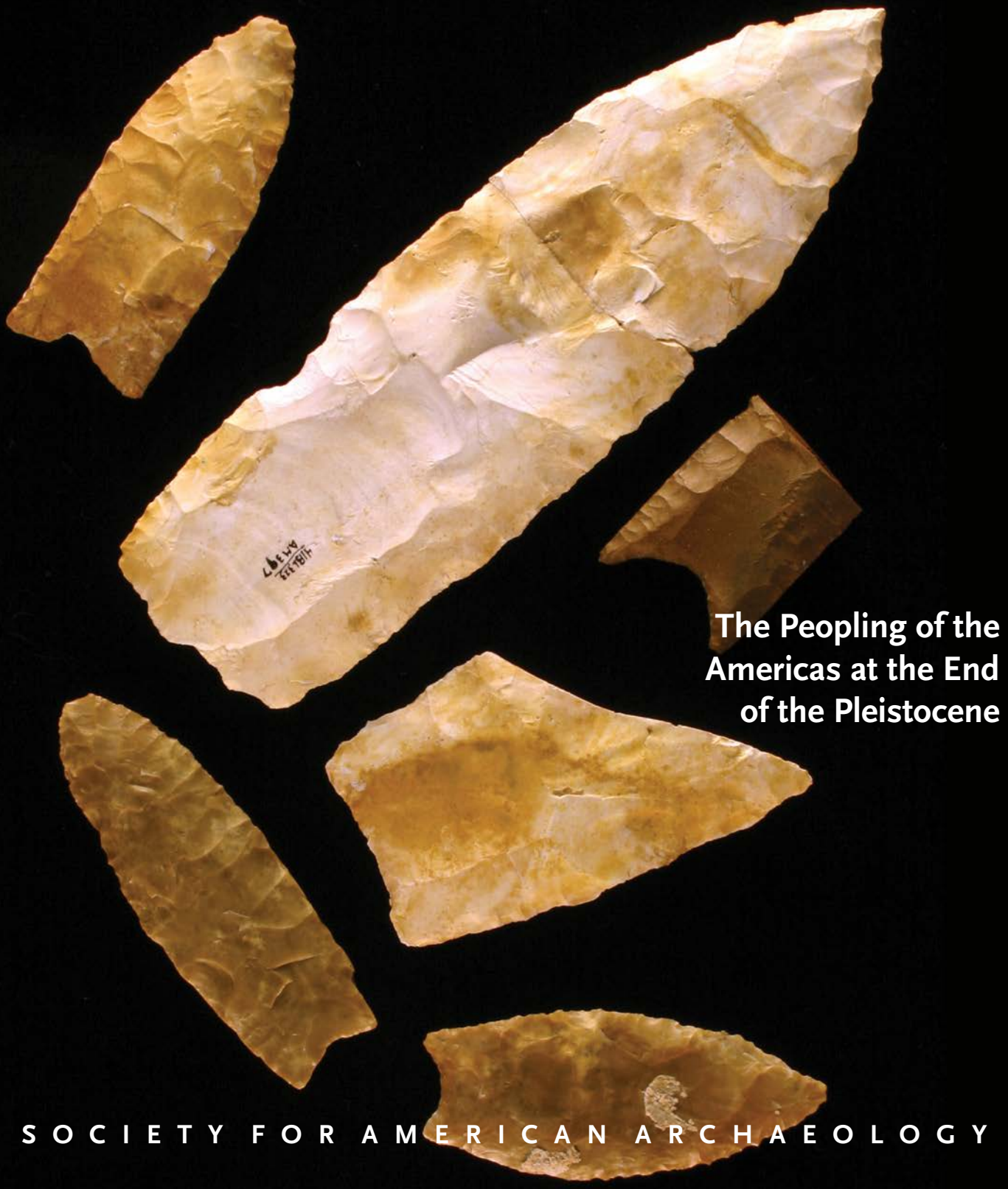
the SAA archaeological record

May 2019 • Volume 19 • Number 3



The Peopling of the Americas at the End of the Pleistocene

SOCIETY FOR AMERICAN ARCHAEOLOGY

the SAA Archaeological record

The Magazine of the Society for American Archaeology
Volume 19, No. 3
May 2019

THE PEOPLING OF THE AMERICAS AT THE END OF THE PLEISTOCENE

On the cover: Clovis preforms and discarded Clovis projectile points from a 13,000- to 12,700-year-old lithic workshop buried in stratum 3 at Excavation Area 8 at the Gault site, Texas. This area was investigated by Texas A&M University. Photograph taken by Charlotte Pevny, Center for the Study of the First Americans. To learn more about this Clovis workshop, see Waters, Michael R., Charlotte Pevny, and David Carlson, 2011, Clovis Lithic Technology: Investigation of a Stratified Workshop at the Gault Site, Texas. *Texas A&M University Press, College Station.*

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The SAA Archaeological Record (ISSN 1532-7299) is published five times a year and is edited by Anna Marie Prentiss. Submissions should be sent to Christopher B. Rodning,crodning@tulane.edu, Tulane University, Deptartment of Anthropology, 101 Dinwiddie Hall, 6823 Saint Charles Avenue, New Orleans, LA 70118, USA.

Deadlines for submissions are: December 1 (January), February 1 (March), April 1 (May), August 1 (September), and October 1 (November). Advertising and placement ads should be sent to advertising@saa.org.

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EDITOR'S CORNER

Anna Marie Prentiss

Anna Marie Prentiss is Regents Professor of Anthropology at The University of Montana.

One of the perks of editing *the SAA Archaeological Record* is the opportunity to develop article content. During my two terms as editor I have welcomed a wide range of submitted articles and special sections with discussions spanning global issues (climate change), human rights (LGBTQI issues, for example), new technologies (as in UAVs and video-technology), new theoretical models (e.g. anarchy theory), and diverse regional and topical areas (Patagonian to Viking archaeology). I have also maintained a long-standing goal of gender parity in authorship of our published articles. We were successful in our invited special section content but not quite as much in contributed articles where women's contributions remained at similar rates to that of *American Antiquity*. Clearly there is more work to do in that regard. Then, as the events of the recent annual meeting in Albuquerque so forcefully demonstrated, it is also clear that we must continue our efforts to better provide safe and welcoming environments for all of our members, whether at conferences, in the office, or in the field.

Peopling of the Americas is a central topic to many of us who work in this hemisphere and indeed it remains an essential issue for many scholars and publics around the globe. However, it is not a topic that has received very much attention in this periodical despite the extraordinary methodological, empirical, and ethical advances we have seen in recent years. So, for my final issue as editor, I asked Mike Waters, Ted Goebel, and Kelly Graf if they would organize and guest-edit a special section on this topic and I am very happy to provide the results of their efforts. Our special section, "The Peopling of the Americas at the End of the Pleistocene" features seven articles covering a diverse array of topics including genomic perspectives (Raff), community and indigenous partnerships in paleogenomic research (Malhi and Bader), Beringian archaeology (Goebel and Graf), routes into the Americas (Froese and colleagues), earliest occupations of North America (Waters), Pre-Clovis in South America (Politis and Prates), and the Clovis record (Jennings and Smallwood).

This issue includes important content beyond the special section. SAA President Joe Watkins offers his first "From the President" column. There is an important letter from the SAA Board of Directors concerning action on sexual harassment policy and safety concerns. Christyann Darwent authors our Volunteer Profile column. Katz and Kimmel contribute a timely discussion of safety in archaeology. Finally, we provide our annual reports stemming from the Annual Business and Awards Meeting. I thank the SAA staff, elected leadership, and membership for their support during my time as editor. I also thank the College and Humanities and Sciences and the Department of Anthropology at the University of Montana for supporting this venture. I thank Cheyenne Laue for being a great assistant and guest editor. Finally, it is my great pleasure to hand off the editorship of *the SAA Archaeological Record* to my esteemed colleague, Chris Rodning, of Tulane University. I have every confidence that *the Record* is in great hands for the coming years.

FROM THE PRESIDENT

Joe Watkins, PhD, RPA

The following column is based on remarks incoming SAA President Joe Watkins made during the Business Meeting on Friday, April 12, 2019.

Approximately 16 months ago, in my candidate statement for this position, I noted that the SAA has made some great strides forward from the society of the 1930s, 1960s, and even 1990s. It has strengthened its relationships with the various communities that are impacted by the practice of archaeology. Descendant communities now employ archaeologists—some their own community members—in order to investigate (or protect) the materials left behind by their ancestors. Other communities are also increasing their relationships with the Society. It's not just academic, student, and professional archaeologists who see the Society as pivotal for their continued growth, but members of avocational, governmental, and contracting communities, to name a few, are becoming more involved with the SAA as we have worked to strengthen our relationships with them.

Yet, in spite of this growth, we have more work to do. We cannot rely on public support without publicizing how important our work is. We as archaeologists have a tendency to believe that everyone sees the same utility of archaeology that we see, but we must be certain that our elected officials and the business communities continue to be reminded of the economic benefit that historic preservation can play in the United States. We must commit not only to increasing public awareness of the value of archaeology and heritage preservation, but also to increasing the knowledge of the benefits the public can derive from our profession.

Today's SAA is not just a society for *American* archaeology; we are increasingly global in scope. As such, the issues we face are not just local or regional ones, but are increasingly tied to issues that impact us all over the world. Climate change, rising sea levels, shifting weather patterns, are impacting communities everywhere. These issues raise questions that can benefit from the time depth that archaeology can offer. As part of this increasing global reach, the SAA and the European Association of Archaeologists are sponsoring a Presidential forum at the EAA meetings in September 2019, with another joint session to be held at the SAA meeting in Austin in 2020.

Archaeology continues to confront issues of social concerns such as gender equity and cultural diversity; professional issues dealing with ethics, public outreach, and improved communication; and legislative issues with the current administration that impact archaeology and historic preservation. Recent legislative attacks on the foundations of historic preservation prove how necessary it is for us to be more proactive, and our interaction with elected officials in Congress will need to remain an important part of our outreach.

SAA's finances are poised to weather unexpected calamities, its membership continues to grow, and its publications are solid. But we must be ready for the unexpected—calamities have more impact when organizations become complacent or when long-term leadership transitions occur, as they have recently. The SAA must move from a business-oriented model focused on survival to one focused on utilizing the results of Society frugality to allow the SAA to expand social and professional opportunities for its members.

Governance of the SAA will also begin a transition. The Board of Directors will shift from an administrative board to a more policy-oriented board. This will not have a direct impact on the membership, but it allows the Board of Directors to turn its focus from directing the day-to-day activities of the Executive Director towards a more full focus on broader topics related to archaeology and its role in contemporary society.

This next year will be a time of change. A new Executive Director after 22 years and a new President [gulp!] will steer the SAA into new directions, and the SAA elected leadership will continue to work actively on your behalf. We will keep lobbying for consideration of historic preservation issues in federal appropriations and legislation. We will keep safe-guarding SAA finances, but we will also begin to implement changes to utilize the results of our previous frugality. We—the elected leadership and the SAA staff—will always try to be available to answer any questions you have throughout the year. Please exercise your right as an SAA member and let your voice be heard. Thank you.

Joe Watkins addresses members
Read Joe Watkins' letters to membership or watch his video messages regarding the events during the meeting in Albuquerque and how he is leading the board forward.
www.saa.org/quick-nav/saa-media-room/saa-news

A LETTER FROM THE SAA BOARD OF DIRECTORS

May 4, 2019

Dear Fellow SAA Members,

It is widely known that we had a situation at the Annual Meeting in Albuquerque involving the attendance of archaeologist Dr. David Yesner. Yesner had reportedly been banned from the property and events of the University of Alaska Anchorage, based on findings of an independent internal investigation (Title IX) of sexual harassment and sexual assault. Several of the women who testified in that investigation were also attending the meeting, and Dr. Yesner's presence caused these women and others not to feel safe at the meeting. We apologize that SAA did not provide an environment in which these women, other survivors of sexual abuse, and others who are at risk could fully and freely participate in all events of the meeting. We are committed to making sure that this does not happen again.

To that end, the Board has established a SAA Task Force on Sexual- and Anti-Harassment Policies, chaired by Kelley Hays-Gilpin and Meagan Thies-Sauder to review and update the SAA's existing policies on sexual harassment (2015) and anti-harassment (2018) and the procedures for implementing these policies. The task force consists of a group of women and men from diverse backgrounds, including students, young professionals, the LGBTQI community, and others who want to help find ways to make SAA and its meetings and events inclusive and free of harassment.

The Board recently took additional actions requiring all meeting presenters certify in advance that they have never been (1) the subject of a negative finding on an investigation (such as Title IX) for sexual harassment, abuse, or assault; or (2) currently have a suspension or termination of Register of Professional Archaeologists resulting from a grievance investigation. In addition, participants will be asked to certify that they will allow a complete background check should it be relevant to providing a safe meeting environment, which will allow SAA to bar those criminally convicted for sexual harassment, abuse, or assault. SAA is working with the SAA Task Force on Sexual- and Anti-Harassment Policies to improve our ability to to adopt these and other standards for all meeting participants. We will also work with the Task Force to develop a process by which people can notify SAA regarding individuals who have a documented history of harassment or sexual harassment, so that SAA can review and, when appropriate, ban them from SAA meetings and events.

SAA has a large and growing membership that currently exceeds 7,000 members. Unfortunately, this membership includes individuals who commit acts of harassment, sexual harassment, sexual abuse, and discrimination. SAA must be prepared to act in advance, when possible, and to respond quickly to reported incidents that take place at our meetings. We need updated and improved policies, but we have learned that strongly worded policies do not ensure a safe meeting environment—actions do. We need to provide better training for our staff and volunteers to better prepare them to take action to make our meetings safe and to provide better support for those who report incidents of harassment, sexual harassment, or abuse.

This problems of harassment and sexual harassment in archaeology have been longstanding, and they will not be solved overnight. We the members of the Board care deeply about the well-being of all SAA members, and we will work hand-in-hand with individual members, committees, and task forces to make our organization open and equitable and our meeting environments welcoming and safe for all participants.

For up-to-date information on the activities of the task force, you can follow them on Facebook at **SAA Task Force on Sexual and Anti-Harassment Policies and Procedures** or search on Facebook for @SAATFPolicies.

Sincerely,

Joe E. Watkins, Ph.D., RPA

Teresita Majewski, Ph.D., RPA

Ricky R. Lightfoot, Ph.D., RPA

Stephen E. Nash, Ph.D., RPA

Jane Eva Baxter, Ph.D., RPA

Cynthia Herhahn, Ph.D., RPA

Heather A. Lapham, Ph.D., RPA

Silvia Salgado, Ph.D.

Lynne P. Sullivan, Ph.D., RPA

VOLUNTEER PROFILE

Christyann M. Darwent

I am an anthropology professor at the University of California, Davis, where I have worked since 2001. I have conducted archaeological fieldwork in Alberta, British Columbia, Nunavut, North Dakota, Alaska, and Greenland. Volunteering takes many forms in academia, and is often referred to as "service" to your department, your campus, or your profession. I have always stepped up and served on countless committees throughout my career, including the SAA Dienje Kenyon Memorial Fellowship Committee. I am most proud of serving as editor for the nonprofit University of Wisconsin Press journal, *Arctic Anthropology*, since 2012.

My passion for volunteering and service began in 1989 after I returned from field school in Edmonton and was not sure what to do next. I was exceptionally shy and my dad's way of dealing with it was to say "get in the car," drive me to a destination, and then shove me out and say "now go in and ask for a job." This was how I got my first minimum wage job in high school, and this is how I started volunteering at Fort Calgary. I had no idea how to get a toe in the CRM door as a 20-year-old female, and clearly neither did my dad, but he thought he'd heard about some "digging" that had been done at the Fort in the 1970s. His plan worked since they took me on as a volunteer. My Fort supervisors were either utterly desperate or believed I had potential, as I was hired on later that summer. When I returned to classes at the University of Calgary in the fall, I continued to volunteer as a docent, teaching school kids about archaeology and Calgary's history with mock excavations and artifact show-and-tells. I absolutely loved it! Fort Calgary was the beginning of nearly 30 years of archaeological outreach.

When I started my MA degree at Simon Fraser University, I immediately sought out their museum and asked to volunteer. I taught school groups about local archaeology, provided information to incoming visitors, and assisted with curation of museum collections. Volunteering continued during my PhD at the University of Missouri where I gave tours to school groups at the Anthropology Museum. When I started at UC Davis, I initially helped out with the student organizations' Picnic Day exhibits, but I soon became the organizer and host of this and other events

such as "Archaeology Month Open House" and "Bring your Kids to Work Day." For the past eight years I have been actively involved with a consortium of museums and collections across campus (we are up to 13 facilities) for an annual event coinciding with Darwin's birthday known as "Biodiversity Museum Day." However, I cannot provide outreach on my own, and thus encourage undergraduate and graduate students to join me in the fun. In addition, local community engagement and participation has been fundamental to my fieldwork across the Arctic. Last July I flew back to the Native village of Shaktoolik, Alaska, to talk about our ongoing research on their lands, and about the history of fishing in Norton Sound.

In my own community I continue to give presentations to elementary school classes, give talks and serve on career panels at the high school, volunteer with the school music association, and provide bone identification workshops as part of NAGPRA consultations. Volunteering and community service has become such an integral part of who I am that both of my sons have been helping out since they were old enough to follow directions. Inspired by some of my peers, I have been using social media to communicate about archaeology, climate change in the Arctic, and being a mom in academia. Join me and my 2,000+ followers on Twitter: Arctic Archaeology @cmdarwent.

TOWARD A SAFER ARCHAEOLOGY

ANTHROPOGENIC DANGERS AND CREW SAFETY IN THE ARCHAEOLOGICAL WORKPLACE

Steven A. Katz and Addison P. Kimmel

Steven A. Katz is a Principal Investigator at Midwest Archaeological Research Services.

Addison P. Kimmel is a PhD candidate at the University of Iowa.

Outside the fanciful world of Indiana Jones, being intimidated by a man with a gun seems quite the unlikely scenario for archaeologists working in twenty-first century America to encounter. However, this is exactly what we experienced while conducting a large-scale architectural survey in Chicago on an unseasonably warm fall day in 2012. The man emerged from a neat, well-kept house built in the late 1940s to accommodate the exploding housing needs of returning GIs and their families. As he approached us, he slowly raised his impressively puffy, oversized winter coat to reveal the unmistakable dull black grip of a pistol peeking out above the waistband of his pants. After hearing out our well-rehearsed spiel about the reasons for the project and how architectural surveys work, the man gave us a nod and walked back inside, having never uttered a single word. Although we did not react in the moment, afterward both of us—one a military combat veteran—were shaken. We were also confused. Was this man threatening us, or was it just a prank? Should we call the police and report the incident, even though calling the police could possibly lead to other problems? Should we continue on our scheduled survey path or move elsewhere for the day? In the end, unsure of the proper approach, we did nothing. It was already late in the day and we finished up work and went home.

