact 1 is not likely associated with hunting activities, it does not have a measurable orientation to compare with caribou movements.

Orientation and structures types in the Esker Locality reveal interesting patterns. Six new human modified structures were recorded in this locality, and of these, one is a likely cache, one a cairn, two are simple hunting blinds, and two are complex hunting structures (a combination of drive lines and hunting blinds). Following the discussion of ethnographic cases and the middle range theory outlined in **Chapter 3**, it is likely that smaller groups of people constructed and used the simple structures, and larger groups were needed to operate the more complex structures (see also **Chapter 8**) (**Table 9.7**) – but the unique topography in the Esker Locality complicates this simple correlation (see below).

Table 9.7. Newly discovered human modified structures, type, and inferred group size.

| Contact | Structure Interpretation | Structure Type | Inferred Group Size |
|--------------------------|--------------------------|----------------|---------------------|
| <i>Overlook Locality</i> | | | |
| 1 | Dwelling | N/A | Cooperative Group? |
| <i>Esker Locality</i> | | | |

| | | | |
|-----------|--|---------|------------------------------|
| 1 | Blind | Simple | Individual; Pair/Small Group |
| 4 | Closed Blind | Simple | Individual; Pair/Small Group |
| 6 | Drive lines and associated hunting blind(s) | Complex | Cooperative Group? |
| 9 | Drive lane with associated hunting blind(s)? | Complex | Cooperative Group? |
| 12 | Cache | Simple | N/A |
| 13 | Cairn | Simple | N/A |

In terms of orientation, Contact 12, the cache, Contact 13, the cairn, and Contact 4, the closed hunting blind, do not have measurable orientations, as the cache did not serve as a hunting feature, and the cairn and closed blind are circular. However, given its circular nature, Contact 4 could have been used as a blind to intercept animals coming from diverse directions, including both north and south during migrations. The Contact 1 hunting blind is more similar to the three-rock hunting blind at the Dragon drive lane (**Chapter 7**) and its slightly southeast orientation is best suited for animals traveling north in the spring. Contact 6, the complex drive lane is oriented east-southeast, and Contact 9 is orientated southeast.

While the Contact 1 hunting blind could only work if the animals were coming from the north (its more open back side would not offer sufficient concealment of the hunter(s) if the animals were moving south, see **Figure 9.17**), the local topographic placement of the two complex structures makes their orientation and use more complicated. Both Contacts 6 and 9 are located in what appear to be natural breaks in the long north-south running esker that cuts through this locality, although these opening may well have been improved by the selective removal of rocks. Both drive lanes therefore are essentially created to be perpendicular to this esker feature that likely *naturally* channeled herd movements through this area. It appears that hunters took advantage of this local topography and created drive lanes that would further

channel the flow of animals travelling either north or south along the esker toward hunting blinds and hunters. While the orientation of Contact 6 is more east than south, at this site animals moving along the west side of the esker would be effectively channeled (see **Figure 9.24**). The more southeastern orientation of Contact 9 would channel animal traveling south on the west side of the esker, or north on the east side of the esker (see **Figure 9.27**). Due to these orientations, and the unique esker feature in this area, it is likely that both complex structures could be used for animals moving either north or south, and thus in *both* the spring and the fall. These new structures in the Esker Locality further support the middle range theory developed in the **Chapter 3**, that seasonality must be determined using both orientation, detailed reconstruction of the local topography, *and* its effects on animal movement, in this case exemplified by the esker dividing this narrow area on the AAR (**Table 9.8**).

Table 9.8. Hunting architecture with measurable orientations and inferred season of use.

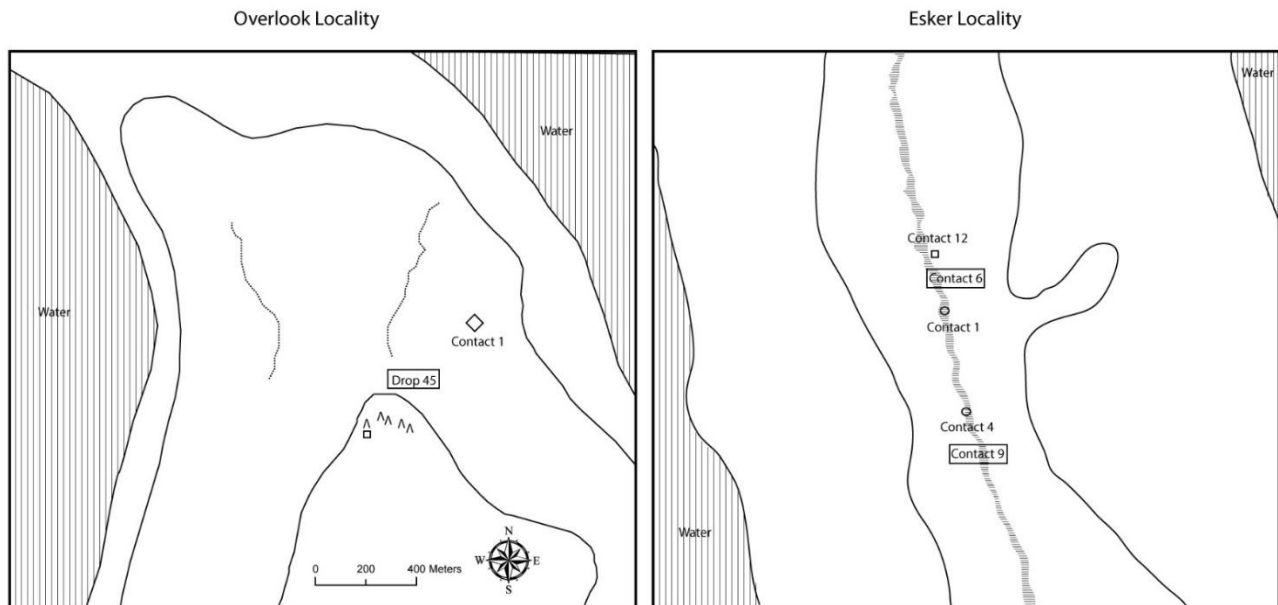
| Structure Name | Orientation | Location | Season of Use/ Hunting Context |
|---------------------------|--------------------|-----------------|---|
| <i>Complex Structures</i> | | | |
| Contact 06 | East-Southeast | Gap in esker | Spring and Fall |
| Contact 09 | Southeast | Gap in esker | Spring and Fall |
| <i>Simple Structures</i> | | | |
| Contact 01 | Slightly Southeast | Gap in esker | Spring |
| Contact 04 | N/A (closed blind) | Bend in esker | Spring and Fall |

Density and Regional Patterning

The meso-scale investigations conducted with the AUV in both the Overlook and Esker Localities allow for the quantification of density of built features over the landscape (see O’Shea 2015b). In the 4.5 km² Overlook Locality (the area of the AUV survey), in addition to Drop 45, and the five v-shaped hunting blinds and rectangular cache, a new structure – a dwelling – was

recorded, for a total of 8 structures, or 1.8 structures per 1 square kilometer. In the slightly larger Esker Locality (5.4 km²), a total of 6 structures (two complex sites, two blinds, one cache, and one cairn) results in a density of 1.1 structures per square kilometer. Importantly, there are likely many more structures in the Esker Locality as research for this dissertation represents the first investigations in this area. The greater density of structures in the Overlook Locality may represent larger groups of people (indicated by the complex Drop 45 site and the dwelling) and/or aggregation from continued seasonal re-use. The lower density of the structures in the Esker Locality may be reflecting smaller groups of people, or limited re-use. Despite differences in the density figures, when compared side by side, both localities indicate clusters of structures taking advantage of respective local topographic features, the overlooking ridge and the esker (Figure 9.37).

Figure 9.37. The Overlook and Esker Localities presented at the same scale.



Human Occupation and Caribou Hunting

From prior investigations in the Overlook Locality and other areas on the AAR, a generalized model was created characterized by small groups of hunters using simple hunting structures in the autumn, and larger groups aggregating to use complex hunting architecture in the spring (**Table 9.9**).

Table 9.9. Generalized model of human occupation and caribou hunting on the AAR.

| Season/ Hunting Context | Structure Type | Number and State of the Animals | Group Size | Hunting Goals |
|--|-----------------------|--|---|---|
| Fall | Simple | Large, Bothered | Individual, Pair/Small Group | Delayed Consumption |
| Spring | Complex | Panicked | Cooperative Group | Immediate Consumption; Social Solidarity/Exchange |
| Non-Migration | Simple and Complex | Bothered, Panicked | Individual, Pair/Small Group, Cooperative Group | Delayed, and Immediate Consumption, Social solidarity/exchange |

New investigations in the Overlook Locality support this model. One new structure was located and investigated which most likely represents a dwelling. This large rectangular structure could have served as a temporary or more permanent dwelling for several people or an extended family. It is easy to imagine a scenario in which this campsite is contemporary with Drop 45 half a kilometer away where a larger group of people aggregated to operate this complex structure in the spring. This campsite may have also been used in the autumn by smaller groups utilizing the hunting blinds to intercept migrating herds, and storing meat for winter in the cache nearby. The presence of the dwelling in the Overlook Locality also adds additional evidence for the hunting

goal of social solidarity and/or exchange, as the presence of social architecture is one of the archaeological expectations for these behaviors (see **Chapter 8**). This structure therefore provides further support for seasonal aggregation of larger groups of people at the Overlook Locality, likely in the spring when Drop 45 could be used to generate a large supply of meat to feed a larger population.

While the additional data from the Overlook Locality supports the generalized model, new investigations in the Esker Locality complicate it. First, it must be pointed out that the null hypothesis was disproved by new research – as the prediction that prehistoric foragers would have modified this area of the AAR with hunting architecture was borne out. More specifically, however, of the model's two essential elements (**Table 9.1**), only one is supported by new data from the Esker Locality.

The first essential element (that the region was used during both seasons) is largely supported by the Esker Locality data. While an analysis of orientation of the Esker Locality structures is not as straightforward as other areas on the AAR (i.e. north-northwest = fall, south-southeast = spring), it is likely that hunting architecture in the area was used in both seasons. In fact, unlike any other complex structures to date, both Contacts 6 and 9 have drive lanes that could conceivably channel caribou migrating in either direction/season. These structures stand in stark contrast with other complex hunting architecture sites on the AAR, such as Drop 45, that would only work in one direction (O'Shea 2015b; O'Shea et al. 2014, **Chapter 7**). Furthermore, the circular shape of the closed hunting blind (Contact 4) could be used for caribou coming from many different directions. The only structure in the Esker Locality that is truly directionally dependent is Contact 1, a simple hunting blind orientated for spring migrations (contra to the

model). Therefore, while hunting in the Esker Locality is likely in both the fall and spring, only one structure can be confidently correlated with a single season.

It is important to note that the computer simulation routes predict that caribou may only have moved along the west side of the esker when traveling north in the spring – in order to traverse the AAR by the most efficient path as spring migration routes tend to be more direct than in the autumn (**Chapter 5**). If this is the case, than Contact 9 would have been best suited for fall migrations (see **Figure 9.27**), since the opening for northward moving animals is on the west side of the esker. Perhaps the most likely explanation is that both Contacts 6 and 9 were created to take advantage in natural breaks in the esker, and could have been used to intercept animals moving in either direction, but that Contact 9 was used primarily in the fall. These different migration scenarios, i.e. favoring one side of the esker, may be solved with additional computer simulation and/or further studies in the Esker Locality.

Taken together, these results suggest that people likely used this meso-scale region in both seasons, and thus, the first element of the seasonal aggregation model is supported (**Table 9.10a**). However, the model’s second essential element, that there is a strict linkage between structure type and season, is not supported by the Esker locality data.

Table 9.10a. Alternative hypotheses for test the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR. Shaded area indicates results from the Esker Locality, First Element.

Essential Elements of the Model

| <i>Hypotheses</i> | AAR is used during Both Seasons | Linkage between Season and Type of Structure |
|--------------------------|--|---|
| H₀ | - | - |
| H₁ | + | + |
| H_{2a} | - | + |
| H_{2b...} | + | - |

While prior work in other areas of the AAR has demonstrated a correlation between complex structures in spring, and simple structures in the autumn (**Chapter 8**), the Esker structures present a different pattern (**Table 9.10b**). Here, it appears that at least one simple structure was oriented for spring hunting, and one simple structure as well as the two complex structures could have been used in one or both migration seasons. The Esker Locality data may be indicating small group hunting in both seasons using both simple and more complex structures, contra to the general expectations for complex hunting architecture. While both complex structures have narrow gaps, which would be traditionally interpreted to as animals being panicked and actively driven into drive lanes by large numbers of people (e.g. Friesen 2013; **Chapter 8**) – the unique topography in the Esker Locality may have naturally funneled caribou into these drive lanes removing the need for larger groups of people to act as beaters driving the animals.

Table 9.10b. Alternative hypotheses for test the Esker Locality based on the presence or absence of the two essential elements of the proposed model of seasonal use of the AAR. Shaded area indicates results from the Esker Locality, Second Element.

Essential Elements of the Model

| <i>Hypotheses</i> | AAR is used during Both Seasons | Linkage between Season and Type of Structure |
|--------------------------|--|---|
| H₀ | - | - |
| H₁ | + | + |
| H_{2a} | - | + |
| H_{2b...} | + | - |

Additional, independent lines of evidence support this hypothesis of small groups in the Esker Locality. First, the very minimal archaeological materials recovered to date are expected for individuals or small groups (although limited sampling cannot be ruled out as a complicating

factor). Second, other facilities in the Esker Locality support small group activities. For example, the cache near Contact 6 indicates delayed consumption as one hunting goal, a likely scenario for small groups meeting immediate needs and storing for winter. Furthermore, there is no evidence for immediate consumption (absence of hearth features) or social solidarity/exchange (absence of social architecture or exotic raw materials) – both activities that characterize larger group aggregations. This interpretation of the Esker Locality data fits with another locality on the AAR that will be the target of future investigations. The Gap Locality (see **Chapter 7**, O’Shea 2015b) is an area where two eskers likely dictated caribou movement, and different simple structures within this gap are orientated for fall or spring (O’Shea et al. 2013). While the limited research undertaken in the Esker Locality may account for some of these absences, it is clear that human behavior in this area is different from others areas on the AAR.

Conclusion

New underwater research conducted for this dissertation sought to evaluate a model of foraging lifeways on the AAR. Additional investigations conducted in the Overlook Locality supported this generalized model of small group hunting in the fall with simple hunting architecture, and cooperative group hunting in the spring using complex structures. The discovery of a dwelling enhances the picture of human occupation of the ridge, and supports seasonal aggregation. Investigations in a new area, the Esker Locality, demonstrate that human occupation and caribou hunting was organized differently across the AAR. In this area, the data best support small groups taking advantage of the local topography is this meso-scale area to hunt during both the fall and spring migrations. The unique channeling effect of a large north-

south running esker in this region likely dictated the flow of caribou movement, and small groups could strategically incorporate hunting architecture sites into this feature.

Overall, comparisons between the Overlook and Esker Localities reveal that prehistoric foragers in the Great Lakes had a sophisticated understanding of both animal behavior and the local topography. These new meso-scale investigations reveal variations on the general theme of caribou hunting architecture, and demonstrate that hunting structures and strategies were tied to unique attributes of the natural landscape. The multi-scalar archaeological investigation conducted for this dissertation resulted in a picture of an intact prehistoric landscape, including the spatial relationships between hunting structures and their role in the larger settlement system creating a culturally engineered landscape.

Chapter 10

Conclusions

Introduction

This dissertation sought to make contributions in three areas; the local archaeological problem of Great Lakes caribou hunters, the theoretical anthropological problem of hunting architecture and forager lifeways, and lastly, the global problem of conducting anthropological archaeology underwater.

This final chapter will move from the specific results of the AAR to a discussion of each of these broader issues. First, the key findings from the research conducted specifically for this dissertation on the AAR will be summarized. Second, the model of seasonal hunting strategies and patterns of social aggregation and dispersal will be revised in light of these results. Third, the results from the AAR project will be situated within their broader environmental, culture historical, and global contexts – summarizing the implications of the AAR research for Great Lakes region and prehistoric caribou hunters more generally. The discussion will then turn to the contributions this dissertation has made concerning hunting architecture and forager lifeways and will finally conclude with a discussion of anthropological archaeology underwater and future prospects.

Great Lakes Caribou Hunters

New research conducted on the AAR for this dissertation compared two meso-scale localities in order to evaluate a model of caribou hunting behavior on the ridge. Seven new human constructed features were identified, including a dwelling, two hunting blinds, two complex drive lane/hunting blind features, a cache, and a cairn. These new structures were analyzed in terms of structure type, orientation, and density and revealed unique patterns of social and economic organization in the Esker Locality. In light of these results, the generalized model of human occupation and caribou hunting on the AAR (i.e. small groups utilizing simple forms of hunting architecture in the fall, and larger groups aggregating to use more complex hunting structures in the spring) can be revised.

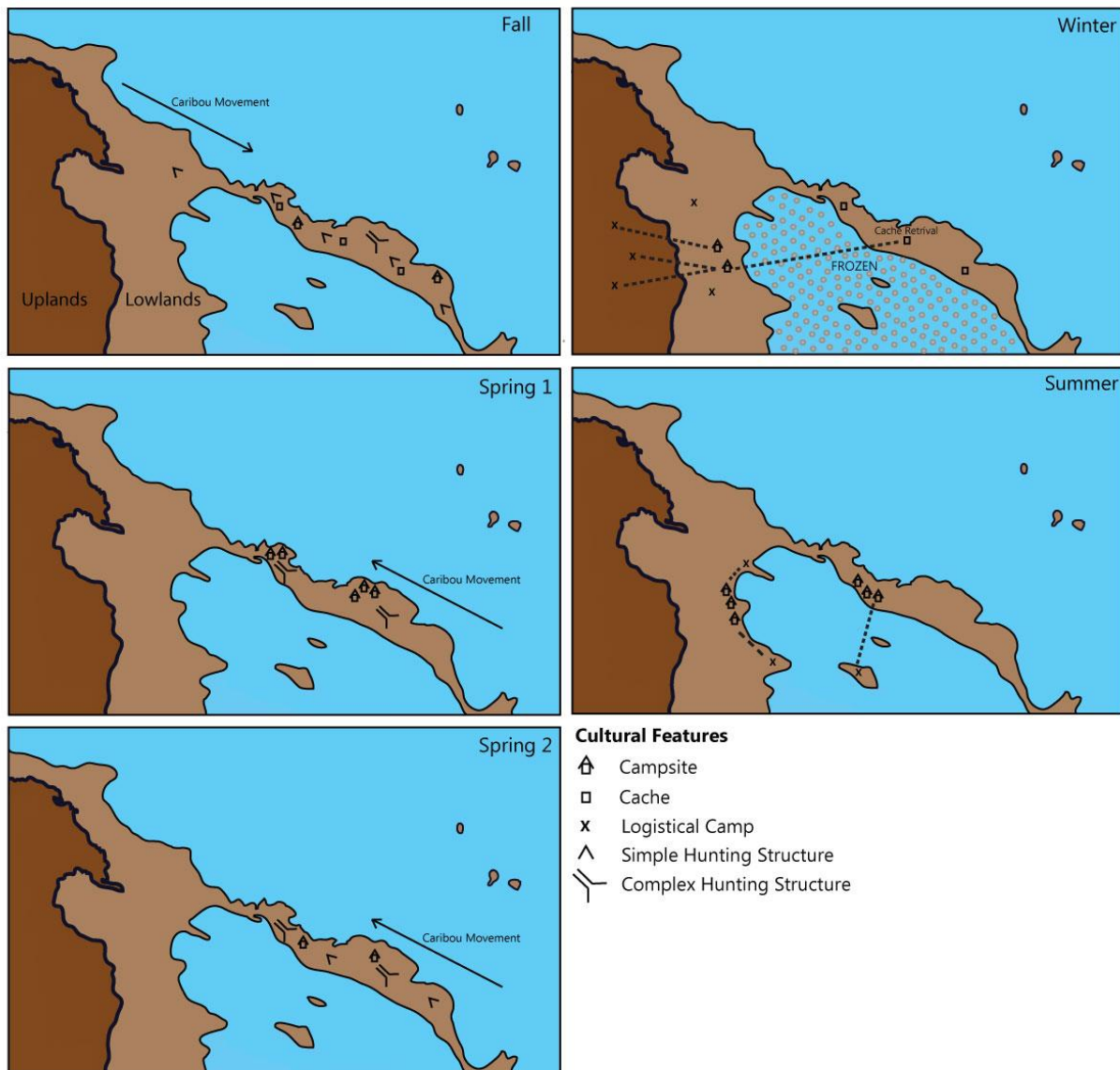
It appears that hunting architecture sites and their associated facilities were most often used by small groups of people, ranging from individuals to small groups, perhaps one or two extended families. New structures identified in the Esker Locality support these inferences concerning group size. Here it appears that the natural topography directed caribou movement sufficiently that minimal groups of people could use hunting architecture designed to take advantage of this feature. Furthermore, the absence of complex structures associated with seasonal aggregation spring hunting in the Esker Locality suggests that the Overlook Locality was a very unique place on the AAR.

Within the Overlook Locality, Drop 45 is the most complex structure identified thus far on the AAR; with a drive lane, four hunting blinds, and over a dozen lithic artifacts including a thumbnail scraper on Bayport chert (Lemke 2015c; O'Shea et al. 2014). Drop 45 can only work in one season (spring) and its longer and more elaborate drive lane and numerous hunting blinds could only have been operated by a larger, cooperative group of people. It is therefore likely that

Drop 45 specifically, and the Overlook Locality more generally, served as an aggregation point for smaller, disparate groups of people on the AAR who used simpler hunting sites and structures for most of the year. The Overlook Locality provides supporting, independent lines of evidence for larger populations gathering for hunting as well as social solidarity/exchange, including a large dwelling and the densest concentration of archaeological materials (some of which are exotic) on the ridge. Taken together with the new results from the Esker Locality, it appears that overall population density was low, and was characterized by relatively small groups moving on and around the AAR, although these groups periodically came together into larger social aggregations.

The seasonal model of social aggregation and caribou hunting on the AAR can therefore be refined (**Figure 10.1**). Caribou hunting can be characterized by individuals and small group in the fall and spring, using primarily simple structures and likely temporary campsites (as indicated by the stone ring with dated charcoal at the Crossing Locality); with periodic social aggregations for spring hunting at the complex Drop 45 site. Hunting goals varied across seasons and included both immediate and delayed consumption, as well as social solidarity and exchange. Winter and summer patterns likely included use of the mainland, off the AAR, specifically in winter when the cold air and overall environment of the ridge would have likely been an inhospitable place. In the summer it is likely that individual hunting took place on both the ridge and the mainland, supplemented by fishing and other gathering activities. For most of year, and for most adaptive economic activities, prehistoric peoples were in relatively small and mobile groups.

Figure 10.1. Revised schematic of seasonal occupations on the American portion of the AAR. Darkest color indicates modern land surface, lighter color indicates additional land surfaces that would have been dry land during Lake Stanley. In the revised model, spring hunting is periodically characterized by group aggregation to operate complex structures (Spring 1), or is organized with small group hunting using different types of hunting structures (Spring 2).

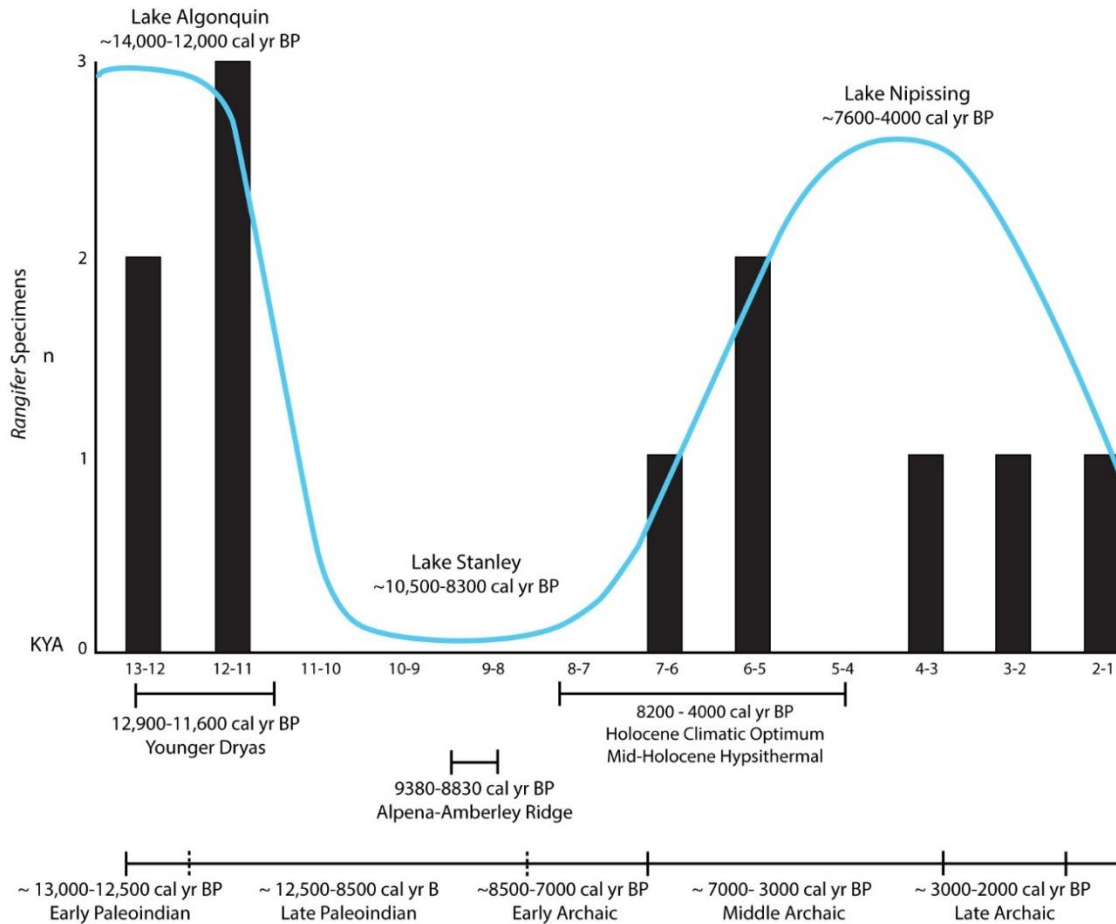


The AAR results provide new pictures of economic lifeways and cultural adaptations in the Great Lakes region. The Great Lakes prehistoric record cannot be fully understood without reference to the crucial period of time now only represented underwater, i.e. the Lake Stanley

which is partially contemporary with both the Paleoindian and Archaic archaeological periods (**Figure 10.2**). As terrestrial archaeology in the region is hindered by a lack of absolute chronologies and drowned archaeological and paleontological records, one of the most significant contributions of the AAR research is providing absolute dates. Given the unique preservation provided by submerged settings, numerous pieces of wood and charcoal have been left *in situ* and available for radiometric dating. There are eight absolute dates spanning the Paleoindian period from terrestrial archaeological sites in the Great Lakes Basin (**Table 4.7**), there are eighteen from Lake Huron (**Table 7.2**).