This was not the first potentially dangerous situation we encountered during this project. Most people who approached us during the survey were simply curious about our work, or most often, friendly retirees just saying hello. But others were combative. Several times residents who believed we were utility workers there to shut off their water or electricity, or undercover police officers patrolling their neighborhood, aggressively harassed us. A large guard dog for an industrial building we were recording as part of the survey chased one of us briefly, although thankfully the dog proved more interested in playing than in her guard duty. We watched from afar as a man, who had earlier the same day followed us for over a mile and asked to borrow money, tried all four doors on our work vehicle before eventually walking away. One morning around 6:30 am, just as we were starting our day, we watched as police and EMTs streamed into the area where we had planned to start surveying, cordoning off several blocks. We later learned that several people had been shot and killed earlier that morning in a house on our survey list.

For us, the big questions—What should we have done in that situation? What should you do if and when you feel unsafe in a work environment?—needed answers. Our own experiences, and the documented experiences of so many others who have suffered from a wide range of workplace harassment, violence, and other problems while working in archaeology, have made it increasingly clear that the discipline—as practiced in both CRM and academic contexts—has failed to appropriately or effectively address systemic workplace safety issues of all kinds. Especially in today's political and social climate and considering the changing nature of archaeological practice, we believe that professional archaeologists—indeed all historic preservation specialists—need to approach the many forms of potential workplace violence seriously and systematically to ensure the safety and security of all archaeological workers.

Safety Issues in Archaeology's Past

Practicing archaeologists have long held a romanticized view of archaeology as a particularly unique and special discipline. In the mid-twentieth century, this feeling of uniqueness and its resultant camaraderie among its practitioners was inculcated in part through shared experiences of danger. Massive excavations at places like Kampsville, Illinois, and elsewhere served as the primary training grounds for several generations of professional archaeologists. One glance at photographs from these excavations immediately reveals the dangers they harbored: excavation blocks dug dangerously deep, unit walls that look anything but load-bearing, shirtless and shoeless workers packed together in deep trenches. Professional meetings still abound with old-timers telling tales of narrowly avoiding injury, and of those who weren't so lucky. It is important to note these dangers of the twentieth century had their roots firmly in the racism and classism of nineteenth-century armchair practitioners who thought nothing of subjecting poor Indigenous people of color to exceedingly

hazardous excavation conditions in order to recover the artifacts they so coveted (Garman 2001).

Archaeological culture slowly began to change after Congress passed the Occupational Safety and Health Act (OSHA) in 1970, requiring employers to provide their employees with working conditions free of recognized (physical) hazards. Even then archaeologists were slow to embrace these regulations. At least initially, many of the previously mentioned large-scale excavations continued with few if any changes being made to ensure worker/student safety. By the 1980s, archaeological work at hazardously polluted brownfield sites, where excavators risked illness or injury if protocols were not strictly enforced; the bureaucratization of higher education; and the pressures of corporate clients concerned with liability and compliance forced archaeologists to finally take OSHA and other state and local safety ordinances more seriously. Moving beyond OSHA, archaeologists also began to pay attention to more fieldwork-specific hazards, including deep-site excavation (Bergman and Doershuk 1995; Merry and Hedden 1995), the contracting of infectious diseases from human remains or archaeologically excavated feces, the dangers of ticks, and unexploded ordnance (see Poirier and Feder 2001). Today, nearly all archaeologists doing both CRM and academic work adhere closely to OSHA and other related regulatory safety standards, although a certain "studied snobbery" toward safety regulations persists in many corners of the discipline (Garman 2001:223).

Workplace Safety in Twenty-First Century Archaeology

Clearly, this evolution of archaeology into a safer discipline constitutes a major step forward. However, as anyone who has watched a safety training video at a job orientation knows, OSHA regulations primarily strive to create a workplace free of bodily injury from accidental or negligent "slips, trips, and falls." Outside of OSHA, most archaeological safety concerns have been similarly focused on accidental, natural, chemical, or otherwise non-human dangers that workers may encounter in the course of archaeological fieldwork. These safety issues are well-founded and concerning, but most can be defused fairly easily through awareness and adherence to site- or material-specific safety protocols.

More concerning at present are the complicated, more deeply human dangers lurking within twenty-first century archaeological culture and practice. Rampant sexual harassment, especially in field settings (Clancy et al. 2014; Nelson et al. 2017), an over-the-top binge drinking culture (Hutson 2011), and other systemic issues have been well-documented within the discipline thanks in large part to the courageous work of victims and activists. The Ivory Tower and the field site may seem far removed from, for instance, larger societal issues of gun violence or mass shootings. But as our opening anecdote illustrates, this is simply not the case. The home institution of the second author, The University of Iowa, carries many somber reminders that academia—and by extension specific disciplines like archaeology—are not immune to the kind of mass shooting events that have become seemingly everyday occurrences in 2018. Archaeology classes are still taught in the same building where, in 1991, a disgruntled former graduate student shot and killed several members of the university community (Bullard and Fruhling 1991).

Table 1. Workplace Fatalities by Year, US Bureau of Labor Statistics.

	2012	2013	2014	2015	2016
Workplace Violence	803	773	765	703	866
Slips, Trips, and Falls	704	724	818	800	849

While rates of fatal occupational injuries have mostly trended downward since the 1990s, deaths due to workplace violence "by persons or animals" reached their highest level since 2003 in 2016. Deaths caused by "slips, trips, and falls" have also been increasing steadily, demonstrating the necessity of a holistic approach to worker safety.

It bears reiterating that archaeology is not unique in suffering from many of these problems. According to the Bureau of Labor Statistics' Census of Fatal Occupational Injuries (2018), in 2016 deaths due to workplace violence reached their highest levels in over a decade (see Table 1). It is, however, important to consider the specific ways in which these kinds of safety issues manifest themselves within archaeological practice. For over half of the twentieth century, archaeology was primarily an academic pursuit. While the large, and dangerous, field projects captured headlines, most archaeology consisted of small-scale excavation and survey, often on public land. Following the passage of the National Historic Preservation Act in 1966, archaeological work in the new field of Cultural Resource Management continued largely in this fashion. For most practicing archaeologists, archaeology was truly "all about digging holes, recording features, collecting artifacts, and writing reports" (Garman 2001:221). Affected by slowing construction markets and the systematic defunding of university programs, the definition of what is considered archaeological "work" now encompasses a broad range of activities. Today, working archaeologists are as likely to be conducting an architectural survey in a densely populated city as they are to be conducting shovel testing in a state park. Archaeologists, particularly in the Western US, have seen their study areas grow more remote every year as cell-phone grids expand. The expansion of what is considered archaeological work comes with an ever-growing list of potential workplace safety issues, some predictable and some not, that need to be addressed.

Toward a Safer Archaeological Practice

James C. Garman, in his 2001 contribution to a collected volume on health and safety in archaeology, implored all archaeological entities to hire dedicated safety managers. These safety managers would be tasked specifically with assessing the strengths and

weaknesses of the company or department's safety-related practices, training and educating employees, and writing and implementing corporate policy. We are disheartened that, nearly 20 years on, Garman's impassioned plea has gone largely unheeded. Of course, the economic realities of archaeology in 2019 are much different than they were in 2001, negatively impacting initiatives aimed at improving worker safety.

But, working within these limitations, much can still be done. Not every dangerous situation one might encounter while doing archaeological work can be predicted nor addressed through additional training or the establishment of specific safety protocols. However, to ensure safer working environments for all people in archaeology, it is clearly worth the attempt. What follows is advice on fostering safe working environments and our beginning attempt to sketch out a new set of best practices for a safer archaeological workplace based on our own experiences working in a variety of archaeological settings.

1. **Update Safety Manuals and Adopt (and Adhere to) Codes of Conduct**

   Long before we embarked on the previously described architectural survey, our employer, Midwest Archaeological Research Services (MARS), had put together a safety manual for its employees. This safety manual's initial creation had been a direct result of the recognition by the late 1990s, that archaeology not only needed to adapt and conform to basic occupational safety standards but also needed to address fieldwork-specific physical and environmental dangers. The MARS safety manual, then, included detailed instructions on treating snakebites and the proper procedure to follow if you think you have released deadly pathogens while excavating a burial. It had, however, absolutely nothing to say about what to do if you are verbally or physically threatened in the field; if you encounter multiple loose, large-breed dogs during the course of your day; or if people are scuffling in your project area. Utilizing the experiences of their workforce and drawing on manuals from related fields, archaeological workplaces can and should update their safety manuals to provide guidance for workers in a range of dangerous situations that can be reasonably predicted. For instance, while updating their safety manual in response to our concerns, MARS referenced the US Postal Service manual to establish an effective response to loose animals in the field.

   Additionally, archaeological practitioners must adopt and enforce reporting protocols for interpersonal workplace violence of all forms, including but not limited to sexual harassment, as well as codes of conduct that explicitly reject and discourage these types of abusive and dangerous behaviors and establish clear penalties for engaging in them. Safety protocols and codes of conduct have long been standardized at colleges and universities. While the disturbing events at Penn State, and more recently at Ohio State and Michigan State, demonstrate their limitations, this kind of institutionalization is a good start and provides a useful model for private archaeological companies to adapt. Many professional organizations, including the SAA, AAA, and RPA now require all advertised field schools to have codes of conduct in place to deal with allegations of sexual assault and sexual harassment, as well as clear and appropriate reporting mechanisms. Formalizing a workplace approach toward guns and gun violence may also be prudent. As our opening anecdote demonstrates, one has little control over what is encountered in the field, but attitudes and approaches within the workplace may help prevent intra-workplace danger. Though the evidence is somewhat ambiguous, United Nations research has indicated that establishing Gun-Free Zones in workplaces and public spaces can be effective at lessening occurrences of gun violence, at least in some instances (Pfiffner and Sutton 2013).

2. **Implement Formal Safety Training for All Archaeological Workers**

   Formalized Occupational Safety and Health (OSH) training, covering all types of hazards, from injuries caused by poor posture, to refreshers on proper equipment usage, to workplace violence, has consistently been shown to have positive effects on worker safety (Robson et al 2010). In many workplaces, even when they have been formalized, procedures for approaching dangerous situations, particularly those involving interpersonal violence, are, at best, tucked away in a cabinet or pinned, forgotten and yellowing, on the bulletin board. Consistent, high-engagement formalized training programs, though often derided, can provide a reengagement with this material and lead to safer behaviors and better outcomes. For archaeologists working in or around institutions of higher education, some training may already be mandatory, and often additional safety training materials can be accessed through the university. Safety-training software packages, already in common use in many educational settings, address a wide range of safety issues and can be personalized for specific jobs or departments. Even the Department of Labor and OSHA, long the domain of "slips, trips, and falls," has gotten involved. At https://www.osha.gov, employers can now access in-depth information, statistics, and guidance, as well as new Department of Labor prevention programs and training resources specifically targeted at reducing the dangers posed by violence in the workplace.

3. **Be Flexible and Creative in Responding to Unexpected Dangers and Challenges**

   The response of MARS to the concerns we expressed at the time can also provide a beginning model for other small companies or academic departments looking to provide their employees with a safer working environment. MARS management

did not brush off our concerns as unfounded or silly but took them seriously and responded promptly. We worked collaboratively to quickly come up with a set of guidelines for the survey that would remove ambiguity and increase our security. Crews already wore high-visibility vests and carried signed letters of introduction into the field. Specific communication protocols were established, where crew leaders sent SMS text updates throughout the day to MARS management as well as the client. We formally introduced ourselves to the local police and fire departments, who made themselves readily available should there have been a need for assistance or intervention. The field supervisor was given the authority to cancel fieldwork at any time in which an unsafe situation was identified. MARS worked from our experiences in the field to limit the exposure of workers to potentially dangerous situations and to equip them with the tools to handle them, with flexible but clear guidelines for response if and when they were encountered. The willingness to abandon entrenched rigidity and work on-the-fly to create a safer working environment when necessary is essential. Archaeological work settings are constantly changing in response to outside pressures, and while having established safety procedures is obviously important as outlined above, unexpected and unpredictable dangers will always arise.

4. **Communicate Effectively and Empathetically with Affected Communities, and Always Consider Context**

Although the public loves learning about great archaeological discoveries, the reality in the CRM world is that many projects archaeologists undertake, though regulatory in nature, are part of larger corporate or governmental initiatives that may not be popular with surrounding communities. In the age of "The Wall," leaking gas and oil pipelines, and other bitterly divisive projects, surveying archaeologists are bound to find themselves in situations where they are the most visible and accessible objects of the public's wrath. In our case study, the client had done little to communicate to people within our survey area that archaeological survey crews would be walking through their neighborhoods continuously for several months and looking generally suspicious: taking lots of pictures of their houses, scribbling notes, and stretching to get as good a look at these buildings as possible from the public right-of-way. Predictably, residents were suspicious of our presence in their neighborhood. Our client was also deeply unpopular among the locals. Those in the community who were familiar with their proposed project were—rightly as it turned out—skeptical of their intentions, and most believed they were acting in something less than good faith. Our client's lack of community engagement and trust, along with tensions between community members and police and multiple escalating gang conflicts—some of the worst in decades—all contributed greatly to the creation of potentially dangerous workplace situations for us and other surveying crews (Gorner 2012).

As with everything in archaeology, it is of utmost importance for working archaeologists to take social and historical context into consideration when embarking on any project. Understanding context helps archaeologists predict possible problems that could arise, as well as come up with solutions to head off these issues before they develop into dangerous situations. Beginning the first day of the architectural survey, we were consistently harassed and confronted by people who believed we were utility workers who had come to shut off their water or electricity while they were at work. For us, this was an unexpected response, and we found ourselves on the defensive, trying to defuse unfortunate situations of mistaken identity that we had not predicted. In retrospect, we shouldn't have been so surprised. Between 2007 and 2011, the number of utility disconnections in Illinois rose from 118,057 to 347,499, leaving local residents especially sensitive to this issue (Illinois Commerce Commission 2007, 2010). To deal with this understandable confusion and hostility, we obtained transit-authority-specific identification badges to go along with our letters of introduction, to help assure local people our motives were benign. While empathy, a friendly demeanor, and good fortune allowed us to safely navigate these situations, an improved understanding of history and context, plus better communication on all levels of archaeological work could likely have prevented them altogether.

Conclusion

The archaeological workplace is at once uniquely idiosyncratic and just the same as everywhere else when it comes to issues of worker safety. Every day, workers in archaeology face a myriad of potential dangers, some unique to the discipline, others more universal. Archaeological practitioners should embrace this unique cultural moment in which workplace dangers in all their forms have come so starkly to the public fore, and systematically work to make our discipline safer for all workers in all situations.

References Cited

Bergman, Christopher A., and John F. Doershuk
1995 OSHA Regulations and the Excavation of the Deeply Stratified Sandts Eddy Site (36NM12). *Journal of Middle Atlantic Archaeology* 11:17–29.

Bureau of Labor Statistics
2018 Census of Fatal Occupational Injuries (CFOI)-Current and Revised Data. Electronic Document. http://www.bls.gov/iif/oshcfoi1.htm#2017, accessed January 1, 2019.

Bullard, Charles, and Larry Fruhling
1991 Gunman Kills Rival Student, 3 Others in U of I Rampage. *Des Moines Register* 2 November:1A, 3A. Iowa.

Clancy, Kathryn B. H., Robin G. Nelson, Julienne N. Rutherford, and Katie Hinde
2014 Survey of Academic Field Experiences (SAFE): Trainees Report Harassment and Assault. *PLoS ONE* 9(7):e102172. https://doi.org/10.1371/journal.pone.0102172

Garman, James C.
2001 A Final Forewarning: Practical Steps to Providing Archaeologists with Safe Working Environments. In *Dangerous Places: Health, Safety, and Archaeology*, edited by David A. Poirier and Kenneth L. Feder, pp. 221–233. Bergin & Garvey, Westport, Connecticut.
Gorner, Jeremy
2012 Shootings May Be Linked, Police Say: Probe Looking at Rap Feud, Gang Conflict. *Chicago Tribune* 2 October:12. Chicago.
Hutson, Scott R.
2011 Alcohol and Archaeologists. *anthropologies* (blog), May 15, 2011. http://www.anthropologiesproject.org/2011/05/alcohol-and-archaeologists.html, accessed October 18, 2018.
Illinois Commerce Commission
2007 *Annual Report on Electricity, Gas, Water and Sewer Utilities.* Illinois Commerce Commission, Springfield.
2010 *Annual Report on Electricity, Gas, Water and Sewer Utilities.* Illinois Commerce Commission, Springfield.
Merry, Carl A., and John G. Hedden
1995 Excavation Safety Plan for the Iowa Office of the State Archaeologist. *Journal of the Iowa Archeological Society* 42:5–7.
Nelson, Robin G., Julienne N. Rutherford, Katie Hinde, and Kathryn B. H. Clancy
2017 Signaling Safety: Characterizing Fieldwork Experiences and Their Implications for Career Trajectories. *American Anthropologist* 119(4):710–722.
Pfiffner, Sabrina, and Heather Sutton
2013 The Gun-Free Zone—A Tool to Prevent and Reduce Armed Violence. *UNODA Occasional Papers No. 25.* United Nations, New York.
Poirier, David A., and Kenneth L. Feder (editors)
2001 *Dangerous Places: Health, Safety, and Archaeology.* Bergin & Garvey, Westport, Connecticut.
Robson, Lynda, Carol Stephenson, Paul Schulte, Ben Amick, Stella Chan, Amber Bielecky, Anna Wang, Terri Heidotting, Emma Irvin, Don Eggerth, Robert Peters, Judy Clarke, Kimberley Cullen, Lani Boldt, Cathy Rotunda, and Paula Grubb
2010 *A Systematic Review of the Effectiveness of Training and Education for the Protection of Workers.* Institute for Work and Health, Toronto, Ontario, Canada; and National Institute for Occupational Safety and Health, Cincinnati, Ohio. Electronic document, https://www.cdc.gov/niosh/docs/2010-127/default.html, accessed January 25, 2019.

INTRODUCTION: THE PEOPLING OF THE AMERICAS AT THE END OF THE PLEISTOCENE

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One of the most enduring debates in American archaeology centers on the late Pleistocene peopling of the Americas. For over 100 years, there has been much debate about fundamental questions: Who were the first Americans and where was their homeland? When did they arrive in eastern Beringia and what is the archaeological record of this region's earliest inhabitants? When did people travel south of the continental ice sheets that covered most of Canada? Which routes did the first Americans take to get south of the ice sheets blocking their path to the unglaciated portions of the New World? Once south of the ice, how did people explore and settle an unknown land with so many varied environments? These and other questions are important because genetic studies demonstrate that all modern Native people are descendants of the first humans to enter the Americas. The first Americans set the stage for all prehistory that followed.