Significantly, the span of dates from the AAR fit within the assumed time span of the Late Paleoindian period as defined for the Great Lakes region (see **Figure 10.2**) and thus the AAR results directly address this period which is poorly known from the terrestrial record. Underwater research can therefore provide not only additional, but *critical*, data for addressing long-standing problems in Great Lakes archaeology, such as the role of caribou as a subsistence resource, the span and nature of the Paleoindian period, and finally it can expand traditional views of *Rangifer* hunters drawn solely from the ethnographic record.

Figure 10.2. Human occupation of the AAR in context. Blue curved line represents generalized ancient water levels in the Great Lakes. Black bars indicate dated caribou specimens from the Great Lakes basin. Environmental phases, AAR dates, and the generalized culture historical sequence for the Great Lakes are listed, (adapted from Lemke 2015b:279, Figure 3).



It is clear that ancient lake levels and human behavior in the Great Lakes region are intimately tied to broader environmental changes at the end of the Ice Age. Underwater research has revealed that the AAR was a continuous dryland corridor which can be characterized as an ice age refugium (**Chapter 7**). This landform dramatically affected local paleoenvironments in the region, and provided a cooler, subarctic-like refugium far different from warming Holocene temperatures and their corresponding closing forests on the nearby mainland. This refugium was

a significant pull for cold adapted plants and animals, such as caribou. Caribou were likely much more common on the landscape than traditionally assumed as dated paleontological and archaeological caribou remains from known terrestrial sites in the Great Lakes reveal a distinct gap during the Lake Stanley phase – precisely because these records are *underwater* (**Figure 10.2**, Lemke 2015b). The AAR provided an ideal migration route for these animals with preferred forage, fresh water, and fewer insects than the mainland, and likewise offered an ideal ecological niche for hunter-gatherers in the region.

Paleoindian adaptations as understood by the Conventional Paleoindian Model (CPM), are often characterized as a highly mobile big-game hunters, would have been well suited to the AAR environment – specifically the targeting of caribou. The AAR offered predictability for hunters in an increasingly unstable landscape of changing water levels, glacial retreat, and warming Holocene climates. While in general caribou hunting sites can be seen as productive locations that are spatially stable but unpredictable from year to year (Stewart 2014), the isolated AAR refugium offered a relatively small geographic area with dense, seasonal, resource patches, i.e. migrating caribou, and provided ample opportunities for hunting *en masse* (similar to salmon runs). Significantly, the AAR results not only support long-standing views that Paleoindians in the Great Lakes region were caribou hunters, but these data also refine our understanding of Paleoindian lifeways and the CPM.

In some aspects, the underwater research in Lake Huron is consistent with the CPM drawn from terrestrial archaeology. For example, the scale of movement and mobility across the AAR is consistent with the scale of chert exploitation in the Paleoindian sites represented in the terrestrial record (Fox et al. 2015). Additionally, investigations on the AAR demonstrate that

some economic adaptations (such as caribou hunting) persisted and became further reified in this unique environment by the creation of a modified hunting landscape.

Beyond this, the underwater archaeological record on the AAR preserves direct evidence of Paleoindian lifeways that have been difficult to reconstruct on land, particularly in the Great Lakes region, including aspects of the subsistence economy, seasonal strategies, and social organization. First, the underwater record supplements and enhances our views of Paleoindian subsistence economies to include built hunting architecture. While natural game traps such as arroyos have been documented to be used by Paleoindian hunters, the unique underwater setting of the AAR has preserved built hunting architecture – an elaboration of natural traps and ambush hunting by literal niche construction. Second, the AAR record documents diverse economic and social strategies that are structured by season. While caribou certainly played a significant role in the annual economy, exploitation methods varied between fall and spring. Lastly, the AAR preserves evidence of both large-scale social aggregations and small group subsistence activities across the year in a localized region. Perhaps ironically, these diverse lines of evidence from the AAR reveal that this chronologically *Late* Paleoindian occupation resembles more traditional models of *Early* Paleoindians, i.e. the CPM, as Ice Age adapted, terrestrial big-game hunting, mobile, small groups of hunter-gatherers. While these traditional models have been questioned for early Paleoindian hunter-gatherers (e.g. Cannon and Meltzer 2004; Collins 2002, 2007), they may be useful for later occupations, although this model is still an oversimplification of hunter-gatherer behavior. In this last respect, the CPM mirrors the broader issue of normative models of hunter-gatherers that often cannot account for variability in forager behavior (see below).

Overall, interdisciplinary research on the AAR is revealing unique and localized environmental and cultural phenomena within broad-scale continental patterns. Hunter-gatherer

lifeways that were well suited to Pleistocene environments and ecologies continued in the Great Lakes longer than in other regions, especially in refugia such as the AAR. Thus, it appears that the Holocene transition happened more *slowly*, and likewise big-game hunting adaptations persisted *longer* in this unique landscape than on the mainland or other regions across North America (Lemke and O'Shea in Press).

Prehistoric Rangifer Hunters

This characterization of the AAR corresponds with patterns across the terminal Pleistocene in Europe. Here also, the slow retreat of Pleistocene environments saw the movement of reindeer herds to Northern Europe, and the persistence of reindeer hunting adaptations in this region (see **Chapter 5**). The regional patterns observed on the AAR echo site locations of prehistoric reindeer hunters in Europe. For example, Upper Paleolithic records in several areas demonstrate that reindeer hunting sites were situated within a wider array of campsites, logistical sites, and other hunting areas (Gaudzinski and Roebroeks 2000:514). On the AAR, drive lanes and hunting blinds are part of a modified landscape with campsites, hearths, and other logistical sites such as caches and cairns. Furthermore, in Germany, site placement seems similar to the AAR, either on high ridges for viewing animal movements, along river valleys where herds were likely to cross, and/or in relation to migration routes (Bokelmann 1991; Bratlund 1990, 1991; Petersen and Johansen 1991:25-28).

Interpretations of such archaeological records of *Rangifer* hunters across North America and Europe often rely on the vast ethnographic and historic records of caribou and reindeer hunters (Conkey 1991; Kenyon 1997:9; Levine 1997, see also Arkush 1986). Ethnographic

analogies are common despite the fact that the extant historic and ethnographic records reflect time periods of vast changes in both human and *Rangifer* populations. While there are certainly comparable aspects between the historic, ethnographic, and archaeological records of caribou hunters, such as the form of built hunting structures, the long prehistory of human interactions with the *Rangifer* species, including the 9,000-year-old caribou hunting structures underwater in Lake Huron, reveal prehistoric behaviors that differ from those of ethnographically known caribou hunters. These differences are primarily due to the simple fact that prehistoric caribou hunting took place in social and environmental contexts that have no modern analogs.

While many ethnographic accounts of caribou hunters document very large group communal hunts, the much larger herd sizes in prehistory prior to global population declines due to overhunting with guns, significantly impacted hunting strategies. For example, migration herds on the AAR appear to have been so large that simple hunting structures along natural topographic features could be used by individuals or small groups (See O'Shea, Lemke, and Reynolds 2013). Furthermore, two common models of prehistoric caribou hunters – herd following and specialization – which are rooted in ethnographic analogy, find no support in the AAR data. Prehistoric caribou hunters certainly stationed themselves and modified strategic places on the landscape to intercept herds, but they did not follow them. The diets of these hunters were also likely supplemented by other plant and animal resources.

While ethnographic data can serve as a hypothesis generating tool, presenting some of the ways in which hunter-gatherer societies may operate, archaeologists should not expect to see entire societies from the ethnographic record represented in the past, but rather some familiar elements may be put together in novel ways – such as on the AAR. Such different strategies and behaviors documented in the prehistoric record can provide important insights into the pre-

contact character of caribou populations and their human predators, and the diversity and ingenuity inherent in prehistoric foraging societies.

Hunting Architecture and Foraging Lifeways

The regional study of caribou hunting architecture submerged beneath the Great Lakes presented in this dissertation reveals complex social and economic organization present in prehistoric foraging cultures. These structures dating to the Pleistocene-Holocene transition reveal the long prehistory of human niche construction in the form of hunting architecture and its associated socioeconomic dynamics. It is likely that hunting structures existed at an even earlier date, but have been obscured or destroyed by subsequent land use and development. The unique underwater setting of the AAR structures offered the possibility to investigate intact hunting architecture in meso-scale regions, and provided insight into social organization and other features that extend far beyond hunting itself. Great Lakes foragers using hunting architecture do not fit the normative characterization of hunter-gatherers – particularly in their modification of the landscape – and this example likely just a single instance of many different kinds of prehistoric foragers that do not conform to traditional models. This regional case study demonstrates that hunting architecture can be used to examine hunter-gatherer lifeways from a new perspective.

The use of hunting architecture by foraging societies is at odds with traditional characterizations of hunter-gatherers. While foragers are often considered to be highly mobile, these built structures anchor them to the landscape. In addition, the presence and nature of these structures reveal active modification of the landscape, social aggregation, and labor organization, and hint at property, ownership, and leadership in the deep past. These traits are often thought to

only characterize “complex” hunter-gatherers. As demonstrated by the AAR and a growing number of studies (e.g. Grier 2000; Friesen 2007; Prentiss et al. 2007, Zedeño et al. 2014), some or all of these traits are likely more broadly characteristic of prehistoric foragers than traditionally assumed.

Many traits often associated with complex hunter-gatherers may find their roots in subsistence strategies adopting hunting architecture as these structures present a fundamental shift in exploitation by actively modifying the hunting landscape to increase the yield and predictability of natural resources (Smith 2013). In this way, hunting architecture is akin to other processes such as broadcast fires which actively modify the landscape to increase productivity. In both these examples, “simple” hunter-gatherers act as ecosystem engineers (Bird 2015).

Similar to the origins of agriculture, the adoption of hunting architecture creates unique social and economic consequences. For example, while hunter-gatherers are generally acephalous and egalitarian, they often do recognize territorial rights and limited kinds of group leadership (e.g., Ames 1994; Flanagan 1989). As a resource, migrating caribou are similar to the salmon in the Pacific Northwest in the sense that they present a concentrated and predictable resource, but one that may be available for only a short time. As such, limiting access to the resource makes little sense. However, once an individual or group erects a permanent structure for harvesting the resource, rights to the facility, and by extension to its location, are generally recognized as belonging to the builder (so long as they continues to utilize the facility). The linking of hunting architecture and associated features with particular individuals is a common feature in ethnographic accounts in the Falls River area (Stewart et al. 2000) and among Nunamiut groups living in the Brooks Range (Binford 1978b), even among people that no longer used the hunting structure. Hunting architecture sites, such as those on the AAR, likely presented

a similar situation concerning property rights comparable to umiak captains (Grier 2000) or fishing weirs on the Northwest Coast (Lemke and O’Shea 2015).

Hunting architecture therefore provides a lens through which to analyze the roots of social and economic complexity in the past – many of which present themselves very early in the archaeological record. Rather than isolating certain characteristics as belonging to “simple” or “complex” hunter-gatherers, a more fruitful approach considers which aspect of the society is termed complex. For example, aspects of economy or kinship may be complex without the society as a whole adopting the set of characteristics of a complex society – such as foragers adopting hunting architecture. The question may not be how complex societies evolved, but rather how hunter-gatherers maintained egalitarian principles for as long as they did (e.g. Woodburn 1982) – particularly in the context of hunting architecture and its associated socioeconomic tensions. Overall, considerations of prehistoric hunter-gatherer behavior are more usefully viewed as a continuum rather than a strict dichotomy (*sensu* Kelly 1995, 2013; see also Jenike 2001; Rowley-Conwy 1983, 2001; Winterhalder 2001).

Anthropological Archaeology Underwater

Underwater archaeology has the potential to play a significant role in documenting novel forager lifeways, as entire prehistoric landscapes are preserved and offer unique data not available on land. The regional case study examined in this dissertation represents an environment that is largely free from subsequent modification and provides a view of an *in situ* engineered landscape. Research on the AAR revealed novel hunter-gatherer behavior that

extends beyond the ethnographic record. What makes this possible is an explicit anthropological archaeology approach.

George Bass stated, “Archaeology under water, of course, should be called simply, *archaeology*” (Emphasis in the original, 1966:5). For many years, underwater archaeology was held to be its own field of inquiry, intimately connected with classical studies, as most early systematic research focused on Greek, Roman, and Byzantine shipwrecks. As underwater archaeological methods and research questions have evolved, archaeologists in anthropology as well as classics have become interested in submerged sites – moving beyond isolated shipwrecks to entire prehistoric landscapes. These landscapes, and the prehistoric archaeological sites preserved on them, require different research methods as well as theoretical understandings compared to historic shipwrecks.

Similar to both maritime and nautical archaeology, prehistoric archaeology underwater has also been considered a subdiscipline (Gusick and Faught 2011). Despite the increasing fragmentation of anthropology, and increasing specialization in archaeology, researching submerged prehistoric sites should be considered anthropological archaeology, despite the specialized methods needed to investigate such sites. In order to contribute to anthropology’s “Big Questions”, underwater research needs to look more like terrestrial archaeology rather than shipwreck hunting. This dissertation seeks to exemplify just such an approach, and the way forward for submerged research – combining underwater methods with archaeological data and anthropological theory. It is not just the connection of terrestrial and underwater archaeological records, or the exploration of terrestrial questions in a submerged context – but rather an anthropological grounding and impetus for research.

Future Prospects

Significantly, the research design generated for work on the AAR can be applied to similar archaeological and anthropological questions in other parts of the globe. The changes in lake levels seen in the Great Lakes mirror larger, global changes in sea level during the Pleistocene. Fluctuating sea levels significantly altered prehistoric landscapes along coastlines. More specifically, these changes drowned vast areas of caribou and reindeer territory, just as they did in the Great Lakes, and there are many ideal comparative cases for the AAR in North America and Europe. One case is the Bull Brook Paleoindian site in Maine where caribou bones were found. The site is adjacent to a funnel-shaped valley with steep slopes, strategically located to intercept caribou during their fall migrations, perhaps from a now submerged island (Robinson et al. 2009:439). Similar to the AAR and the Great Lakes, sea level in the Gulf of Maine was 55 meters below present at this time exposing substantial areas of land which are now submerged, include Jeffrey's Ledge, a feature directly east of the site (Barnhardt et al. 1995:319; Oldale 1985; Pelletier and Robinson 2005). It is likely this feature may preserve archaeological sites dating to the Late Pleistocene.

Another comparable case can be found in Europe. Reindeer bones dating to the Late Pleistocene have been recovered from the bed of the North Sea (Glimmervenn, Mol, and van der Plicht 2006; Kortenbout van der Sluijs 1971), and similar to the ice age refugium on the AAR, the now submerged landscape under the North Sea (i.e. Doggerland) would have retained a tundra biome longer than more southerly areas (Indrelid 1975:13). It has been speculated that prehistoric peoples inhabiting this region combined reindeer hunting with sealing, fishing, and

fowling along the Late Pleistocene shores (Aaris-Sørensen et al. 2006, Coles 1998). These two case studies offer ideal prospects for future comparative research.

In all these cases, connecting the terrestrial and underwater archaeological records is essential. The results of underwater research on the AAR have implications for the complete seasonal round of Pleistocene- Holocene transition foragers, and thus archaeological expectations for the terrestrial record. For example, it is clear that hunting architecture sites in general, and on the AAR specifically fit into larger, regional, settlement patterns. Therefore, both logistical sites and campsites are likely to be found on the mainland, as the AAR would not have been an ideal area of winter habitation. Scattered finds of Paleoindian material near Hubbard Lake (O'Shea n.d.) in far northern Michigan provide support for these expectations – as well as testable models for future terrestrial research.

More broadly, some of the most important questions in human history such as the origin of human culture, the spread of hominids out of Africa, and the colonization of the Americas, require the investigation of submerged archaeological sites. Underwater investigations must play a significant role in understanding the global human expansion of prehistoric hunter-gatherers since some of the best places on the landscape to forage, e.g. coastal areas, are now submerged (Lemke in press). Absent such research, models of mobility, landscape use, and subsistence strategies cannot be firmly evaluated.

Ultimately, this dissertation demonstrates that through systematic and sustained research, and an anthropological archaeology approach, submerged prehistoric research can contribute to anthropology's most important questions.

References Cited

A

Aaris-Sørensen

1992 Deglaciation chronology and re-immigration of large mammals. A south Scandinavian example from Late Weichselian–Early Flandrian. In *Mammalian Migration and Dispersal Events in the European Quaternary*, edited by W. von Koenigswald and L. Werdelin, L, pp.143-149. Courier Forschungs-Institut Senckenberg 153.

Aaris-Sørensen, Kim, Mühlodorf, Rudi, and Erik Brinch Petersen

2007 The Scandinavian reindeer (*Rangifer tarandus L.*) after the last glacial maximum: time, seasonality and human exploitation. *Journal of Archaeological Science* 34:914-923.

Abramova, Z. A.

1983 Tri goda roskopok pozdnepaleolithicheskoi stoyanki Yudinovo. *Tezisy Dakladov, Arkheologicheskii Plenum, Moscow.*

Adovasio, J.M. and A. Hemmings

2009 *Inner continental shelf archaeology in the northeast Gulf of Mexico*. Paper presented to the 74th annual meeting of the Society for American Archaeology, Atlanta.

Agenbroad, L. D.

1978 Buffalo Jump Complexes in Owyhee County Idaho. *Plains Anthropologist* 23(82):213-221.

Aguliar, M. Trinidad

1988 Las trampas para cazar camélidos. Llamichos y Paqocheros, in *Pastores de Llamas y Alpacas*, edited by Jorge Flores Ochoa, pp.59-65. Centro de Estudios Andinos, CEAC, Cusco.

Albrecht, G.

1977 Testing of Materials as Used for Bone Points of the Upper Paleolithic. In *Méthodologie Appliquée à l'Industrie de l'Os Préhistorique*, edited by H. Camps-Fabrer, pp. 119-123. Éditions du Centre National du Recherche Scientifique, Paris.

- 1979 *Magdalenien-Inventare vom Petersfels. Tübinger Monographien zur Urgeschichte Band 6.* Tübingen, Verlag Archaeologica Venatoria, Universität Tübingen.
- Albrechtsen, E.
1959 Flinteflækker og frømand. *Fynske Minder.* Odense.
- Ames, Kenneth M.
1994 The Northwest Coast: Complex Hunter-Gatherers, Ecology, and Social Evolution. *Annual Review of Anthropology* 23:209-229.

2004 Review: Supposing Hunter-Gatherer Variability. *American Antiquity* 69(2):364-374.
- Anderson, A.
2012 Submerged Prehistory. *International Journal of Nautical Archaeology* 41 (2): 427-428.
- Anderson, David G., and Glen T. Hanson
1988 Early Archaic Settlement in the Southeastern United States: A Case Study from the Savannah River Valley. *American Antiquity* 53(2):262-286.
- Andersen, Søren H.
1980 Tybrind Vig, a Preliminary Report on a Submerged Ertebølle Settlement on the Little Belt. *Antikvariske Studier* 4:7–22.

1987 Tybrind Vig: A Submerged Ertebølle Settlement in Denmark. In *European Wetlands in Prehistory*, edited by J. M. Coles and A. J. Lawson, pp 253–80. Clarendon Press, Oxford.

2013 *Tybrind Vig: Submerged Mesolithic Settlements in Denmark.* Jysk Arkæologisk Selskabs Skrifter 77. Aarhus University Press.
- Anderson, T. W.
1971 *Postglacial Vegetative Changes in the Lake Huron-Lake Simcoe District, Ontario, with Special Reference to Glacial Lake Algonquin.* Ph.D. Dissertation, University of Waterloo, Waterloo, Ontario.
- Andrews, Thomas D., and John B. Zoe
1997 The Idaà trail: Archaeology and the Dogrib cultural landscape. In *At a Crossroads: Archaeology and First Peoples in Canada*, edited by George P. Nicholas and Thomas D. Andrews, pp. 160–77. Archaeology Press, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.
- Anell, B.
1969 *Running Down and Driving of Game in North America.* Studies Ethnographica Upsaliensia 30. Berlingska, Uppsala.

Arkush, Brooke S.

1986 Aboriginal Exploitation of Pronghorn in the Great Basin. *Journal of Ethnobiology* 6(2):239-255.

Arima, E.

1975 *A contextual study of the Caribou Eskimo kayak*. National Museum of Man, Mercury Series No. 5. Canadian Ethnology Service, Ottawa.

Arnold, Jeanne E.

1996a Labor and the Rise of Complex Hunter-Gatherers. *Journal of Anthropological Archaeology* 12(1):75-119.

1996b The Archaeology of Complex Hunter-Gatherers. *Journal of Archaeological Methods and Theory* 3(1):77-126.

2004 *Foundations of Chumash Complexity*. Perspectives in California Archaeology 7. Los Angeles: Cotsen Institute, UCLA.

Atherton, M

2011 *Echoes and Images: The encyclopedia of Side-Scan and Scanning Sonar Operations*. OysterInk Publications, Vancouver, BC.

B

Baales, Michael

1996 Umwelt und Jagdökonomie der Ahrensburger Rentierjäger im Mittelgebirge. In: *Monographien der Römisch-Germanischen Zentralmuseums*, 38. Mainz and Bonn.

1999 Economy and Seasonality in the Ahrensburgian. In *Tanged Point Cultures in Europe*, edited by Stefan Karol Kozłowski, pp. 64-75. Maria Curie-Skłodowska University Press, Lublin.

Back, George

1836 *Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River*. London.

Bailey, Geoffrey N.

2011 Continental Shelf Archaeology: Where Next? In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 311–331. Oxbow Books.

2014 New Developments in Submerged Prehistoric Archaeology: An Overview. In *Prehistoric Archaeology on the Continental Shelf*, edited by Amanda M. Evans, Joe C. Flatman, and Nicholas C. Flemming, pp. 291–300. Springer, New York.

- Bailey, Geoffrey N., and Nicholas C. Flemming
 2008 Archaeology of the continental shelf: Marine resources, submerged landscapes and underwater archaeology. *Quaternary Science Reviews* 27(23):2153-2165.
- Bailey, G. N., and J. Parkington
 1988 *The Archaeology of Prehistoric Coastlines*. New Directions in Archaeology, Cambridge University Press, Cambridge.
- Bailey, R. E., and P. J. Ahearn
 1981 A Late- and Postglacial Pollen Record from Chippewa Bog, Lapeer Co., MI: Further Examination of White Pine and Beech Immigration into the Central Great Lakes Region. In *Geobotany II*, edited by R. C. Romans, pp. 53-74. Plenum Press, New York.
- Balikci, Asen
 1963 *Vuntut Kutchi Social Change: A Study of the People of Old Crow, Yukon Territory*. Northern Co-ordination and Research Centre, Department of Northern Affairs and National Resources, Ottawa.
- 1964 *Development of Basic Socio-economic units in two Eskimo Communities*. National Museum of Canada Bulletin No. 202, Anthropological Series No. 69, Ottawa.
- 1970 *The Netsilik Eskimo*. Natural History Press, New York.
- Bang-Andersen, Sveinung
 1989 Mesolithic adaptations in the Southern Norwegian Highlands. In *The Mesolithic of Europe*, edited by C. Bonsall, pp.338-350. John Donald, Edinburgh.
- 1996 Coast/inland Relations in the Mesolithic of Southern Norway. *World Archaeology* 27(3):427-443.
- Banfield, A. W. F.
 1961 *A revision of the reindeer and caribou genus Rangifer*. Ottawa, Dept. of Northern Affairs and National Resources.
- Bahn, P.
 1977 Seasonal Migration in South-West France during the Late Glacial Period. *Journal of Archaeological Science* 4:245-257.
- Barge, O. and J. É. Brochier
 2011 *Visible from Space, Understood during the Fieldwork: An Example of "Desert Kites" in Armenia*. Paper presented at Conference on Cultural heritage and New Technologies, November 2011, Vienna.
- Barge, O., Brochier, J. É., Chahoud, J., Chataigner, C., Chambrade, M.-L., Karakhanyan, A., Régagnon, E., and R. Crassard

- 2013 Toward a New Approach to the “Kites Phenomenon” in the Old World: The GLOBALKITES Project. *Antiquity* 87(338).
- Barnhardt, Walter A., W. Roland Gehrels, Daniel F. Belknap, and Joseph T. Kelley
1995 Late Quaternary Relative Sea-level Change in the Western Gulf of Maine: Evidence for a Migrating Glacial Forebulge. *Geology* 23(4):317-320.
- Barnes, Peter W., Edward W. Kempema, Erk Reimnitz, and Michael McCormick
1994 The Influence of Ice on Southern Lake Michigan Coastal Erosion. *Journal of Great Lakes Research* 20(1):179-195.
- Barnosky, A. D., Koch P. L., Feranec, R. S., Wing, S. L., and A. B. Shabel
2004 Assessing the Causes of Late Pleistocene Extinction on the Continents. *Science* 306:70-75.
- Bar-Oz, G., and D. Nadel
2013 Worldwide Large-Scale Trapping and Hunting of Ungulates in Past Societies. *Quaternary International* Guest Editorial 297:1-7.
- Bar-Oz, G., Nadel, D., Avner, U., and D. Malkinson
2011 Mass hunting game traps in the southern Levant: the Negev and Arava ‘Desert Kites’. *Near Eastern Archaeology* 74:208-215.
- Barsky, D.
2013 The Caune de l’Arago stone industries in their stratigraphical context. *Comptes Rendus Palevol* 12:305-315.
- Basilyan, A. E., Anisimov, M. A., Nikoskiy, P. A., and V. V. Pitulko
2011 Woolly mammoth mass accumulation next to the Paleolithic Yana RHS site, Arctic Siberia: its geology, age, and relation to past human activity. *Journal of Archaeological Science* 38:2461-2474.
- Barth, E.
1971 Spor etter fortidens veidemenn. *Vi Menn* 51.
- Bass, George Fletcher
1966 *Archaeology under Water*. Ancient Peoples and Places. Praeger, New York.

1972 *A History of Seafaring Based on Underwater Archaeology*. Thames and Hudson, London.

1988 *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology*. Thames and Hudson, New York.

- Bass, George Fletcher., and Frederick H. Van Doorninck
 1982 *Yassi Ada*. Nautical Archaeology Series.no. 1-, v. College Station: Published with the cooperation of the Institute of Nautical Archaeology by Texas A&M University Press.
- Bass, George F., Peter Throckmorton, J. B Hennessey, Alan R Shulman, and Hans-Günter Buchholz
 1967 Cape Gelidonya: A Bronze Age Shipwreck. *Transactions of the American Philosophical Society* 57, Part 8.
- Bayón, María Cristina and Gustavo G. Politis
 2014 The Inter-Tidal Zone Site of La Olla: Early–Middle Holocene Human Adaptation on the Pampean Coast of Argentina. In *Prehistoric Archaeology on the Continental Shelf*, edited by Amanda M. Evans, Joe C. Flatman, and Nicholas C. Flemming, pp. 115-130. Springer, New York.
- Beck, Charlotte, and George T. Jones
 2010 Clovis and Western Stemmed: population migration and the meeting of two technologies in the Intermountain West. *American Antiquity* 75:81-116.
- Beck, Robin
 2013 *Chiefdoms, Collapse, and Coalescence in the Early American South*. Cambridge University Press, Cambridge.
- Benedict, James B.
 1970 *Aerial Photography and Mapping of the Rollins Pass Site, Colorado*. In *The American Philosophical Society, Yearbook 1969*, pp. 504-506.
- 1975a The Murray Site: A Late Prehistoric Game Drive System in the Colorado Rocky Mountains. *Plains Anthropologist* 20(69):161-174.
- 1975b Scratching Deer: A Late Prehistoric Campsite in the Greek Lakes Valley, Colorado. *Plains Anthropologist* 20(70):267-278.
- 1996 *The Game Drives of the Rocky Mountain National Park*. Research Report 7. Center for Mountain Archaeology, Ward.
- 2005 Tundra Game Drives: An Arctic-Alpine Comparison. *Arctic, Antarctic, and Alpine Research* 37(4):425-434.
- Benedict, James B. and B. L. Olson
 1978 *The Mount Albion Complex: A Study of Prehistoric Man and the Altithermal*. Research Report No. 1 Center for Mountain Archaeology, Ward, Colorado.
- Benjamin, Jonathan, Bonsall, Clive, Pickard, Catriona, Pickard, and Anders Fischer
 2011 *Submerged Prehistory*. Oxbow Books, Oxford.

- Berenguer, Magín
1988 *Prehistoric Cave Art in Northern Spain, Asturias*. Ciudad de México.
- Bergerud, A.T., Stuart N. Luttich, and Lodewijk Camps
2008 *The Return of Caribou to Ungava*. McGill-Queen's University Press, Montreal and Kingston.
- Berkes, F.
2008 *Sacred Ecology*, second ed. Routledge, New York.
- Bettinger, Robert L.
1991 *Hunter-Gatherers: Archaeological and Evolutionary Theory*. Plenum Press, New York and London.
- Betts, A. V. G. and S. Helms
1986 Rock Art in Eastern Jordan: Kite Carvings? *Paléorient* 12(1):67-72.
- Betts, A. V. G. and V. Yagodin
2000 Hunting Traps on the Ustiurt Plateau, Uzbekistan. In *Realms of the Silk Roads: Ancient and Modern Silk Road Studies*, edited by D. Christian and C. Benjamin, pp.29-45. Turnhout Press, Brepols.
- Bicho, Nuno Ferreira., Jonathan A. Haws, Loren G. Davis
2011 *Trekking the Shore Changing Coastlines and the Antiquity of Coastal Settlement*. Interdisciplinary Contributions to Archaeology. Springer, New York.
- Billy, G.
1975 Etude Anthropologique des Restes Humains de l'Abri Pataud. In *Excavation of the Abri Pataud, Les Eyzies (Dordogne)*, edited by H. L. Movius, pp. 201-261. Harvard University Press, Cambridge.
- Binford, Lewis R.
1976 Forty-seven Trips: A Case Study in the Character of Some Formation Processes. In *Contributions to Anthropology, the Interior Peoples of Northern Alaska*, edited by E.S. Hall, Jr., pp. 299-351. National Museum of Man, Mercury Series, Paper No. 49. National Museum of Canada, Ottawa.
- 1978a Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand. *American Antiquity* 43(3):330-361.
- 1978b *Nunamiut Ethnoarchaeology*. Academic Press, New York.
- 1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.
- 1981 *Bones: Ancient Men and Modern Myths*. Academic Press, New York.

- 1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1(1):5-31.
- 1984 *Faunal Remains from Klasies River Mouth*. Academic Press, Orlando.
- 1985 Human ancestors: changing views of their behavior. *Journal of Anthropological Archaeology* 3:235-257.
- 1987 Were there elephant hunters at Torralba? In *The Evolution of Human Hunting*, edited by M. N. Nitecki and D. V. Nitecki, pp. 47-105. Plenum Press, New York.
- 1991 A Corporate Caribou Hunting: Documenting the Archaeology of Past Lifeways. *Expedition* 33(1):33-43.
- 2001 *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building and Using Ethnographic and Environmental Data Sets*. University of California Press, Berkeley and Los Angeles.
- Bird, Rebecca
- 2015 Disturbance, complexity, scale: new approaches to the study of human-environment interactions. *Annual Reviews of Anthropology* 44:241–257.
- Birket-Smith, Kaj
- 1918 The Greenland Bow. *Meddelelser om Grønland* 56. Bianco Lunos, Copenhagen.
- 1924 Ethnography of the Egedesminde District. *Meddelelser om Grønland* 66. Bianco Lunos, Copenhagen.
- 1927 *Eskimoerne*. Copenhagen.
- 1929 *The Caribou Eskimos. Report of the Fifth Thule Expedition 1921-24*, Vol. 5. Gyldendals Forlagstrykkeri, Copenhagen.
- Björck, S., Ekström, J., Iregren, E., Larsson, L., Liljegren, R.
- 1996 Reindeer and palaeoecological and palaeogeographic changes in South Scandinavia during late-glacial and early post-glacial times. *Arkæologiske Rapporter, Esbjerg Museum* 1:195-214.
- Blachet, G. H.
- 1964 Exploring with Sousi and Black Basile. *The Beaver*, Outfit 195, 34-41. Hudson Bay Company, Winnipeg.
- Blasi, Adriana, Gustavo Politis, and Cristina Bayón
- 2013 Palaeoenvironmental Reconstruction of La Olla, a Holocene Archaeological Site in the Pampean Coast (Argentina). *Journal of Archaeological Science* 40(3):1554-1567.

- Blehr, Otto
 1990 Communal hunting as a prerequisite for caribou (Wild Reindeer) as a human resource. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 304-326. Unwin Hyman, London.
- Blitz, John
 1988 Adoption of the bow in prehistoric North America. *North American Archaeologist* 9(2):123-145.
- Broadwater, John D.
 2002 Timelines of Underwater Archaeology. In *International Handbook of Archaeology Underwater*, edited by Carol V. Ruppé and Janet E. Barstad, pp. 17-24. Kluwer Academic/Plenum Publishers, New York.
- Boas, Franz
 1888 *The Central Eskimo*. Annual Report No. 6. Bureau of American Ethnology, Washington D.C.
 1902 Some Problems in North American Archaeology. *American Journal of Archaeology* 6:1-6.
- Bokelmann, K.
 1979 Rentierjäger am Gletscherrand in Schleswig-Holstein? *Offa* 36:12-22.
 1991 Some new thoughts on old data on human and reindeer in the Ahresburgian Tunnel Valley in Schleswig-Holstein, Germany. In *Late Glacial in north-west Europe: human adaptation and environmental change at the end of the Pleistocene*, edited by N. Barton, A. J. Roberts and D. A. Roe, pp. 72-81. Council for British Archaeology Report.
- Borziyakov, Llia Aleksandrovich
 1993 Subsistence Practices of Late Paleolithic Groups along the Dnestr River and its Tributaries. In *From Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations*, edited by Olga Soffer and N. D. Praslov, pp. 67-83. Plenum Press, New York and London.
- Bouchard, J.
 1953 La mandibule du renne. *Mammalia* 17: 27-49.
 1966 *Essai sur la Renne et la Climatologie du Paléolithique Moyen et Supérieur*. Périgueux, Imprimerie Magne.
 1975 *Etude de la Faune de l'Abri Pataud*. Harvard University Press, Cambridge.
- Boyle, K. V.
 1990 *Upper Palaeolithic Faunas from South-West France: A Zoogeographic Perspective*. British Archaeological Reports International Series 557, Oxford.

- 1996 From Laugerie Basse to Jolivet: The Organization of Final Magdalenian Settlement in the Vezere Valley. *World Archaeology* 27:477-491.
- Bradshaw, R. H. W.
1981 Modern pollen-representation factors for woods in south-east England. *Journal of Ecology* 69(1):45-70.
- Brantingham, P. J. Olsen, J. W., and G. B. Schaller
2001 Lithic Assemblages from the Chang Tang Region, Northern Tibet. *Antiquity* 75:319-327.
- Bratlund, Bodil
1990 Rentierjagd im spä'tglacial. Eine Untersuchung der Jagdfrakturen an Rentierknochen von Meiendorf und Stellmoor, Kreis Stormarn. *Offa* 47:7-34.

1991 A study of hunting lesions containing flint fragments on reindeer bones at Stellmoor, Schleswig-Holstein, Germany. In *Late Glacial in north-west Europe: human adaptation and environmental change at the end of the Pleistocene*, edited by N. Barton, A. J. Roberts and D. A. Roe, pp. 193-207. Council for British Archaeology Report.

1994a A Survey of the Subsistence and Settlement Pattern of the Hamburgian cultural in Schleswig-Holstein. *Jahrbuch des Römisch-Germanischen Zentralmuseum Mainz*.

1994b Archaeozoological comments on final Paleolithic frontiers in south Scandinavia. Paper presented at the conference Earliest Settlement of Scandinavia, Ystad.

1996 Hunting Strategies in the Late Glacial of Northern Europe: A Survey of the Faunal Evidence. *Journal of World Prehistory* 10(1):1-48.
- Brink, J. W.
2005 *Inukshuk: Caribou Drive Lanes on Southern Victoria Island, Nunvut, Canada*. *Arctic Anthropology* 42(1):1-28.

2008 *Imagining Head-Smashed-In: Aboriginal Buffalo Hunting on the Northern Plains*. AU Press, Edmonton, Alberta.

2013 The Barnett Site: A Stone Drive Lane Communal Pronghorn Trap on the Alberta Plains. *Quaternary International* 297:24-35.
- Brink, J. W. and M. Rollans
1990 On the Structure and Function of Drive Lane Systems at Communal Buffalo Jumps, *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 152-167. Unwin Hyman, London.
- Britton, K., V. Grimes, L. Niven, T. E. Steele, S. McPherron, M. Soressi, T. E. Kelly, J. Jaubert, J.-J. Hublin and M. P. Richards

- 2011 Strontium isotope evidence for migration in late Pleistocene Rangifer: implications for Neanderthal hunting strategies at the Middle Palaeolithic site of Jonzac, France. *Journal of Human Evolution* 61(2):176-185.
- Brochier, J. É., Barge, O., Karakhanyan, A., Kalatarian, I., Chataigner, C., Chambrade, M.-L., & Magnin, F.
2014 Kites on the Margins: the Aragats Kites in Armenia. *Paléorient* 40(1): 25–53.
- Brose, David S.
1994 Archaeological Investigations at the Paleo Crossing Site, a Paleoindian Occupation in Medina County, Ohio. In *The First Discovery of America*, edited by William S. Dancey, pp. 61-76. The Ohio Archaeological Council, Columbus.
- Broyles, B. J.
1971 *Second Preliminary Report: The St. Albans Site, Kanawha County, West Virginia*. Archaeological Investigation No. 3. West Virginia Geological and Economic Survey Report.
- Brunner, U.
2008 Les Pièges de chasse antiques au Yémen. *Chroniques Yéménites* 15:29-34.

1921 *Ethnology of the Kwakiutl, based on data collected by George Hunt*. Annual Report of the Bureau of American Ethnology, Washington, Government Printing Office.
- Bubenik, A. B.
1975 Taxonomic values of antlers in genus *Rangifer*. *Biological Papers University of Alaska*, Special Report 1:41-63.
- Buchanan, Briggs, and Marcus J Hamilton
2009 A Formal Test of the Origin of Variation in North American Early Paleoindian Projectile Points. *American Antiquity* 74(2):279.
- Bupp, S. L.
2008 *The Willow Springs Bison Pound: 48AB130*. M. A. Thesis, University of Wyoming, Laramie.
- Burch, Ernest S. Jr.
1972 The Caribou/Wild Reindeer as a Human Resource. *American Antiquity* 37(3): 339.

1986 The Caribou Inuit. In *Native Peoples: The Canadian Experience*, edited by R. B. Morrison, R. B. and C. Roderick, pp. 74-95. McLelland and Stewart, Toronto.
- Burch, E. S. and O. Blehr
1991 Herd Following Reconsidered. *Current Anthropology* 32(4):439-445.

- Burke, A.
1995 *Prey Movements and Settlement Patterns during the Upper Palaeolithic in Southwestern France*. British Archaeological Reports International Series 619, Oxford.
- Burke, A. a. A. Pike-Tay
1997 Reconstructing "l'Age du Renne." In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 69-81. Ashgate Publishing, Vermont.
- Burnett, P., Bollong, C., Kennedy, J., Millinton, C., Berg, C.M., Zietz, V., Fife, A., Reed, K., Seletstewa, M.
2008 *Archaeological Data Recovery for the Rockies Express/Entrega Pipeline Project at the Joe Miller Site (48AB18), Albany County, Wyoming*. SWCA Environmental Consultants, Broomfield, Colorado.
- Byerly, Ryan M., Judith R. Cooper, David J. Meltzer, Matthew E. Hill, and Jason M. LaBelle
2005 On Bonfire Shelter (Texas) as a Paleoindian Bison Jump: An Assessment Using GIS and Zooarchaeology. *American Antiquity* 70(4):595-629.
- Byers, Douglas A.
1954 Bull Brook – A Fluted Point Site in Ipswich, Massachusetts. *American Antiquity* 19:343-351.

1955 Additional Information on the Bull Brook Site, Massachusetts. *American Antiquity* 20:274-276.
- C**
- Calef, George
1981 *Caribou and the Barren-Lands*. Firefly Books Limited.
- Campbell, John Martin
2004 *In a Hungry Country. Essays by Simon Paneak*. University of Alaska Press, Fairbanks.
- Cannon, Mike D., and David J. Meltzer
2004 Early Paleoindian foraging: examining the faunal evidence for large mammal specialization and regional variability in prey choice. *Quaternary Science Reviews* 23:1955-1987.

2008 Explaining variability in Early Paleoindian foraging. *Quaternary International* 191(1):5.

- Carabias, D., Cartajena, I., Simonetti, R., Lopez, P., Morales, C., and C. Ortega
 2014 Submerged Paleolandscapes: Site GNL Quintero 1 (GNLQ1) and the First Evidences from the Pacific Coast of South America. In *Prehistoric Archaeology on the Continental Shelf*, edited by Amanda M. Evans, Joe C. Flatman, and Nicholas C. Flemming, pp. 131-150. Springer, New York.
- Carlson, K.
 2011 *Prehistoric Bison Procurement: Human Agency and Drive Lane Topography on the Northwestern Plains*. M.A. Thesis, Department of Anthropology, Northern Arizona University.
- Carlson, K. and L. Bement
 2013 Organization of Bison Hunting at the Pleistocene/Holocene transition on the Plains of North America. *Quaternary International* 297:93-99.
- Carr, D. H.
 2012 *Paleoindian Economic Organization in the Lower Great Lakes Region: Evaluating the Role of Caribou as a Critical Resource*, PhD Dissertation, Michigan State University.
- Chadefaux, C., C. Vignaud, M. Menu and I. N. A. Reiche
 2008 Multianalytical study of Palaeolithic reindeer antler: Discovery of antler traces in Lascaux pigments by TEM*. *Archaeometry* 50(3):516.
- Chahoud, Jwana, Villa, Emmanuelle, Balasescu, Adrian, and Remy Crassard
 2015 The Diversity of Late Pleistocene and Holocene Wild Ungulates and Kites Structures in Armenia. *Quaternary International* 395:133-153.
- Chang, Chun-Hsiang, Yousuke, K., Takai, M., Kono, R. T., Grün, R., Matsu'ura, S., Kinsley, L., and L.-K. Lin.
 2015 The First Archaic Homo from Taiwan. *Nature Communications* 6:6037.
- Chard, C. S.
 1963 The Nganasan: Wild Reindeer Hunters of the Taimyr Peninsula. *Arctic Anthropology* 1(2):105.
- Chatters, J. C., D. J. Kennett, Y. Asmerom, B. M. Kemp, V. Polyak, A. N. Blank, P. A. Beddows, E. Reinhardt, J. Arroyo-Cabrales, D. A. Bolnick, R. S. Malhi, B. J. Culleton, P. L. Erreguerena, D. Rissolo, S. Morell-Hart and J. T. W. Stafford
 2014 Late Pleistocene human skeleton and mtDNA link Paleoamericans and modern Native Americans. *Science* 344(6185):750-754.

- Chapman, Jefferson C.
1977 *Archaic Period Research in the Lower Little Tennessee River Valley*. Report of Investigations No. 18. University of Tennessee Department of Anthropology in conjunction with the Tennessee Valley Authority, Knoxville.
- Chinn, S., G. Wang, and J. Tardif
2004 Dendroclimatic Analysis of White Spruce at its Southern Limit of Distribution in the Spruce Woods Provincial Park, Manitoba, Canada. *Tree-Ring Research* 60:31-43.
- Clark, J.D.
1968 The Economic Impact of the change from Late-Glacial to Post-Glacial conditions in Northern Europe. In *Proceedings of the III International Congress of Anthropological and Ethnological Sciences*. Volume III. Tokyo, pp. 241.
- Cleland, Charles E.
1965 Barren Ground Caribou (*Rangifer arcticus*) from an Early Man Site in Southeastern Michigan. *American Antiquity* 30(3):350-351.

1966 *The Prehistoric Animal Ecology and Ethnozoology of the Upper Great Lakes Region*. Anthropological Papers, Museum of Anthropology, Ann Arbor: University of Michigan.

1968 Analysis of the fauna of the Indian Point site on Isle Royale in Lake Superior. *Southeastern Archaeological Conference Newsletter* 14(3-4):143-146.
- Christensen, Charlie
1995 The Littorina Transgressions in Denmark. In *Man & Sea in the Mesolithic: Coastal Settlement above and below Present Sea Level*, edited by Anders Fischer, pp. 15-22. Oxbow Monographs, Oxford.
- Clausen, C. J., Brooks, H. K., & Wesolowsky, A. B.
1975 The early man site at warm Mineral Springs, Florida. *Journal of Field Archaeology* 2(3):191-213.
- Clausen, C. J, A. D Cohen, Cesare Emiliani, J. A Holman, and J. J Stipp
1979 Little Salt Spring, Florida: A Unique Underwater Site. *Science* 203(4381): 609-614.
- Coard, R. and A. T. Chamberlain
1999 The nature and timing of faunal change in the British Isles across the Pleistocene/Holocene transition. *The Holocene* 9:372-376.
- Coggins, Clemency, and Orrin C. Shane
1984 *Cenote of Sacrifice: Maya Treasures from the Sacred Well at Chichén Itz*. University of Texas Press, Austin.

- Cohen, Vadim
 1997 Reindeer Distribution in the Late Paleolithic of the Ukraine: Results of Research. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 245-255. Ashgate Publishing, Vermont.
- Coles, B.J.
 1998 Doggerland: a speculative survey. *Proceedings of the Prehistoric Society* 64:45-81.
- Collins, Michael B.
 1979 *Excavations at Four Archaic Sites in the Lower Ohio Valley, Jefferson County, Kentucky*. Occasional Papers in Anthropology No. 1, University of Kentucky, Lexington.
 2002 The Gault Site, Texas and Clovis Research. *Athena Review* 3(2):24-36.
 2007 Discerning Clovis Subsistence from Stone Artifacts and Site Distributions on the Southern Plains Periphery. In *Foragers of the Terminal Pleistocene in North America*, edited by R.B. Walker and B.N. Driskill, pp. 59-87. University of Nebraska Press, Lincoln.
- Collins, Michael B., D. J. Stanford, D. Lowery, and B. Bradley
 2014 North America before Clovis: Variance in temporal/spatial cultural patterns, 27,000-13,000 cal yr BP. In *Paleoamerican Odyssey*, edited by Graf, K. E., Ketron, C. V., and M. R. Waters, pp. 521-539. Center for the Study of the First Americans, College Station.
- Comer, G.
 1910 A geographical distribution of Southhampton Island and notes upon the Eskimos. *American Geographical Society of New York Bulletin* 42:84-90.
- Conkey, Margaret
 1991 Context of Action, Context of Power: Material Culture and Gender in the Magdalenian. In *Engendering Archaeology: Women and Prehistory*, edited by J. Gero and M. Conkey, pp. 57-92. Blackwell publishing, Oxford.
- Connaway, J.
 2007 *Fishweirs*. Archaeological Report No. 33. Mississippi Department of Archives and History, Jackson, Mississippi.
- Costamagno, Sandrine
 2003 Exploitation de la grande faune au Magdalénien dans le sud de la France. In *Mode de Vie au Magdalénien: Les Apports de l'Archéozoologie*, edited by S. Costamagno and V. Laroulandie, pp. 73-88. BAR International Series 1144, Oxford.
 2004 Si les magdaléniens du sud de la France n'étaient pas des chasseurs spécialisés, qu'étaient-ils? In: *Approches Fonctionnelles en Préhistoire. Société Préhistorique française*, edited by P. Bodu and C. Constantin, pp.361-369. Paris.

- Costamagno, S., Liliane, M. Cedric, B., Bernard, V., and M. Bruno
 2006 Les Pradelles (Marillace-le-Franc, France): A Mousterian reindeer hunting camp? *Journal of Anthropological Archaeology* 25:466-484.
- Cranz, David
 1995 Historie von Gronland Teil I und II. In Nikolaus Ludwig von Zinzendorf, *Materialien und Dokumente* 26. 1. Erich Beyreuther, ed. Hildesheim: Georg Olms.
- Crassard, Remy, Barge, Olivier, Bichot, Charles-Edmond, Brochier, Jacque Elie, Chahoud, Jwana, Chambrade, Marie-Laure, Chataigner, Christine, Madi, Kamel, Regagnon, Emmanuelle, Seba, Hamida, and Emmanuelle Vila
 2014 Addressing the Desert Kites Phenomenon and Its Global Range through a Multi-proxy Approach. *Journal of Archaeological Method and Theory* 22(4):1093-1121.
- Croitor, Roman
 2010 Preliminary Data on Reindeer Fossils from the Paleolithic site Rascov-8 (Eastern Moldova) with remarks on systematics and evolution of Upper Pleistocene reindeer. Muzeul Olteniei Craiova. *Oltenia. Studii și comunicări. Științele Naturii* 26(1):323-330.
- Cronin, M. A., M. D. MacNeil and J. C. Patton
 2005 Variation in Mitochondrial DNA and Microsatellite DNA in Caribou (*Rangifer tarandus*) in North America. *Journal of Mammalogy* 86(3): 495-505.
- Curran, Mary Lou
 1984 The Whipple Site and Paleoindian Tool Assemblage Variation: A Comparison of Intrasite Structuring. *Archaeology of Eastern North America* 12:5-40.
- 1987 *The Spatial Organization of Paleoindian Populations in the Late Pleistocene of the Northeast*. Ph.D. dissertation, Department of Anthropology, University of Massachusetts, Amherst.
- 1999 Exploration, Colonization, and Settling In: The Bull Brook Phase, Antecedents, and Descendants. In *The Archaeological Northeast*, edited by Mary Ann Levine, Kenneth E. Sassaman, and Michael S. Nassaney (Eds.), pp. 3-24. Bergin and Garvey, Westport, Connecticut.
- Curry, B. B., and C. H. Yansa
 2004 Evidence for Stagnation of the Harvard Sublobe (Lake Michigan Lobe) in Northeastern Illinois, U.S.A., From 24,000 to 17,600 and Subsequent Tundra-like Ice-marginal Paleoenvironments from 17,600 to 15,700. *Geographie physique et Quaternaire* 58:205-321.
- Custred, Glynn
 1979 Hunting Technologies in Andean Culture, *Journal de la Société des Américanistes* 66:7-19.

Cuyler, Christine

2007 West Greenland Caribou Explosion: What Happened? What about the Future? *Rangifer* 27(Special Issue 17):219–226.

D

Dalton, Kevin

2011 A Geospatial Analysis of Prehistoric Hunting Blinds and Forager Group Size at Cowhead Slough, Modoc County, California. M. A. Thesis, California State University, Chico.

Dahl, Jens

2000 *Saqqaq—An Inuit Hunting Community in the Modern World*. University of Toronto, Toronto.

Dall, W. H.

1870 *Alaska and its Resources*. Lee and Shepard, Boston.

David, F., and J. G. Enloe

1992 Chasse saisonnière des magdaleniens de Bassin Parisien. *Bulletins et Mémoires Société d'Anthropologie de Paris* 4:167-174.

Davis, L.B., and B. O. K. Reeves

1990 *Hunters of the Recent Past*. Unwin Hyman, London.

Davis, Loren G., S. A. Jenevein, M. L. Punke, J. S. Noller, J. A. Jones, and S. C. Willis

2009 Geoarchaeological Themes in a Dynamic Coastal Environment, Lincoln and Lane Counties, Oregon. In *Volcanoes to Vineyards: Geologic Field Trips through the Dynamic Landscape of the Pacific Northwest*, edited by J. E. O'Connor, R. J. Dorsey, and I. P. Madin, pp. 331–48. Geological Society of America Field Guide 15.

Davis, Ronald B. and George L. Jacobson, Jr.

1985 Late Glacial and Early Holocene Landscapes in Northern New England and Adjacent Areas of Canada. *Quaternary Research* 23:341-368.

Davis, Stephen A.

1991 Two Concentrations of Palaeo-Indian Occupation in the Far Northeast. *Revista de Arqueologia Americana* 3:31-56.

Dawson, K. C. A.

1983 Cummins Site: A Late Paleo-Indian (Plano) site at Thunder Bay, Ontario. *Ontario Archaeology* 39:3-31.

- Dean, W.E., Ahlbrandt, T.S., Anderson, R.Y., Bradbury, J.P.,
1996 Regional aridity in North America during the middle Holocene. *The Holocene* 6:145–155.
- Delcourt, P. A., H. R. Delcourt, and T. Webb III
1984 *Atlas of Mapped Distributions of Dominance and Modern Pollen Percentages for Important Tree Taxa of Eastern North America*. AASP Contributions Series, No. 14. American Association of Stratigraphic Palynologists Foundation, Dallas, Texas.
- Deller, D. Brian
1976 Paleo-Indian locations on late Pleistocene shorelines, Middlesex County, Ontario. *Ontario Archaeology* 26:3-20.
- 1979 Paleo-Indian reconnaissance in the counties of Lambton and Middlesex, Ontario. *Ontario Archaeology* 32:3-20.
- 1980 *The Parkhill (Brophey) Site, AhHk-49: Analyses of burtace Materials*. M.A. Thesis. Department of Anthropology, Wilfrid Laurier University.
- 1988 *The Paleo-Indian Occupation of Southwestern Ontario: Distribution, Technology and Social Organization*. PhD Dissertation, Dept. of Anthropology, McGill University, Montreal, Quebec.
- Deller, D. Brian, and Christopher J. Ellis
1984 Crowfield: a preliminary report on a probable Paleo-Indian cremation in southwestern Ontario. *Archaeology of Eastern North America* 12:41-71.
- 1988 Early Paleo-Indian complexes in southwestern Ontario. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. Laub, N. G. Miller, and D. W. Steadman, pp. 251-263. Bulletin of the Buffalo Society of Natural Sciences 33.
- 1992 *Thedford II: a Paleo-Indian Site in the Ausable River Watershed of Southwestern Ontario*. Memoirs of the Museum of Anthropology. University of Michigan No. 24, Ann Arbor.
- 1996 The Bolton Site (AfHj-89): A Crowfield Phase Early Paleo-Indian Site in Southwestern Ontario. *Ontario Archaeology* 61:5–44.
- 2011 *The Crowfield Site (AfHj-31): A Unique Paleoindian Fluted Point Site in Southwestern Ontario*. Museum of Anthropology Memoirs No. 49, University of Michigan, Ann Arbor.
- Deller, D. Brian, Christopher J Ellis, and I. T. Knyon
1985 *Archaeology of the Southeastern Huron Basin*. Paper presented in symposium: Archaeology of the Lake Huron Basin Area, organized by William Fox (Ontario Ministry

- of Citizenship and Culture). 12th Annual Meeting, Ontario Archaeological Society, London, Ontario.
- Deller, D. Brian, Christopher J. Ellis, and James R. Keron
2009 Understanding Cache Variability: A Deliberately Burned Early Paleoindian Tool Assemblage from the Crowfield Site, Southwestern Ontario, Canada. *American Antiquity* 74(2): 371.
- Delpech, F.
1983 *Les faunes du Paléolithique Supérieur dans le sud-ouest de la France*. Sciences Naturelles, Université de Bordeaux, Bordeaux.
- Dibble, David S. and Dessamae Lorrain
1968 *Bonfire Shelter: A Stratified Bison Kill Site, Val Verde County, Texas*. Texas Memorial Museum, Miscellaneous Papers No.1. The University of Texas, Austin.
- Dibble, Harold L.
1984 Interpreting Typological Variation of Middle Paleolithic Scrapers: Function, Style, or Sequence of Reduction. *Journal of Field Archaeology* 11:431-436.