These fundamental questions are discussed in the following set of seven essays. While these questions are far from being resolved, new archaeological, geological, and genetic studies over the last few decades are bringing us closer to the answers. The seven essays in this series provide an up-to-date overview of some of the important questions related to the peopling of the Americas. The first two papers discuss what we have learned from ancient and modern genomic research (Raff), and the importance of the Native American voice in this research (Malhi and Bader). Next, the archaeology and genomic data for Beringia are reviewed (Goebel and Graf). This is followed by an in-depth look at the corridors that were traversed as people moved from Beringia to the unglaciated areas south of the continental ice sheets (Froese, Young, Norris, and Margold). Two essays then review the early archaeological records of North America (Waters) and South America (Politis and Prates). The series concludes with a discussion of Clovis, the first widespread archaeological complex in North America (Jennings and Smallwood). These essays provide an up-to-date summary of the state of our knowledge about the first Americans. We have come a long way, but there is much more work to be done.

GENOMIC PERSPECTIVES ON THE PEOPLING OF THE AMERICAS

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Recent paleogenomics research on models for the entry and initial dispersals of humans in the Americas has focused on several questions: Which populations were ancestral to the First Peoples[1] of the Americas? What demographic events happened during this process? When did the inferred events occur?

The answers to these questions can serve as tests of longstanding archaeological hypotheses, such as the geographic origin of the ancestors of contemporary Indigenous peoples, the timing of the initial peopling, and even the route(s) taken during the initial peopling process. But, as we shall see, paleogenomics has also generated new hypotheses that need to be tested with archaeological ground-truthing.

Which Population(s) Were Ancestral to the First Peoples of the Americas?

Paleogenomics research in recent years has revealed that multiple populations contributed ancestry to the Indigenous peoples of the Americas. The genome of a 24,000-year-old child from the Upper Paleolithic Mal'ta site in south-central Siberia (Raghavan et al. 2014) showed that the population from this region, termed "ancient North Eurasians" (ANE), contributed between 14% and 38% of the ancestry seen in contemporary Indigenous peoples of the Americas. The remaining ancestry is related to present-day East Asian populations. However, these estimates should be interpreted cautiously; as Raghavan and colleagues note, they "assume unadmixed ancestral populations" (p 89). Paleogenomics has emphatically demonstrated that no population, ancient or contemporary, is "pure" or genetically homogeneous, and it is very likely that there was more genetic diversity present in these ancestral populations than our naming conventions imply. Indeed, a genomic investigation of ancient Siberian populations published on bioRxiv (Sikora et al. 2018), shows that ANE is a descendant of the "Ancient North Siberians" (ANS) that includes the population resident at the Yana RHS site (dating to ~31,600 calibrated years before present; all dates given here are calibrated), with additional ancestry from early "Caucasus hunter-gatherer" (CHG), "Western hunter-gatherer" (WHG), and "Eastern hunter-gatherer" (EHG) populations. We can expect the East Asian ancestors of Native Americans themselves to have similarly complex genetic histories, although less is known about them at this time.

All genetic studies—whether based on uniparental markers or whole genomes—have emphatically ruled out a European source for pre-1492 ancestry of Native Americans as predicted under the Solutrean Hypothesis (Raff and Bolnick 2015; Rasmussen et al. 2014).

What Demographic Events Occurred during the Initial Peopling of the Americas?

Szathmary and colleagues (1978) suggested that all the peoples of the Americas were descended from a single ancestral population, and that the peopling of the Americas was a multi-stage process based on findings from classical genetic markers and cranial morphology. Comparative analyses of classical markers and mitochondrial and Y chromosome lineages revealed patterned variation consistent with expectations for a founder effect model (reduction in diversity compared to parent population, followed by radiation of new lineages). Analyses of mitochondrial genomes further identified a period of extended isolation (7,500–15,000 years) of the ancestral population, followed by one or more dispersals out of Beringia into North and South America, which has come to be known as the "Beringian Isolation," "Beringian Standstill," or "Beringian Pause" model (Tamm et al. 2007). Later analyses of whole mitochondrial genomes using a different mutation rate suggested a much shorter period of isolation, ranging from 2,400–9,000 years (Llamas et al. 2016).

Analysis of whole nuclear genomes has confirmed the Beringian Isolation model and revealed many additional details. Collectively, genomic analyses of contemporary and ancient peoples of the Americas (Moreno-Mayar 2018a, 2018b; Raghavan et al. 2014, 2015; Rasmussen et al. 2014; Rasmussen et al. 2015; Reich et al. 2012) show that the First Peoples are descended from an East Asian group that separated from its parental population

approximately 36,000 years ago. This group experienced gene flow with the parental population for an extended period of time (estimated to be around 11,000 years). At about the same time as this population ceased gene flow with its parent population, it experienced gene flow with the ANE population related to Mal'ta (at approximately 25,000 years ago). Following this event the population became isolated, during which time it evolved genetic variation unique to American populations. One explanation for the population fissions, gene flow, and isolation events is that they reflect population movements, perhaps in response to climatic events such as the Last Glacial Maximum (LGM).

The population isolated during the LGM (hereafter called "Ancestral First Peoples") split into at least three branches. One branch, known as the Ancient Beringians and represented by two genomes from the Upward Sun River and the Trail Creek Cave sites, diverged approximately 20,900 years ago, and continued living in Alaska after the end of the Last Glacial Maximum (Moreno-Mayar et al. 2018a). Another branch, currently referred to as "Unsampled Population A," diverged approximately 24,700 years ago. This group, which was first detected by its contribution to the genomes of the ancestors of the Mixe, has no currently known representatives in the archaeological record and is therefore poorly understood (Moreno-Mayar et al. 2018b). The third branch of Beringians moved south of the ice sheets. This branch split into three groups: one ancestral to Northern Native Americans (NNA), who include Algonquian, Na-Dené, Salishan, and Tsimshian speakers from Canada; one ancestral to Southern Native Americans (SNA), who include ancient and contemporary Central and South Americans, Anzick-1, Spirit Cave, and Lagoa Santa individuals; and one ancestral to an unnamed population represented by a 5,600-year-old individual from Big Bar Lake who appeared to have diverged prior to the NNA/SNA split (Moreno-Mayar 2018b; Posth et al. 2018; Rasmussen et al. 2014). It is likely that the Ancestral First Peoples also engaged in gene flow with a population ("Ancient Paleosiberians") in Siberia, as represented by the Kolyma1 genome (Sikora et al. 2018), presumably after northern Siberia was repopulated following the end of the LGM.

The two major genetic clades found in the Americas, NNA and SNA, are estimated to have diverged between approximately 17,500 and 14,600 years ago, just as routes for entry into the Americas were becoming open due to glacial retreat (Moreno-Mayar et al. 2018a). Gene flow between these two branches has been documented in the genomes of several descendant individuals, including Kennewick Man/The Ancient One (Moreno-Mayar et al. 2018b; Rasmussen et al. 2015; Scheib et al. 2018).

Details of the peopling of Central and South America have emerged in recent publications, revealing it to be a complex process marked by the migration of multiple genetically distinguishable groups at different times (Moreno-Mayar et al. 2018b; Posth et al. 2018). One puzzling finding that has emerged from recent studies is a subtle genetic affinity between some South American Amazonian populations in the Amazon and Indigenous Australians, New Guineans, and Andaman Islanders (Raghavan et al. 2015; Skoglund et al. 2015). This affinity appears to be derived from a very ancient ancestor to both groups (called "Population Y" by the authors), rather than via a migration to the Americas by a group of Australasian ancestors (Skoglund et al. 2015). Some researchers have suggested that this signal is an artifact of sampling or analysis (Posth et al. 2018), but still others have confirmed it (Moreno-Mayar 2018b). Genomic characterization of more populations is needed to clarify this issue.

Implications for Archaeology

Although genetic data do not directly pinpoint the geographic location for the emergence of American-specific genetic diversity, the lack of gene flow between outside groups and the ancestral population is evidence in favor of this isolation having taken place within Beringia itself. It would have been difficult for a population to remain isolated within southern Siberia or coastal Northeast Asia, and the archaeological record indicates that central and northern Siberia were abandoned during this period, likely due to environmental conditions associated with the Last Glacial Maximum. Paleoclimatic reconstructions show that certain regions of Beringia experienced higher productivity and warmer average temperatures than central and northern Siberia, making them possible candidates for an LGM refugium (Hoffecker et al. 2016; Sikora et al. 2018). Additionally, the findings of Population Y, Unsampled Population A, and Ancient Beringians in addition to the ancestors of the Big Bar Lake population, NNA, and SNA clearly indicate that the Beringian ancestral population was not homogeneous. It may be that there was genetic structure within the initial population, as well as additional structure developed during its isolation. If the latter were true, this would imply some weak barriers to gene flow existed, either in the form of geographic dispersal over a large area, or perhaps subdivision in separate refugia. If this model is correct, there must be archaeological evidence of human occupation of Beringia during the LGM. Although much of central Beringia is now underwater and inaccessible, much of western Alaska remains under-surveyed. It is there that archaeological evidence of the Beringian Isolation could be sought.

Secondly, because descendants of both NNA and SNA branches are equally related to the Ancient Beringians, it is most likely that their divergence happened after migration into North America south of the retreating ice sheets, cutting off gene flow between them and the Ancient Beringians remaining in Alaska (Moreno-Mayar et al. 2018a). The genetic relationship between the Big Bar Lake individual and NNA/SNA fits a scenario for a

divergence of the ancestors of the Big Bar Lake population prior to this migration (Moreno-Mayar et al. 2018b). If this series of population splits left an archaeological signature, we might expect it to be found in Alaska and along potential dispersal routes.

The series of rapid population splits reflected in ancient South American genomes argues strongly for a peopling process "akin to leap-frogging across large portions of the diverse intervening landscape" (Moreno-Mayar et al. 2018b:18). This is consistent not only with the unimpeded movement of peoples into previously unoccupied lands, but also with the more rapid dispersal process via boat (rather than more slowly by foot across land). Indeed, evidence from eDNA taken from lake sediment cores in the center of the ice-free corridor region (Pedersen et al. 2016) shows that the interior route was not viable until about 12,600 years ago, supporting a coastal route as the most likely path of initial dispersal of pre-Clovis peoples. This too is a hypothesis that needs further testing with archaeological data.

The Future of Ancient DNA Research in the Americas

As I hope is clear from the above review, paleogenomics research has contributed immensely to the field in recent years. And yet, this contribution is not without critiques (some of them well-merited, some of them perhaps not). The concern I see voiced most frequently by the archaeological community is the occasional lack of a nuanced understanding of the work that has already been done in a research area prior to the undertaking of genetics research, and the lack of true partnership between geneticists and archaeologists (and other specialists) in developing projects and interpreting data. We geneticists would do well to pay attention to this critique—which obviously doesn't apply to all research groups—as the most accurate understanding of history derives from explanations that incorporate data from different sources. Meaningful interdisciplinary collaborations are essential for future research relating to questions about the initial peopling of the Americas.

In addition to DNA from humans, aDNA from nonhuman beings is increasingly being used to clarify details of early Pleistocene history. Environmental DNA and genomes from dogs, megafauna, pathogens, plants, and parasites can all provide insights into the environment and behavior of the first humans in the Americas, and I expect that this is one area of paleogenomics that will be extremely productive in future years.

Finally, it is important for all researchers in this area to be aware of ethical issues inherent in conducting genomic analyses of ancient and contemporary Indigenous peoples. The history of genetics research in the Americas is unfortunately marred by exploitation and insensitivity to the concerns and priorities of Native communities. I urge geneticists and archaeologists both to center ethics and consultation in study design and implementation; guidelines for doing so have recently been published (Bardill et al. 2018). For a fuller discussion of this subject, I recommend reading the piece by Malhi and Bader (this issue).

Note:

1. I use this term in lieu of "First Americans" at the request of Indigenous colleagues to avoid projecting backwards in time the implication of membership in a colonizing nation-state.

References Cited

Bardill, Jessica, Alyssa C. Bader, Nanibaa' A. Garrison, Deborah A. Bolnick, Jennifer A. Raff, Alexa Walker, Ripan S. Malhi, and the Summer Internship for INdigenous peoples in Genomics (SING) Consortium
2018 Advancing the Ethics of Paleogenomics. *Science* 360 (6387):384–385.

Hoffecker John, Scott Elias, Dennis O'Rourke, G. Richard Scott, and Nancy Bigelow
2016 Beringia and the Global Dispersal of Modern Humans. *Evolutionary Anthropology* 25(2):64–79.

Llamas, Bastien, Lars Fehren-Schmitz, Guido Valverde, Julien Soubrier, Swapan Mallick, Nadin Rohland, Susanne Nordenfelt, et al.
2016 Ancient Mitochondrial DNA Provides High-Resolution Time Scale of the Peopling of the Americas. *Science Advances* 2:e1501385.

Moreno-Mayar, J. Víctor, Ben Potter, Lasse Vinner, Matthias Steinrücken, Simon Rasmussen, Jonathan Terhorst, John A. Kamm, et al.
2018a Terminal Pleistocene Alaskan Genome Reveals First Founding Population of Native Americans. *Nature* 553:203–207.

Moreno-Mayar, J. Víctor, Lasse Vinner, Peter de Barros Damgaard, Constanza de la Fuente, Jeffrey Chan, Jeffrey P. Spence, Morten E. Allentoft, et al.
2018b Early Human Dispersals within the Americas. *Science* 362(6419):eaav2621.

Pedersen, Mikkel, Anthony Ruter, Charles Schweger, Harvey Friebe, Richard Staff, Kristian K. Kjeldsen, Marie L. Z. Mendoza, et al.
2016 Postglacial Viability and Colonization in North America's Ice-Free Corridor. *Nature* 537:45–49.

Posth, Cosimo, Nathan Nakatsuka, Iosif Lazaridis, Pontus Skoglund, Swapan Mallick, Thiseas C. Lamnidis, Nadin Rohland, et al.
2018 Reconstructing the Deep Population History of Central and South America. *Cell* 175:1–13.

Raff, Jennifer, and Deborah Bolnick
2015 Does Mitochondrial Haplogroup X Indicate Ancient Trans-Atlantic Migration to the Americas? A Critical Re-evaluation. *PaleoAmerica* 1(4):297–304.

Raghavan, Maanasa, Pontus Skoglund, Kelly E. Graf, Mait Metspalu, Anders Albrechtsen, Ida Moltke, Simon Rasmussen, et al.
2014 Upper Palaeolithic Siberian Genome Reveals Dual Ancestry of Native Americans. *Nature* 505:87–91.

Raghavan, Maanasa, Matthias Steinrücken, Kelley Harris, Stephan Schiffels, Simon Rasmussen, Michael DeGiorgio, Anders Albrechtsen, et al.
2015 Genomic Evidence for the Pleistocene and Recent Population History of Native Americans. *Science* 349(6250):aab384. http://science.sciencemag.org/content/349/6250/aab3884

Rasmussen, Morten, Sarah L. Anzick, Michael R. Waters, Pontus Skoglund, Michael DeGiorgio, Thomas W. Stafford Jr., Simon Rasmussen, et al.
2014 The Genome of a Late Pleistocene Human from a Clovis Burial Site in Western Montana. *Nature* 506:225–229.

Rasmussen, Morten, Martin Sikora, Anders Albrechtsen, Thorfinn Sand Korneliussen, J. Víctor Moreno-Mayar, G. David Poznik, Christoph P. E. Zollikofer, et al.
2015 The Ancestry and Affiliations of Kennewick Man. *Nature* 523:455–458. https://www.nature.com/articles/nature14625

Reich, David, Nick Patterson, Desmond Campbell, Arti Tandon, Stéphane Mazieres, Nicolas Ray, Maria V. Parra, et al.
2012 Reconstructing Native American Population History. *Nature* 488:370–374.

Scheib, C. L., Hongjie Li, Tariq Desai, Vivian Link, Christopher Kendall, Genevieve Dewar, Peter William Griffith, et al.
2018 Ancient Human Parallel Lineages within North America Contributed to a Coastal Expansion. *Science* 360 (6392):1024–1027.

Sikora, Martin, Vladimir Pitulko, Vitor Sousa, Morten E. Allentoft, Lasse Vinner, Simon Rasmussen, Ashot Margaryan, et al.
2018 The Population History of Northeastern Siberia since the Pleistocene. *bioRxiv* https://doi.org/10.1101/448829

Skoglund, Pontus, Swapan Mallick, Maria Cátira Bortolini, Niru Chennagiri, Tábita Hünemeier, Maria Luiza Petzl-Erler, Francisco Mauro Salzano, et al.
2015 Genetic Evidence for Two Founding Populations of the Americas. *Nature* 525:104–108.

Szathmary, Emoke J. E., Nancy S. Ossenberg, Marie S. Clabeaux, Della Collins Cook, Michael H. Crawford, Don E. Dumond, Roberta L. Hall, et al.
1978 Are the Biological Differences between North American Indians and Eskimos Truly Profound? *Current Anthropology* 19:673–701.

Tamm, Erika, Toomas Kivisild, Maere Reidla, Mait Metspalu, David Glenn Smith, Connie J. Mulligan, Claudio M. Bravi, et al.
2007 Beringian Standstill and Spread of Native American Founders. *PLoS ONE* 2(9):e829. https://doi.org/10.1371/journal.pone.0000829

HUMAN PALEOGENOMIC RESEARCH IN THE AMERICAS

A LOOK AT CURRENT DATA AND VISION FOR MORE INCLUSIVE PRACTICES NOW AND INTO THE FUTURE

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Paleogenomic research is often touted as "revolutionizing the study of the past." Much of this excitement and optimism is due to advances in DNA sequencing technology and computational genomic analysis, such as the development of High-Throughput Sequencing (HTS) and the multitude of bioinformatic pipelines built to analyze the billions of DNA sequence reads that result from an HTS run. Initial ancient DNA studies of Indigenous ancestors in the Americas in the early 1990s focused primarily on analyzing parts of the mitochondrial genome, providing a window into the past based only on the direct maternal line. Human paleogenomic studies today have much more data because of the capacity to generate genome-wide data with information not only about the individual sampled but also about their ancestors expanding beyond the direct maternal line. This allows for a population-level analysis to occur with the sequencing of a single individual.

But as the field of paleogenomics continues to grow in exciting new directions, we face important considerations. First, the rapid expansion of DNA sequencing preparation methods means there are many different types of paleogenomic data accessible to researchers, but the various biases and limitations of these datasets have not been widely discussed. Second, the field is positioned at a critical point in its ethical development. While much of the early research in paleogenomics failed to incorporate meaningful elements of community engagement, or even consultation, paleogenomic researchers are increasingly working to use methods that are more inclusive. By using frameworks that center research on the linked Indigenous community instead of the academic lab, we will diversify the experiences and knowledge used in paleogenomic research, ensuring the results are mutually beneficial to Indigenous peoples, researchers, and society as a whole.