1987 The Interpretation of Middle Paleolithic Scraper Morphology. *American Antiquity* 52: 109-1-17.

1988 The Interpretation of Middle Paleolithic Scraper Reduction Patterns. In *La technique*, edited by L. R. Binford and J.-P. Rigaud, pp. 49-58. *L'Homme de Néandertal*, vol. 4, M. Otte, general editor. Etudes et Recherches Archéologiques de l'Université de Liège No. 31, Liège.
- Dionne, Jean-Claude
1979 Ice Action in the Lacustrine Environment. A Review with Particular Reference to Subarctic Quebec, Canada. *Earth-Science Reviews* 15(3):185-212.
- Dixon, James E.
1979 A Predictive Model for the Distribution of Archaeological Sites on the Bering Continental Shel. Ph.D. Dissertation, Department of Anthropology, Brown University.
- Dobosi, V. T.
1999 Upper Paleolithic Excavations in Hungary between 1986-1990. In *Precirculated Papers of the UISPP*, Bratislava:79-86.
- Driver, Jonathan C.
1990 Meat in due Season: the timing of communal hunts. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 11-33. Unwin Hyman, London.

- Drucker, D. and H. Bocherens
 2004 Carbon and nitrogen stable isotopes as tracers of change in diet breadth during Middle and Upper Palaeolithic in Europe. *International Journal of Osteoarchaeology* 14:162-177.
- Drzyzga, S.A.
 2007 Relict shoreline features at Cockburn Island, Ontario. *Journal of Paleolimnology* 37:411-417.
- Dunbar, J. S.
 1991 Resource orientation of Clovis and Suwannee Age paleoindian sites in Florida. In *Clovis: Origins and adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 185–214. Center for the Study of the First Americans, College Station.
- Dwyer, Thomas R., Mullins, Henry T., and Steven C. Good
 1996 Paleoclimatic Implications of Holocene lake-level fluctuations, Owasco Lake, New York. *Geology* 24(6):519-522.
- E**
- Easton, N. A., & Moore, C.
 1991 Test excavations of subtidal deposits at Montague Harbour, British Columbia. *International Journal of Nautical Archaeology* 20:269–280.
- Échallier, J.-C., and F. Braemer, F.
 1995 Nature et Fonction des “Desert Kites”: Données et hypothèses nouvelles. *Paléorient* 21(1):35–63.
- Edwards, R. L., & Merrill, L.
 1977 Reconstruction of the continental shelf areas of eastern North America for the times 9,500 B.P. and 12,500 B.P. *Archaeology of Eastern North America* 5:1.
- Egede, Hans
 1745 *A Description of Greenland. Shewing the Natural History, Situation, Boundaries, and Face of the Country; ... With a New Map of Greenland. And Several Copper Plates.* Translated from the Danish. Det Gamle Grønlands Nye perustration. English. London: printed for C. Hitch; S. Austen; and J. Jackson.
- 1925 *Grønland* 54. København: C.A. Reitzel.
- Egan, Howard R. and Wm. M. Egan
 1917 *Pioneering the West, 1846 to 1878: Major Howard Egan's diary: also thrilling experiences of pre-frontier life among Indians, their traits, civil and savage, and part of autobiography, inter-related to his father's*, Skelton Publishing Company, Salt Lake City, Utah.

Egloff, Michel

1988 Recent archaeological discoveries in Lake Neuchatel, Switzerland. From the Paleolithic to the Middle Ages. In *Wet Site Archaeology*, edited by Barbara Purdy, pp.31-42. Telford Press. Cladwell.

Eisenberg-Degen, D.

2010 A hunting scene from the Negev: the depiction of a desert kite and throwing weapon. *Israel Exploration Journal* 60:146–165.

Ellis, Christopher J.

1984 *Paleo-indian lithic technological structure and organization in the lower Great Lakes area: A first approximation*. Ph.D. Dissertation, Simon Fraser University; Burnaby, B. C., Canada.

1989 The explanation of northeastern Paleoindian lithic procurement patterns. In *Eastern Paleoindian Lithic Resource Use*, edited by C. Ellis and J. Lothrop, pp. 139–64. Westview Press, Boulder, Colorado.

1999 Some Sites and Artifacts I have Known: The Welke-Tonkonoh Site Revisited, or What is a Meadowood Point? *Kewa* 99(3-4): 9-26.

2004 Understanding "Clovis" fluted point variability in the Northeast: a perspective from the Debert site, Nova Scotia. *Canadian Journal of Archaeology* 28:205-253.

2009 The Crowfield and Caradoc Sites, Ontario: Glimpses of Palaeo-Indian Sacred Ritual and World View. In *Painting the Past with a Broad Brush: Papers in Honour of James Valliere Wright*, edited by David L. Keenlyside and Jean-Luc Pilon, pp. 319-352. Mercury Series.

2011 Measuring Paleoindian range mobility and land-use in the Great Lakes/Northeast. *Journal of Anthropological Archaeology* 30(3): 385.

Ellis, Christopher J., and D. Brian Deller

1982 Hi-Lo materials from southwestern Ontario. *Ontario Archaeology* 38:3–22.

1986 Post-glacial Lake Nipissing waterworn assemblages from the southeastern Huron basin area. *Ontario Archaeology* 45:39–60.

1990 Paleoindians. In: *The Archaeology of Southern Ontario to A. D. 1650*, edited by C. J. Ellis and N. Ferris, pp.37-63. Occasional Publications, London, Ontario, pp. 37-63. London Chapter OAS No. 5.

1997 Variability in the archaeological record of northeastern early Paleo-Indians: a view from southern Ontario. *Archaeology of Eastern North America* 25:1-30.

- 2000 An Early Paleo-Indian Site Near Parkhill, Ontario. *Mercury Series Archaeology Paper 159, Canadian Museum of Civilization, Hull.*
- Ellis, Christopher J., Carr, Dillion, H., and Thomas J. Loebel
2011 The Younger Dryas and Late Pleistocene peoples of the Great Lakes region. *Quaternary International* 242:534-545.
- Ellis, Christopher J., Albert C. Goodyear, Dan F. Morse, and Kenneth B. Tankersley
1998 Archaeology of the Pleistocene-Holocene transition in eastern North America. *Quaternary International* 49/50:151-66.
- Ellis, Christopher J., Peter A. Timmins, and Holly Martelle
2009 At the crossroads and periphery: The Archaic archaeological record of southern Ontario. In *Archaic Societies: Diversity and Complexity across the Midcontinent*, edited by Thomas E. Emerson, Dale L. McElrath, and Andrew C. Fortier, pp. 787-837. Suny Press, Albany, New York.
- Elton, C.
1942 *Voles, Mice, and Lemmings: Problems in population dynamics*. Clarendon Press, Oxford.
- Enloe, James G.
1993 Subsistence organization in the Early Upper Paleolithic: reindeer hunters of the Abri Du Flageolet, Couche V. *Before Lascaux: the Complex Record of the Early Upper Paleolithic*, edited by H. Knecht, A. Pike-Tay, R. White, and R. Boca Raton, pp. 101-116. CRC Press.

2003 Acquisition and processing of reindeer in the Paris Basin. In *Zooarchaeological Insights into Magdalenian Lifeways*, edited by S. Costamagno and V. Laroulandie, pp. 23-31. British Archaeological Reports International Series no. 1144.
- Enloe, J.G., and F. David
1997 *Rangifer* herd behavior: seasonality of hunting in the Magdalenian of the Paris Basin. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 52-68. Ashgate Publishing, Vermont.
- Eren, Metin I.
2009 Paleoindian stability during the Younger Dryas in the North American lower great lakes. In *Transitions in Prehistory: Papers in Honor of Ofer Bar-Yosef*, edited by J. Shea and D. Lieberman, pp. 389-422. American School of Prehistoric Research Press, Cambridge.
- Erlandson, Jon M.
2001 The Archaeology of Aquatic Adaptations: Paradigms for a New Millennium. *Journal of Archaeological Research* 9(4): 287-350.

- Erlandson, J. M., Braje, T. J., Rick, T. C., & Peterson, J. E.
2005 Beads, bifaces, and boats: An Early Holocene adaptation on the south coast of San Miguel Island, California. *American Anthropologist* 107(4):677–683.
- Erlandson, Jon M., Rick, Torben C., Braje, Todd C., Casperson, Molly, Culleton, Brendan, Fulfrost, Brian, Garcia, Tracy, Guthrie, Daniel A., Jew, Nicholas, Kennett, Douglas J., Moss, Madonna Lk, Reeder, Leslie, Skinner, Craig, Watts, Jack, and Lauren Willis
2011 Paleoindian Seafaring, Maritime Technologies, and Coastal Foraging on California's Channel Islands. *Science* 331:1181-1184.
- Eschelman, R., and F. Grady
1986 Quaternary Vertebrate Localities of Virginia and Their Avian and Mammalian Fauna. In *The Quaternary of Virginia: A Symposium Volume*, edited by J. N. McDonald and S. O. Bird, pp. 43-70. Publication No. 75. Virginia Division of Mineral Resources, Charlottesville.
- Eschman, D. F., and Paul F. Karrow
1985 Huron basin glacial lakes: A review. In *Quaternary Evolution of the Great Lakes*, edited by Paul F. Karrow and Parker E. Calkin, pp. 79–93. Geological Association of Canada, Special Paper 30.
- Evans, Amanda, Joe Flatman, and Nic Flemming.
2014 *Prehistoric Archaeology on the Continental Shelf*. Springer, Verlag.
- Evans, A., R. Floyd and M. Keith
2007 *Identifying offshore prehistoric sites from remote sensing data: preliminary site investigation in the Gulf of Mexico*. Paper presented to the 72nd annual meeting for the Society for American Archaeology, Austin.

F

- Fancy, S. G., Whitten, K. R., Pank, L. F., and W. L. Regelin
1989 Seasonal Movements of caribou in arctic Alaska as determined by satellite. *Canadian Journal of Zoology* 67:644-650.
- Fainberg, A.
1991 Ohotniki Amerikanskogo severa. *Nauka*:112-116.
- Fairbanks, Richard G.
1989 A 17,000-Year Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation. *Nature* 342(6250):637-642.

Faught, Michael

1988 Inundated sites in the Apalachee Bay area of the eastern Gulf of Mexico. *Florida Anthropologist* 41(1):185–190.

2002 Submerged Paleoindian and Archaic sites of the big bend, Florida. *Journal of Field Archaeology* 29: 273–290.

2004 The Underwater Archaeology of Paleolandscapes, Apalachee Bay, Florida. *American Antiquity* 69(2):275.

2015 *The Geoarchaeology of Submerged, Intertidal, and Wetland Places: Advances in Method and Theory of Prehistoric Archaeology Underwater*. Symposium at the 80th Annual Meeting of the Society for American Archaeology, San Francisco.

Fedje, D.W. and T. Christensen

1999 Modeling paleoshorelines and locating Early Holocene coastal sites in Haida Gwaii. *American Antiquity* 64:635–652.

Fedje, D. W., and H. Johsenhans

1999 *A prehistoric stone tool recovered from a deeply drowned fluvial fan in Hecate Strait, British Columbia, Canada*. Manuscript on file, Parks Canada, Victoria.

2000 Drowned forests and archaeology on the continental shelf of British Columbia, Canada. *Geology* 28(2):99–102.

Fedje, D.W., R.J. Wigen, D. McClaren and Q. Mackie

2004 *Pre-Holocene archaeology and environment from karst cases in Haida Gwaii, west coast, Canada*. Paper presented to the 57th Annual Northwest Anthropological Conference, Eugene.

Firestone, R. B., A. West, J. P. Kennett, L. Becker, T. E. Bunch, Z. S. Revay, P. H. Schultz, T. Belgya, D. J. Kennett, J. M. Erlandson, O. J. Dickenson, A. C. Goodyear, R. S. Harris, G. A. Howard, J. B. Kloosterman, P. Lechler, P. A. Mayewski, J. Montgomery, R. Poreda, T. Darrah, S. S. Que Hee, A. R. Smith, A. Stich, W. Topping, J. H. Wittke and W. S. Wolbach

2007 Evidence for an Extraterrestrial Impact 12,900 Years Ago That Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling. *Proceedings of the National Academy of Sciences of the United States of America* 104(41):16016-16021.

Fischer, Anders

1993a. *Stenalderbopladsen På Bunden Af Øresund: Afprøvning Af En Model*. Copenhagen:Skov-og naturstyrelsen.

1993b. *Stenalderbopladsen På Bunden Af Smålandsfarvandet : En Teori Afprøvet Ved Dykkerbesigtigelse*. Hørsholm: Miljøministeriet, Skov-og Naturstyrelsen.

- 1995a. An Entrance to the Mesolithic World below the Ocean. Status of Ten Years' Work on the Danish Sea Floor. In *Man and Sea in the Mesolithic: Coastal Settlement above and below Present Sea Level*, 371–84. Oxford: Oxbow Books.
- 1995b. *Man and Sea in the Mesolithic: Coastal Settlement above and below Present Sea Level*. Oxbow Monographs, Oxford
- 1997 People and the Sea—settlement and Fishing along the Mesolithic Coasts. In *The Danish Storebaelt since the Ice Age—man, Sea and Forest*, edited by Lisbeth Pedersen, Anders Fischer, and B. Aaby, pp. 63–77. Storebaelt Publications, Copenhagen.
- 2011 Stone Age on the Continental Shelf: An Eroding Resource. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 298-310. Oxbow Books.
- Fish, J. and H. Carr
1990 *Sound underwater images: a guide to the generation and interpretation of side scan sonar data*. Lower Cape Publishing, Orleans, MA.
- Fisher, Daniel C.
1984 Taphonomic Analysis of Late Pleistocene Mastodon Occurrences: Evidence of Butchery by North American Paleo-Indians. *Paleobiology* 10(3):338-357.
- 1987 Mastodont procurement by Paleoindians of the Great Lakes Region: Hunting or scavenging? In *The evolution of human hunting* M. H. Nitecki and D. V. Nitecki, pp. 309-421. Plenum, New York.
- 2010 Paleobiology and Extinction of Proboscideans in the Great Lakes Region of North America. In *American Megafaunal Extinctions at the End of the Pleistocene*, edited by G. Haynes, pp. 55-75. Springer.
- Fisher, D. C., B. T. Lepper, and P. E. Hooge
1994 Evidence for Butchering of the Burning Tree Mastodon. In *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, edited by W. S. Dancey, pp. 43-57. The Ohio Archaeological Council, Columbus.
- Fitting, James E., Jerry DeVisscher, and Edward J. Wahla
1966 *The Paleo-Indian Occupation of the Holcombe Beach*. Anthropological Papers, No. 27. Museum of Anthropology, University of Michigan, Ann Arbor.
- Fitzhugh, William W.
1981 A Prehistoric Caribou Fence from Williams Harbour, Northern Labrador. In *Megaliths to Medicine Wheels: Boulder Structures in Archaeology*, edited by Michael Wilson, Kathie L. Road, and Kenneth J. Hardy, pp. 187-206. Proceedings of the Eleventh Annual Chacmool Conference. Archaeological Association, Calgary: University of Calgary.

Fitzhugh, Ben

2003 *The Evolution of Complex Hunter-Gatherers: Archaeological Evidence from the North Pacific*, Interdisciplinary Contributions to Archaeology, Springer.

Flagstad, Ø. and K. H. Røed

2003 Refugial Origins of Reindeer (*Rangifer tarandus L.*) Inferred from Mitochondrial DNA Sequences. *Evolution* 57(3):658-670.

Flanagan, J. G.

1989 Hierarchy in simple “egalitarian” societies. *Annual Review of Anthropology* 18:245–66.

Flemming, Nicholas C.

2011 Research Infrastructure for Systematic Study of the Prehistoric Archaeology of the European Submerged Continental Shelf. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 272-286. Oxbow Books.

n.d. *Submarine Prehistoric Archaeology of the North Sea: Research Priorities and Collaboration with Industry*. CBA Research Report 141. York: Council for British Archaeology.

Flerov, C. C.

1952 Musk Deer and Deer in *Fauna of USSR Vol. 2 Mammals* (in Russian), Moscow: Academy of Sciences USSR.

Fontana, L.

1998 *Mobilité et Subsistance au Magdalénien dans le Languedoc Occidental et le Roussillon*. Thèse de Doctorat, Université de Paris I, Paris.

Franklin, J.

1823 *Narrative of a journey to the shores of the Polar Sea, in the years 1819, 20, 21, and 22*, vol. 2. J. Murray, London.

Freisen, T. Max

2002 Analogues at Iqaluktuuq: The social context of archaeological inferences in Nunavut, Arctic Canada. *World Archaeology* 34(2):330–45.

2004 A Tale of Two Settlement Patterns: Environmental and Cultural Determinants of Inuit and Dene Site Distributions. In *Hunters and Gatherers in Theory and Archaeology*. Edited by George M. Crothers, pp. 299-315. Center for Archaeological Investigations, Occasional Paper No. 31, Southern Illinois University.

2007 Hearth Rows, Hierarchies, and Arctic Hunter-Gatherers: The constriction of equality in the Late Dorset Period. *World Archaeology* 39(2):194-214.

- 2013 The impact of weapon technology on caribou drive system variability in the Prehistoric Canadian Arctic. *Quaternary International* 297:13-23.
- French, Hugh M.
1996 *The Periglacial Environment*. Harlow: Wiley.
- Freuchen, P.
1912 *Om Rene rog Moskusokser I Kap York Distriktet*. GT. Bd. XXI.
- Frison, George C.
1968 Site 48SH312: an Early Middle Period bison kill in the Powder River Basin of Wyoming. *Plains Anthropologist* 13(39):31-39.

1970 The Glenroock Buffalo Jump, 48CO304: Late Prehistoric period buffalo procurement and butchering on the Northwestern Plains. *Plains Anthropologist* 15(50) Part 2.

1971 The buffalo pound in North-Western Plains prehistory: site 48CA302, Wyoming. *American Antiquity* 36(1):77-91.

1975 *Prehistoric Hunters on the High Plains*. Academic Press, New York.

2004 *Survival by Hunting: Prehistoric Human Predation and Animal Prey*. University of California Press, Berkeley.
- Frison, G. C., Wilson, M., and D. J., Wilson, D. J.
1976 Fossil bison and artifacts from an Early Altithermal period arroyo trap in Wyoming. *American Antiquity* 41(1):28-57.
- Frison, George C., Reher, Charles A., and Danny N. Walker
1990 Prehistoric Mountain Sheep Hunting in the Central Rocky Mountains of North America. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 208-240. Unwin Hyman, London.
- Fogarty, James, Reynolds, Robert G, Salaymeh, Areej, and Thomas Palazzolo
2015 Serious Game Modeling of Caribou Behavior across Lake Huron using Cultural Algorithms and Influence Maps. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp.31-52. University of Michigan Museum of Anthropology Memoirs, No. 57.
- Fox, Joseph L. and Tsechoe Dorji
2009 Traditional Hunting of Tibetan Antelope: Its Relation to Antelope Migration, and its Rapid Transformation in the Western Chang Tang Nature Reserve. *Arctic, Antarctic, and Alpine Research* 41(2):204-211.

Fox, William A.

1975 *The Paleo-Indian Lakehead Complex*. Papers Contributed to the Canadian Archaeological Association Annual Meetings, March 1975. Ontario Ministry of Culture and Recreation, Historical Planning and Research Branch, p. 28-49.

1980 *The Lakehead Complex; New insights*, in Skeene Melvin, D. (Ed.) Archeological Research Report 13. Ontario Ministry of Culture and Recreation, pp. 127-154.

Fox, William A., D. Brian Deller, and Christopher J. Ellis

2015 Chert Sources and Utilization in the Southern Huron Basin during the Early Holocene. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 67-72. University of Michigan Museum of Anthropology Memoirs, No. 57.

Funk, R. E.

1972 Early Man in the Northeast and the Late-Glacial Environment. *Man in the Northeast* 4:7-39.

Funk, R. E., Fisher, D.W., and E.M. Reilly, Jr.

1970 Caribou and Paleo-Indian in New York State: A presumed association. *American Journal of Science* 268:181-186.

Funk, R. E., G. R. Walters, and W. F. Ehlers, Jr.

1969 The Archaeology of Dutchess Quarry Cave, Orange County, New York. *Pennsylvania Archaeologist* 39:7-22.

G

Galili, Ehud, and S. Arenson

2015 Management of the underwater and coastal archaeological heritage in Israel's seas (II): The endangered coastal settlements. *RIPARIA* 1:5-96.

Galili, Ehud, and Baruch Rosen

2011 Submerged Neolithic Settlements off the Carmel Coast, Israel: Cultural and Environmental Insights. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 272-286. Oxbow Books.

Garland, E. B., and J. W. Cogswell

1985 The Powers mastodon site. *Michigan Archaeologist* 31:3-39.

Garrison, E. G.

2000 A Geoarchaeological Study of Prisoner's Harbor, Santa Cruz Island, Northern Channel Islands, California - Past Sea Levels and Delatic Deposits of an Insular Stream." In *Proceedings of the 5th California Islands Symposium*, edited by C. J. Dolan, B. R. Tershy, B. S. Keitt, and B. Wood, pp. 531-40. Santa Barbara: Santa Barbara Museum of Natural History.

- Gaspari, Andrej, Miran Eric, and Bostjan Odar
 2011 A Palaeolithic Wooden Point from Ljubljansko Barje, Solvenia. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 286-292. Oxbow Books.
- Gaudreau, D. C.
 1988 The Distribution of Late Quaternary Forest Regions in the Northeast. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 215-256. Bulletin No. 33. Buffalo Society of Natural Sciences, Buffalo, New York.
- Gaudzinski, S.
 1996 On bovid assemblages and their consequences for the knowledge of subsistence patterns in the Middle Palaeolithic. *Proceedings of the Prehistoric Society* 62:19–39.
- Gaudzinski, S. and W. Roebroeks
 2000 Adults only. Reindeer hunting at the middle palaeolithic site Salzgitter Lebenstedt, northern Germany. *Journal of Human Evolution* 38(4):497.
- Gambaryan, R.
 1974 *How Animals Run*. New York, John Wiley & Sons.
- Gardeisen A.
 1999 Middle Palaeolithic subsistence in the West Cave of ‘Le Portel’ (Pyrénées, France). *Journal of Archaeological Science* 26:1145–1158.
- Garvey, Raven, and Robert L. Bettinger
 2014 Adaptive and Ecological Approaches to the Study of Hunter-Gatherers, in *The Oxford Handbook of Archaeology and Anthropology of Hunter-Gatherers*, edited by Vicki Cummings, Peter Jordan, and Marek Zvelebil (Eds.), pp.69-91, Oxford University Press.
- Gasparyan, B., Khechoyan, A., Bar-Oz, G., Malkinson, D., Nachmias, A., D. Nadel
 2013 The Northernmost Kites in South-West Asia: the Fringes of the Ararat Depression (Armenia) Project. *Antiquity* 87:336.
- Geist, Valerius
 1978 *Life Strategies, Human Evolution, and Environmental Design*. Springer, New York.
- 1998 Reindeer and Caribou. In *Deer of the world: their evolution, behaviour, and ecology*, pp. 315-336. Stackpole Books, Mechanicsburg, Pennsylvania.
- Giesecke, Karl Ludwig
 1910 *Bericht einer mineralogischen Reise in Grönland 1806–1813*. Meddelelser om Grønland 35. København: C.A. Reitzel.

Gillespie, Beryl C.

1975 An Ethnohistory of the Yellowknives: A Northern Athapaskan Tribe. In *Contributions to Canadian Ethnology*, edited by D. B. Carlyle, pp. 191-245. National Museum of Man Mercury Series, Canadian Ethnology Service Paper 31. Ottawa.

1976 Changes in Territory and Technology of the Chipewyan. *Arctic Anthropology* 13: 6–11.

1981 *Mountain Indians*. In *Handbook of North American Indians Vol 6. Subarctic*, Helm, June (Ed.), pp. 236-337. Smithsonian Institution, Washington D. C.

Glimmervenn, Jan, Mol, Dick, and Hans van der Plicht

2006 The Pleistocene reindeer of the North Sea – initial palaeontological data and archaeological remarks. *Quaternary International* 142-142:242-246.

Gómez-Olivencia, A., Arceredillo, D., Álvarez-Lao, D. J., Garate, D., San Pedro, Z., Castaños, P., and J. Rios-Garaizar

2013 New Evidence for the presence of reindeer (*Rangifer tarandus*) on the Iberian Peninsula in the Pleistocene: an archaeological and chronological reassessment. *Boreas* 43(2):286-308.

Gómez Otero, J.

2007 Dieta, Uso Del Espacio Y Evolución En Poblaciones Cazadoras-Recolectoras de La Costa Centro-septentrional de Patagonia Durante El Holoceno Medio Y Tardío. Ph.D. Dissertation, Facultad de Filosofía y Letras, Universidad Buenos Aires.

Goodyear, A. C., & Warren, L. O.

1972 Further observations on the submarine oyster shell deposits of Tampa Bay. *Florida Anthropologist* 25(2.1):52–66.

Gordon, Bryan C.

1974 Thule culture investigations at Baker Lake, N.W.T. *Canadian Archaeological Association Bulletin* 6:218-224.

1975 *Of Men and Herds in Barrenland Prehistory*. National Museum of Man, Mercury Series, Archaeological Survey of Canada.

1988 *Of men and reindeer herds in French Magdalenian prehistory*. British Archaeological Reports. Oxford, England.

1990 World *Rangifer* Communal Hunting. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 277-303. Unwin Hyman, London.

2003 *Rangifer* and man: An ancient relationship. *Rangifer* (Special Issue No. 14): 15-28.

- Goss, R. J.
1980 *Is antler asymmetry in reindeer and caribou genetically determined?* 2nd International Reindeer/Caribou Symposium Roros, Norway, Direktoratet for vilt og ferskvannfisk.
- Gould, Richard A.
2000 *Archaeology and the Social History of Ships*. Social History of Ships. Cambridge, U.K. ; New York, NY: Cambridge University Press.
- Gramly, Richard M.
1982 *The Vail Site: A Palaeo-Indian Encampment in Maine*. Bulletin No. 30. Buffalo Society of Natural Sciences, Buffalo, New York.

1988 Paleo-Indian Sites South of Lake Ontario, Western and Central New York State. In *Late Pleistocene and Early Holocene Paleocology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 265-280. Bulletin No. 33. Buffalo Society of Natural Sciences, Buffalo, New York.

2010 The Vail Habitation and Kill Site: Implications for Palaeo-American Behavior and Band Size. *Ohio Archaeologist* 60(3):4-17.
- Gravenor, C. P., and M. Stupavsky
1976 Magnetic, Physical, and Lithological Properties and Age of Till Exposed Along the East Coast of Lake Huron, Ontario. *Canadian Journal of Earth Sciences* 13:1655-1666.
- Grayson, Donald
1989 Bone Transport, Bone Destruction, and Reverse Utility Curves. *Journal of Archaeological Science* 16:643-652.
- Grayson, Donald K. and Françoise Delpech
1998 Specialized Early Upper Paleolithic Hunters in Southwestern France? *Journal of Archaeological Science* 29:1439-1449.
- Grayson, Donald K. and David J. Meltzer
2002 Clovis Hunting and Large Mammal Extinction: A Critical Review of the Evidence. *Journal of World Prehistory* 16(4): 313-359.

2003 A requiem for North American overkill. *Journal of Archaeological Science* 30(5): 585.
- Grayson, D. K., Delpech, F., Rigaud, J-Ph. & Simek, J.
2001 Explaining the development of dietary dominance by a single ungulate taxon at Grotte XVI, Dordogne, France. *Journal of Archaeological Science* 28:115–125.

- Green, H. S, C. B Stringer, S. N Collcutt, A. P Carrant, J Huxtable, H. P Schwarcz, N Debenham, C. Embleton, P. Bull, T. I. Molleson and R.E. Bevins
1981 Pontnewydd Cave in Wales-a New Middle Pleistocene Hominid Site. *Nature* 294(5843):707-713.
- Greenman, Emerson F.
1940 A geologically dated camp site, Georgian Bay, Ontario. *American Antiquity* 5(3):194-99.

1943 An early industry on a raised beach near Killarney, Ontario. *American Antiquity* 8(3):260-65.

1966 Chronology of sites at Killarney, Canada. *American Antiquity* 31:540-551.
- Greenman, Emerson F., and George M. Stanley
1941 Two post-Nipissing sites near Killarney, Ontario. *American Antiquity* 6(4):305-13.
- Greer, Sheila
1984 *Traditional land-use patterns of the Carcross-Tagish Band*. Manuscript prepared for the Clifford E. Lee Foundation, Edmonton, Alberta, on behalf of the Carcross-Tagish Indian Band. Unpubl. ms available at Yukon Archives, Department of Tourism & Culture, Government of Yukon, Box 2703, Whitehorse, Yukon Y1A 2C6.

1986 *Kusawa Lake archaeology: Management, research and interpretation*. Unpubl. ms. Available at Government of Yukon, Department of Business, Tourism and Culture, Box 2703, Whitehorse, Yukon Y1A 2C6.
- Grier, Colin
2000 Labor Organization and Social Hierarchies in North American Arctic Whaling Societies. In *Hierarchies in Action, Cui Bono?* edited by Michael W. Diehl, pp. 264-283. Center for Archaeological Investigations Occasional Paper No. 27, Southern Illinois University, Carbondale, Illinois.
- Grimm, E. C., and G. L. Jacobson, Jr.
2004 Late Quaternary Vegetation History of the Eastern United States. In *The Quaternary Period in the United States*, edited by A. R. Gillespie, S. C. Porter, and B. F. Atwater, pp. 381-402. Elsevier, Boston.
- Grønnow, Bjarne
1986 Recent Archaeological Investigations of West Greenland Caribou Hunting. *Arctic Anthropology* 23(1/2):57-80.

1987 Meiendorf and Stellmoor revisited. An analysis of Late Palaeolithic reindeer exploitation. *Acta Archaeologica* 56:131-166.

- 2006 Aasiviit as Focal Places in Historical Greenland. In *Dynamics of Northern Societies*, edited by Jette Arneborg and Bjarne Grønnow, pp. 209–214. Studies in Archaeology and History 10. Copenhagen: National Museum of Denmark.
- 2009 Caribou Hunting Structures and Hunting Grounds of the Thule Culture in Angujaartorfiup Nunaa, West Greenland. In *On the Track of the Thule Culture from Bering Strait to east Greenland: Proceedings of the SILA Conference*, pp. 201-210.
- Grønnow, B., Meldgaard, M., and J. Berglund Nielsen
 1983 Aasivissuit: The Great Summer Camp. Archaeological, Ethnographical, and Zooarchaeological Studies of a Caribou-Hunting Site in West Greenland. *Meddelelser om Grønland, Man and Society* 5.
- Gubser, N. J.
 1965 *The Nunamiut Eskimos: Hunters of caribou*. New Haven, Yale University Press.
- Guilday, J. E.
 1968 Archaeological Evidence of Caribou from New York and Massachusetts. *Journal of Mammalogy* 49:344-345.
- Guilday, J. E., Harold W. Hamilton, and Paul W. Parmalee
 1975 Caribou (*Rangifer tarandus* L.) from the Pleistocene of Tennessee. *Journal of the Tennessee Academy of Science* 50(3):109-112.
- Guilderson, T. P., Burckle, L., Hemming, S., and W. R. Peltier
 2000 Late Pleistocene sea level variations derived from the argentine shelf. *Geochemistry, Geophysics, Geosystems: An Electronic Journal of the Earth Sciences*, 1, paper 2000GC000098.
- Gulløv, Hans Christian
 1985 Whales, Whalers, and the Eskimos. The Impact of European Whaling on the Demography and Economy of Eskimo society in West Greenland. In *Cultures in Contact*, edited by William W. Fitzhugh, pp. 71–96. Smithsonian Institution, Washington, D. C.
- 1988 Where Is the Greenlandic Qassi?—A Study of Settlement Structures. *Folk* 30:181–200.
- 1997 From Middle Ages to Colonial Times. *Meddelelser om Grønland, Man & Society* 23. Copenhagen: Danish Polar Center.
- 2007 Inuit og norboerne i 1300-tallets vesterbygd. *Tidsskriftet Grønland*:88–93.
- Gusick, Amy E. and Loren G. Davis
 2010a. Exploring Baja California's submerged landscapes. *Journal of California and Great Basin Anthropology* 30(1):35–49.

Gusick, Amy E. and Loren G. Davis

2010b. *Sea of Cortez 2010: exploring Mexico's submerged landscapes*. Paper presented at 4th Annual Explorers Symposium at the National Geographic Society, Washington D.C.

Gusick, Amy and Michael Faught

2011 Prehistoric Archaeology Underwater: A Nascent Subdiscipline Critical to Understanding Early Coastal Occupations and Migration Routes. In *Trekking the Shore: Changing Coastlines and the Antiquity of Coastal Settlement*, edited by N. F. Bicho, J. W. Haws, and L. G. Davis, pp. 27-50. Springer, New York.

Guslitzer, Boris Isaakovich and Pavel Yurievich Pavlov

1993 Man and Nature in Northeastern Europe in the Middle and Late Pleistocene. In *From Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations*, edited by Olga Soffer and N. D. Praslov (Eds.) pp. 175-188. Plenum Press, New York.

Guthrie, R. D.

1983 *Osseous Projectile Points: Biological considerations affecting raw material selection and design among Paleolithic and Paleoindian Peoples*. BAR International Series 163:273-294.

H

Hagen, A.

1963 Mesolittiske jegergrupper I norske høyfjell. *Univ. Olds.saml. Årb.* 1960-1961, 109.

Hall, C. F.

1879 *Narrative of the Second Arctic Expedition*. Nourse, J. E. (Ed.), Senate Doc. Washington, D. C.

Hall, E. S. J., (Ed.)

1989 *People and caribou in the Northwest Territories*. Yellowknife, Department of Renewable Resources, Government of the Northwest Territories.

Hamilton, Lawrence C. and Rasmus O. Rasmussen

2010 Populations, Sex Ratios, and Development in Greenland. *Arctic Anthropology* 63(1):43-52.

Hassan, K.M., Swinehart, J.B., Spalding, R.F.

1997 Evidence for Holocene environmental change from C/N ratios and $\delta^{13}C$ and $\delta^{15}N$ values in Swan Lake sediments, western Sand Hills, Nebraska. *Journal of Paleolimnology* 18:121-130.

- Harding, G. L.
1953 The Cairn of Hadi, *Annual Department of Antiques of Jordan* 2:8-56.
- Hardy, B. L. and M. H. Moncel
2011 Neanderthal use of fish, mammals, birds, starchy plants and wood 125-250,000 years ago. *PloS one* 6(8):e23768.
- Hare, P. Gregory, Greer, Sheila, Gotthardt, Ruth, Farnell, Richard, Bowyer, Vandy, Schweger, Charles, and Diane Strand
2004 Ethnographic and Archaeological Investigations of Alpine Ice Patches in Southwest Yukon, Canada. *Arctic* 57(3):260-272.
- Harrington, C.R.
1999 Caribou. *Beringian Research Notes* 12:1-4.
- Hayshida, Kenzo Jun Kimura, and Randall Sasaki
2014 State and Perspectives of Submerged Sites in Japan. In *Prehistoric Archaeology on the Continental Shelf*, edited by Amanda M. Evans, Joe C. Flatman, and Nicholas C. Flemming, pp. 275-290. Springer, New York.
- Haynes, C. V., D. J. Donahue, A. J. T. Jull, and T. H. Zabel
1984 Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America* 12:184-191.
- Haynes, Gary
2007 A Review of some Attacks on the Overkill Hypothesis, with Special Attention to Misrepresentations and Doubletalk. *Quaternary International* 169-170:84-94.
- Helms, S., and A. V. G. Betts, A.V.G.
1987 The Desert "Kites" of the Badiyat Esh-Sham and North Arabia. *Paléorient* 13(1):41-67.
- Heard, D. C.
1997 Causes of barren-ground caribou migrations and implications to hunters. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 27-31. Ashgate Publishing, Vermont
- Hearne, Samuel
1795 *A Journal from Prince of Wales' Fort in Hudson's Bay to the Northern Ocean*. A Strahan and T. Cadell, London.

1958 *A Journal to the Northern Ocean*. R. Glover (Ed.) Macmillian, Toronto.
- Helskog, Knut
1977 Nye helleristninger ved Kvalsund. *Ottar* 98: 6-9.

- 2012 Ancient Depictions of Reindeer Enclosures and their Environment. *Fennoscandia archaeologica* 29:29-54.
- Hershkovitz, I., Ben-David, Y., Arensburg, B., Goren, A., and A. Pinchasov
 1987 Rock Engravings in Southern Sinai, in *Sinai Part 2: Human Geography/Gvirtzman Gdaliahu*, edited by G. Gvirtzman, A. Shmueli, Y. Gardos, I. Beit-Arieh, and M. Harel, pp.605-616. Givatayim, Eretz Ha-Tzvi.
- Heptner, W. G., A. A. Nasimovitch, and A. A. Bannikov
 1961 *Mammals of the Soviet Union* (in German), edited by Gustav Fischer, Jena: Verlag.
- Heuer, Karsten
 2008 *Being Caribou: Five Months on Foot with an Arctic Herd*. The Mountaineers Books, Seattle, Washington.
- Hockett, B., Creger, C., Smith, B., Young, C., Carter, J., Dillingham, E., Crews, R., Pellegrini, E.
 2013 Large-scale trapping features from the Great Basin, USA: The significance of leadership and communal gatherings in ancient foraging, *Quaternary International* 297:64-78.
- Holm, G.
 1914 *Ethnological Sketch of the Angmagsalik Eskimo*. *Meddelelser om Grønland* 39. Bianco Lunos, Copenhagen.
- Holzer, A., Avner, U., Porat, N., and L. K. Horwitz
 2010 Desert kites in the Negev Desert and Northeast Sinai: Their function, chronology and ecology. *Journal of Arid Environments* 74(7):806–817.
- Honess, F., and N. Frost
 1942 *A Wyoming Bighorn Sheep Study*. Wyoming Game and Fish Department, Bulletin 1, Cheyenne, Wyoming.
- Honigmann, J.
 1954 *The Kaska Indians: an ethnographic reconstruction*. Yale University Publications in Anthropology 51. Yale University Press, New Haven.
- Hostnig, Rainer
 2011 *Caza o captura de camélidos mediante trampas en las pinturas rupestres de Pulpintogasa, Apurímac, Perú*. Repestreweb, Accessed 17 January 2016.
- Hough, Jack L.
 1958 *Geology of the Great Lakes*. University of Illinois Press, Urbana.
- 1962 Lake Stanley, A Low Stage of Lake Huron Indicated by Bottom Sediments. *Geological Society of America Bulletin* 73:613-620.

- Howley, J. P.
1915 *The Beothucks or Red Indians, the aboriginal inhabitants of Newfoundland*.
Cambridge University Press, Cambridge.
- Hoyt, W. H., J. C. Kraft, and M. J. Chrzastowski
1990 Prospecting for Submerged Archaeological Sites on the Continental Shelf;
Southern Mid Atlantic Bight of North America. In *Archaeological Geology of North
America: Centennial Special Volume 4*, pp.147-160. Boulder: Geological Society of
America.
- Huber, Toni
2005 Antelope Hunting in Northern Tibet: Cultural Adaptation to Wildlife Ecology, In
*Wildlife and plants in traditional and modern Tibet: Conceptions, Exploitation, and
Conservation*, edited by A. Boesi and F. Cardi. Memorie della Società Italiana di Scienze
Naturali e del Museo Civico di Storia Naturale di Milano 33(1):5–17
- 2012 The Changing Role of Hunting and Wildlife in Pastoral Communities of Northern
Tibet, in *Pastoral Practices in High Asia: Advances in Asian Human-Environmental
Research*, edited by H. Kreutzmann, pp. 195-215. Springer, New York.
- Hublin, Jean-Jacques, Darlene Weston, Philipp Gunz, Mike Richards, Wil Roebroeks, Jan
Glimmerveen, and Luc Anthonis
2009 Out of the North Sea: The Zeeland Ridges Neandertal. *Journal of Human
Evolution* 57(6):777-785.
- Hublin, Jean-Jacques
1984 The Fossil Man from Salzgitter-Lebenstedt (FRG) and Its Place in Human
Evolution during the Pleistocene in Europe. *Zeitschrift Für Morphologie Und
Anthropologie* 75(1):45-56.
- Hunter, R. Douglas, Irina P. Panyushkina, Steven W. Leavitt, Alex C. Wiedenhoeft, and John
Zawiskie
2006 A multiproxy environmental investigation of Holocene wood from a submerged
conifer forest in Lake Huron, USA. *Quaternary Research* 66:67–77.
- Humlum, Ole
1988 Natural Cairns on Rock Glaciers as an Indication of a Solid Ice Core. *Geografisk
Tidsskrift* 88:78–82.
- Hyland, D. C., J. M. Tersak, J. M. Adovasio and M. I. Siegel
1990 Identification of the Species of Origin of Residual Blood on Lithic Material.
American Antiquity 55(1):104.

Ikawa-Smith, F.

2004 Humans along the Pacific margin of Northeast Asia before the Last Glacial Maximum. In *Entering America: Northeast Asia and Beringia before the Last Glacial Maximum*, edited by D. B. Madsen, pp. 285-309. University of Utah Press, Salt Lake City.

Inamura, Tetsuya

2006 *Chacu* Collective Hunting of Camelids and Pastoralism in the Peruvian Andes. *Global Environmental Research* 10(1):39-48.

Indrelid, Svein

1975 Problems Relating to the Early Mesolithic Settlement of Southern Norway. *Norwegian Archaeological Review* 8(1):1-18.

Ingold, T.

1980 *Hunters, Pastoralists, and Ranchers: Reindeer Economies and Their Transformations*. Cambridge University Press, Cambridge.

Ingstad, Helge

1954 *Nunamiut; among Alaska's Inland Eskimos*. W.W. Norton, New York.

Israel, Heinz

1969 *Kulturwandel der grönländischen Eskimo im 18. Jahrhundert*. Abhandlungen und Berichte des Staatlichen Museums für Völkerkunde Dresden 29. Berlin: Akademie.

Irimoto, T.

1981 *Chipewyan ecology: Group structure and caribou hunting system*. Osaka Senri Ethnological Studies No. 8

J

Jackson, Lawrence J.

1983 Geochronology and settlement disposition in the Early Paleo-Indian occupation of southern Ontario, Canada. *Quaternary Research* 19:288-299.

1988 Fossil Cervids and Fluted Point Hunters: A Review from Southern Ontario. *Ontario Archaeology* 48:27-41.

1990 Interior Paleoindian Settlement Strategies: A First Approximation for the Lower Great Lakes. In *Early Paleoindian Economies of Eastern North America*, edited by K. B. Tankersley and B. L. Isaac, pp. 95- 142. Research in Economic Anthropology, supplement 5. JAI Press, Greenwich, Connecticut.

1998 *The Sandy Ridge and Halstead Paleo-Indian sites, unifacial tool use and Gainey Phase definition in south-central Ontario*. Memoirs of the Museum of Anthropology No. 32, Ann Arbor: University of Michigan.

- Jackson, Lawrence J. and Andrew Hinshelwood
 2004 *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*. Mercury Series, Archaeology Paper 165. Canadian Museum of Civilization, Gatineau, Quebec.
- Jackson, Lawrence J., Chris Ellis, Allen V. Morgan, and John H. McAndrews
 2000 Glacial lake levels and eastern Great Lakes Palaeo-Indians. *Geoarchaeology* 15:415–40.
- Jackson, Lawrence J. and H. McKillop
 1991 Approaches to Palaeo-Indian Economy: An Ontario and Great Lakes Perspective. *Midcontinental Journal of Archaeology* 16:34–68.
- Janes, R. R.
 1983 *Archaeological Ethnography among the Mackenzie Basin Dene, Canada*. Technical Paper 28. Arctic Institute of North America, Calgary.
- Janusas, Scarlett E., Steve Blasco, Stan McClellan, and Jessica Lusted
 2004 Prehistoric drainage and archaeological implications across the submerged Niagara escarpment north of Tobermory, Ontario. In *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*, edited by Lawrence J. Jackson and Andrew Hinshelwood, pp. 303–14. Mercury Series, Archaeology Paper 165. Canadian Museum of Civilization, Gatineau, Quebec.
- Jaubert, J., Hublin, J.-J., McPherron, S.P., Soressi, M., Bordes, J.-G., Claud, E., Cochard, D., Delagnes, A., Mallye, J.-B., Michel, A., Niclot, M., Niven, L., Park, S.-J., Rendu, W., Richards, M., Richter, D., Roussel, M., Steele, T.E., Texier, J.-P., and C. Thiébaud
 2008 Paléolithique moyen récent et Paléolithique supérieur ancien à Jonzac (Charente-Maritime): premiers résultats des campagnes 2004-2006. In *Les Sociétés du Paléolithique dans un Grand Sud-ouest de la France: Nouveaux Gisements, Nouveaux Résultats, Nouvelles Méthodes*, edited by J. Jaubert, J.-G. Bordes, and I. Ortega, I., pp.203-244. Mémoire de la Société Préhistorique Française 48.
- Jefferies, Richard W.
 1988 Archaic Period Research in Kentucky: Past Accomplishments and Future Directions. In *Paleoindian and Archaic Research in Kentucky*, edited by C. D. Hockensmith, David Pollack, and Thomas N. Sanders, pp. 85-126. Kentucky Heritage Council, Lexington.
- Jenike, M.R.
 2001 Nutritional ecology: diet, physical activity and body size. In *Hunter-gatherers: an interdisciplinary perspective*, edited by C. Panter-Brick, R. Layton and P. Rowley-Conwy, pp. 205–238. Cambridge University Press, Cambridge.

- Jenness, D.
1922 *Life of the Copper Eskimos. Report of the Canadian Arctic Expedition 1916-18*, vol. 12. F.A. Acland, Ottawa, Canada.
- Jochim, Michael A.
1983 Paleolithic cave art in ecological perspective. In *Hunter-Gatherer Economy in Prehistory*, edited by G. N. Bailey, pp.212-219. Cambridge University Press, Cambridge.
1991 Archaeology as Long-Term Ethnography. *American Anthropologist* 93(2):308-321.
- Jochim, M., C. Herhahn and H. Starr
1999 The Magdalenian Colonization of Southern Germany. *American Anthropologist* 101(1):129-142.
- Johansen, A. B.
1978 Høgnipen-funnene. Et nytt blad av Norges eldste innvandringshistorie. *Viking* 27:177-179.
- Johnson, Gregory
1982 Organizational Structure and Scalar Stress. In *Theory and Explanation in Archaeology: The Southampton Conference*, edited by Colin Renfrew, Michael J. Rowlands, and Barbara A. Segraves, pp. 389-421. Academic Press, New York.
- Johnson, Lucille Lewis and Melanie Stright
1992 *Paleoshorelines and Prehistory: An Investigation of Method*. CRC Press, Boca Raton, Florida.
- Johnstone, J., D.E. Russel, and B. Griffith
2002 Variations in Plant Forage Quality in the Range of the Porcupine Caribou Herd. *Rangifer* 22:83-92.
- Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer
2011 *Submerged Prehistory*. Oxbow Books, Oakville.
- Jordan, Douglas F.
1960 *The Bull Brook Site in Relation to "Fluted Point" Manifestations in Eastern North America*. Ph.D. Dissertation, Harvard University, Cambridge.
- Josenhans, H.W., D.W. Fedje, K.W. Conway and J.V. Barrie
1995 Post glacial sea levels on the western Canadian continental shelf: evidence for rapid change, extensive subaerial exposure, and early human habitation. *Marine Geology* 125: 73–94.
- Josenhans, H., Fedje, D., Pienitz, R., & Southon, J.
1997 Early humans and rapidly changing Holocene sea-levels in the Queen Charlotte Islands—Hecate Strait, British Columbia, Canada. *Science* (277)71–72.

Joyce, D.

2006 Chronology and New Research on the Schaefer Mammoth (*Mammuthus primigenius*) Site, Kenosha County, Wisconsin, USA. *Quaternary International* 142-143:44-57.

Julig, P. J.

1984 Cummins Paleo-Indian site and its paleoenvironment, Thunder Bay, Canada. *Archaeology of Eastern North America* 12:192-209.

1985 A brief report on recent excavations at Cummins Palaeo-Indian Site, Thunder Bay. *Wanihan* 85:3-14.

1988 *The Cummins site complex and Paleoindian occupations in the northwestern Lake Superior region*. Ph.D. Dissertation. University of Toronto.

Julig, P. J., McAndrews, J.H., and William C. Mahaney

1986 Geoarchaeological investigations at the Cummins Paleoindian site, Thunder Bay, Ontario. *Current Research in the Pleistocene* 3:79-80.

Julig, P. J., McAndrews, J.H., and William C. Mahaney

1990 Geoarchaeology of the Cummins site on the beach of proglacial Lake Minong, Lake Superior Basin, Canada. In *Archaeological Geology of North America*, Geological Society of America Centennial Special Volume 4:21-50.

Julig, P.J., and J. H. McAndrews

1993 Les cultures Paléindiennes dans la région des Grands Lacs en Amérique du Nord: contextes paléoclimatique, géomorphologiques et stratigraphiques. *L'Anthropologie* 97:623-650.

Justice, Noel D.

1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States: A Modern Survey and Reference*. Indiana University Press, Bloomington.

K

Kapp, R. O.

1986 Late-Glacial Pollen and Macrofossils Associated with the Rappuhn Mastodont (Lapeer County, Michigan). *American Midland Naturalist* 116:368-377.

1999 Michigan Late Pleistocene, Holocene and Presettlement Vegetation and Climate. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*, edited by J. R. Halsey and M. D. Stafford, pp. 30-58. Bulletin X. Cranbrook Institute of Science, Bloomfield Hills, Michigan.

- Karrow, Paul F.
 1980 The Nipissing transgression around southern Lake Huron. *Canadian Journal of Earth Sciences* 17(9):1271-1274.
- 2004 Ontario geological events and environmental change in the time of the Late Palaeo-Indian and Early Archaic cultures (10,500 to 8,500 B.P.). In *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*, edited by Lawrence J. Jackson and Andrew Hinshelwood, pp. 1–23. Mercury Series, Archaeology Paper 165. Canadian Museum of Civilization, Gatineau, Quebec.
- Karrow, Paul F., Anderson, T. W., Clarke, A. H., Delorme, L. D., and M. R. Sreenivasa
 1975 Stratigraphy, Paleontology, and Age of Lake Algonquin Sediments in Southwestern Ontario. *Quaternary Research* 5:49-87.
- Karrow, P.F., Anderson, T.W., Delorme, L.D., Miller, B.B., & Chapman, L.J.
 1995 Late-glacial paleoenvironment of Lake Algonquin sediments in southwestern Ontario. *Journal of Paleolimnology* 14: 297–309.
- Keenlyside, D. L.
 1991 Paleoindian occupations of the Maritimes region of Canada. In *Clovis: Origins and Adaptations*, edited by R. Bonnicksen, and K. L. Turnmire, pp. 163-173. Center for the Study of the First Americans, Corvallis.
- Kehoe, Thomas F.
 1990 Corraling: Evidence from Upper Paleolithic Cave Art. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 34-44. Unwin Hyman, London.
- Kelly, Robert L.
 1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institution Press, Washington, D.C.
- 2013 *The Lifeways of Hunter-Gatherers: The Foraging Spectrum*. Cambridge University Press, Cambridge.
- Kelly, Robert L. and Lawrence C. Todd
 1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53(2):231-244.
- Kelsall, J. P.
 1968 *The Migratory Barren Ground Caribou of Canada*. Ottawa, Department of Indian Affairs and Northern Development.
- Kempe, Stephan and Ahmad Al-Malabeh
 2013 Desert Kites in Jordan and Saudi Arabia: Structure, Statistics, and Function, a GoogleEarth Study. *Quaternary International* 297:126-146.