Uses and Limitations of Human Paleogenomic Data in the Americas

Paleogenomic studies of Indigenous ancestors in the Americas have generated multiple types of DNA sequence data (Table 1). Comprehensive reviews of the technologies and analytical methods in human genomics used to generate these data have already been published, and we refer you to these articles in the References Cited. Specifically, the details of HTS and associated methods in paleogenomics are described in a recent issue of *The SAA Archaeological Record* by Hofman and Warinner (2019). In addition, Harris and DeGiorgio (2017) provide an overview of the conceptual principles of *f*- and *D*-statistics and other analytical methods that are currently being used in paleogenomic studies. Here, we categorize the existing DNA sequence data from the Americas into five sets and briefly discuss their uses and limitations.

1. There exist a small number of low-moderate coverage genomes from ancient individuals in the Americas (e.g., Moreno-Mayar et al. 2018; Rasmussen et al. 2014). Of the paleogenomic datasets that exist, these genomic data likely exhibit the least bias when inferring population history and genetic relationships among ancient and present-day individuals because nearly all of the information present in human genomes can be used to estimate genetic relatedness. Although this type of data is currently used to investigate questions on a continental scale, including the peopling of the Americas, low-moderate coverage

Table 1. Paleogenomic Datasets in the Americas.

Data type	Nucleotides in human genome	Genomic region(s)
Low-moderate coverage genomes	1x–18x coverage	Full human genome
Genome-wide shotgun data	<1x coverage	Random coverage across human genome
Human Origins data	~1.2 million	Human regions previously identified as polymorphic in worldwide population panel
Whole-exome data	~40–60 million	Human protein-coding and adjacent regulatory regions
Metagenomic data (e.g., dental calculus/ coprolites)	Usually <<.1x	Human-associated bacteria, pathogens, and consumed flora and fauna

genomes can also be useful when studying regional population history in the Americas—addressing hypotheses that may more strongly impact present-day Indigenous communities. Here, we note that all paleogenomic data likely exhibit unknown DNA damage patterns that manifest in a phenomenon called "ancient DNA attraction." That is, in some genomic analyses, geographically and/or temporally distant (presumably unrelated) individuals exhibit a closer genetic relationship than expected due to shared artifact structure, likely as a result of DNA damage. For continental-scale analyses, the extent of the bias caused by these unknowns is likely negligible, but may be more pronounced in regional-scale analyses.

2. A large proportion of human paleogenomic data in the Americas consists of genome-wide shotgun sequence data. This data consists of random DNA sequences across the human genome. Genome-wide shotgun sequence data have also been used to address continental-scale questions on evolutionary history when compared to whole genome data from ancient and present-day individuals (e.g., Scheib et al. 2018). This shotgun sequence data can show broad differences in ancestry between individuals from different geographic regions in the Americas. However, individuals with this type of data can rarely be directly compared because they will usually only have a small overlap of DNA sequence from homologous regions and this data is therefore much more limited when addressing regional-level questions.
3. The Human Origins dataset is derived from genomic capture methods. Practically, this means that the same genomic regions are sequenced and comparable in every sample, and so this data is useful for both continental-scale and regional-scale questions (e.g., Posth et al. 2018). The genomic regions captured and sequenced in Human Origins datasets are informative regions derived from sequencing genomes of present-day individuals from a worldwide panel and should therefore exhibit less ascertainment bias. However, the worldwide panel included only one individual from South America and no individuals from North America, so it is likely that the Human Origins capture would exhibit bias among Indigenous peoples of North America as some genomic variants that exist in North American populations would not be represented in this dataset. As a result, populations in North America will artificially exhibit less variation when compared to populations in South America due to the genomic regions sequenced in this dataset. Also, researchers using this capture method in North America will have fewer variants to detect subtle admixture and other demographic events that occurred within North America in the past.
4. Whole-exome datasets in the Americas also use capture methods. In this case, the genomic regions being captured for sequencing are the protein-coding regions and adjacent regulatory regions of the human genome. Whole-exome data are much more limited in paleogenomic data in the Americas but have been used to address regional human population history. However, whole-exome data are ideally suited to assess environmental influences and natural selection acting on human genomes over time, because the genomic regions sequenced are directly translated to phenotypes (e.g., Lindo et al. 2016).
5. An emerging paleogenomic dataset in the Americas consists of meta-genomic data from sources like dental calculus and coprolites. This data usually consists of DNA sequences from human commensal bacteria, pathogens, and flora and fauna consumed by the ancient individual to address questions of diet and health in the past.

Knowledge of the uses and limitations of the many forms of paleogenomic data available from the Americas should facilitate better integration of archaeological and paleogenomic data for hypothesis testing.

Moving Toward More Inclusive Practices in Paleogenomic Research

Paleogenomic researchers studying Indigenous ancestors have the opportunity to revolutionize the study of the past not just by expanding the breadth of genomic tools available but also by strengthening the ethics of their research practice. Human paleogenomic studies in the Americas are beginning to undergo a shift in study design toward inclusion and community-based research methods. Most human ancient DNA studies in the Americas during the 1990s and the turn of the twentieth century were published with no consultation or engagement with local (to where the ancestral remains were found) Indigenous communities. Notable exceptions to this trend include ancient DNA analyses of Kwäday Dän Ts'ìnchį, or "Long Ago Person Found" (Monsalve et al. 2002), Shuká Káa (Kemp et al. 2008), and ancient individuals from the Great Basin and Aleutian Islands (O'Rourke et al. 2005). Over the last decade, a significant shift in research practices has occurred with some paleogenomics studies incorporating elements of community-based research practices.

This shift mirrors developments across several other related fields, including archaeology. Frameworks like Indigenous archaeology (Nicholas 2010; Watkins 2000) and community-based participatory research (Atalay 2012; Atalay et al. 2014) have worked to address similar challenges in the field of archaeology by decolonizing or Indigenizing archaeological methods and practices. These provide models for collaborative work with Indigenous communities where research intersects with Indigenous knowledge, upholds community values, redresses previous unequal research practices, and broadens interpretations of the generated data (Nicholas 2010). Similar frameworks have been created in the field of health genomics as well, such as Hudson and colleagues' (2016) model incorporating a Maori knowledge base (Figure 1). In addition, the SING Consortium recently provided an ethical framework for health genomics research with Indigenous communities, where the community is central, instead of ancillary, to the research project (Figure 1; Claw et al. 2018). In summary, researchers do not need to start from scratch when developing inclusive methods to employ in paleogenomics research. Practitioners can incorporate and modify existing frameworks for Indigenous community engagement from other fields. Additionally, resources are already beginning to emerge within the field of paleogenomics, such as the ethical guiding questions for researchers developed by the SING Consortium (Bardill et al. 2018).

To better illustrate the potential for more inclusive and engaged paleogenomic research with Indigenous communities, we have created a "paleogenomic community engagement chart" based on three interrelated axes (Figure 2): 1) Indigenous research team, 2) Community-centered approach, and 3) Local responsibility.

The *Indigenous research team* axis measures the proportion of the research team members who are Indigenous, including the Principal Investigator. Projects that include Indigenous team members, who potentially have shared histories and experiences with local community members linked to the ancestor(s) under study, may more effectively navigate the potential risks and needs of the communities. However, the ancient DNA field (and STEM fields in general) have a dearth of Indigenous practitioners and trainees

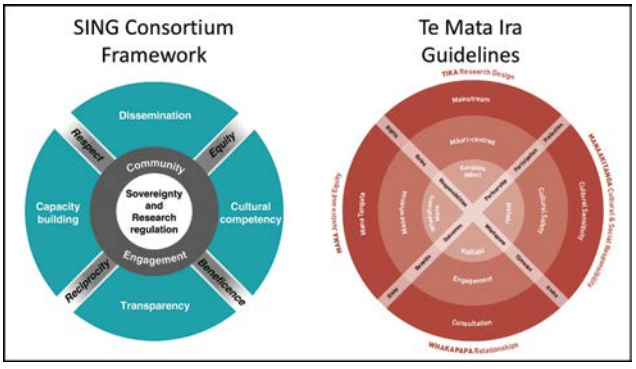

Figure 1. Ethical frameworks for health genomics research with Indigenous communities by Claw et al. (2018) left, and Hudson et al. (2016) right.

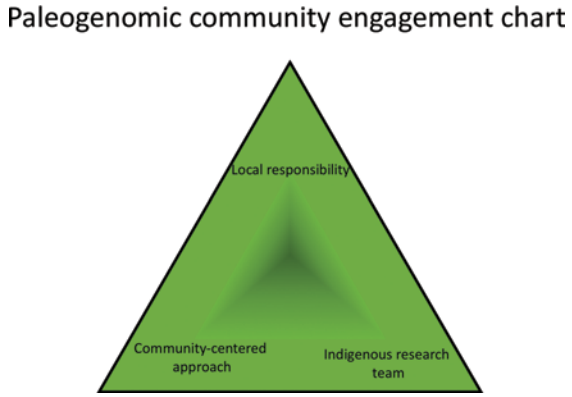

Figure 2. Paleogenomic community engagement chart.

in the educational pipeline to become paleogenomic researchers. To address this issue, the Summer internship for INdigenous peoples in Genomics (SING) program was founded in 2010 and is working to 1) increase the number of Indigenous leaders in genomic (including paleogenomics) fields, and 2) train Indigenous scientists to use genomics as a tool within an Indigenous framework and worldview. SING currently runs three week-long workshops annually in the US, Canada, and New Zealand. The program has graduated over 100 participants from Indigenous communities and has created a worldwide network of Indigenous scientists and scholars. The SING Consortium is under the umbrella of the SING program and consists of faculty and graduates of SING who publicly comment on and help create policy for genomic research with Indigenous communities. This program has been successful in creating a public voice for Indigenous scientists in genomics as well as mitigating isolation of Indigenous students in STEM fields. Both of these actions are helping to increase the number of Indigenous leaders in genomics and related fields.

The second axis, labeled *Community-centered approach*, measures the degree to which the study incorporates Indigenous knowledge, adheres to tribal research regulations and sovereignty, and involves linked community members in the research process. Studies that embrace a community-centered approach by incorporating community-held knowledge and values into the research process will create and test hypotheses that are of value to local Indigenous peoples as well as the broader scientific community. For example, Tsimshian society is based on matrilines, each of which have their own oral history, or *adawx*, to provide a record of historical events and key figures in the past. *Adawx* have an inherent chronology based on references to geological or historical events so that collectively, the *adawx* preserve a history of the Tsimshian from multiple perspectives (Martindale and Marsden 2003). Researchers who continue to use past colonial research practices and choose not to involve community members in the research process may miss details of local population history or demographic events that would strengthen their research questions or interpretation of results.

The third axis, labeled *Local responsibility*, measures how the study provides benefits to the linked community as well as to society more broadly. Paleogenomic studies that minimize risks to linked communities and provide tangible, more immediate benefits that meet the needs of the community exhibit local social responsibility and justice. For example, an ancestral cemetery on the coast at Point Barrow, Alaska, has been eroding and contributing to the loss of ancestral remains into the ocean. The Utqiaġvik community partnered with researchers at universities in the US to remove the remaining ancestors for reburial further inland, and the community encouraged skeletal and paleogenomic analyses of the ancestors before reburial to learn about ancient lifeways and local population history. Community high school students were hired to assist with the project and were taught scientific excavation and laboratory methods. Lastly, before the study is completed, there are plans for the research findings to be developed into accessible educational materials for community members (Bardill et al. 2018). These activities ensure that the paleogenomic research is not extractive, but part of a mutually beneficial collaboration between Indigenous communities and researchers.

Based on these three measures, studies that continue to use more colonial research paradigms by choosing not to engage with local communities or include Indigenous team members will reside on the edges of the chart. For example, studies where the only community engagement was to obtain permission to study the ancestral remains from a linked community would still fall on or near the edges of the chart. In contrast, paleogenomic studies that have multiple Indigenous team members, partner with communities throughout the research process for coproduction of knowledge, and have immediate tangible benefits for community members will be located more toward the center of the chart. The ideal community engagement methodology will vary based on the objectives, needs, and resources of the research partners. As a whole, human paleogenomic research studies in the Americas should continue the transition to more inclusive, community-centered practices, moving from the edges toward the center of the community engagement chart.

Archaeologists who are considering incorporating paleogenomic analyses into their research in the Americas should consider the uses and limitations of different types of DNA sequence data, and which ones might best address their research questions. Paleogenomic research can also impact present-day Indigenous communities. By using inclusive, community-centered practices, archaeologists can ensure that their studies are mutually beneficial to Indigenous peoples, researchers, and society as a whole.

References Cited

Atalay, Sonya
2012 *Community-Based Archaeology: Research with, by, and for Indigenous and Local Communities.* University of California Press, Berkeley.

Atalay, Sonya, Lee Rains Clauss, Randall H. McGuire, and John R Welch

2014 *Transforming Archaeology: Activist Practices and Prospects*. Left Coast Press, Walnut Creek, California.

Bardill, Jessica, Alyssa C. Bader, Nanibaa' A. Garrison, Deborah A. Bolnick, Jennifer A. Raff, Alexa Walker, Ripan S. Malhi, and the Summer Internship for INdigenous peoples in Genomics (SING) Consortium
2018 Advancing the Ethics of Paleogenomics. *Science* 360(6387):384–385.

Claw, Katrina G., Matthew Z. Anderson, Rene L. Begay, Krystal S. Tsosie, Keolu Fox, Nanibaa' A. Garrison, and the Summer Internship for INdigenous peoples in Genomics (SING) Consortium
2018 A Framework for Enhancing Ethical Genomic Research with Indigenous Communities. *Nature Communications* 9(1):2957. https://www.nature.com/articles/s41467-018-05188-3

Harris, Alexandre M., and Michael DeGiorgio
2017 Admixture and Ancestry Inference from Ancient and Modern Samples through Measures of Population Genetic Drift. *Human Biology* 89(1):21–46.

Hofman, Courtney A., and Christina Warinner
2019 Ancient DNA 101: An Introductory Guide in the Era of High-Throughput Sequencing. *The SAA Archaeological Record* 19(1):18–25.

Hudson, Maui, Angela Beaton, Moe Milne, Waiora Port, Khyla Russell, Barry Smith, Valmaine Toki, Lynley Uerata, and Phil Wilcox
2016 *Te Mata Ira: Guidelines for Genomic Research with Maori*. Te Mata Hautu Taketake-Maori and Indigenous Governance Centre. University of Waikato, Hamilton, New Zealand.

Kemp, Brian M., Ripan S. Malhi, John McDonough, Deborah A. Bolnick, Jason A. Eshleman, Olga Rickards, Cristina Martinez-Labarga, et al.
2008 Genetic Analysis of Early Holocene Skeletal Remains from Alaska and Its Implications for the Settlement of the Americas. *American Journal of Physical Anthropology* 132:605–621.

Lindo, John, Emilia Huerta-Sanchez, Shigeki Nakagome, Morten Rasmussen, Barbara Petzelt, Joycelynn Mitchell, Jerome S. Cybulski, et al.
2016 A Time Transect of Exomes from a Native American Population before and after European Contact. *Nature Communications* 7:13175. https://www.nature.com/articles/ncomms13175

Martindale, Andrew, and Susan Marsden
2003 Defining the Middle Period (3500 BP to 1500 BP), Tsimshian History through a Comparison of Archaeological and Oral Records. *BC Studies* 138:13–50.

Monsalve, M. Victoria, Anne C. Stone, Cecil M. Lewis, Allan Rempel, Michael Richards, Dan Straathof, and Dana V. Devine
2002 Brief Communication: Molecular Analysis of the Kwäday Dän Ts'ìnchi Ancient Remains Found in a Glacier in Canada. *American Journal of Physical Anthropology*: 119:288–291.

Moreno-Mayar, J. Víctor, Lasse Vinner, Peter de Barros Damgaard, Constanza de la Fuente, Jeffrey Chan, Jeffrey P. Spence, Morten E. Allentoft, et al.
2018 Early Human Dispersals within the Americas. *Science* 362(6419):eaav2621.

Nicholas, George
2010 *Being and Becoming Indigenous Archaeologists*. Left Coast Press, Walnut Creek, California.

O'Rourke, Dennis H., M. Geoffrey Hayes, and Shawn W. Carlyle
2005 The Consent Process and aDNA Research: Contrasting Approaches in North America. In *Biological Anthropology and Ethics: From Repatriation to Genetic Identity*, edited by Trudy R. Turner, pp. 229-240. State University of New York Press, Albany.

Posth, Cosimo, Nathan Nakatsuka, Iosif Lazaridis, Pontus Skoglund, Swapan Mallick, Thiseas C. Lamnidis, Nadin Rohland, et al.
2018 Reconstructing the Deep Population History of Central and South America. *Cell* 175:1–13.

Raghavan, Maanasa, Matthias Steinrücken, Kelley Harris, Stephan Schiffels, Simon Rasmussen, Michael DeGiorgio, Anders Albrechtsen, et al.
2015 Genomic Evidence for the Pleistocene and Recent Population History of Native Americans. *Science* 349(6250):aab384. http://science.sciencemag.org/content/349/6250/aab3884

Rasmussen, Morten, Sarah L. Anzick, Michael R. Waters, Pontus Skoglund, Michael DeGiorgio, Thomas W. Stafford Jr., Simon Rasmussen, et al.
2014 The Genome of a Late Pleistocene Human from a Clovis Burial Site in Western Montana. *Nature* 506:225–229.

Scheib, C. L., Hongjie Li, Tariq Desai, Vivian Link, Christopher Kendall, Genevieve Dewar, Peter William Griffith, et al.
2018 Ancient Human Parallel Lineages within North America Contributed to a Coastal Expansion. *Science* 360(6392):1024–1027.

Watkins, Joe
2000 *Indigenous Archaeology: American Indian Values and Scientific Practice*. Alta Mira Press, Walnut Creek, California.

BERINGIAN ARCHAEOLOGY AND ANCIENT GENOMICS

A NEW SYNTHESIS

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Genetic models based primarily on ancient DNA from archaeological specimens are now steering archaeological research in Beringia. They have incentivized archaeologists to search for archaeological evidence in new places, both geographically and geochronologically, and they are pushing us to reconsider long-held theoretical perspectives explaining technological variability in the Upper Paleolithic record.

Briefly, the current genomic model predicts that humans dispersed from two core areas in greater northeast Asia (central Siberia and eastern Asia) to Beringia, becoming isolated there by about 20,000 calendar years ago (cal BP). During the next ~5,000 years, a distinctive ancestral Native American population emerged, along with at least one other population that became uniquely Beringian. Around 15,000 cal BP, as western Canada's ice sheets were rapidly receding, the ancestral Native American population dispersed southward through one or two ice-free corridors, along the Pacific coast or east of the Cordillera.

The archaeological populations that contributed to the peopling of Beringia and America, therefore, are predicted to have been the Upper Paleolithic people of Siberia and eastern Asia, either mainland China and Korea or maritime Japan. Technologically, we know that these people primarily used two or three major lithic industries to produce the tools needed for survival: bifaces, blades, and, at least late in the Upper Paleolithic, microblades. In addition, Upper Paleolithic material culture included carefully formed osseous tools such as points, awls, and needles made of ivory, antler, and bone, as well as distinctive beads and pendants made of a variety of materials. These hunter-gatherers practiced a highly mobile lifestyle, although in places the remains of substantial dwellings suggest at least seasonal, likely winter, sedentism. Their adaptation was fundamentally terrestrial and centered on large game, but subsistence also often included small fur-bearing mammals and waterfowl (even fish in some late Upper Paleolithic contexts). In the Japanese Archipelago, technologies included watercraft needed to colonize nearshore islands where important lithic resources like obsidian could be obtained. Generally, then, this well-documented assortment of northeast Asian Upper Paleolithic traditions, stretching from Lake Baikal in Siberia to Hokkaido Island in Japan, represents the immediate archaeological ancestors of the first Beringians and, ultimately, Native Americans.

Paleoecologically, without question the peopling of Beringia unfolded on the northern mammoth-steppe; however, our understanding of this important late-Pleistocene biome continues to evolve. Early portrayals of a northern Serengeti-like environment certainly were oversimplifications. A patchwork of different habitats existed during full-glacial times, from polar desert in upland areas to treeless tundra-steppe in low-elevation arctic and subarctic plains, in some places dominated by sedges and grasses, in others, herbs. Even isolated refugia of shrub tundra appear to have existed during full-glacial times, as Scott Elias and Barnaby Crocker have shown with fossil beetles, paleobotanical remains, and paleosols for the now-submerged central land bridge (Elias and Crocker 2008). Species-specific genomic histories and radiocarbon chronologies of the mammoth-steppe fauna indicate a dynamic and variable environment both geographically and temporally, with extinctions occurring asynchronously, under variable pressures. Wapiti (*Cervus canadensis*), for example, was once considered to have been absent from the mammoth-steppe during the full glacial; however, geneticist Ian Barnes and colleagues (Meiri et al. 2014) have shown that this browsing ungulate surprisingly persisted in low-population densities in

Figure 1. Late-glacial Beringia showing locations of archaeological sites mentioned in the text: 1) Yana sites; 2) Urez-22; 3) Nikita Lake; 4) Berelekh; 5) Ushki; 6) Serpentine Hot Springs; 7) Raven Bluff; 8) Lake E5; 9) Bluefish Caves; 10) Owl Ridge; 11) Teklanika West; 12) Nenana Valley sites, including Dry Creek, Walker Road, Moose Creek, and Panguingue Creek; 13) Eroadaway; 14) McDonald Creek; 15) Upward Sun River; 16) Swan Point, Broken Mammoth, Mead, Keystone Dune, and Holzman; 17) Linda's Point; 18) Little John; 19) Tangle Lakes sites.

isolated refugia in western Beringia through the last glacial maximum, and rapidly dispersed across the rest of Beringia to the Americas during the late glacial, paralleling the modeled dispersal of humans. Wapiti's spread to Alaska coincided with climate amelioration during earliest late-glacial warming.

A major expectation of the genomic model of human dispersal is that we should not expect a human population in Beringia that was immediately ancestral to Native Americans until after the last glacial maximum, which spanned 28,000–19,000 cal yr BP. If correct, then the amazingly preserved early Upper Paleolithic record at the 32,000-cal-BP Yana site (and others nearby that are potentially even earlier in age) in the high Arctic of Asian Beringia (Figure 1; Pitulko et al. 2017) is not directly tied to the peopling of the Americas. This is supported by newly reported ancient DNA recovered from human teeth at the site (Sikora et al. 2018). Genomically, the Yana people appear to represent a population of northern Siberians who contributed to the peopling of the Americas only indirectly, via a descendant Mal'ta or later Upper Paleolithic population who existed around Lake Baikal in southern Siberia 24,000–14,000 cal BP. Nonetheless, the well-preserved Yana sites, with their osseous technologies (which include an amazing ivory bowl among other well-crafted decorative pieces), preserved features, and associated large-mammal remains, represent a sustained occupation of the arctic plain of western Beringia during a relatively warm interstadial, ~4,000 years before the onset of the last glacial maximum. So far we have no clear evidence of early Upper Paleolithic Alaskans, but a new study of sediment cores from Lake E5 on the North Slope suggests the presence of human fecal biomarkers in sediments dated to 31,000–22,000 cal BP (Vachula et al. 2019). These results are compelling but require verification (through archaeological survey and perhaps environmental DNA analysis) and a clear presentation of the taphonomy of such molecules, because they seem to be virtually absent from the Holocene component of the core, a time when we know humans existed in the area.

With the side-lining of Yana, we suddenly have no early footprint of the predicted Beringian population ~20,000–15,000

Figure 2. The Urez-22 Upper Paleolithic site. Photograph courtesy of Vladimir Pitulko.

cal BP, unless the early record from Bluefish Caves, Yukon (Canada), is validly archaeological and not just paleontological. Excavated by Jacques Cinq-Mars in the 1970s, for many years the fate of Bluefish as a full-glacial archaeological site hinged on acceptance of a 'core and flake' on mammoth bone (directly radiocarbon dated to 23,500 cal BP) as human-produced, but now it centers on possible cut marks on a horse and caribou bone, both directly dated to 24,000–22,000 cal BP (Bourgeon et al. 2017). These pieces, however, make up <0.01% of the faunal assemblage, and without clearly associated lithic artifacts the Bluefish record still fails to satisfy many northern archaeologists. Thus, we still lack unequivocal evidence of Upper Paleolithic Beringians at the genetically appointed time, ~20,000–15,000 cal BP.

After 15,000 cal BP, the record of Upper Paleolithic humans in Beringia mushrooms, on both sides of the land bridge. In western Beringia, Vladimir Pitulko's recent field surveys in the lower Yana-Indigirka lowlands, north of the Arctic Circle, have led to the discovery of Upper Paleolithic sites in addition to Yana. Most important is Urez-22, dating to the period of 14,800–14,100 cal BP and yielding lithic artifacts and bones of mammoth (Figure 2), as well as worked pieces of ivory, including a spear-point blank. The lithic industry includes clear microblade technology, an obvious sign of the late Upper Paleolithic Diuktai culture. Across the land bridge in Alaska the earliest unequivocal evidence of humans is still the Swan Point site, dating to ~14,100 cal yr BP. The record is similar to that from Urez-22, although more expressive, with Yubetsu-style wedge-shaped microblade cores having been reduced on site, as well as ivory materials having been worked into a variety of forms (Gómez Coutouly 2012; Hirasawa and Holmes 2017; Lanoë and Holmes 2016). Along with Urez-22, the Swan Point industry chronicles the dispersal of a Diuktai-like complex into Beringia, not surprising given the preponderance of such microblade technologies across interior northeast Asia in the millennia leading up to this time. More remarkable is the >15,000-year-gap that still separates these earliest late-glacial sites at 15,000–14,000 cal BP and Beringia's early archaeological record at Yana (32,000 cal BP). Equally confounding is the apparent 5,000-year lag between these first-known late Upper Paleolithic industries (<15,000 cal BP) and the genomically modeled timing of Asian dispersal to Beringia (i.e., 20,000 cal BP). Either we are still missing an important segment of Beringian prehistory, or the genomic models are inflating the timing of dispersal from Asia to Beringia.

After 14,000 cal BP, late Upper Paleolithic sites abound, but they have a decidedly Beringian character, what Roger Powers and John Hoffecker (1989) originally termed the Nenana complex. The first Nenana complex sites to be excavated and unequivocally dated to before 13,000 cal BP (the Allerød interstadial) were in the Nenana River valley of interior Alaska. Repeated stratigraphic contexts at Dry Creek, Walker Road, and Moose Creek produced a consistent lithic industry of small triangular or teardrop-shaped bifacial points (generally called Chindadn points), end scrapers, side scrapers, and marginally retouched blades and blade-like flakes, often associated with hearth features. Since these early excavations in the 1970s–1990s, additional Nenana complex-like industries from Allerød contexts have been found, and continued research has yielded much new information. Renewed excavations at the Dry Creek type-site, for example, have pushed the age of this earliest occupation of the Nenana valley to ~13,500 cal BP (Graf et al. 2015), and at the Owl Ridge site in neighboring Teklanika valley, another Nenana complex industry recently has been dated to 13,400–12,800 cal BP (Gore and Graf 2018). In the middle Tanana River valley, about 150 km to the east-northeast, David Yesner and Chuck Holmes in the 1990s established the presence of a Nenana-like industry at the Broken Mammoth site, with well-preserved remains of large mammals (e.g., bison) as well as waterfowl (e.g., swans), again dating in excess of 13,000 cal BP (Yesner 1995). Since those pioneering excavations at Broken Mammoth, additional industries potentially ascribable to the Nenana complex have been found at Linda's Point along the north shore of Healy Lake (Younie and Gillispie 2016) as well as at the nearby Keystone Dune, Mead, and Upward Sun River sites (e.g., Lanoë et al. 2018; Potter et al. 2013), all potentially predating 13,000 cal BP. The newest Nenana complex occupation to be excavated (and possibly the oldest yet found) is at McDonald Creek (Figure 3), located along the Tanana River about halfway between Dry Creek and Broken Mammoth. There we

have exposed a well-preserved ~13,800-cal-BP living floor with core-reduction and small retouch debitage, a triangular Chindadn point, and several biface fragments, associated with large-bodied mammals like steppe bison and elk, large birds such as swan or eagle, fur-bearers (possibly marten), and dog or wolf. Nenana complex industries appear to continue into the Younger Dryas, too, as late as 12,700 cal BP at sites like McDonald Creek (C2), Eroadaway in the upper Nenana River valley, and Little John in Yukon, Canada, and possibly even later at Swan Point (CZ3; see Goebel and Potter 2016). In none of these Nenana assemblages, from 13,800 to 12,700 cal BP, is a clear microblade industry present. Swan Point (CZ3) may contradict this pattern, but this is not surprising given its late age, after which microblades abound in the central Alaskan archaeological record.

The Nenana pattern is replicated in western Beringia, in both Kamchatka and the Yana-Indigirka lowlands. Kamchatka's Allerød record is dominated by the well-known early Ushki culture, with its well-preserved dwelling, hearth, and burial features, and its characteristic lithic industry with small bifacial points, albeit stemmed and not triangular or teardrop-shaped. A series of dates from two Ushki localities demonstrate this occupation occurred ~13,000 cal BP. Again, though, the most compelling new evidence from Asian Beringia has been found in the Yana-Indigirka lowlands, this time from the Nikita Lake site, located near Urez-22. Here Pitulko and colleagues (2017) recently unearthed butchered mammoth remains associated with teardrop-shaped bifacial points (which they unhesitatingly label Chindadn) as well as ivory debitage and spear-point preforms dating to 14,000–13,700 cal BP. Complementing this is Pitulko's renewed work at the Berelekh site along the lower Indigirka River, where he found a similar assemblage, again with teardrop-shaped Chindadn points and rough ivory artifacts, > 13,500 cal BP. Bifacial points with coarse stems have also been found at Nikita Lake and Berelekh, potentially linking them with Ushki. Importantly, neither the early Ushki nor the Nikita Lake/Berelekh assemblages contain microblades, a pattern reminiscent of the Allerød situation in Interior Alaska.

For us, this is one of the most satisfying aspects of recent Beringian research, that repeated excavations from one end of Beringia to the other have finally demonstrated the existence of a technological complex with a consistent set of bifacial and blade lithic tools and (when preserved) ivory tools, lacking microblade technology. Interpreting the meaning of this Nenana complex will take additional excavations, complete technological and subsistence analyses, and most obviously an ancient-human genome from a Nenana occupation. This is one reason why Brian Wygal and Kathryn Krasinski have opened excavations at the Holzman site (near Mead), and why we continue working at McDonald Creek.

Figure 3. The exposed 13,800-cal-BP living floor preserved at McDonald Creek, Alaska. Photograph by Kelly Graf.

During the later Younger Dryas stadial and into the early Holocene, the archaeological record is primarily made up of wedge-shaped core and microblade industries, locally called the Denali complex in central Alaska and regionally the Paleoarctic tradition. For a long time, we considered Dry Creek's Component 2 to represent the earliest such industry in central Alaska, citing an early conventional radiocarbon age of ~12,500 cal BP from the 1970s excavation. Our recent excavations there, however, suggest it may date to only 11,000 cal BP or later. At nearby Moose Creek (C2) and Owl Ridge (C2), occupations ascribed to the Denali complex nonetheless consistently date as early as ~12,400 cal BP, while other Denali sites like Teklanika West (recently re-excavated by Sam Coffman), Tangle Lakes, and Panguingue Creek are likely centuries younger (Blong 2018; Goebel and Potter 2016). The new human genome from Xaasaa Na' (Upward Sun River) is associated with this later Denali complex, suggesting that genetically these people were 'Ancient Beringians,' a local lineage which had split from the Beringian lineage that eventually gave rise to Americans south of the ice sheets (Moreno-Mayar et al. 2018).

Another interesting development in the Younger Dryas archaeology of Alaska is the dating of fluted-point industries in the northern part of the state. With the recent excavations at Serpentine Hot Springs and Raven Bluff (Buvit et al. 2019; Smith and Goebel 2018), northern fluted points date to as early as 12,300 cal BP but no earlier, indicating they represent a post-Clovis phenomenon. Heather Smith's comprehensive geometric-morphometric/technological analysis of fluted points from Alaska, western Canada, and temperate North America strongly suggests an ancestral-descendant relationship between

Clovis and northern fluted points, with a sample of points in the interior, ice-free corridor representing an intermediate group (Smith and Goebel 2018). The parsimonious explanation of this evolutionary relationship is that Alaska's fluted points represent a back-migration from temperate North America during the Younger Dryas, coincident with the northward dispersal of plains bison into the corridor (Heintzman et al. 2016).

With the early archaeological record of the interior corridor currently suggesting a relatively recent back-migration to Alaska, many northern archaeologists are turning to the Pacific coastal corridor as a viable alternate route of human dispersal from Beringia to America. Although southwest and south-central Alaska have not yet yielded any Pleistocene-aged sites, in southeast Alaska Younger Dryas-aged sites have been known for some time, and the ancient genome of Shuká Káa, from On Your Knees Cave, suggests regional population structure had emerged by 10,300 cal BP (Lindo et al. 2017). Farther south in coastal British Columbia, Quentin Mackie, Daryl Fedje, and Duncan McLaren (2018) have convincingly shown that many late Pleistocene shorelines are now above the modern shoreline because of post-glacial crustal rebound after melting of the heavy Cordilleran Ice Sheet. Using a predictive model for locating paleo-coastal sites, they have quickly pushed the archaeological record along the Canadian coast back to as early as 13,000 cal BP. Risa Carlson and James Baichtal's (2015) similar work in southeastern Alaska has led to the discovery of sites on raised shorelines as early as 10,500 cal BP.

Obviously, this is an exciting time to be a Beringian archaeologist. The synthesis of archaeological and genomic evidence—human and nonhuman—is creating a dynamic marketplace of new ideas and new research efforts. As we move to the future, though, we need to expand dialogue with Native Alaskan and First Nations peoples of the Arctic and Subarctic, sharing the knowledge and experience. Already great strides have been made in this regard, the most evident involving the excavation, study, and repatriation of ancient human remains, most notably the recent genomic analysis of Shuká Káa, which was accomplished through sustained consultations between scientists, the US Forest Service, and two tribal organizations, the Klawock Cooperative Association and Craig Community Association of southeast Alaska. Similarly, the decision to conduct ancient-genomic analyses of the Xaasaa Na' remains from Upward Sun River was reached through dialogues involving the Tanana Chiefs Conference of central Alaska, University of Alaska archaeologists, geneticists, and the National Science Foundation (NSF). Importantly, however, these discussions had begun long before the discovery of the remains, early in the development of the excavation program. Such experiences only improve relationships between indigenous peoples, professional archaeologists, and government agencies, and they further enhance our understanding of the process of the peopling of the Americas.

Figure 4. Atlatl-throwing experience during Bering Sea Days on St. Paul Island, Alaska, led by Joshua Lynch, a PhD candidate in Anthropology, Texas A&M University. Photograph courtesy of Veronica Padula.

Other important steps are being made every year by the newest generation of Beringian archaeologists, most notably through PhD dissertation support from the NSF. Angela Younie's excavations at Linda's Point, Healy Lake, is a case in point. Her dissertation project was co-sponsored by NSF and the Tanana Chiefs Conference, and through this collaboration, she actively engaged rural Native Alaskan schoolchildren in field and lab work, making them active partners in the research. Similarly, Joshua Lynch is sharing new knowledge of ancient projectile technology that he has gained through experimentation, using his NSF dissertation grant as a way to reach out to Native Alaskan schoolchildren in the remote Bering Sea region, introducing them to ancient Beringian subsistence practices (Figure 4). To these graduate students, the 'broader impacts' of their research are very important. Engaging indigenous communities in these ways undoubtedly enriches the research experience for all involved, and portends a healthy, more inclusive future for the study of Ice Age archaeology in Alaska.

References Cited

Blong, John C.
2018 Late-Glacial Hunter-Gatherers in the Central Alaska Range and the Role of Upland Ecosystems in the Peopling of Alaska. *PaleoAmerica* 4(2):103–133.

Bourgeon, Lauriane, Ariane Burke, and Thomas Higham
2017 Earliest Human Presence in North America Dated to the Last Glacial Maximum: New Radiocarbon Dates from Bluefish Caves, Canada. *PLoS ONE* 12(1):e0169486. https://doi.org/10.1371/journal.pone.0169486

Buvit, Ian, Jeffrey T. Rasic, Steven R. Kuehn, and William H. Hedman
2019 Fluted Projectile Points in a Stratified Context at the Raven Bluff Site Document a Late Arrival of Paleoindian Technology in Northwest Alaska. *Geoarchaeology* 34(1):3–14. https://onlinelibrary.wiley.com/doi/full/10.1002/gea.21693

Carlson, Risa J., and James F. Baichtal
2015 A Predictive Model for Locating Early Holocene Archaeological Sites Based on Raised Shell-Bearing Strata in Southeast Alaska, USA. *Geoarchaeology* 30:120–138.

Elias, Scott A., and Barnaby Crocker
2008 The Bering Land Bridge: A Moisture Barrier to the Dispersal of Steppe-Tundra Biota? *Quaternary Science Reviews* 27:2473–2483.