- Kennedy, D.L.
 2011 The “Works of the Old Men” in Arabia: remote Sensing in Interior Arabia, *Journal of Archaeological Science* 38:3185-3203.
- 2012 Kites: New Discoveries and a New Type. *Arabian Archaeology and Epigraphy* 23: 145-155.
- Kennedy, D., and M. C. Bishop,
 2011 Google Earth and the Archaeology of Saudi Arabia: A Case Study from the Jeddah Area. *Journal of Archaeological Science* 38(6):1284–1293.
- Kent, Susan (Ed.)
 1996 *Cultural Diversity among Twentieth-Century Foragers: An African Perspective*, Cambridge University Press, Cambridge.
- Kenyon, Dienje
 1997 Large Kill Sites and the Potential for Illuminating Provisioning Behavior: Preliminary thoughts and expectations. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 1-26. Ashgate Publishing, Vermont.
- Kerfoot, W.C.
 1974 Net Accumulation Rates and the History of Cladoceran Communities. *Ecology* 55:51-61.
- Kieran Westley, Trevor Bell, Ruth Plets, and Rory Quinn
 2011 Investigation Submerged Archaeological Landscapes: A Research Strategy Illustrated with Case Studies from Ireland and Newfoundland, Canada. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 129-144. Oxbow Books.
- Kierdorf, H.
 1992 *Saisonbestimmung anhand der Wurzelzementzonierung einiger Rentierzähne vom Kartstein*. In "head'em-off-at-the-pass" - Ökologie und Ökonomie der Ahrensburger Rentierjäger im Mittelgebirge M. Baales (Ed.). Cologne, pp.76-80.
- Kincare, K., and G. J. Larson
 2009 Evolution of the Great Lakes. In *Michigan Geography and Geology*, edited by R. Schaeztl, J. Darden, and D. Brandt, pp. 174-190. Pearson, New York.
- King, Nathaniel R. and Ivor R. Mollema
 2015 *Sandalwood and Starfish: A Study of the Shipwreck Brunswick (1805) and Site Formation Processes in Simons Bay*. Paper presented at the 48th Annual Conference on Historical and Underwater Archaeology, Seattle, Washington January 7-10, 2015.

- King, R.
1836 *Narrative of a journey to the shores of the Arctic Ocean, in 1833, 1834, and 1835.* Bentley, London.
- Klein, D. R.
1970 Interaction of *Rangifer tarandus* (reindeer and caribou) with habitat in Alaska. *Finnish Game Research* 30: 350-367.
- Klein, R. G.
1973 *Ice-Age hunters of the Ukraine.* University of Chicago Press, Chicago.
- Klutschak, H. W.
1881 *Als Eskimo unter den Eskimos.* Wien, Prest, Leipzig.
- Knecht, H.
1993 Early Upper Paleolithic Approaches to Bone and Antler Projectile Technology. In *Hunting and Animal Exploitation in the Later Paleolithic and Mesolithic of Eurasia*, edited by G. L. Peterkin, H. M. Bricker and P. Mellars, pp. 33-47. Archeological Papers of the American Anthropological Association No. 4.
- Koldehoff, Brad, and John A. Walthall
2009 Dalton and the Early Holocene Midcontinent: Setting the Stage. In *Archaic Societies: Diversity and Complexity Across the Midcontinent*, edited by Thomas E. Emerson, Dale L. McElrath, and Andrew C. Fortier, pp. 137-151. State University of New York Press, Albany.
- Kornfeld, M., Frison, G.C., Larson, M.L.
2010 *Prehistoric Hunter-Gatherers of the High Plains and Rocky Mountains.* Left Coast Press, Walnut Creek, CA.
- Kornitez, N. L.
1962 Pro prichini vimirannya mamonta na teritorii Ukraini. In *Vikopno fauni Ukraini I sumizhnih teritorii*, edited by I. G. Pidoplichko, pp. 93-196. AN USSR Kiev.
- Kornietz, N. L., Giadkih, M.I., Velichko, A. A., Antonova, G. A., Gribchenko, Y. N., Zelikson, E. M, Kurenkova, E. I., Haicheva, T. A., and A. L. Chepaiya
1981 Mezhirich. In *Arkheologiya I paleogeografiya pozdego paleolita Russkoi ravnini*, edited by A. A. Velichko, pp.106-119. Nauka, Moscow.
- Kortenbout van der Sluijs, G.
1971 Bones of mammals from the Brown Bank area (North Sea). In *Mesolithic bone and antler implements from the North Sea and from the Netherlands*, edited by L.P Louwe Kooijmans, pp. 69-70. Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek 20-21.

- Kopper, J. S., R. E. Funk, and L. Dumont
1980 Additional Paleo-Indian and Archaic Materials from the Dutchess Quarry Cave Area, Orange County, New York. *Archaeology of Eastern North America* 8:125-127.
- Krishnamurthy, R.V., Syrup, K.A., Baskaran, M., and A. Long
1995 Late glacial climate record of midwestern United States from the hydrogen isotope ratio of lake organic matter. *Science* 269:1565–1567.
- Krist, F. J., Jr., and R. J. Schaetzl
2001 Paleowind (11,000 BP) Directions Derived from Lake Spits in Northern Michigan. *Geomorphology* 31:1-18.
- Krupnik, I.
1993 *Arctic adaptations: native whalers and reindeer herders of northern Eurasia*. Hanover, NH, University Press of New England.
- Kuehn, Steven R.
1998 New evidence for late Paleoindian – early Archaic subsistence behavior in the western Great Lakes. *American Antiquity* 63(3): 457 – 476.
- Kuhn, Steven L., and Mary C. Stiner
2001 The Antiquity of Hunter-Gatherers, in *Hunter-Gatherers: An Interdisciplinary Perspective*, edited by Catherine Panter-Brink, Robert H. Layton, and Peter Rowley-Conway, pp. 99-129. Cambridge University Press, Cambridge.
- In Press The Antiquity of Hunter-Gatherers Revisited, in *Foraging in the Past: Archaeological Studies of Hunter-Gatherer Diversity*, edited by Lemke, Ashley K., University Press of Colorado.
- Kuhn, Tyler S., Keri A. McFarlane, Pamela Groves, Arne Ø. Mooers, and Beth Shapire
2010 Modern and ancient DNA reveal recent partial replacement of caribou in the southwest Yukon. *Molecular Ecology* 19:1312–1323.
- Kurtén, B.
1968 *Pleistocene Mammals of Europe*. Aldine, Chicago.
- Kurten, B., and E. Anderson
1980 *Pleistocene Mammals of North America*. Columbia University Press, New York.
- Kusimba, Sibel B.
2005 What Is a Hunter-Gatherer? Variation in the Archaeological Record of Eastern and Southern Africa. *Journal of Archaeological Research* 13(4):337-366.
- Kuzyk, G., Russel, D. E., Farnell, R. S., Gotthardt, R. M., Hare, P. G., and E. Blake
1999 In pursuit of prehistoric caribou on Thandlät, southern Yukon. *Arctic* 52(2):214–219.

L

- LaBelle, J., and Spencer R. Pelton,
2013 Communal hunting along the Continental Divide of Northern Colorado: results from the Olson game drive (5BL147), USA. *Quaternary International* 297:45-63.
- Lambeck, Kurt, Tezer M Esat, and Emma-Kate Potter
2002 Links between Climate and Sea Levels for the Past Three Million Years. *Nature* 419(6903):199-206.
- Larsen, Curtis E.
1985 *A Stratigraphic Study of Beach Features on the Southwestern Shore of Lake Michigan: New evidence of historical lake level fluctuation*. Illinois State Geological Survey Environmental Notes, Urbana.

1987 *Geological History of Glacial Lake Algonquin and the Upper Great Lakes*. U.S. Geological Survey Bulletin 1801. U.S. Government Printing Office.
- Larson, G. J., and R. J. Schaetzl
2001 Origin and Evolution of the Great Lakes. *Journal of Great Lakes Research* 27:518-546.
- Larson, G. J., Lowell, T. V., and N. E. Ostrom
1994 Evidence for the Two Creeks interstade in the Lake Huron basin. *Canadian Journal of Earth Science* 31:793-797.
- Lartet, E. and H. Christy
1875 *Reliquae Aquitanicae: being contributions to the archaeology of Périgord and adjoining provinces of Southern France*. Williams & Norgate. London.
- Laub, Richard S.
2000 A second dated mastodon bone artifact from Pleistocene Deposits at the Hiscock Site (Western New York State). *Archaeology of Eastern North America* 28:141-154.
- Laub, Richard S., John Tomenchuk and Peter L. Storck
1996 A Dated Mastodon Bone Artifact from the Late Pleistocene of New York. *Archaeology of Eastern North America* 2(4):1-17.
- LeMâitre, S., and P. L. Van Berg
2008 The engraved rock sites of Hemma (Syria). *International Newsletter on Rock Art* 52:5-12.
- Leach, P. A., and D. F. Belknap
2007 Marine geophysics and vibracoring applied to refining the search for submerged prehistory in Damariscotta River, Maine, USA. In L. Wilson, P. Dickenson, & J. Jeandron (Eds.), *Reconstructing human-landscape interactions: Proceedings of the*

developing international geoarchaeology conference, St. John, New Brunswick, Canada, October 2005 (pp. 21–23). Newcastle: Cambridge Scholar's Press.

Legge, A.J., and P. A. Rowley-Conwy

1987 Gazelle Killing in Stone Age Syria. *Scientific American* 257:76-83.

Lee, Richard B.

1992 Art, Science, or Politics? The Crises in Hunter-Gatherer Studies. *American Anthropologist* 94:31-54.

Lee, Richard B., and Irven DeVore (Eds.)

1968 *Man the Hunter*. Aldine Press, Chicago.

Lee, Richard B., and Mathias Guenther

1993 Problems in Kalahari Historical Ethnography and the Tolerance of Error. *History in Africa* 20:185-235.

Lee, T. E.

1954 The first Sheguiandah expedition, Manitoulin Island, Ontario. *American Antiquity* 20:101-111.

1955 The second Sheguiandah expedition, Manitoulin Island, Ontario. *American Antiquity* 21:63-71.

1957 The Antiquity of the Sheguiandah site: *The Canadian Field Naturalist* 71:117-137.

Leechman, D.

1954 *The Vanta Kutchin*. National Museum of Canada, Bulletin 130, Ottawa.

Leineweber, Rosmarie, Harald Lubke, Monika Hellmund, Hans-Jurgen Dohle, and Stefanie Kloob

2011 A Late Neolithic Fishing Fence in Lake Arendsee, Sachsen-Anhalt, Germany. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 173-185. Oxbow Books.

Lemke, Ashley K.

2015a Comparing Global Ungulate Hunting Strategies and Structures: General Patterns and Archaeological Expectations. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 73-99. University of Michigan Museum of Anthropology Memoirs, No. 57.

2015b Great Lakes *Rangifer* and Paleoindians: Archaeological and Paleontological Caribou Remains from Michigan. *PaleoAmerica* 1(3):276-283.

- 2015c Lithic Artifacts from Submerged Archaeological Sites on the Alpena- Amberley Ridge In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 139-146. University of Michigan Museum of Anthropology Memoirs, No. 57.
- Lemke, Ashley K. and John M. O'Shea
 2015 Hunters and Hunting on the Alpena-Amberley Ridge during the Late Paleoindian and Early Archaic Periods. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 169-176. University of Michigan Museum of Anthropology Memoirs, No. 57.
- In Press *The End of an Era? Early Holocene Paleoindian Caribou Hunting in a Great Lakes Glacial Refugium*. In *The Human Occupation during the Ice Age in the Americas: New Directions and Advances*, edited by Suárez, Rafael and Ciprian Ardelean, Utah University Press.
- Lemke, A. K., Wernecke, D. C., and M. B. Collins
 2015 Early Art in North America: Clovis and Later Paleoindian Incised Artifacts from the Gault Site, Texas (41BL3232). *American Antiquity*, 80(1):113-133.
- Leroi-Gourham, A. and M. Brezillion
 1972 *Fouilles de Pincevent. Essai d'analyse ethnographique d'un habitat magdalénien: la section 36*. Supplement à Gallie Préhistoire (VII).
- de Lesseps, M.
 1790 *Journal Historique du voyage de M. de Lesseps*. T. I-II. Paris.
- Levine, Mary Ann
 1997 The Tyranny Conitunes: Ethnographic Analogy and Eastern Paleo-Indians. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 222-244. Ashgate Publishing, Vermont.
- Lewis, Christopher F. M
 1969 *Lake Quaternary History of Lake Levels in Huron and Erie Basins*. Proceedings of the 12th Conference on Great Lakes Research, pp.250-270. International Associations for Great Lakes Research.
- 1970 Recent Uplift of Manitoulin Island. *Canadian Journal of Earth Sciences* 7:665-675.
- Lewis, Christopher F. M and T. W. Anderson
 1992 Stable Isotope (O and C) and Pollen Trends in Eastern Lake Erie, Evidence for a Locally-Induced Climatic Reversal of Younger Dryas Age in the Great Lakes Basins. *Climate Dynamics* 6:241-250.

- Lewis, Christopher F. M., Blasco, S.M., and P.L. Gareau
 2005 Glacial Isostatic Adjustment of the Laurentian Great Lakes Basin: Using the empirical record of strandline deformation of Early Holocene Paleo-Lakes and Discovery of a hydrologically closed phase. *Géographie physique et Quaternaire*, 59(2-3):187-210.
- Lewis, Christopher F. M., Clifford W. Heil Jr., J. Brad Hubeny, John W. King, Theodore C. Moore Jr., and David K. Rea
 2007 The Stanley unconformity in Lake Huron basin: Evidence for a climate-driven closed lowstand about 7900 14C BP, with similar implications for the Chippewa lowstand in Lake Michigan basin. *Journal of Paleolimnology* 37(3):435–52.
- Lewis, Christopher F. M., Theodore C. Moore Jr., David K. Rea, David L. Dettman, A. M. Smith, and L. A. Mayer
 1994 Lakes of the Huron basin: Their record of runoff from the Laurentide Ice Sheet. *Quaternary Science Reviews* 13:891–922.
- Liljeblad, S,
 1986 Oral tradition: content and style of verbal arts. In *Handbook of North American Indians, Great Basin*, Volume 11, edited by W.L. D'Azevedo, pp. 641-659. Smithsonian Institution, Washington, D. C.
- Liljegren, R. & Ekström, J.
 1996 The Terrestrial Late Glacial Fauna in South Sweden. In *The Earliest Settlement of Scandinavia and its Relationship with Neighbouring Areas*, edited by L. Larsson, pp. 135-139. Acta Archaeologica Lundensia 24.
- Lips, J.
 1947 Notes on Montagnais-Naskapi economy (Lake St. John and Lake Mistassinibands). *Ethnos* 12:1-78.
- Lisiecki, Lorraine E., and Maureen E. Raymo
 2005 A Pliocene-Pleistocene Stack of 57 Globally Distributed Benthic Delta O-18 Records. *Paleoceanography* 20(1):PA1003.
- Loebel, Thomas
 2013 Endscrapers, use-wear, and Early Paleoindians in eastern North America. In *The Eastern Fluted Point Tradition*, edited by J. Gingerich, pp. 315–30, University of Utah Press, Salt Lake City.
- Long, D., Wickham-Jones, C. R., and Ruckley, N.A.
 1986 A Flint Artefact from the Northern North Sea. In *Studies in the Upper Palaeolithic of Britain and Northwest Europe*, British Archaeological Reports International Series 296, pp.55-62.

- Lorenzen, Eline D., D Nogués-Bravo, L Orlando, J Weinstock, et al.
2011 Species-specific responses of Late Quaternary megafauna to climate and humans. *Nature* 479:359-364.
- Loring, S.
1997 On the trail to the caribou house: some reflections on Innu caribou hunters in Northern Ntessinan (Labrador). In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 185-220. Ashgate Publishing, Vermont.
- Lothrop, Jonathan C.
1988 *The Organization of Paleoindian Lithic Technology at the Potts Site* (2 Vols.). Ph.D. Dissertation, State University of New York-Binghamton.
- Lowie, R. H.
1923 The Buffalo Drive and an Old-World Hunting Practice. *Natural History* Vol. XXIII. New York.
- Lovis, William, and Robert Whallon
2016 *Marking the Land: Hunter-Gatherer Creation of Meaning within their Environment*. Routledge Studies in Archaeology.
- Lowell, T. V., G. J. Larson, J. D. Hughes, and G.H. Denton
1999 Age Verification of the Lake Gribben Forest Bed and the Younger Dryas Advance of the Laurentide Ice Sheet. *Canadian Journal of Earth Sciences* 36:383-393.
- Lowie, Robert H.
1935 *The Crow Indians*. Farrar and Rinehart, New York.
- Lubinski, P.M.
1999 The communal pronghorn hunt: a review of the ethnographic and archaeological evidence. *Journal of California and Great Basin Anthropology* 21:158-181.
- de Lumley, H., Fournier, A., Park, Y.C., Yokoyama, Y., Demouy, A.
1984 Stratigraphie du remplissage Pléistocène moyen de la Caune de l'Arago à Tautavel. Étude de huit carottages effectués de 1981 à 1983. *L'Anthropologie* 88:5-18.
- Lyman, R. Lee
2007 Archaeology's Quest for a Seat at the High Table of Anthropology. *Journal of Anthropological Archaeology* 26:133-149.
- Lynch, Thomas F.
1997 Introduction. In *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. x-1. Ashgate Publishing, Vermont.

Lyons, Natasha, Peter Dawson, Matthew Walls, Donald Uluadluak, Louis Angalik, Mark Kalluak, Philip Kigusuituak, Luke Kiniski, and Luke Suluk
2010 Person, place, memory, thing: How Inuit elders are informing archaeological practice in the Canadian north. *Canadian Journal of Archaeology* 34:1–31.

M

MacDonald, George F.
1968 *Debert: A Paleo-Indian Site in Central Nova Scotia*. National Museum of Canada Anthropological Papers No. 16 Ottawa.

MacDonald, M.C.
2005 Of Rock-art, ‘Desert Kites’ and Mesayid. in *Arabia Vitalis: Arabskij Vostok, Islam, drevnyaya, Araviya: Sbornik Naychnykh statej, posvyashchennyj 60-letiyu*, edited by V.V. Naumkina, A. V. Sedov, and I.M. Smulyanskaya, pp.332-345. Rossijskaya Akademiya Nauk, Moscow.

Mackie, Quentin, Proctor, Alison, Fedje, Daryl, and Bradley Colin
2015 *Survey for Stone Wall Fish Weirs on the Continental Shelf near Haida Gwaii, British Columbia using an Autonomous Underwater Vehicle (AUV)*. Paper presented at the 80th Annual Meeting of the Society for American Archaeology, San Francisco.

MacNeish, R. Scottie
1952 A possible early site in the Thunder Bay District, Ontario. *National Museum of Canada Bulletin* 126:23-47.

Madsen, David B.
2015 A Framework for the Initial Occupation of the Americas. *PaleoAmerica* 1(3):217-250.

Magniez, P., Moigne, A. and H. de Lumley
2011 *First reindeer exploitation by Acheulean people in South of the France: Case study of the lower Paleolithic site of Caune de l’Arago (Tautavel, Prénées-Orientales, France)*. Poster presented at Deer and People, University of Lincoln.

Maher, L. J., Jr., N. G. Miller, R. G. Baker, B. B. Curry, and D. M. Mickelson
1998 Paleobiology of the Sand beneath the Valdres Diamicton at Valdres, Wisconsin. *Quaternary Research* 49:208-221.

Malm, Torben
1995 Excavating Submerged Stone Age Sites in Denmark - the Tybrind Vig Example. In *Man & Sea in the Mesolithic: Coastal Settlement above and below Present Sea Level*, edited by Anders Fischer, pp. 385-396. Oxbow Monographs, New York.

- Manning, T.H.
1960 *The relationship of the Peary and barren-ground caribou*. Arctic Institute North America, Technical Paper No. 4.
- Marcus, Joyce
2008 The Archaeological Evidence for Social Evolution. *Annual Review of Anthropology* 37:251-266.
- Martin, Paul S.
1984 Prehistoric Overkill: The Global Model. In *Quaternary Extinctions: A Prehistoric Revolution*, edited by Paul S. Marion and Richard G. Klein, pp. 354-403. University of Arizona Press, Tucson.
- Martin, Terrance J.
1995 Prehistoric animal exploitation on Isle Royale. In *Archaeological Survey and Testing at Isle Royale National Park, 1987–1990 Seasons*, edited by Caven P. Clark, 205–214. Lincoln: Midwest Archaeological Center. Report submitted to U.S. Department of the Interior, National Park Service.
- Martin, Terrance J., and Angela R. Perri
2011 *Animal Remains from the Getewaaking Site (20MK457), a Multiple-Component Middle to Late Woodland Habitation on Mackinac Island, Michigan*. Illinois State Museum Landscape History Program Technical Report 2011-000-7. Springfield: Illinois State Museum.
- Mason, R.
1958 *Late Pleistocene geochronology and the Paleo-Indian penetration into the lower Michigan peninsula*. Anthropological Papers, Museum of Anthropology, No. 11, Ann Arbor: University of Michigan.

1960 Early man and the age of the Champlain Sea. *Journal of Geology* 68:366–376.

1962 The Paleo-Indian tradition in eastern North America. *Current Anthropology* 3: 227–246.

1981 *Great Lakes Archaeology*. Academic Press, New York.
- Masters, Patricia M., N. C. Flemming (Editors)
1983 *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves*. Academic Press, New York and London.
- Mathiassen, T.
1927 Archaeology of the Central Eskimos. Pt. I-III. *Report of the 5th Thule Expedition Vol. IV*. Copenhagen.

- 1928 Eskimo Relics from Washington Land and Hall Land. *Meddelelser om Grønland* 71. Bianco Lunos, Copenhagen.
- Mazurkevich, Andrey, and Ekaterina Dolbunova
 2011 Underwater Investigations in Northwest Russia: Lacustrine Archaeology of Neolithic Pile Dwellings. In *Submerged Prehistory*, edited by Jonathan Benjamin, Clive Bonsall, Catriona Pickard, and Anders Fischer, pp. 158-172. Oxbow Books.
- McCabe, R.E., O’Gara, B., O’Gara, W., Reeves, H.M.
 2004 *Prairie Ghost: Pronghorn and Human Interaction in Early America*. University Press of Colorado, Boulder.
- McCarthy, Francine M. G. and John H. McAndrews
 2012 Early Holocene drought in the Laurentian Great Lakes basin caused hydrologic closure of Georgian Bay. *Journal of Paleolimnology* 47:411–28.
- McCarthy, Francine M. G., E. S. Collins, John H. McAndrews, H. A. Kerr, D. B. Scott, and F. S. Medioli
 1995 A comparison of postglacial arcellacean (“thecamoebian”) and pollen succession in Atlantic Canada, illustrating the potential of arcellaceans for paleoclimatic reconstruction. *Journal of Paleontology* 69:980–93.
- McCarthy, Francine, McAndrews, John H., and Elli Papangelakis
 2015 Paleoenvironmental Context for Early Holocene Caribou Migration on the Alpena-Amberley Ridge. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O’Shea, pp. 13-30. University of Michigan Museum of Anthropology Memoirs, No. 57.
- McClellan, C.
 1975 *My old people say: An ethnographic survey of southern Yukon Territory*. Publications in Ethnology No. 6. Ottawa: National Museums of Canada. [Republished in 2001, as Mercury Series, Canadian Ethnology Service Paper 137, by the Canadian Museum of Civilization, Hull].
- McClellan, C. and G. Denniston
 1981 Environment and Culture in the Cordillera. In *Handbook of North American Indians, Vol. 6: Subarctic*, edited by J. Helm, pp.372-386. Smithsonian Institute, Washington D. C.
- McFee, Ron D.
 1981 Caribou Fence Facilities of the Historic Yukon. In *Megaliths to Medicine Wheels: Boulder Structures in Archaeology*, edited by Michael Wilson, Kathie L. Road, and Kenneth J. Hardy, pp. 159-170. Proceedings of the Eleventh Annual Chacmool Conference. Archaeological Association. Calgary: University of Calgary.

- McKenna, R.
1965 *The Chandler Kutchin*. Arctic Institute of North America, Technical Paper 17. Montreal.
- Meldgaard, Morten
1986 The Greenland caribou - zoogeography, taxonomy and population dynamics. *Meddeleser om Gronland, Bioscience* 20:1-88.
- Mellars, Paul R.
1989 Major issues in the emergence of modern humans. *Current Anthropology* 30:349–385.

1996 *The Neanderthal legacy: An archaeological perspective from western Europe*. Princeton University Press.

2004 Reindeer specialization in the early Upper Palaeolithic: the evidence from South West France. *Journal of Archaeological Science* 31:613–617.
- Meltzer, David J.
2009 *First Peoples in a New World: Colonizing ice age America*. University of California Press, Berkeley.
- Meltzer, David J., and Vance T. Holliday
2010 Would North American Paleoindians have Noticed Younger Dryas Age Climate Changes? *Journal of World Prehistory* 23:1-41.
- Meltzer, David J., Vance T. Holliday, Michael D. Cannon, and D. Shane Miller
2014 Chronological evidence fails to support claim of an isochronous widespread layer of cosmic impact indicators dated to 12,800 years ago. *Proceedings of the National Academy of Sciences* 111(21):E2161-2171.
- Meltzer, David J. and Bruce D. Smith
1986 Paleo-Indian and Early Archaic subsistence strategies in eastern North America. In *Foraging, Collecting, and Harvesting: Archaic period subsistence and settlement in the eastern woodlands*, edited by Sarah W. Neusius. Center for Archaeological Investigations, Southern Illinois University at Carbondale.
- Mertz, E. L.
1924 *Oversigt over de Sen- Og Postglaciale Niveauforandringer I Danmark*. København: DGU II Rk. 41.
- Metcalfe, D. & Jones, K. T.
1988 A reconsideration of animal body-part utility indices. *American Antiquity* 53:486–504.

- Metcalfe, Jessica Z., and Fred J. Longstaffe
2014 Environmental Change and Seasonal Behavior of Mastodons in the Great Lakes region inferred from Stable Isotope Analysis. *Quaternary Research* 82:366-377.
- Meyers, Philip A.
2003 Applications of Organic Geochemistry to Paleolimnological Reconstructions: A summary of examples from the Laurentian Great Lakes. *Organic Geochemistry* 34:261-289.
- Miller, Frank
1974 *Biology of the Kaminuriak population of barren-ground caribou, Part 2*. Canadian Wildlife Service Report Series 36.
- Miller, F. L., Russell, R. H., and A. Gunn
1977 Peary caribou and musk oxen on western Queen Elizabeth Islands, NWT 1972-1974. *Canadian Wildlife Service Report Series No. 10*.
- Møbjerg, Tinna
1983 An Ethno-Archaeological Investigation of the Sermermiut Settlement, West Greenland. *Folk* 25:23–50.
- Mølmen, O.
1976 Fangst og jakt på villrein. *Viltbiologiske forundersøkelser Jotunheimen/Breheimen*, Felt 2.
- Monaghan, G. William and William A. Lovis
2005 *Modeling Archaeological Site Burial in Southern Michigan: A Geoarchaeological Synthesis*. Michigan State University Press, East Lansing.
- Monteleone, K. and E.J. Dixon
2013 *Underwater Archaeology in SE Alaska: Exploring the continental shelf of the Alexander Archipelago for submerged archeological sites*. In the Proceedings of the 2013 Canadian Archaeological Association (CAA) meeting in Whistler, BC.
- Moore, Katherine M.
2014 *Traces of Drive Structures at Parque Nacional Volcán Isluga, Tarapacá, Chile*, poster presented at 12th International Council for Archaeozoology Conference September, San Rafael, Argentina.
- Morandi Bonacossi, D. and M. Iamoni
2012 The Early History of the Western Palmyra Desert Region The Change in the Settlement Patterns and the Adaptation of Subsistence Strategies to Encroaching Aridity: A First Assessment of the Desert-kite and Tumulus Cultural Horizons. *Syria* 89:31–58.