Gómez Coutouly, Yan Axel
2012 Pressure Microblade Industries in Pleistocene-Holocene Interior Alaska: Current Data and Discussions. In *The Emergence of Pressure Blade Making: From Origin to Modern Experimentation*, edited by Pierre M. Desrosiers, pp. 347–374. Springer, New York.

Goebel, Ted, and Ben A. Potter
2016 First Traces: Late Pleistocene Human Settlement of the Arctic. In *The Oxford Handbook of the Prehistoric Arctic*, edited by T. Max Friesen and Owen K. Mason, pp. 223–252. Oxford University Press, Oxford.

Gore, Angela K., and Kelly E. Graf
2018 Technology and Human Response to Environmental Change at the Pleistocene-Holocene Boundary in Eastern Beringia: A View from Owl Ridge, Central Alaska. In *Lithic Technological Organization and Paleoenvironmental Change*, edited by Erick Robinson and Frédéric Sellet, pp. 203–234. Springer, Cham, Switzerland.

Graf, Kelly E., Lyndsay M. DiPietro, Kathryn E. Krasinski, Angela K. Gore, Heather L. Smith, Brendan J. Culleton, Douglas J. Kennett, and David Rhode
2015 Dry Creek Revisited: New Excavations, Radiocarbon Dates, and Site Formation Inform on the Peopling of Eastern Beringia. *American Antiquity* 80:671–694.

Heintzman, Peter D., Duane Froese, John W. Ives, André E. R. Soares, Grant D. Zazula, Brandon Letts, Thomas D. Andrews, et al.
2016 Bison Phylogeography Constrains Dispersal and Viability of the Ice Free Corridor in Western Canada. *Proceedings of the National Academy of Sciences* 113(29):8057–8063.

Hirasawa, Yu, and Charles E. Holmes
2017 The Relationship between Microblade Morphology and Production Technology in Alaska from the Perspective of the Swan Point Site. *Quaternary International* 442:104–117.

Lanoë, François B., and Charles E. Holmes
2016 Animals as Raw Material in Beringia: Insights from the Site of Swan Point CZ4B, Alaska. *American Antiquity* 81:682–696.

Lanoë, François B., Joshua D. Reuther, Caitlin R. Holloway, Charles E. Holmes, and Jennifer R. Kielhofer
2018 The Keystone Dune Site: A Bølling-Allerød Hunting Camp in Eastern Beringia. *PaleoAmerica* 4(2):151–161.

Lindo, John Alessandro Achilli, Ugo A. Perego, David Archer, Cristina Valdiosera, Barbara Petzelt, Joycelynn Mitchell, et al.
2017 Ancient Individuals from the North American Northwest Coast Reveal 10,000 Years of Regional Genetic Continuity. *Proceedings of the National Academy of Sciences* 114(16):4093–4098.

Mackie, Quentin, Daryl Fedje, and Duncan McLaren
2018 Archaeology and Sea Level Change on the British Columbia Coast. *Canadian Journal of Archaeology/Journal Canadien d'Archéologie* 42:74–91.

Meiri, Meirav, Adrian M. Lister, Matthew J. Collins, Noreen Tuross, Ted Goebel, Simon Blockley, Grant D. Zazula, et al.
2014 Faunal Record Identifies Bering Isthmus Conditions as Constraint to End-Pleistocene Migration to the New World. *Proceedings of the Royal Society B: Biological Sciences* 281:20132167. https://royalsocietypublishing.org/doi/full/10.1098/rspb.2013.2167

Moreno-Mayar, J. Víctor, Ben Potter, Lasse Vinner, Matthias Steinrücken, Simon Rasmussen, Jonathan Terhorst, John A. Kamm, et al.
2018 Terminal Pleistocene Alaskan Genome Reveals First Founding Population of Native Americans. *Nature* 553:203–207.

Pitulko, Vladimir, Elena Pavlova, and Pavel Nikolskiy
2017 Revising the Archaeological Record of the Upper Pleistocene Arctic Siberia: Human Dispersal and Adaptations in MIS 3 and 2. *Quaternary Science Reviews* 165:127–148.

Potter, Ben A., Charles E. Holmes, and David R. Yesner
2013 Technology and Economy among the Earliest Prehistoric Foragers in Interior Eastern Beringia. *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 81–104. Center for the Study of the First Americans, Texas A&M University Press, College Station.

Powers, William R., and John F. Hoffecker
1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54:362–287.

Sikora, Martin, Vladimir Pitulko, Vitor Sousa, Morten E. Allentoft, Lasse Vinner, Simon Rasmussen, Ashot Margaryan, et al.
2018 The Population History of Northeastern Siberia since the Pleistocene. *bioRxiv* https://doi.org/10.1101/448829

Smith, Heather L., and Ted Goebel
2018 Origins and Spread of Fluted-Point Technology in the Canadian Ice-Free Corridor and Eastern Beringia. *Proceedings of the National Academy of Sciences* 115:4116–4121.

Vachula, Richard S., Yongsong Huang, William M. Longo, Sylvia G. Dee, William C. Daniels, and James M. Russell
2019 Evidence of Ice Age Humans in Eastern Beringia Suggests Early Migration to North America. *Quaternary Science Reviews* 205:35–44.

Yesner, David R.
1995 Human Adaptation at the Pleistocene-Holocene Boundary (circa 13,800 to 8,000 BP) in Eastern Beringia. In *Humans at the End of the Ice Age*, edited by Lawrence G. Straus, Berit V. Ericksen, Jon M. Erlandson, and David R. Yester, pp. 255–276. Plenum Press, New York.

Younie, Angela M., and Thomas E. Gillispie
2016 Lithic Technology at Linda's Point, Healy Lake, Alaska. *Arctic* 69(1):79–98.

AVAILABILITY AND VIABILITY OF THE ICE-FREE CORRIDOR AND PACIFIC COAST ROUTES FOR THE PEOPLING OF THE AMERICAS

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Potential routes between Beringia and continental North America have taken on special significance as a new generation of techniques have provided insight into the timing of human occupation of North America, including pre-Clovis sites (e.g., Waters et al. 2018), and the deep lineages preserved in modern and ancient genomes (e.g., Llamas et al. 2016). These approaches have pushed the limits of our understanding of potential routes, forced reassessment of the chronology of North American ice sheets, and, most recently, spurred new work to address these limitations (e.g., Darvill et al. 2018; Lesnek et al. 2018). Recently, several papers have provided assessments of the chronology, viability, and potential connectivity between Beringia and continental North America, as a means to understand peopling of the Americas (Braje et al. 2017; Darvill et al. 2018; Heintzman et al. 2016; Lesnek et al. 2018; Pedersen et al. 2016; Potter et al. 2018). These studies have largely highlighted a particular collection of dates or paleoecological data to make statements about the potential viability of either the Pacific Coastal Route (PCR) or the interior Ice-Free Corridor (IFC) during the critical interval from circa 16,000 to 13,000 cal yr BP. In this review, we assess these chronologies in terms of their constraints on ice sheet history, the reliability and internal consistency of these dates, and the viability of these environments as reflected in immediately post-glacial paleoenvironmental data.

Ice Sheet Chronologies: *Caveat emptor*

The most commonly cited reconstruction of the deglacial chronology for the Laurentide (LIS) and Cordilleran (CIS) ice sheets is that of Dyke and colleagues (2003). This chronology is based primarily on the large database of radiocarbon dates generated over the last ~50 years. In preparing the ice sheet summary, the authors place emphasis on the highest quality dates available, but given the history of investigations, they include many dates that were produced using methods that would not typically be used in modern studies. These include dates on materials such as mixed or bulk samples, including materials like aquatic macrofossils that may not have been in equilibrium with atmospheric CO_2 at the time the organism was living, resulting in an erroneous date. As well, early dates were typically dated via radiometric methods, the only radiocarbon option available prior to the late 1970s. Radiometric (or conventional) radiocarbon dating is not in itself problematic, but the technique requires much larger sample sizes than modern Accelerator Mass Spectrometry (AMS) dating, and so it can be difficult to select discrete materials of sufficient size for reliable dating. In contrast, AMS radiocarbon dating allows isolation of particular organic remains such as individual plant macrofossils, or the opportunity to isolate discrete organic fractions, including in the case of bone, ultrafiltration of collagen, or even single amino acids, that can be advantageous in producing accurate radiocarbon dates (e.g.,Waters et al. 2015). In the case of bone, ultrafiltration separates the high molecular weight proteins from shorter fragments that are the most common source of contaminants that may be incorporated in the bone following burial. These contaminants, which are most likely sourced from the environment and not the organism, are typically of younger age, and may preclude accurate dating (e.g., Froese 2014).

Radiocarbon-based chronologies can also have biases related to the relationship between the organic material and the dating of ice margin retreat. First, the period of ecesis, the time between the ice sheet leaving an area and colonization by a plant or animal, is generally unknown and may be significant. And secondly, the organic material is usually in a detrital context with some unknown period between the death of the organism and its inclusion in the sedimentary record. These biases and potential inaccuracies in the largely radiocarbon-based chronology for the LIS and CIS have led to alternative chronometers for dating ice sheet retreat, including luminescence (e.g., Munyikwa et al. 2017) and cosmogenic radionuclide dating (e.g., Menounos et al. 2017). There are, however, considerable differences between the uncertainties provided by radiocarbon dates (typically 1%–2% for modern calibrated dates at two standard deviations), and those from cosmogenic radionuclide and luminescence dates, where propagated uncertainties are typically ~8%–10% at one standard deviation. These uncertainties can be reduced through averaging of multiple ages associated with a particular landform or sedimentary unit. It should be noted that the multiple dating approaches used to constrain ice sheet chronology, including terrestrial cosmogenic radionuclide (e.g., ^{10}Be, ^{36}Cl), calibrated radiocarbon, and luminescence dates, are broadly comparable and presented here as cal yr BP.

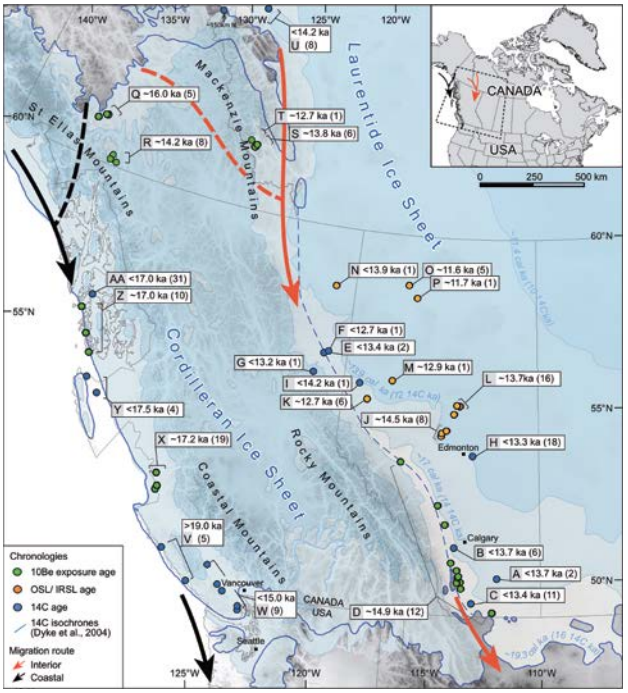

Figure 1. Cordilleran and western Laurentide Ice Sheet deglaciation from circa 19,000–11,400 cal yr BP (after Dyke et al. 2003). PCR and Interior IFC routes into continental North America from eastern Beringia (unglaciated Yukon and Alaska). The IFC includes the over-the-top route through the Mackenzie Valley and the alternative route through the Yukon Plateaus in northeastern British Columbia. Labels (A–Z, AA) show dates with groups (closely co-located sites) of dates with approximate age (OSL/IRSL, 10Be, 14C; Tables S1, S2, S3). Samples in close association have been grouped with outliers removed following original authors or as explained in text, and average ages indicated along with the number of samples (n) for each site. Individual dates, by indicated site, are plotted in Figures 2 and 4.

Routes into the Americas

Archaeological data indicate that early human populations were present in eastern Beringia by ~14,000–15,000 cal yr BP, with records potentially pre-dating that time (Potter et al. 2018). Sites south of the LIS and CIS indicate that people were present by at least 14,200 cal yr BP (Jenkins et al. 2012) and perhaps as early as ~15,000 cal yr BP (Waters et al. 2018). Two potential routes are generally considered either through the interior IFC route down the Mackenzie Valley or along the PCR (Figure 1). Typically the IFC route is shown as the over the top path into the northern Mackenzie Valley, available following the detachment of the LIS and CIS to the south along the mountain front (Figure 1). A variant of the IFC route is through the Yukon Plateaus of the northern Cordillera that may have been available with early deglaciation of the upland areas prior to the main valleys (e.g., Menounos et al. 2017; Figure 1).

Alternatively, if maritime adaptations were available, the PCR may have provided an abundance of natural resources (Braje et al. 2017; Fladmark et al. 1979). Understanding the PCR and the potential distribution of sites has been hampered by rapid sea level change, poorly constrained deglacial chronologies, and complex sea level histories along the coast, leading to the need to develop local sea level records repeatedly over short distances (e.g., Fedje et al. 2018; Josenhans et al. 1997; Shugar et al. 2014). The potential of these routes for the first people into the Americas is largely dependent on the geological constraints on the obstacle-forming ice sheets and sea level history, as well as on the extent to which these areas were biologically viable to early human populations.

Ice-Free Corridor Route

Three different scenarios have been proposed recently for the availability and viability of the IFC route. First, Pedersen and colleagues (2016), based on the analysis of two lake sediment cores, suggest that the LIS persisted much later than in other reconstructions, but also argue that sufficient biological resources were only available after ~12,600 cal yr BP. Alternatively, Potter and colleagues (2018) place emphasis on luminescence ages

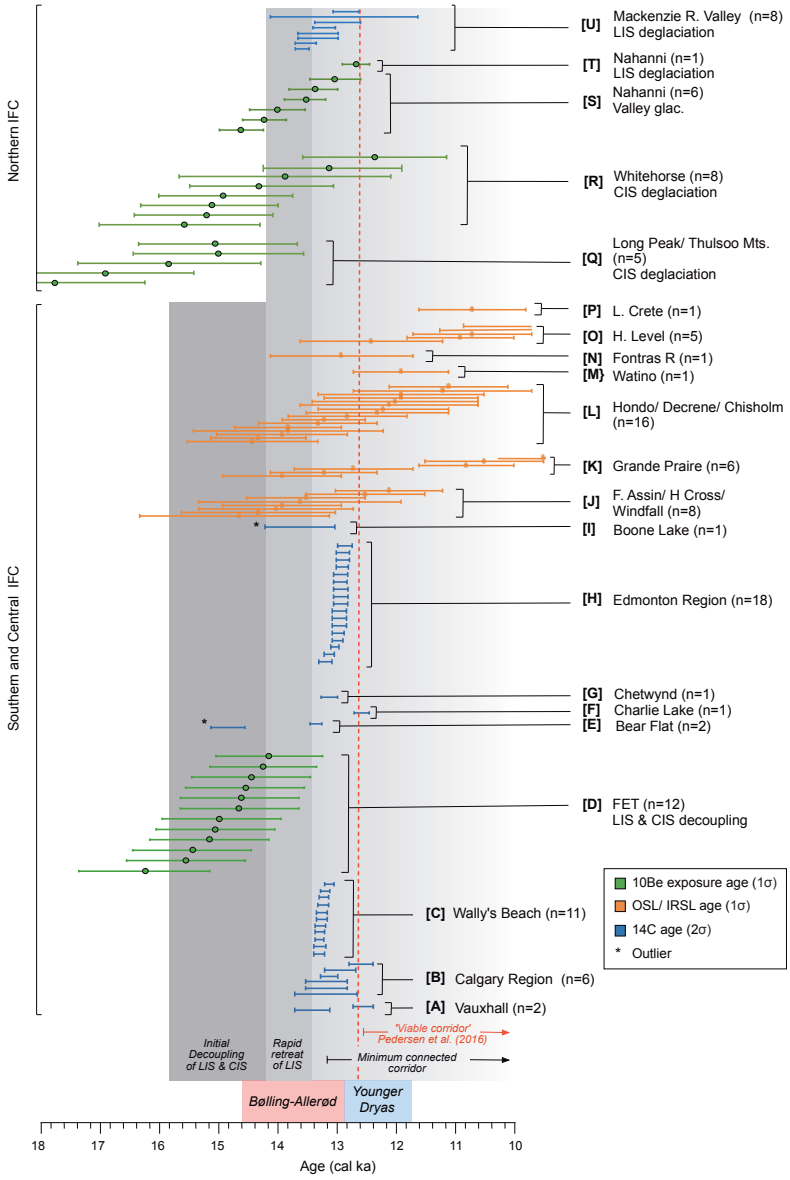

Figure 2. Synthesis of 10Be, OSL, and 14C dates (in cal yr BP) for Cordilleran and western Laurentide Ice Sheet deglaciation. Cosmogenic dates plotted at one standard deviation uncertainty with scaling, erosion rate, and production rate as indicated by authors. Luminescence dates plotted at one standard deviation uncertainty with propagation of error as indicated by authors. Radiocarbon dates calibrated and presented at two standard deviation uncertainty. Individual dates with references in Tables S1 and S3. [A] refers to locations on Figure 1.

from the region (Sites J–P, Figure 1), coupled with a date on a taiga vole (Site E, Figure 1), and to some extent regional cosmogenic dates, to argue that the IFC was potentially available as early as 15,000 cal yr BP. The third scenario, on the basis of bison phylogeography from ancient maternal lineages, indicates that the earliest dispersal of Beringia bison (most closely related to Yukon and Alaska populations) took place by ~13,200 cal yr BP with the appearance of northern bison in northeastern British Columbia (Site G, Figure 2) and Edmonton (Site H, Figure 2; Heintzman et al. 2016). In order to evaluate these

hypotheses, we compiled the available chronologic information, not including dates on bulk sediments, terrestrial shells, or mixed assemblages known to be problematic in providing reliable chronologies, and present these graphically in Figure 2; individual 'higher quality' dates and their references are listed in Tables S1, S2, and S3 (please see https://www.saa.org/publications/the-saa-archaeological-record for supplementary materials).

The key means by which the coalescence and initial detachment of the LIS and CIS has been dated is the Foothills Erratics Train (Figure 3; Jackson et al. 1997; Margold et al. 2019). The Foothills Erratics Train is a linear concentration of large quartzite blocks derived from a rockfall onto the surface of a valley glacier, flowing from the Athabasca Valley, that carried the blocks to the eastern slopes of the Rocky Mountains where the glacier merged with the LIS (Figures 1, 3). These boulders, stretching over several hundred kilometres, were carried south along the Foothills, marking the zone of coalescence of the LIS and CIS. Jackson and colleagues (1997) used one of the early applications of cosmogenic dating (whole rock ^{36}Cl) to estimate the age of several erratics, with a central group of dates ranging between circa 19,900 and 10,800 cal yr BP. These dates were key to demonstrating the late Wisconsinan coalescence of the LIS and CIS and movement away from the primacy of the IFC for peopling of the New World (Ives et al. 2013). Recently, Margold and authors (2019) dated many of the same boulders using ^{10}Be concentrations from quartz to derive a more precise age (Table S3). Of the 16 boulders that were dated, 12 dates are tightly clustered between 16,300 and 14,200 cal yr BP, and provide a weighted mean age, including propagated uncertainty, of 14,900 ± 900 cal yr BP (Site D, Figures 1, 2). These dates indicate initial decoupling of the LIS and CIS took place at about 15,000 cal yr BP.

Munyikwa and authors (2017) place emphasis on luminescence ages from eolian sands to constrain deglaciation of the LIS in western Canada. The authors argue that, unlike radiocarbon-based approaches for ice sheet chronology, which require plants or animals to colonize the formerly glaciated terrain, luminescence dating of eolian deposits should more closely relate to the time of deglaciation. While this principle is strong, the large uncertainties associated with luminescence dating (typically 8%–10% at one standard deviation when uncertainty is propagated) make individual dates more difficult to interpret than radiocarbon dates. We plot the dates and their one standard deviation uncertainties, grouped by sites within 30 km, on Figure 2 (Sites I–P on Figure 1). We have removed outliers proposed by the original authors. By focusing on groups of dates, rather than individual dates, site means can be calculated where larger numbers of dates exist in close proximity. This approach gives mean site ages of circa 14,500 ± 1125 (Site J: n = 8, Figure 2) and 13,700 ± 1160 (Site L: n =16, Figure 2). Additional sites are consistent, though generally younger than these ages (Figure 2).

Figure 3. Quartzite block of the Foothills Erratics Train sampled for 10Be cosmogenic radionuclide dated to 15,500 ± 1000 cal yr BP. Photo by Martin Margold.

Potter and colleagues (2018) emphasize the date on a taiga vole from northeastern British Columbia (Site E, Figure 2) to demonstrate the viability of the IFC route by circa 15,000 cal yr BP. That site produced several dates, ranging from nearly ~20,000 cal yr BP to late Holocene, most on mixed aliquots of charcoal, presumably including non-finite material, leading to unrealistically old ages for this glaciated area. Two voles at the site yielded dates of 15,150–14,565 cal yr BP and 14,225–13,030 cal yr BP (Table S1), while bounding charcoal ages are mid-Holocene (Hebda et al. 2008). Potter and colleagues (2018) focus on the earlier vole date to demonstrate the viability of the IFC by ~15,000 cal yr BP, but when considered within the scope of other ages in western Canada, the age is outside their distribution and clearly anomalous (Figure 2). This date pre-dates other regional chronologies, including the coalescence dates indicated by the Foothills Erratics Train (Site C, Figure 2), the average age of the luminescence dates, and all other vertebrate records we are aware of in deglacial settings in western Canada. These bone dates are on standard collagen, and the lack of ultrafiltration leaves open the strong potential for contamination. Given these caveats and its lack of replication, we treat this date as an outlier and remove it from discussion of the IFC (Figure 2).

Coastal Route

The PCR has taken on special significance because of the potential late opening of the IFC, the possibility of abundant resources along the coast, and the rapid passage that may

have been available for marine-adapted people (e.g., Braje et al. 2017; Fladmark et al. 1979;). Understanding of the geologic constraints on the PCR has been hindered by the complex record of sea level change along the coast, and the seeming differences in the history of advancing and retreating local and CIS glaciers through the late Pleistocene. Lesnek and colleagues (2018) used cosmogenic dating in the Alexander Archipelago along with earlier vertebrate dates to constrain deglaciation and the potential viability of the northern coast (Figure 1). They demonstrate that the CIS extended onto the continental shelf until ~17,000 cal yr BP when ice retreated. The cosmogenic dates indicate that islands and other low-lying areas along the coast were increasingly ice free by about 16,000 cal yr BP (Site Z, Figure 1, Figure 4). This chronology is consistent with vertebrate records on Prince of Wales Island that show a hiatus in bone dates between ~19,800 and 17,200 cal yr BP with an increase in the frequency of dates and diversity of taxa after 15,000 cal yr BP (Figure 4). Similarly,

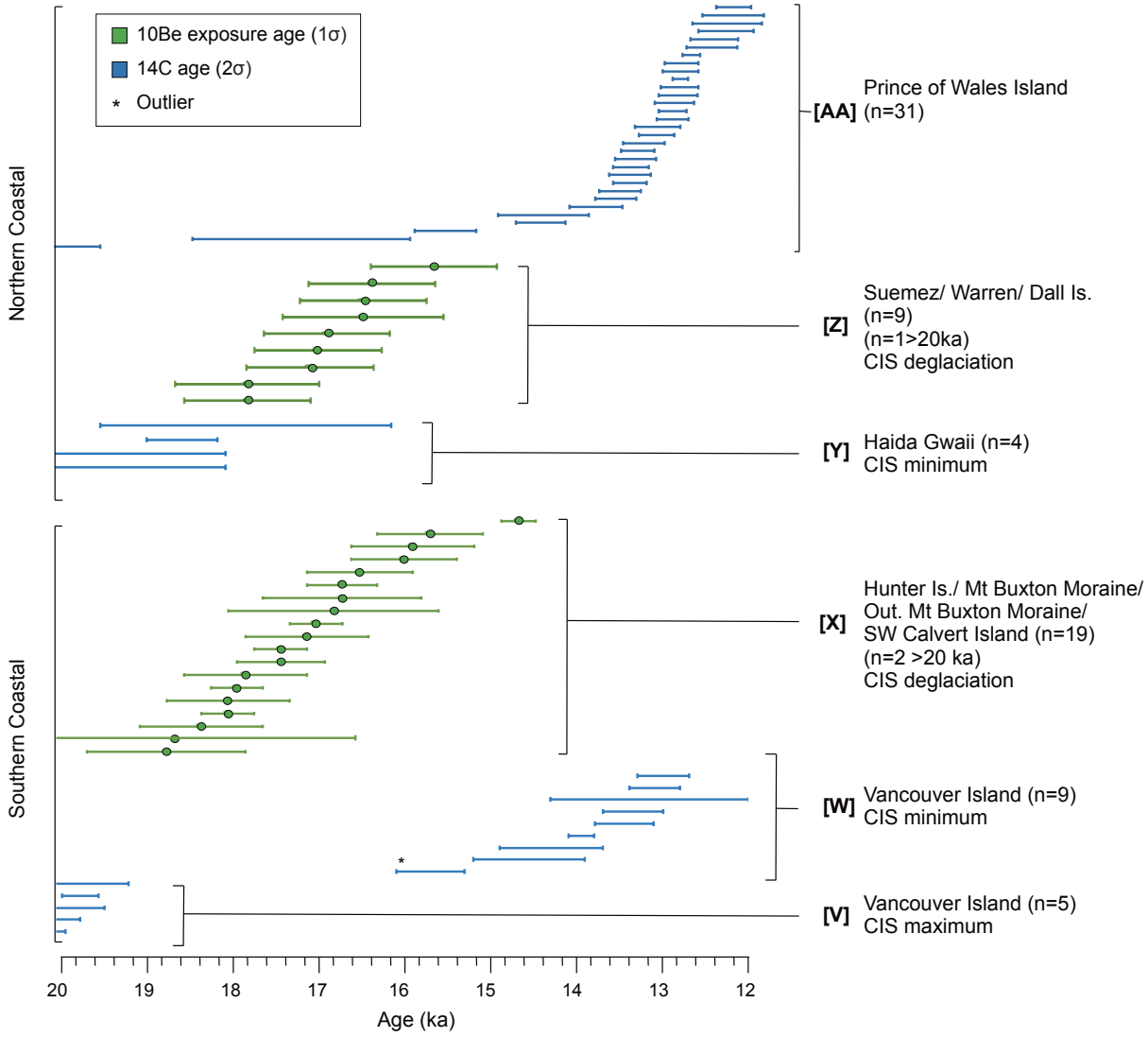

Figure 4. Synthesis of key late Pleistocene 10Be and 14C dates (in cal yr BP) on the Pacific Coast. Cosmogenic dates plotted at one standard deviation uncertainty with scaling, erosion rate, and production rate as indicated by authors. Radiocarbon dates calibrated and presented at two standard deviation uncertainty. Individual dates with references in Tables S2 and S3. [V] refers to locations on Figure 1.

sites on Haida Gwaii (Site Y, Figure 4) suggest the CIS reached the area after 22,000 cal yr BP and was retreating as early as 19,400 cal yr BP (Figure 4).

Along the central coast of British Columbia, cosmogenic dates on boulders indicate the CIS began retreating around 18,000 cal yr BP while still reaching its maximum in areas to the south at circa 17,000 cal yr BP (Darvill et al. 2018). Dates from sites further within the extent of the coastal CIS indicate ice was retreating and exposing lowland sites by ~16,000 cal yr BP (Site X, Figures 1, 4). This record is broadly similar to the radiocarbon-based chronology from Vancouver Island that indicates ice reached the area after ~19,000 cal yr BP and was retreating from the area after ~15,000 cal yr BP (Site W, Figures 1, 4).

Discussion and Conclusions

In terms of the interior IFC route, three hypotheses have been presented for its availability and viability. The first, the 'minimally-available and minimally-viable' IFC of Pedersen and colleagues (2016), argues that a significant bottleneck in the Peace River area maintained the LIS locally with a proglacial lake barrier extending to near Site F (Figure 1) until ~12,900 cal yr BP with the area only becoming biologically viable after 12,600 cal yr BP. LIS reconstructions and stratigraphic data place the LIS boundary in northeastern Alberta beyond sites O and P at that time in order to account for the northwest outlet of glacial Lake Agassiz and the Mackenzie Valley stratigraphy (e.g., Murton et al. 2010). This reconstruction of a lack of LIS barrier in central and northern Alberta at 12,900 cal yr BP is consistent with luminescence chronologies (sites J–L, Figure 2) and minimum radiocarbon dates from central Alberta (e.g., Site H). The argument with respect to the viability of the IFC prior to 12,600 cal yr BP is best addressed by the abundance of Quaternary vertebrate data and paleobotanical indicators that suggest a diverse grazing megafauna present in the central corridor region prior to 13,200 cal yr BP (sites G, H, I, Figure 2).

The second hypothesis, that of Potter and colleagues (2018) that the IFC was likely available by ~15,000 cal yr BP, places emphasis on questionable dates that have not been replicated , such as the taiga vole and the early ranges of date distributions of luminescence and cosmogenic dates (Figure 2). New dates on the Foothills Erratics Train, indicating coalescence until about 15,000 cal yr BP (Margold et al. 2019; Figure 2), provide further support to reject the early IFC availability, consistent with averaging closely spaced luminescence dates on sand dunes through central and northern Alberta (Figures 1, 2). Collectively the cosmogenic, luminescence, and minimum radiocarbon dates from the IFC present a consistent record of LIS-CIS detachment beginning at ~15,000 cal yr BP with substantial retreat of the LIS only after circa 14,000 cal yr BP (e.g., sites A–C, H–L, Figures 1 and 2).

The intermediate IFC hypothesis of Heintzman and colleagues (2016) argues for a viable corridor connected to eastern Beringia by 13,200 cal yr BP at Site G (Figure 1) with the appearance of a Beringian bison. This provides a minimum age for IFC connectivity between Beringia and areas south of the LIS. However, it should be noted that this is a minimum age estimate and it is unlikely that the earliest bison was indeed sampled, leaving open the possibility for earlier IFC connectivity, although the extent of this bias is unknown.

Since the late 1990s, with the recognition of the rapid sea level change and potential for extensive areas to be potentially available along the coast (Josenhans et al. 1997), coupled with recognition that the LIS and CIS coalesced during the last glacial maximum (Jackson et al. 1997), attention has been drawn to the PCR. In recent years, with increasing numbers of deglacial dates spanning the southern through central coast, an emerging picture indicates initial retreat of the CIS along the outer margin beginning after ~18,000 cal yr BP with extensive lowland areas available by ~15,000 cal yr BP. It is more difficult to estimate the continuity of these landscapes than in the areas of the IFC because of the complex and variable relative sea level and ice margin histories (e.g., Shugar et al. 2014) necessitating careful, local reconstructions in the search for archaeological sites (e.g., Fedje et al. 2018).

The archaeological data south of the LIS and CIS indicate the presence of early human populations by at least 14,200 cal yr BP (Jenkins et al. 2012) and perhaps as early as 15,000 cal yr BP (Waters et al. 2018). Existing data for the IFC provide no compelling evidence for the availability or viability of this route until well after 14,000 cal yr BP and likely until nearer 13,200 cal yr BP. In contrast, the PCR provides suggestions for extensive lowland landscapes after ~15,000 cal yr BP and increasingly diverse and abundant vertebrate records by ~14,500 cal yr BP. If the first peoples did indeed traverse from Beringia to continental North America by ~15,000–14,500 cal yr BP, the existing evidence strongly favours the PCR.

References Cited

Braje, Todd J., Tom D. Dillehay, Jon M. Erlandson, Richard G. Klein, and Torben C. Rick
2017 Finding the First Americans. *Science* 358(6363):592–594.

Darvill, Christopher. M., Brian Menounos, Brent M. Goehring, Olav B. Lian, and Marc W. Caffee

2018 Retreat of the Western Cordilleran Ice Sheet Margin during the Last Deglaciation. *Geophysical Research Letters* 45(18): 9710–9720.

Dyke, Arthur S., Andrew Moore, and Louis Robertson
2003 Deglaciation of North America. Geological Survey of Canada Open File, 1574. Thirty-two digital maps at 1:7,000,000 scale with accompanying digital chronological database and poster with full map series. Electronic document, https://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/downloade.web&search1=R=214399, accessed March 14, 2019.

Fedje, Daryl, Duncan McLaren, Thomas S. James, Quentin Mackie, Nicole F. Smith, John R. Southon, and Alexander P. Mackie
2018 A Revised Sea Level History for the Northern Strait of Georgia, British Columbia, Canada. *Quaternary Science Reviews* 192:300–316.

Fladmark, Knut R.
1979 Routes: Alternate Migration Corridors for Early Man in North America. *American Antiquity* 44:55–69.

Froese, Duane G.
2014 The Curious Case of the Arctic Mastodons. *Proceedings of the National Academy of Sciences* 111(52):18405–18406.

Hebda, Richard J., Burns, James A., Geertsema, Marten, & Jull, A. J. Timothy
2008 AMS-dated late Pleistocene taiga vole (Rodentia: *Microtus xanthognathus*) from northeast British Columbia, Canada: a cautionary lesson in chronology. *Canadian Journal of Earth Sciences,* 45(5), 611-618. doi:10.1139/E07-064

Heintzman, Peter D., Duane Froese, John W. Ives, André E. R. Soares, Grant D. Zazula, Brandon Letts, Thomas D. Andrews, et al.
2016 Bison Phylogeography Constrains Dispersal and Viability of the Ice Free Corridor in Western Canada. *Proceedings of the National Academy of Sciences* 113(29):8057–806

Ives, John W., Duane Froese, Kisha Supernant, and Gabriel Yanicki
2013 Vectors, Vestiges and Valhallas: Rethinking the Corridor. In *Paleoamerican Odyssey,* edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 149–169. Texas A&M University Press, College Station.

Jackson, Lionel E., Jr., Fred M. Phillips, Kazuharu Shimamura, and Edward C. Little
1997 Cosmogenic 36Cl Dating of the Foothills Erratics Train, Alberta, Canada. *Geology* 25(3): 195–198.

Jenkins, Dennis L., Loren G. Davis, Thomas W. Stafford, Paula F. Campos, Bryan Hockett, George T. Jones, Linda Scott Cummings, et al.
2012 Clovis Age Western Stemmed Projectile Points and Human Coprolites at the Paisley Caves. *Science* 337(6091):223–228.

Josenhans, Heiner, Daryl Fedje, Reinhard Pienitz, and John Southon
1997 Early Humans and Rapidly Changing Holocene Sea Levels in the Queen Charlotte Islands-Hecate Strait, British Columbia, Canada. *Science* 277(5322):71–74.

Lesnek, Alia J., Jason P. Briner, Charlotte Lindqvist, James F. Baichtal, and Timothy H. Heaton
2018 Deglaciation of the Pacific Coastal Corridor Directly Preceded the Human Colonization of the Americas. *Science Advances* 4(5):eaar5040. http://advances.sciencemag.org/content/4/5/eaar5040

Llamas, Bastien, Lars Fehren-Schmitz, Guido Valverde, Julien Soubrier, Swapan Mallick, Nadin Rohland, Susanne Nordenfelt, et al.
2016 Ancient Mitochondrial DNA Provides High-Resolution Time Scale of the Peopling of the Americas. *Science Advances* 2:e1501385. http://advances.sciencemag.org/content/2/4/e1501385

Margold, Martin, John C. Gosse, Alan J. Hidy, Robin J. Woywitka, Joseph M. Young, and Duane Froese
2019 Beryllium-10 Dating of the Foothills Erratics Train in Alberta, Canada, Indicates Detachment of the Laurentide Ice Sheet from the Rocky Mountains at ~15 ka BP. *Quaternary Research,* in press.

Menounos, Brian, Brent M. Goehring, G. Osborn, Martin Margold, Brent Ward, Jeff Bond, Garry KC Clarke, et al.
2017 Cordilleran Ice Sheet Mass Loss Preceded Climate Reversals Near the Pleistocene Termination. *Science* 358(6364): 781–784.

Munyikwa, Kennedy, Tammy M. Rittenour, and James K. Feathers
2017 Temporal Constraints for the Late Wisconsinan Deglaciation of Western Canada Using Eolian Dune Luminescence Chronologies from Alberta. *Palaeogeography, Palaeoclimatology, Palaeoecology* 470:147–165.

Murton, Julian B., Mark D. Bateman, Scott R. Dallimore, James T. Teller, and Zhirong Yang
2010 Identification of Younger Dryas Outburst Flood Path from Lake Agassiz to the Arctic Ocean. *Nature* 464(7289):740–743.

Pedersen, Mikkel, Anthony Ruter, Charles Schweger, Harvey Friebe, Richard Staff, Kristian K. Kjeldsen, Marie L. Z. Mendoza, et al.
2016 Postglacial Viability and Colonization in North America's Ice-Free Corridor. *Nature* 537:45–49.

Potter, Ben A., James F. Baichtal, Alwynne B. Beaudoin, Lars Fehren-Schmitz, C. Vance Haynes, Vance T. Holliday, Charles E. Holmes, et al.
2018 Current Evidence Allows Multiple Models for the Peopling of the Americas. *Science Advances* 4(8):eaat5473. http://advances.sciencemag.org/content/4/8/eaat5473

Shugar, Dan H., Ian J. Walker, Olav B. Lian, Jordan B. R. Eamer, Christina Neudorf, Duncan McLaren, and Daryl Fedje
2014 Post-glacial Sea-Level Change along the Pacific Coast of North America. *Quaternary Science Reviews* 97:170–192.