- Moreno, E.
2012 The construction of hunting sceneries: Interactions between humans, animals and landscape in the Antofalla valley, Catamarca, Argentina. *Journal of Anthropological Archaeology* 31(1):104-177.
- Morgan, Lewis H.
1851 *The League of the Ho-Dé-No-Sau-Nee or Iroquois*. New York.
- Morris, Elizabeth A.
1990 Prehistoric Game Drive Systems in the Rocky Mountains and High Plains Areas of Colorado. In *Hunters of the Recent Past*, edited by L. B. Davis and B. O. K. Reeves, pp. 195-207. Unwin Hyman, London.
- Morrison, David
1981 Chipewyan drift fences and shooting-blinds in the central barren grounds. In *Megaliths to Medicine Wheels: Boulder structures in archaeology*, edited by M. Wilson, K. L. Road, and K. J. Hardy, pp.171-187 *Proceedings of the Eleventh Annual Chacmool Conference*. University of Calgary Archaeological Association, pp. 171-187.
- Morrow, Juliet, and T. A. Morrow
1999 Geographic Variation in Fluted Point Projectile Points: A Hemispheric Perspective. *American Antiquity* 64(2):215-230.

2002 Exploring the Clovis-Gainey-Folsom Continuum: Technological and morphological variation in Midwestern fluted points. In *Folsom Technology and Lifeways*, John E. Clark and Michael B. Collins (Eds.), pp. 140-157. Lithic Technology Special Publication No. 4.
- Mowat, F.
1962 *People of the deer*. Berlin, Seven Seas Publishers.
- Muckelroy, Keith
1978 *Maritime Archaeology*. New Studies in Archaeology, Cambridge University Press, Cambridge and New York.

1980 *Archeology under Water: An Atlas of the World's Submerged Sites*. McGraw-Hill, New York.
- Muller, J. P.
1999 *The McLeod Site: A Small Paleo-Indian Occupation in Southwestern Ontario*. M. A. Thesis, Department of Anthropology, McMaster University, Hamilton, Canada.
- Müller, Rasmus
1907 *Vidtet og jagten i Sydgrønland*. København: H. Hagerup.

- Müller, Sophus
1897 Vor Oldtid: Danmarks Forhistoriske Archæologi. Nabu Press.
- Mullins, Henry T.
1998 Holocene lake level and climate change inferred from marl stratigraphy of the Cayuga Lake basin, New York. *Journal of Sedimentary Research* 68(4):569-578.
- Munsil, Alois
1928 *The Manners and Customs of the Rwala Bedouins*, The American Geographical Society, New York.
- Munson, Patrick J.
1990 Folsom Fluted Projectile Points East of the Great Plains and their Biogeographical Correlates. *North American Archaeologist* 11:255-272.
- Munson, Patrick J. and Curtis W. Marean
2003 Adults only? A reconsideration of Middle Paleolithic 'prime-dominated' reindeer hunting at Salzgitter Lebenstedt. *Journal of Human Evolution* 44(2):263-273.
- Murray, L.
2012 All Aboard the Titanic. *Engineering and Technology* 7(3):28-31.
- Murdoch, John
1892 *Ethnological Results of the Point Barrow Expedition*. Bureau of American Ethnology, Annual Report 9.
- N
- Nadel, D., Bar-Oz, G., Avner, U., Boaretto, E., and D. Malkinson
2010 Walls, ramps and pits: the construction of the Samar desert kites, southern Negev, Israel. *Antiquity* 84:976-992.
- Nadel, D., Bar-Oz, G., Avner, U., Malkinson, D., and E. Boaretto
2013 Ramparts and Walls: Building Techniques of Kites in the Negev Highland. *Quaternary International* 297:147-154.
- Nelleman, George
1970 Caribou hunting in West Greenland. *Folk* 70(11-12):233-153.
- Nelson, E. W.
1899 *The Eskimo about Bering Straight*. 18th ARBE. Pt. I.
- Newby, P., J. Bradley, A. Spiess, B. Shuman, and P. Leduc
2005 A Paleoindian Response to Younger Dryas Climate Change. *Quaternary Science Reviews* 24:141-154.

- Newman, M.E., and P. Julig
1989 Protein residues on lithic artifacts from a stratified boreal forest site. *Canadian Journal of Archaeology* 13:119–132.
- Niven, L., T. E. Steele, W. Rendu, J.-B. Mallye, S. P. McPherron, M. Soressi, J. Jaubert and J.-J. Hublin
2012 Neandertal mobility and large-game hunting: the exploitation of reindeer during the Quina Mousterian at Chez-Pinaud Jonzac (Charente-Maritime, France). *Journal of Human Evolution* 63(4):624-635.
- Nowak, R. M.
1999 *Walker's Mammals of the World*, 6th Edition. Johns Hopkins University Press, Baltimore.
- O**
- O'Connell, Jim F., and J. Allen
2004 Dating the Colonization of Sahul (Pleistocene Australia-New Guinea): a review of recent research. *Journal of Archaeological Science* 31(6):835-853.
- O'Gara, B.W.
2004 Physical characteristics. In *Pronghorn Ecology and Management*, edited by B. O'Gara, and J. D. Yoakum, J.D., pp.109-143. University Press of Colorado, Boulder.
- Odling-Smee, J., Laland, K.N., Feldman, M.W.
2003 *Niche Construction: the Neglected Process in Evolution*. Princeton University Press, Princeton.
- Oetelaar, Gerald Anthony
2014 Better Homes and Pastures: Human agency and the construction of place in communal bison hunting on the Northern Plains. *Plains Anthropologist* 59(229):9-37.
- Ogden, J.G. III
1977 The Late Quaternary Paleoenvironmental Record of the Northeastern North America. In *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by W. S. Newman and B. Salwen, pp. 16-34. Annals of the New York Academy of Sciences 288.
- Oldale, Robert N.
1985 A Drowned Holocene Barrier Spit off Cape Ann, Massachusetts. *Geology* 13:375-377.
- Oltz, D. F., and R. O.Kapp
1963 Plant Remains Associated with Mastodon and Mammoth Remains in Central Michigan. *American Midland Naturalist* 70:339-346.

- Osborn, Gerald, McCarthy, Daniel, LaBrie, Aline, and Randall Burke
 2015 Lichenometric Dating: Science or pseudo-science? *Quaternary Research* 83(1):1-12.
- Osgood, C.
 1958 *Ingalik social structure*. Yale University Publications in Anthropology 74. Yale University Press, New Haven.
- O'Shea, John M.
 2002 The archaeology of scattered wreck-sites: formation processes and shallow water archaeology in western Lake Huron. *The International Journal of Nautical Archaeology* 31(2):211-227.
- 2004 The identification of shipwreck sites: a Bayesian approach. *Journal of Archaeological Science* 31:1533-1552.
- n. d. *Hubbard Lake Survey Report*. Manuscript on file, University of Michigan, Museum of Anthropological Archaeology, Great Lakes Range.
- 2015a Strategies and Techniques for the Discovery of Submerged Sites on the Alpena-Amberley Ridge. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 105-114. University of Michigan Museum of Anthropology Memoirs, No. 57.
- 2015b Constructed Features on the Alpena-Amberley Ridge. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 115-138. University of Michigan Museum of Anthropology Memoirs, No. 57.
- O'Shea, John M. and Guy A. Meadows
 2009 Evidence for early hunters beneath the Great Lakes. *Proceedings of the National Academy of Sciences of the United States of America* 106(25):10120-10123.
- O'Shea, John M., Lemke, Ashley K., and Robert G. Reynolds
 2013 "Nobody Knows the Way of the Caribou": *Rangifer* Hunting at 45° North Latitude. *Quaternary International*, 297:36-44.
- O'Shea, John M., Ashley Lemke, Robert Reynolds, Elizabeth Sonnenburg, and Guy Meadows
 2013 *Approaches to the archaeology of submerged landscapes: Research on the Alpena-Amberley Ridge, Lake Huron*. Proceedings of the 2013 AAUS/ESDP Curaçao Joint International Scientific Diving Symposium, pp. 211-15. American Academy of Underwater Sciences and European Scientific Diving Panel Joint International Scientific Diving Symposium, October 24-27, 2013, Curaçao. American Academy of Underwater Sciences, Dauphin Island, Alabama.

- O'Shea, John M., Lemke, Ashley K., and Elisabeth Sonnenburg
 2015 *Microregional Approaches to Underwater Landscapes and Submerged Archaeological Sites*. Paper presented at the 80th Society for American Archaeology Annual Meeting, San Francisco, CA.
- O'Shea, John M., Lemke, Ashley K., Sonnenburg, Elisabeth, Reynolds, Robert G., and Brian Abbot
 2014 A 9,000- year-old Caribou Hunting Structure beneath Lake Huron, *Proceedings of the National Academy of Sciences*. 111(19):6911-6915.
- Overstreet, D. F., and M. F. Kolb
 2003 Geoarchaeological Contexts for Late Pleistocene Archaeological Sites with Human-Modified Woolly Mammoth Remains in Southeastern Wisconsin, U.S.A. *Geoarchaeology* 18:91-114.
- P**
- Palmer H. A., and J. B. Stoltman
 1976 The Boaz Mastodon: A Possible Association of Man and Mastodon in Wisconsin. *Midcontinental Journal of Archaeology* 1:163-177.
- Panther-Brink, Catherine, Layton, Robert H., and Peter Rowley-Conway (Eds.)
 2001 *Hunter-Gatherers: An Interdisciplinary Perspective*. Cambridge University Press, Cambridge.
- Park, W.
 1938 *Shamanism in Western North America*. Northwestern University, Evanston.
- Pasda, Clemons
 2014 Regional Variation in Thule and Colonial Caribou Hunting in West Greenland. *Arctic Anthropology* 51(1):41-76.
- Peterkin, Gail L., Bricker, Harvey M., and Paul Mellars
 1993 *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia* (Archeological Papers of the American Anthropological Association) Book 4. American Anthropological Association.
- Petitot, E.
 1889 *Quinze ans sous le Cercle Polaire: Mackenzie, Anderson, Youkon*. E. Dentu, Paris.
- Pavlov, P., Svendsen, J.I., Indrelid, S.
 2001 Human presence in the European Arctic nearly 40,000 years ago. *Nature* 413:64-67.

- Pearson, C.E., D.B. Kelley, R.A. Weinstein and S.M. Gagliano
 1986 *Archaeological investigations on the outer continental shelf: a study within the Sabine River valley, offshore Louisiana and Texas*. Washington, DC: US Dept. of Interior, Minerals Management Service.
- Peers, Laura
 1985 Ontario Paleo-Indians and caribou predation. *Ontario Archaeology* 43:31-40.
- Pedersen, Lisbeth
 1995 7000 Years of Fishing: Stationary Fishing Structures in the Mesolithic and Afterwards. In *Man & Sea in the Mesolithic: Coastal Settlement above and below Present Sea Level*, edited by Anders Fischer, pp.75-86. Oxbow Monographs, New York.
- Pelletier, Bertrand G., and Brian S. Robinson
 2005 Tundra, Ice and a Pleistocene Cape on the Gulf of Maine: A Case of Paleoindian Transhumance. *Archaeology of Eastern North America* 33:163-176.
- Pelto, Pertti J.
 1973 *Snowmobile Revolution: Technology and Social Change in the Arctic*. Waveland Press.
- Pelton, Spencer
 2012 Putting Rollins Pass on the map: revitalizing the research of a high altitude archaeological landscape. *Southwestern Lore* 78(1):54-57.
- Person, S. J., R. G. White, and J. R. Luick
 1980 Determination of Nutritive Value of Reindeer-Caribou Range. In *Proceedings of the 2ed International Reindeer/Caribou Symposium, Rovos, Norway, 1979*, edited by E. Reimers, E. Gaare and S. Skjenneberg, pp. 224-239. Direktoratet for vilt og ferskvannsfisk, Trondheim, Norway.
- Peteet, Dorothy
 2000 Sensitivity and Rapidity of Vegetational Response to Abrupt Climate Change. *Proceedings of the National Academy of Sciences of the United States of America* 97(4): 1359-1361.
- Petersen, Peter Vang and Lykke Johansen
 1991 Solbjerg I – An Ahrensburgian Site on a Reindeer Migration Route through Eastern Denmark. *Journal of Danish Archaeology* 10(1):20-37.
- Petersen, Robert
 2003 Settlement, Kinship and Hunting Grounds in Traditional Greenland. *Meddelelser om Grønland, Man & Society* 27. Copenhagen: Danish Polar Center.
- 1963 Family Ownership and Right of Disposition in Sukkertoppen District, West Greenland. *Folk* 5:269–281.

- Pettit, P. B.
2010 *The Paleolithic Origins of Human Burial*. Routledge.
- Pettitt, P. B. and E. Trinkaus
2000 Direct Radiocarbon dating of the Brno 2 Gravettian human remains. *Anthropologie (Brno)* 38:149-150.
- Picalause, P., Cauwe, N., Lemaitre, S., Vander Linden, M., and P. L. Van Berg, P. L. (
2004 Desert-kites of the Hemma Plateau (Hassake, Syria), *Paléorient* 30(1):89–99.
- Pidoplichko, I. G.
1969 *Pozdnepaleliticheskiye zhillscha iz kosiei mamonta na Ukraine*. Naukova Dumba. Kiev.
- Pike-Tay, A. and H. M. Bricker
1993 Hunting in the Gravettian: An examination of evidence from southwestern France. In *Hunting and animal exploitation in the Later Palaeolithic and Mesolithic of Eurasia*, edited by Gail Larsen Peterkin, H. M. Bricker, and P. Mellars, *Archaeological Papers of the American Anthropological Association* 4.
- Pitulko, V.V., Nikolsky, P.A., Girya, E.Y., Basilyan, A.E., Tumskey, V.E., Koulakov, S.A., Astakhov, S.N., Pavlova, E.Y., Anisimov, M.A.
2004 The Yana RHS site: humans in the Arctic before the Last Glaciation. *Science* 303:52-56.
- Polikarpovich, K. M.
1968 *Paleolit verhnego podneprovya*. Nauka i Tekhnika. Minsk.
- Politis, Gustavo
2005 *Myths about Tropical Rainforest Hunter-Gatherers: A Reappraisal from South America*. Paper presented at the 18th Annual Meeting of the Society for American Archaeology, San Francisco, California.
- Popov, A. A.
1966 *The Nganasan: The Material Culture of the Tavgi Samoyeds*. E. K. Ristinen (Translator), Uralic and Altaic Series, Indiana University. The Hague, Mouton.
- Prentiss, Anna Marie, Lyons, Natasha, Harris, Lucille, E., Burns, Melissa R. P., and Terrence M. Godin
2007 The Emergence of Status Inequality in Intermediate Scale Societies: A Demographic and Socio-Economic History of the Keatley Creek site, British Columbia. *Journal of Anthropological Archaeology* 26: 299-327.
- Prentiss, Anna Marie, Foor, Thomas A., Cross, Guy, Harris, Lucille, E., and Michael Wanzneried

2012 The Cultural Evolution of Material Wealth-Based Inequality at Bridge River, British Columbia. *American Antiquity* 77(3):542-564.

Prufer, O., and R. Baby

1963 *Paleo-Indians of Ohio*. Ohio Historical Society. Columbus.

Pruitt, W. O.

1960 Behavior of the barren-ground caribou. *Biological Papers of the University of Alaska* 3:1-43.

Pullen, W. J. S.

1852 *Journal of the Proceedings of the Party from the River Mackenzie towards Cape Bathurst*. Further Correspondence and Proc. Conn. With the Arctic Exp. Pres. Both Houses of Parl. London.

Purdy, Barbara A.

1988. *Wet Site Archaeology*. Telford Press, Caldwell.

Q

Quenet, P., and M.-L. Chambrade

2013 Nouveaux kites en Jezireh syrienne, *Studia Orontica* XI:61-76.

Quimby, G. I.

1961 *Indian Life in the Upper Great Lakes*. University of Chicago Press. Chicago.

R

Rae, J.

1850 *Narrative of an Expedition to the Shores of the Arctic Sea*. London.

Rankama, Tuija and Pirkko Ukkonen

2008 On the Early History of the Wild Reindeer (*Rangifer tarandus* L.) in Finland. *Boreas* 30:131-146.

Rasmussen, K.

1925 *Fra Gronland til Stillehavet*, vol. 1. Copenhagen.

1930 Observations on the intellectual culture of the Caribou Eskimos. *Report of the Fifth Thule Expedition, 1921-1924. Vol. II, Part 2*. Gyldendal, Copenhagen.

Raymond, Anan

1982 Two Historical Game-drive Enclosures in the Eastern Great Basin. *Journal of California and Great Basin Anthropology* 4:23-33.

Redmond, Brian G., and Kenneth B. Tankersley

- 2005 Evidence of Early Paleoindian Bone Modification and Use at the Sheridan Cave Site (33WY252), Wyandot County, Ohio. *American Antiquity* 70(3):503-526.
- Reeves, B. O. K.
1978 Head-Smashed-In: 5500 Years of Bison Jumping in the Alberta Plains. *Plains Anthropologist* 23(82):151-174.
- Reher, C. A., and Frison, G.C.
1980 The Vore Site, 48CK302: a stratified buffalo jump in the Wyoming Black Hills. *Plains Anthropologist* 25(88) Part 2.
- Reimers, E.
1972 Growth in domestic and wild reindeer in Norway. *Journal of Wildlife Management* 36(2):612-619.
- Reimers, E., and T. Ringberg
1983 Seasonal changes in body weight of Svalbard reindeer from birth to maturity. *Acta Zoologica Fennica* 175:69- 72.
- Rich, Edwin Ernest
1967 *The Fur Trade and the Northwest to 1857*. Mecllelland and Stewart Ltd.
- Riches, D.
1982 *Northern Nomadic Hunter-gatherers*. Academic Press, New York.
- Rick, John W.
1988 Identificando el Sedentarismo Pre- histórico en los Cazadores Recolectores: un Ejemplo de la Sierra Sur del Perú, in Llmichos y Paqocheros, in *Pastores de Llamas y Alpacas*, edited by Jorge Flores Ochoa, pp. 37-43. Centro de Estudios Andinos, CEAC, Cusco.
- Rick, T. C., Erlandson, J. M., & Vellanoweth, R. L.
2001 Paleocoastal marine fishing on the Pacific Coast of the Americas: Perspectives from Daisy Cave, California. *American Antiquity* 66:595–613.
- Rick, Torben C., Erlandson, Jon M., Vellanoweth, René L., and Todd J. Braje
2005 From Pleistocene Mariners to Complex Hunter-Gatherers: The Archaeology of the California Channel Islands. *Journal of World Prehistory* 19:169-228.
- Ritchie, W. A.
1957 *Traces of early man in the Northeast*. New York State Museum and Science Service Bulletin 358, Rochester: New York State Museum and Science Service.
- Rivals, F., S. Kacimi and J. Moutoussamy

- 2004 Artiodactyls, favourite game of prehistoric hunters at the Caune de l'Arago Cave (Tautavel, France). Opportunistic or selective hunting strategies? *European Journal of Wildlife Research* 50(1):25-32.
- Rivals, Florent and Nikos Solounias
2007 Differences in Tooth Microwear of Populations of Caribou (*Rangifer taradus*, Ruminantia, Mammalia) and Implications to Ecology, Migration, Glaciations, and Dental Evolution. *Journal of Mammal Evolution* 14:182-192.
- Roberts, Patrick, Krigbaum, John, and Julia Lee-Thorp
In Press Hunting and Gathering in Prehistoric Rainforests: Insights from Stable Isotope Analysis, in *Foraging in the Past: Archaeological Studies of Hunter-Gatherer Diversity*, edited by Ashley K.Lemke. University Press of Colorado.
- Robinson, B. S., J. C. Ort, W. A. Eldridge, A. L. Burke and B. G. Pelletier
2009 Paleoindian Aggregation and Social Context at Bull Brook. *American Antiquity* 74(3):423.
- Røed, Knut H.
2005 Refugial origin and postglacial colonization of Holarctic reindeer and caribou. *Rangifer* 25:19-30.
- Rogers, E. S. and J. G. E. Smith
1981 Environment and Culture in the Shield and Mackenzie Borderlands. In *Handbook of North American Indians, Vol. 6: Subarctic*, edited by J. Helm, pp.130-145. Smithsonian Institute, Washington D. C.
- Rolland, Nicolas and Harold L. Dibble
1990 A New Synthesis of Middle Paleolithic Variability. *American Antiquity* 55(3):480-499.
- Roosa, William B.
1965 Some Great Lakes fluted point types. *Michigan Archaeologist* (9)89-102.

1968 *Data on early sites in central New Mexico and Michigan*, Ph.D. Dissertation, University of Michigan, Ann Arbor.

1977a Great Lakes Palaeo-Indian: The Parkhill site, Ontario. In *Amerinds and Their Palaeoenvironments in Northeastern North America*, edited by Walter S. Newman and Bert Salwen, pp. 349-354. Annals of the New York Academy of Sciences 288.

1977b *Fluted points from the Parkhill, Ontario site*. Museum of Anthropology, University of Michigan, Anthropological Paper 61: 87-122.
- Roosa, W.B. and D.B. Deller

- 1982 The Parkhill Complex and eastern Great Lakes Paleo Indian. *Ontario Archaeology* 3(7): 3-15.
- Ross, J.
1835 *Narrative of a Second Voyage in Search of a North-West Passage*. London.
- Rowley-Conwy, Peter
1983 Sedentary hunters: the Ertebølle example. In *Hunter-gatherer Economy*, edited by G. N. Bailey, pp. 111–126. Cambridge University Press, Cambridge.
- 2001 Time, change and the archaeology of hunter-gatherers: how original is the ‘Original Affluent Society’. In *Hunter-gatherers: an interdisciplinary perspective*, edited by C. Panter-Brick, R. Layton and P. Rowley-Conwy, pp. 39–72. Cambridge University Press, Cambridge.
- Ruppe, R. J.
1980 *The archaeology of drowned terrestrial sites: A preliminary report*. Talahasee: Bureau of Historic Sites and Properties.
- Rust, A.
1943 *Die Alt-und mittelsteinzeitlichen Funde von Stellmoor*. Wachholtz Verlag, Neumünster.
- 1962 *Vor 20000 Jahren. Retierjäger der Eiszeit*. Neumünster.
- S**
- Saladin d’Anglure, B. and M. Vézinet
1977 Chasses collectives au caribou dans le Québec arctique. *Inuit Studies* 1(2):97-110.
- Sassaman, Kenneth E.
2004 Complex Hunter-Gatherers in Evolution and History: A North American Perspective. *Journal of Archaeological Research* 12(3):227-280.
- Sawyer, H. and M. J. Kauffman
2011 Stopover Ecology of a Migratory Ungulate. *Journal of Animal Ecology* 80(5):1078-1087.
- Schaeffer, Claude E. and Mrs. Schaeffer
1934 *Field work among Blackfeet Indians, Montana*. Correspondence and field notes M1100-119-154. On file and online at the Glenbow Museum, Calgary, Alberta.
- Schaetzl, R. J., S. A. Drzyzga, B. N. Weisenborn, K. A. Kincare, X. C. Lepczyk, K. Shein, C. M. Dowd, and J. Linker
2002 Measurement, Correlation, and Mapping of Glacial Lake Algonquian Shorelines in Northern Michigan. *Annals of the Association of American Geographers* 92:399-415.

- Schaller, G. B.
1998 *Wildlife of the Tibetan Steppe*. University of Chicago Press, Chicago.
- Schuler, A.
1994 *Die Schussenquelle: Eine Freilandstation des Magdalenien in Oberschwaben*. Stuttgart, Materialheft zur Archäologie.
- Schwatka, F.
1884 *The Neitschilluk Innuits*. Science. Vol. IV. Cambridge, Massachusetts.
- Scott, Eric
2010 Extinctions, Scenarios, and Assumptions: Changes in latest Pleistocene large herbivore abundance and distribution in western North America. *Quaternary International* 217:225-239.
- Scuvée, F., and J. Verague
1988 *Le Gisement Sous-Marin Du Paléolithique Moyen de L'anse de La Mondrée À Fermanville, Manche*. Cherbourg: C.E.H.P-Littus.
- Seeman, Mark F.
1994 Intercluster Lithic Patterning at Nobles Pond: A Case for "Disembedded" Procurement among Early Paleoindian Societies. *American Antiquity* (59)2:273-288.
- Seeman, Mark F., Nils E Nilsson, Garry L Summers, Larry L Morris, Paul J Barans, Elaine Dowd, and Margaret E Newman
2008 Evaluating Protein Residues on Gainey Phase Paleoindian Stone Tools. *Journal of Archaeological Science* 35(10): 2742.
- Semken, Holmes A., Graham, Russell W. and Thomas W. Stafford Jr.
2010 AMS 14C analysis of Late Pleistocene non-analog faunal components from 21 cave deposits in southeastern North America. *Quaternary International* 217:240-255.
- Service, Elmen
1966 *The Hunters*. Prentiss-Hall, Englewood Cliffs, New Jersey.
- Shane, L. K.
1994 Intensity and Rate of Vegetation and Climatic Change in the Ohio Region between 14,000 and 9,000 YBP. In *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, edited by W. S. Dancey, pp. 23-42. Ohio Archaeological Society, Columbus.
- Shott, Michael J.,
1986 *Settlement mobility and technological organization among Great Lakes Paleo-Indian foragers*. Ph.D. Dissertation, Department of Anthropology, University of Michigan; Ann Arbor.

- 1990 Stone Tools and Economics: Great Lakes Paleoindian Examples. In *Early Paleoindian Economies of Eastern North America*, edited by K. B. Tankersley and B. L. Isaac, pp. 3-43. Research in Economic Anthropology, Supplement 5. JAI Press, Greenwich, Connecticut.
- 1993 *The Leavitt Site: A Parkhill Phase Paleo-Indian Occupation in Central Michigan*. Memoirs No. 25. Museum of Anthropology, University of Michigan, Ann Arbor.
- Shovkoplyas, I. G.
1965 *Mezinsksya stoyanka*. Naukova Dumka. Kiev.
- Shuman, B., Bartlein, P., Webb III, T.
2005 The magnitudes of millennial- and orbital-scale climatic change in eastern North America during the Late Quaternary. *Quaternary Science Reviews* 24:2194–2206.
- Sidney, A.
1980 *Place names of the Tagish Region, southern Yukon*. Whitehorse: Yukon Native Languages Project, Council for Yukon Indians.
- Simchenko, Y. B.
1976 *The culture of reindeer hunters of northern Eurasia*. Moscow.
- Simeone, William E.
2007 People of the river: the subsistence economy of the Han, Athabaskan people of the Upper Yukon River. In *International Handbook of Research on Indigenous Entrepreneurship*, edited by Léo-Paul Dana and Robert B. Anderson, pp. 313-327. Edward Elgar, Glos, U.K.
- Simons, Alan H.
2014 *Stone Age Sailors: Paleolithic Seafaring in the Mediterranean*. Routledge.
- Simons, Donald B.
1997 The Gainey and Butler sites as focal points for caribou and people. In *Caribou and Reindeer Hunters of the Northern Hemisphere*, edited by Lawrence J. Jackson and Paul T. Thacker, pp. 105–31. Avebury, Brookfield, Vermont.
- Simons, Donald B., Michael J. Shott, and Henry T. Wright
1984 The Gainey site: Variability in a Great Lakes Paleo-Indian assemblage. *Archaeology of Eastern North America* 12:266–79. Buffalo.
- Simons, Donald B., and Henry T. Wright
1992 Butler 1991: Excavations at a Fluted Point Site in the Central Great Lakes (20GS104). *Current Research in the Pleistocene* 9:35-37.
- Simpson, T.
1843 *Narrative of the Discoveries on the North Coast of America*. London.

- Skaarup, J.
 1983 Submarine Stenalderboplads I Det Sydfynske Øhav. *Antikvariske Studier* 6, Fredningsstyrelsen, Copenhagen.
- 1993 Submerged Settlements. In *Digging Into the Past: 25 Years of Archaeology in Denmark*, edited by S. Hvass and B. Storgaard. Jutland Archaeological Society Publications, Aarhus University Press.
- Skoog, R. O.
 1968 *Ecology of the caribou (Rangifer tarandus granti) in Alaska*, ProQuest, UMI Dissertations Publishing.
- Skorupka, M.
 2010 Les “Desert Kites” Yéménites, Une Relecture Critique des Données, *Chroniques Yéménites* 16:5–14.
- Sly, P. G. and C.F. M. Lewis
 1972 *The Great Lakes of Canada-Quaternary Geology and Limnology. Guidebook for Field Excursions A43*. 24th International Geological Congress, Montreal.
- Smith, Bruce
 2007 Niche construction and the behavioral context of plant and animal domestication. *Evolutionary Anthropology* 16:188-199.
- 2011 General patterns of niche construction and the management of wild plant and animal resources by small-scale societies. *Philosophical Transactions of the Royal Society B*, 336:pp.836-848.
- 2013 Modifying Landscapes and mass kills: Human niche construction and communal ungulate harvests. *Quaternary International*. 297:8-12.
- Smith, James G. E.
 1981 Chipewyan, Cree, and Inuit Relations West of Hudson Bay, 1714-1955. *Ethnohistory* 28(2):133-156.
- Smith, James G. E., and Ernest S. Burch Jr.
 1979 Chipewyan and Inuit in the Central Canadian Subarctic, 1613-1977. *Arctic Anthropology* 16(2):76-101.
- Soffer, Olga
 1985 *The Upper Paleolithic of the Central Russian Plain*. Academic Press.
- Soffer, Olga, and James M. Adovasio
 2010 The Roles of Perishable Technologies in Upper Paleolithic Lives. In *The Magdalenian Household: Unraveling Domesticity*, edited by Ezra Zubrow, Ezra,

- Françoise Audouse and James G. Enloe, pp. 235-245. State University of New York Press.
- Spencer, J.W.
1888 Notes on the origin and history of the Great Lakes of North America: *Proceedings of the American Association for the Advancement of Science* 37:197-199.
- Spencer, R. F.
1959 *The North Alaskan Eskimo: A Study in Ecology and Society*. Bulletin No. 171. Bureau of American Ethnology, Smithsonian Institution, Washington, D.C.
- Speth, John D.
2004 News flash: Negative evidence convicts Neanderthals of gross mental incompetence. *World Archaeology* 36(4):519-526.

2010 *The Paleoanthropology and Archaeology of Big-Game Hunting Protein, Fat, or Politics*. New York, NY, Springer.
- Speth, J. D., K. Newlander, A. A. White, A. K. Lemke and L. E. Anderson
2013 Early Paleoindian big-game hunting in North America: Provisioning or Politics? *Quaternary International* 285:111-139.
- Speth, J. D. and K. A. Spielmann
1983 Energy Source, Protein Metabolism, and Hunter-Gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2(1):1-31.
- Spiess, A.E.
1979 *Reindeer and Caribou Hunters: An Archaeological Study*. Academic Press, New York.
- Spiess, A. E., Curran, M. L., and J. R. Grimes
1985 Caribou (*Rangifer tarandus L.*) bones from New England Paleoindian sites. *North American Archaeologist* 6: 145-156.
- Spiess, A. E., D. Wilson, and J. W. Bradley
1998 Paleoindian occupation in the New England-Maritimes region: Beyond cultural ecology. *Archaeology of Eastern North America* 26:201-64.
- Spiess, A. E., and P. L. Storck
1990 New Faunal Identifications from the Udora Site: A Gainey-Clovis Occupation Site in Southern Ontario. *Current Research in the Pleistocene* 7:127-129.
- Stanford, Dennis, Lowery, Darrin, Jodry, Margaret, Bradley, Bruce A., Kay, Marvin, Stafford, Thomas W., and Robert J. Speakman
2014 Evidence for a Possible Paleolithic Occupation of the Eastern North American Continental Shelf at the Last Glacial Maximum. In *Prehistoric Archaeology on the*

Continental Shelf, edited by Amanda Evans, Joe Flatman, and Nicholas C. Flemming, pp.73-94. Springer.

Steadman, D. W., and R. E. Funk

1987 New Paleontological and Archaeological Investigations at Dutchess Quarry Cave No.8, Orange County, New York. *Current Research in the Pleistocene* 4:118-120.

Steensby, Hans Peder

1910 *Contributions to the Ethnology and Anthropogeography of the Polar Eskimos.*

Steele, T., Niven, L., Britton, K., Grimes, V., Mallye, J.B., Rendu, W., Richards, M.

2009 *Neanderthal exploitation of reindeer in the Quina Mousterian a Chez Pinaud, Jonzac (France): zooarchaeological and isotopic evidence.* Paleoanthropological Society of America Meeting Abstracts, Chicago, IL.

Stefansson, Vilhjalmur

1914 *The Stefánsson-Anderson Arctic Expedition of the American Museum: Preliminary Ethnological Report.* Anthropological Papers of the American Museum of Natural History.vol. XIV, Pt. 1, 1 p. 1. The Trustees, New York.

1919 *The Stefanson-Anderson Arctic Expedition of the American Museum, Preliminary Ethnological Report.* American Museum of Natural History (Anthropological Paper of the American Museum of Natural History, vol. XVI part 1). New York.

1921 *The Friendly Arctic.* New York.

1951 *My Life with the Eskimo.* The Macmillan Company, New York.

Steward, Julian

1938 *Basin-Plateau Aboriginal Socio-Political Groups.* Bulletin Number 120. Bureau of American Ethnology. Washington, Government Printing Office.

1941 Culture Element Distributions: XIII, Nevada Shoshone. *University of California Anthropological Records* 4(2):209-259.

1943 Culture Element Distributions: XXIII Northern and Gosiute Shoshone. *University of California Anthropological Records* 8(3):263-392.

Stewart, Andrew M.

1984 The Zander Site: Paleo-Indian Occupation of the Southern Holland Marsh Region of Ontario. *Ontario Archaeology* 41 (1984): 45–79.

2014 *Viewing Cultural Landscapes in the Long and Short Term: Inland Inuit Settlement Patterning on the Lower Kazan River, Nunavut, Canada.* Paper presented at the 79th Annual Meeting of the Society for American Archaeology, Austin, Texas.

- 2015 Searching for Archaeological Evidence on the Alpena-Amberley Ridge – Is the Arctic Record Informative? *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O’Shea, pp. 81-104. University of Michigan Museum of Anthropology Memoirs, No. 57.
- Stewart, A., Freisen, T., Keith, D., and L. Henderson
2000 Archaeology and Oral History of Inuit land use on the Kazan River, Nunavut: a feature-based approach. *Arctic* 53:260-278.
- Stewart, A., Keith, D., and J. Scottie
2004 Caribou crossings and cultural meanings: placing traditional knowledge and archaeology in context in a Inuit landscape. *Journal of Archaeological Method and Theory* 11:83-112.
- Stewart, Brian A., and Peter Mitchell
In Press Beyond the Shadow of a Desert: Illuminating Southern Africa’s Foraging Spectra, in *Foraging in the Past: Archaeological Studies of Hunter-Gatherer Diversity*, edited by Ashley K. Lemke, University Press of Colorado.
- Stiner, M.C., Barkai, R., Gopher, A.
2009 Cooperative hunting and meat sharing 400–200 kya at Qesem Cave, Israel. *Proceedings of the National Academy of Sciences of the United States of America* 106:13207–13212.
- Stickel, E. Gary, and Ervan G. Garrison
1988 New applications of remote sensing: Geophysical prospection for underwater archaeological sites in Switzerland. In *Wet Site Archaeology*, Purdy, Barbara (Ed.), pp. 69-88. Telford Press. Cladwell.
- Stopp, M. P.
1994 Cultural utility of the cobble beach formation in coastal Newfoundland and Labrador. *Northeast Anthropology* 48:69–89.
- 2002 Ethnohistoric analogues for storage as an adaptive strategy in northeastern subarctic prehistory. *Journal of Anthropological Archaeology* 21:301–28.
- Storck, Peter L.
1979 *A Report on the Banting and Hussey Sites: Two Palaeo-Indian Campsites in Simcoe County, Southern Ontario*. National Museum of Man, Mercury Series, Archaeological Survey of Canada 93.
- 1982 Paleo-Indian settlement patterns. *Canadian Journal of Archaeology* 6: 1-32.
- 1983 The Fisher Site, fluting techniques, and Early Paleo-Indian cultural relationships. *Archaeology of Eastern North America* 11:80-97

- 1984 Glacial Lake Algonquin and Early Paleo-Indian Settlements Patterns in Southcentral Ontario. *Archaeology of Eastern North America* 12:286-298.
- 1997 *The Fisher Site: Archaeological, Geological and Paleobotanical Studies at an Early Paleo-Indian Site in Southern Ontario, Canada*. Memoirs, No. 30. Museum of Anthropology, University of Michigan, Ann Arbor.
- 2004 *Journey to the Ice Age: Discovering an Ancient World*. University of Washington Press, Seattle.
- Storck, Peter L., and Arthur E. Spiess
 1994 The significance of new faunal identifications attributed to an Early Paleoindian (Gainey complex) occupation at the Udora site, Ontario, Canada. *American Antiquity* 59(1):121-42.
- Storemyr, Pet
 2011 The Ancient Stone-Built Game Traps at ghard Aswan and Beyond, Lower Nubia and Upper Egypt. *Sahara* 22:15-28.
- Straus, Lawrence Guy
 1987 Hunting in Late Upper Palaeolithic Western Europe. In *The Evolution of Human Hunting*, edited by M. Nitecki and D. Nitecki, pp. 147-176. Plenum Press, New York.
- 1993 *Upper Paleolithic Hunting Tactics and Weapons in Western Europe*. Archaeological Papers of the American Anthropological Association 26(1):84-93.
- Stright, M. J.
 1990 Archaeological sites on the North American continental shelf. *Geological Society of America Centennial Special* 4:439-465.
- 1995 Archaic period sites on the continental shelf of North America: The effects of relative sea-level changes on archaeological site locations and preservation. In *Archaeological Geology of the Archaic Period in North America: Geological Society of America*, edited by E. A. III Bettis, pp. 131-147. Geological Society of America, Boulder.
- Sturdy, D. A.
 1975 Some reindeer economies in prehistoric Europe. In *Palaeoeconomy* edited by E. S. Higgs, pp. 55-96. Cambridge University Press, Cambridge.
- Sullivan, Alan P. III
 2007 Archaeological Anthropology and Strategies of Knowledge Formation in American Archaeology, in *Archaeological Anthropology: Perspectives on Method and Theory*, Skibo, edited by James M., Graves, Michael W., and Miriam T. Stark, pp. 40-56. University of Arizona Press, Tucson.

- Surovell, T. A. and N. M. Waguespack
2008 How many elephant kills are 14? Clovis Mammoth and Mastodon Kills in Context. *Quaternary International* 191:82-97.
- 2009 Human prey choice in the late Pleistocene and its relation to megafaunal extinctions. In *American Megafaunal Extinctions at the End of the Pleistocene*, edited by G. Haynes, pp. 77-105. Springer.
- Sonnenburg, Elizabeth
2015 *Paleoenvironmental Reconstruction of the Alpena-Amberley Ridge Submerged Landscape during the Lake Stanley Lowstand (ca. 8.4-9 ka cal BP), Lake Huron*. In *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*, edited by E. Sonnenburg, A. K. Lemke, and J. O'Shea, pp. 147-164. University of Michigan Museum of Anthropology Memoirs No. 57.
- Sonnenburg, Elizabeth, Boyce, Joseph I., and Eduard G. Reinhardt
2011 Quartz flakes in lakes: Microdebitage evidence for submerged Great Lakes prehistoric (Late Paleoindian-Early Archaic) tool-making sites. *Geology* 39(7):631-634.
- Sonnenburg, Elizabeth, O'Shea, John M., and Ashley K. Lemke
2015a *Where the Hunters Hunted: Paleoenvironmental Reconstruction of the Submerged Archaeological Landscapes of the Alpena-Amberley Ridge, Lake Huron*. Paper presented at the 80th Annual Meeting of the Society for American Archaeology, San Francisco.
- Sonnenburg, Elizabeth, Lemke, Ashley K., and John M. O'Shea
2015b *Caribou Hunting in the Upper Great Lakes: Archaeological, Ethnographic, and Paleoenvironmental Perspectives*. University of Michigan Museum of Anthropology Memoirs No. 57.
- Sommer, R.S., Zachos, F.E., Street, M., Jöris, O., Skog, A. and N. Benecke
2008 Late Quaternary distribution dynamics and phylogeography of the red deer (*Cervus elaphus*) in Europe. *Quaternary Science Reviews* 27:714-733.
- Sommer, R.S., Fahlke, J., Schmölcke, U., Benecke, N. & Zachos, F.E.
2009 Quaternary history of the European roe deer (*Capreolus capreolus*). *Mammal Review* 38:1-16.
- Sommer, R. S., Kalbe, J., Ekström, J. Benecke, N., and R. Liljegen
2014 Range Dynamics of the Reindeer in Europe during the last 25,000 years. *Journal of Biogeography* 41:298-306.
- Sommer, R. S., and A. Nadachowski
2006 Glacial Refugia of Mammals in Europe: Evidence from fossil records. *Mammal Review* 36(4):251-265.

Straus, L.G.

1995 Les Derniers Chasseurs de Rennes du Monde Pyrénéen. L'Abri Dufaure: Un Gisement Tardiglaciaire en Gascogne. Mémoire de la Société Préhistorique Française 22, Paris.

Sundstrom, L.

2000 Cheyenne pronghorn procurement and ceremony. In *Pronghorn Past and Present: Archaeology, Ethnography, and Biology*, edited by J.V. Pastor and P.M. Lubinski, pp. 119-132. Plains Anthropologist Memoir, vol. 32.

Svoboda, Jiří

1993 The Complex Origin of the Upper Paleolithic in the Czech and Slovak Republics. In *Before Lascaux: The Complex Record of the Early Upper Paleolithic*, edited by Heidi Knecht, Anne Pike-Tay, and Randall White, pp.23-36. Crc Pr L Llc.

2008 The Upper Paleolithic Burial Area at Předmostí: Ritual and taphonomy. *Journal of Human Evolution* 54:15-33.

T

Taylor, J. G

1969 William Turner's Journeys to the Caribou Country with the Labrador Eskimos in 1780. *Ethnohistory* 16(2):14.

Teale, Chelsea L., and Norton G. Miller

2012 Mastodon Herbivory in Mid-Latitude Late-Pleistocene Boreal Forests of Eastern North America. *Quaternary Research* 78:72-81.

Teit, James A.

1909 *The Shuswap, Jessup North Pacific Expedition* Vol 2, Part 5. Memoirs of the American Museum of Natural History, New York.

Terasmae, J., and H. L. Mathews

1980 Late Wisconsin White Spruce (*Picea glauca* (Moench) Voss) at Brampton Ontario. *Canadian Journal of Earth Sciences* 17:1087-1095.

Tester, Frank James and Peter Kulchyski

1994 *Tammarniit (Mistakes): Inuit Relocation in the Eastern Arctic, 1939-63*. UBC Press, Vancouver.

Thacker, P. T.

1997 The significance of *Rangifer* as a human prey species during the central European upper Paleolithic. *Caribou and reindeer hunters of the Northern Hemisphere*, edited by L. J. Jackson and P. T. Thacker, pp. 82-104. Ashgate Publishing, Vermont.

- Thalbitzer, W.
1914 Ethnographical Collections from East Greenland. *Meddelelser om Grønland* 39. Bianco Lunos, Copenhagen.
- Throckmorton, Peter
1970 *Shipwrecks and Archaeology; the Unharvested Sea*. 270 p. London.
- Timmins, Peter
1994 Alder Creek: A Paleo-Indian Crowfield Phase Manifestation in the Region of Waterloo, Ontario. *Midcontinental Journal of Archaeology* 19(2): 170–97.
- Todd, L.C., Jones, D.C., Walker, R.S., Burnett, P.C., Eighmy, J.
2001 Late Archaic bison hunters in Northern Colorado. *Plains Anthropologist* 46 (176):125-147.
- Tode, A.
1953 Die Untersuchung der paläolithischen Freilandstation von Salzgitter-Lebenstedt. 8. Einige archäologische Erkenntnisse aus der paläolithischen Freilandstation von Salzgitter-Lebenstedt. *Eiszeitalter und Gegenwart* 3:192–215.
- Tuck, James A.
1974 Early Archaic Horizons in Eastern North America. *Archaeology of Eastern North America* 2(1):72-80.
- Turner, Lucien M.
1894 *Ethnology of the Ungava District*. U.S. Bureau of American Ethnology. Eleventh Annual Report, p. 159-350. Washington.
- Tyrrell, J. W.
1897 *Across the Sub-Arctics of Canada*. William Briggs, Toronto.
- U**
- V**
- Van Berg, P.L., Vander Linden, M., Lemaitre, S., Cauwe, N., and V. Picalause
2004 Desert-kites of the Hemma Plateau (Hassake, Syria). *Paléorient* 30(1):89-99.
- Verechagin, N. K.
1971 Okhota pervobytnogo cheloveka I vymiraniye Pleistotsennovih mlyekopitayuschih v SSSR. In *Materialy po faunam Antoprogena SSSR*, edited by N. K. Vereschagin. Trudy Zoologicheskogo Instituta XLIX: 123-193. Leningrad Nauka.

1977 Berelyohoskoye “kladibische” mamontov. In *Mamontovaya fauna Russkoi ravnini*, edited by A. O. Skarlato. Trudy Zoologicheskogo Instituta LXXII: 5-50. Leningrad Nauka.

1979 *Pochemu vymerli mamonty*. Leningrad Nauka.

Viebe, C.

1967 Arctic animals in relation to climatic fluctuations. *Meddeleser om Gronland* 170(5):1-227.

Vorren, Ø.

1958 Samisk villreinfangst i elder tid. *Ottar* 17.

W

Waguespack, N. M. and T. A. Surovell

2003 Clovis Hunting Strategies, or How to Make out on Plentiful Resources. *American Antiquity* 68(2): 333-352.

Wakelyn, Leslie

1993 *The Qamanirjuaq herd: An Arctic Enigma*. The Beverly and Qamanirjuaq Caribou Management Board, Iqaluit.

Walthall, John A.

1998 Overwinter Strategy and Early Holocene Hunter-Gatherer Mobility in Temperate Forests. *Midcontinental Journal of Archaeology* 23(1):1-22.

1999 Mortuary Behavior and Early Holocene Land Use in the North American Midcontinent. *North American Archaeologist* 20:1-30.

Waters, M. R., Stafford, T. W., McDonald, H. G., Gustafson, C. Rasmussen, M. Cappellini, E., Olsen, J. V., Szldarcyk, D., Jensen, L. J., Gilbert, M. T. P., E. Willerslev

2011 Pre-Clovis Mastodon Hunting 13,800 Years Ago at the Manis Site, Washington. *Science* 334:351-353.

Webb, David S.

2006 *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*. Springer, New York.

Weniger, G.

1982 *Wildbeuter und ihre Umwelt*. Tübingen, Institut für Urgeschichte der Universität Tübingen.

- Weinstein-Evron, Mina, and Ehud Galili
 1985 Prehistory and Paleoenvironments of Submerged Sites along the Carmel Coast of Israel. *Paléorient* 11 (1): 37–52.
- Werz, B.E.J.S, and N.C Flemming
 2001 Discovery in Table Bay of the Oldest Handaxes yet Found Underwater Demonstrates Preservation of Hominid Artefacts on the Continental Shelf. *South African Journal of Science* 97 (5-6): 183.
- Wheeler, E. P.
 1930 Journeys about Nain Winter Hunting with the Labrador Eskimo. *Geographical Review* 20(3):454-468.
- White, Andrew A.
 2006 A Model of Paleoindian Hafted Biface Chronology in Northeastern Indiana. *Archaeology of Eastern North America* 34:29-59.
- 2012 *The Social Networks of Early Hunter-Gatherers in Midcontinental North America*. Ph.D. Dissertation, University of Michigan.
- 2013 Functional and Stylistic Variability in Paleoindian and Early Archaic Projectile Points from Midcontinental North America. *North American Archaeologist* 34(1):71.
- White, R. G.
 1982 Rethinking the Middle/Upper Paleolithic transition. *Current Anthropology* 23:169–192.
- 1985 *Upper Paleolithic Land Use in the Perigord: a Topographic Approach to Subsistence and Settlement*. British Archaeological Reports International Series 253, Oxford.
- White, R., P. G. Bahn, J. Clottes, R. Cribb, F. Delpech, T. F. Kehoe, D. J. Olszewski, L. G. Straus, D. Sturdy and J. Svoboda
 1989 Husbandry and Herd Control in the Upper Paleolithic: A Critical Review of the Evidence [and Comments and Reply]. *Current Anthropology* 30(5):609.
- White, R. G., Bunnell, F. L., Gaare, E., Skogland, T., and B. Hubert
 1980 Ungulates on Arctic Ranges. In *Tundra Ecosystems: A comparative analysis*, edited by L. C. Bliss, O. W. Heal, and J. J. Moore, pp.397-485. Cambridge University Press, Cambridge.
- Whitehead, Donald R.
 1973 Late-Wisconsin Vegetational Changes in Unglaciaded Eastern North America. *Quaternary Research* 3:621-631.
- Whitehead, Donald R., Stephen T. Jackson, Mark C. Sheehan, and Barbara W. Leyden

- 1982 Late-Glacial Vegetation Associated with Caribou and Mastodon in Central Indiana. *Quaternary Research* 17:241-257.
- Whitmore, F., Emery, K., Cooke, H., & Swift, D.
1967 Elephant teeth from the Atlantic continental shelf. *Science* 156:1477–1481.
- Whymper, F.
1868 *Travel and Adventure in the Territory of Alaska*. John Murray, London.
- Wienstein-Evron, Mina and Ehud Galili
1985 Prehistory and Paleoenvironments of submerged sites along the Carmel Coast of Israel. *Paléorient* 11(1):37-52.
- Widmer, Randolph J.
1988 *The Evolution of the Calusa: A Nonagricultural Chiefdom on the Southwest Florida Coast*. Tuscaloosa: University of Alabama Press.
- Wilke, P.J.
2013 The Whiskey Flat pronghorn trap complex, Mineral County, Nevada, Western United States: Preliminary report. *Quaternary International* 297:79-92.
- Williams, J. W., B. N. Shuman, T. Webb III, P. J. Bartlein, and P. L. Leduc
2004 Late-Quaternary Vegetation Dynamics in North America: Scaling from Taxa to Biomes. *Ecological Monographs* 74:309-334.
- Wilmsen, E.
1983 The Ecology of Illusion: Anthropological Foraging in the Kalahari. *Reviews in Anthropology* 10:9-20.

1989 *Land Filled with Flies: A Political Economy of the Kalahari*. University of Chicago Press, Chicago.
- Wilmsen, E. and J. Denbow
1990 Paradigmatic History of San-Speaking Peoples and Current Attempts at Revision. *Current Anthropology* 31:489-524.
- Wilson, M., Road, K.L., and K. J. Hardy (Editors)
1981 *Megaliths to Medicine Wheels: boulder structures in archaeology*. Proceedings of the Eleventh Annual Chacmool Conference. University of Calgary Archaeological Association, pp. 171-187.
- Winterhalder, B.
2001 The behavioural ecology of hunter-gatherers. In *Hunter-gatherers: an interdisciplinary perspective*, edited by C. Panter-Brick, R. Layton and P. Rowley-Conwy, pp. 12–38. Cambridge University Press, Cambridge.

- Wright, Henry T.
1981 A Fluted Point from Muskegon Valley. *The Michigan Archaeologist* 27(3-4):87-91.
- Wright H.T. and W.B. Roosa
1966 The Barnes site: A fluted point assemblage from the Great Lakes region. *American Antiquity* 31:850-860.
- Wobst, Martin
1978 The Archaeo-Ethnology of Hunter-Gatherers or the Tyranny of the Ethnographic Record in Archaeology, *American Antiquity* 43(2):303-309.
- Woodburn, J.
1982 Egalitarian societies. *Man* 17:431-451.
- Woodman and Athefield
2009 Post-Clovis Survival of American Mastodon in the southern Great Lakes Region of North America. *Quaternary Research* 72:359-363.
- X**
- Y**
- Yengoyan, Aram A.
1979 Economy, Society, and Myth in Aboriginal Australia. *Annual Review of Anthropology* 8:393-415.
- Yesner, D. R.
2000 Caribou and Reindeer. In the *Cambridge World History*, edited by Kenneth F. Piple, pp.480-489. Cambridge University Press, Cambridge.
- York, Jill
2002 The Life Cycle of Bronze Age Metalwork from the Thames. *Oxford Journal of Archaeology* 21(1): 77.
- Yu, Zicheng
2003 Late Quaternary Dynamics of Tundra and Forest Vegetation in the Southern Niagara Escarpment, Canada. *New Phytologist* 157(2):365-390.
- Z**
- Zaliznyak, L. L.
1989 Ohotniki na severnogo olenya Ukrainского Polesya epohi finalnogo paleolita. *Nauka*:173.

Zeder, M. A., Bar-Oz, G., Rufolo, S., and F. Hole

2013 New Perspectives on the Use of Kites in Mass-kills of Levantine Gazelle: A View from Northeastern Syria. *Quaternary International* 297:110–125.

Zedeño, Maria Nieves, Ballenger, Jesse A. M. and John R. Murray

2014 Landscape Engineering and Organizational Complexity among Late Prehistoric Bison Hunters of the Northwestern Plains. *Current Anthropology* 55(1):23-58.