Waters, Michael R., Joshua L. Keene, Steven L. Forman, Elton R. Prewitt, David L. Carlson, and James E. Wiederhold
2018 Pre-Clovis Projectile Points at the Debra L. Friedkin Site, Texas—Implications for the Late Pleistocene Peopling of the Americas. *Science Advances* 4(10):eaat4505. http://advances.sciencemag.org/content/4/10/eaat4505

Waters, Michael R., Thomas W. Stafford, Brian Kooyman, and L. V. Hills
2015 Late Pleistocene Horse and Camel Hunting at the Southern Margin of the Ice-Free Corridor: Reassessing the Age of Wally's Beach, Canada. *Proceedings of the National Academy of Sciences* 112(14):4263–4267.

EARLY EXPLORATION AND SETTLEMENT OF NORTH AMERICA DURING THE LATE PLEISTOCENE

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Excavations at Folsom and Clovis, New Mexico, during the first half of the twentieth century revealed that people had entered the Americas at the end of the Pleistocene. During the second half of the century, more Clovis sites were investigated and Clovis became accepted as the first people to enter the Americas. This view changed, after much acrimony, with the reporting and acceptance of the 14,200-year-old Monte Verde site in southern Chile, excavated by Tom Dillehay (Meltzer 2009). Since Monte Verde, many new sites have been found and investigated and old sites reinvestigated with modern techniques and technologies in North America. Applying state-of-the-art Accelerated Mass Spectrometry (AMS) dating and pretreatment protocols revealed that Clovis dates to a narrow time window between 13,000 and 12,700 calendar years before present (cal yr BP), and that there are a number of sites older than 13,000 cal yr BP containing artifacts that occur in secure geological contexts that are accurately dated. These are scattered across North America (Figure 1) and date between ~15,500 and ~14,000 cal yr BP (Goebel et al. 2008; Madsen 2015; Pitblado 2011; Waters and Stafford 2014). These sites appear soon after the opening of the coastal corridor along the western edge of the Cordilleran Ice Sheet and provide the evidence of the first human presence south of the ice sheets.

Near the southern margin of the Laurentide Ice Sheet, at the Hebior site in southeastern Wisconsin, the disarticulated bones of a single woolly mammoth were excavated from pond clays by David Overstreet (2005). Cut and pry marks on the bones indicate that the animal was butchered by humans. Four lithic artifacts, including two bifaces, occurred in direct association with the mammoth bones. Three XAD-purified collagen ages on the mammoth bone are 14,850 ± 150 cal yr BP. One kilometer south of the Hebior site, the disarticulated remains of a single woolly mammoth and stone artifacts were excavated from pond clays by Daniel Joyce at the Schaefer site

Figure 1. Map showing North America and key archaeological sites mentioned in the text. Artifacts from some of these sites are shown.

(Joyce 2014). The mammoth bones also show signs of butchering, including cut and pry marks. Two blade-like flakes made on local chert were associated with the mammoth. Thirteen radiocarbon dates on XAD-purified collagen from different elements of the mammoth and 16 radiocarbon ages on wood samples around the bone indicate that the site dates to 14,650 ± 150 cal yr BP. In southern Alberta, Canada, seven butchered horses and one butchered camel were recovered from eolian sediments at the Wally's Beach site by Brian Kooyman and his colleagues. Only flake and core tools are associated with these carcasses. Twenty-seven XAD-purified collagen ages date these individual kill sites to ~13,300 cal yr BP (Waters et al. 2015).

In the American Southeast, the Page-Ladson site lies submerged under 9 m of water within a mid-channel sinkhole along a segment of the Aucilla River, 11.5 km inland from the Gulf of Mexico (Figures 2 and 3). The site was first investigated by S. David Webb and James Dunbar (Webb 2006) and most recently by Jessi Halligan and Michael Waters. At Page-Ladson, lithic artifacts, including a biface (Figure 1), made of local chert were associated with mastodon, camelid, and bison remains (Halligan et al. 2016). Six parallel, deeply incised grooves around the circumference of a mastodon tusk from the same deposits as the artifacts appear to have been made during the extraction of the tusk from the skull. The artifacts and modified tusk occur in an undisturbed geological context overlain by 4 m of sediments. Seventy-one radiocarbon dates were obtained to unequivocally show that the sediments were not disturbed and that these artifacts and the modified tusk date to ~14,550 cal yr BP. During the time people occupied the sinkhole, sea level was much lower than it is today and the site was ~175–250 km from the coast. The sinkhole would have been dry with a freshwater pond near the bottom that attracted animals and humans.

In the northwestern portion of the United States, Luther Cressman investigated Paisley Caves, Oregon, in 1938–1939 and reported the association of artifacts with extinct megafauna. Beginning in 2002, Dennis Jenkins returned to the caves and recorded a well-stratified sequence of deposits that he dated from the late Pleistocene through the Holocene by 190 radiocarbon ages (Jenkins et al. 2014). At the base of the sequence, five human coprolites are directly dated to ~14,200–14,100 cal yr BP. Mitochondrial DNA extracted from these coprolites belonged to Native American founding haplogroups A and B. Also within these deposits were stone tools and debitage. Farther north, at the Manis site, Washington, a single male mastodon was excavated from sediments at the base of a kettle pond by Carl "Gus" Gustafson (Waters et al. 2011). The bones of the right side of the mastodon were disarticulated and moved 0.6 m to 3 m from the rest of the skeleton and toward the bank of the pond. Some bones were spirally fractured, multiple flakes were removed from one long-bone fragment, and other bones showed cut marks. The only associated artifact was the tip of a projectile point made of mastodon bone that was embedded into the mastodon's fourteenth right rib. Four dates on XAD-purified collagen from the rib with the bone point and from the tusk ivory of the skeleton are ~13,800 cal yr BP.

In Central Texas, along Buttermilk Creek, are the Debra L. Friedkin and Gault sites. At the Friedkin site (Figure 4), in floodplain clays that are up to 1.4 m thick, is a record of human occupation going back to ~15,500 cal yr BP (Waters et al. 2018). At the site, 120 diagnostic projectile points define a Late Prehistoric horizon, overlying Late Archaic and Early Archaic components, which in turn overlay a layer with Late Paleoindian artifacts. Below this is a discrete layer with Folsom and Clovis diagnostic artifacts. A 15 cm thick layer is below this, with over 300 stone tools and 100,000 pieces of debitage that define the Buttermilk Creek Complex. Seventy-one Optically Stimulated Luminescence (OSL) ages, primarily from four columns through the floodplain sediments, date the sediments and the contained artifacts. OSL ages from the Early Archaic, Late Paleoindian, Folsom, and Clovis horizons correspond well with the known age of these archaeological time periods. Nineteen OSL ages from the zone with Buttermilk Creek

Figure 2. Excavations at the Page-Ladson site, Florida. Site lies between the pontoon boat and barges. Photo courtesy of the Center for the Study of the First Americans.

Figure 3. Excavations underwater at the Page-Ladson site, Florida. Photo courtesy of the Center for the Study of the First Americans.

Complex artifacts range from ~15,500 to ~13,500 cal yr BP. The artifacts in this layer include blades, bladelets, scrapers, bifaces, bifacial discoidal cores, snap-fracture tools, retouched flakes, expedient tools, and ground hematite. In addition, 11 complete and fragmentary lanceolate stemmed projectile points (Figures 1 and 5) were found in the ~15,500–13,500 cal yr BP sediments, and 1 triangular lanceolate projectile point with a concave base and basal thinning occurs in the layers dated between ~14,000 and ~13,500 cal yr BP. At the Gault site, 250 m upstream of the Friedkin site, Michael Collins has headed investigations of the Clovis and "Older than Clovis" layers at the site. In the "Older than Clovis" layers, Collins and his colleagues report 5 stemmed and 2 lanceolate base projectile points that are dated to ~16,000 cal yr BP and occur below a dated Clovis horizon (Williams et al. 2018). One of the stemmed points from the Gault site is similar to the stemmed point from the Friedkin site. The remaining points have two distinct base morphologies (Figure 1), which may have resulted during the resharpening process. The concave lanceolate base points are smaller, but similar to the specimen from the Friedkin site. These points occur with biface and blade-and-core lithic technologies. Points similar to those from central Texas were excavated from lacustrine deposits associated with mammoth skeletons at the Santa Isabel Iztapan I and II sites in Mexico that are bracketed by ~14,500 and ~10,800 cal yr BP tephra (Figure 1; Arroyo de Anda and Maldonado-Koerdell 1953; Waters et al. 2018). A stemmed projectile point, along with other artifacts, was associated with the bones of a single mammoth buried in undisturbed lacustrine sediments at Santa Isabel Iztapan I. Four hundred meters away, at Santa Isabel Iztapan II, two stemmed points were associated with butchered mammoth bones in the same lacustrine sediments.

These early sites are not without critics (Haynes 2015). At the Hebior and Schaefer sites, the taphonomic evidence for butchering has been challenged. In addition, it has been suggested that the artifacts are intrusive from overlying layers even though no younger artifacts occur above these sites, and they were found in dense clay deposits. At Paisley Caves, the human origin of the coprolites has been challenged. The proposed bone projectile point tip embedded into the rib of a mastodon from the Manis site has been suggested to be the result of an elk goring the mastodon, an internal self-inflicted bone injury sustained while this animal fought with another mastodon, or even an injection by a backhoe during excavation. At the Friedkin and Gault sites, it has been suggested that the thousands of artifacts found in the layers below Clovis are intrusive due to trampling and natural processes. The investigators of each of these sites have addressed these concerns by conducting additional studies and providing more data. Interestingly, the evidence from the Page-Ladson site is so secure that no challenges have been raised about the integrity of the site since its publication in 2016, except to suggest that it may represent a site of a failed migration.

Figure 4. Excavations at the Debra L. Friedkin site, Texas, in 2015. Photo courtesy of the Center for the Study of the First Americans.

Figure 5. Stemmed point dating ~15,000 cal yr BP in situ at the Debra L. Friedkin site, Texas, in 2015. Photo courtesy of the Center for the Study of the First Americans.

What makes these sites—Hebior, Schaefer, Paisley Caves, Manis, Wally's Beach, Page-Ladson, Debra L. Friedkin, and Gault—important is that the artifacts at each site were found in a secure geological context, and that this context and the associated artifacts could be dated using reliable and accurate dating methods. These data demonstrate that humans were present in North America by ~15,500 cal yr BP and widely dispersed in the period 15,000 to 14,000 cal yr BP, with Clovis

and the Western Stemmed Tradition emerging from the biface, blade, and osseous technologies carried by the earliest pioneering groups.

You might ask, what about Meadowcroft Rockshelter, Pennsylvania? At Meadowcroft Rockshelter (Figure 1), James Adovasio (1993) excavated hearths and ~700 artifacts from Stratum IIa including blades, unifacial and bifacial knives, gravers, edge-modified flakes, debitage, and a lanceolate projectile point (Haynes 2015; Madsen 2015; Waters and Stafford 2014). Charcoal from two hearths brackets the lanceolate point between 11,300 ± 700 14C yr BP (12,200–14,100 cal yr BP) and 12,800 ± 870 14C yr BP (13,900–16,300 cal yr BP). Because of the large standard errors associated with these ages, the calibrated ages could be correlated with either the early Paleoindian period or pre-date Clovis. The five other radiocarbon samples from hearths in Stratum IIa also have wide standard errors resulting in calibrated ages ranging from 14,300 to 20,700 cal yr BP. Another issue with the radiocarbon ages from Stratum IIa is that they appear to be contaminated by older particulate and soluble organics as demonstrated by two charcoal-humate date pairs from two Stratum IIa hearths. In both cases, the soluble organics produced ages that were 7,000 and 12,000 radiocarbon years older than the insoluble charcoal. Only new dates and additional chronological studies at the site will resolve the chronological issues at Meadowcroft Rockshelter (Goebel et al. 2008; Haynes 2015; Madsen 2015; Waters and Stafford 2014).

A number of sites are proposed that pre-date 16,000 cal yr BP, before either corridor was open, which means that humans would have entered the Americas prior to the Last Glacial Maximum (LGM). In North America at the Calico Hills and Texas Street sites, California, core tools dating >100,000 cal yr BP have been reported from alluvial fan deposits. At the Topper site, South Carolina, Late Prehistoric through Clovis artifacts are found in colluvium overlying a terrace of the Savannah River. Albert Goodyear (2005) reports that a core and microlithic industry occurs at the base of the ~15,000-year-old colluvium and in the >50,000-year-old terrace alluvium. At the Burnham site, Oklahoma, chert debitage and bison bones occur in alluvium dated to ~36,000–35,000 cal yr BP. Similarly, at the Coats-Hines-Litchey site, Tennessee, lithic debitage is association with mastodon and other extinct fauna in alluvial deposits dated to ~35,000–27,000 cal yr BP. While the geology and dates from these sites are secure, the reported artifacts are geofacts–objects made by natural processes that appear to look like artifacts (Haynes 2015; Madsen 2015; Meltzer 2009; Waters and Stafford 2014).

From unconsolidated eolian dune sand at the Cactus Hill site, Virginia (Figure 1), lithic artifacts, including small prismatic blade cores, blades, and two basally thinned heavily resharpened subtriangular bifacial points were recovered 5–15 cm below a Clovis horizon by Joseph and Lynn McAvoy (McAvoy and McAvoy 2015). Charcoal from two reported hearths range from ~18,400 to ~17,100 cal yr BP. Concerns at this site center around possible movement of artifacts in the sandy unconsolidated dune sediments due to post-depositional processes (Goebel et al. 2008; Haynes 2015; Madsen 2015; Waters and Stafford 2014), which is why the evidence from the site remains equivocal.

The Miles Point site is located along the edge of the Chesapeake Bay on the western side of the Delmarva Peninsula (Figure 1). Here, Darrin Lowery reports that a polyhedral blade core, blade flakes, bifacial lanceolate projectile point, bipolar core, hammerstones, and anvil were recovered in situ within the Tilghman paleosol that developed on the Miles Point Loess, which in turn is overlain by the Paw Paw Loess (Lowery et al. 2010). Nine additional artifacts were found in the surf zone and thought to have been eroded from the site. Three radiocarbon ages on carbonized plant material range from ~31,300 to 25,700 cal yr BP. Two OSL ages yielded similar results. At a new site on Parson's Island, Darrin Lowery reports that artifacts occur in loess deposits of a similar age. However, until excavations at these sites are conducted, the processes of site formation and chronology will remain uncertain.

Several localities with mammoth, mastodon, bison, or sloth remains are suggested to be archaeological sites (Goebel et al. 2008; Haynes 2015; Madsen 2015; Waters and Stafford 2014). Stone tools are absent from these localities and the evidence of human activity is based entirely on bone breakage patterns, interpretation of surface marks on bones, and the spatial arrangement of the bones (Goebel et al. 2008; Haynes 2015; Madsen 2015). Steve Holen proposes that proboscidean bone breakage patterns and the position of different skeletal elements are the result of human activity at the ~130,000-year-old Cerutti Mastodon site, California (Holen et al. 2017); the ~22,400-year-old La Sena site, Nebraska; and the ~23,500-year-old Lovewell site, Colorado (Holen and Holen 2014). At the Lindsey site, Montana, a nearly complete skeleton of a mammoth was excavated from late-Pleistocene loess by Les Davis. On four different bone elements, 15 butchery marks made by stone tools were identified and inferred to have been made while stripping meat and disarticulating the carcass. These bones are also broken and show chop marks. No stone tools were found at the site; however, directly associated with the mammoth remains are 8 sandstone blocks, which are suggested to have been used to break open and splinter the bones. Three XAD-purified collagen ages on the bone are 14,200 ± 100 cal yr BP (Waters and Stafford 2014). Other examples of

proposed human-modified bone includes the 13,200 ± 100 cal yr BP Burning Tree Mastodon, Ohio, and the 13,850 ± 50 cal yr BP bison remains from Ayer Pond, Washington. The evidence from these sites is equivocal, because stone tools are absent from these sites and alternative taphonomic processes can break bone, creating spiral fractures and percussion marks, and create surface marks that mimic cut marks (Haynes 2015; Madsen 2015). Some of these localities may indeed be archaeological sites, but this evidence will remain equivocal until researchers can define a reliable and consistent way to identify human interaction with carcasses where stone tools are absent.

In short, the archaeological evidence of a human presence in North America during and before the LGM is equivocal. The evidence from most of these sites is problematic, with uncertainties related to a site's geologic context, geochronology, or the absence of definitive human-made artifacts.

Genetic information from contemporary Native Americans and prehistoric human skeletons provides a fresh and different perspective on the origin and population history of the first Americans. Genetic studies provide estimates on the timing of the entry of the first Americans and the homeland of these first people. Studies of modern and ancient genomes show that people were south of the ice sheets sometime between ~17,500 and 14,600 cal yr BP (Moreno-Mayar 2018). Analysis of mitochondrial genomes places the arrival of humans into unglaciated America at ~16,000 cal yr BP (Llamas et al. 2016), and Y-chromosome estimates place this between ~19,500 and 15,200 cal yr BP (Pinotti et al. 2019). These estimates are consistent with archaeological evidence suggesting that people entered the Americas by ~15,500 cal yr BP. Genetic estimates on the entry of humans into North America are inconsistent with the hypothesis that Clovis represents the first people to enter and explore the Americas. The genetic estimates also do not support a pre-LGM occupation of the Americas, again agreeing with the archaeological data. If a pre-LGM occupation occurred, these people left no genetic legacy. The biological evidence shows that there was a single migration into the Americas and genetic continuity between the first inhabitants of North America and all the Native Americans that followed. This tells us that the biface, blade, and osseous technologies carried by the earliest pioneering populations that explored the Americas eventually gave rise to later Clovis and Western Stemmed Tradition technologies.

Our understanding of the late Pleistocene peopling of the Americas has undergone rapid change in the last few decades. New archaeological discoveries and the reinvestigation of old sites using modern technologies have shed new light on the first Americans, and genetic studies have illuminated their population ancestry. Both are converging to tell a new and consistent story of the first Americas, with people first arriving by ~15,500 years ago, spreading across the Americas, and leaving both an archaeological and genetic signal we are just beginning to understand. We will continue to advance our understanding of the earliest people to enter North America by undertaking more genetic studies and excavating more archaeological sites, with special attention paid to site geology, site formation, and geochronology.

References Cited

Adovasio, J. M.
1993 The Ones That Will Not Go Away: A Biased View of Pre-Clovis Populations in the New World. In *From Kostenki to Clovis: Upper Paleolithic–Paleo-Indian Adaptations*, edited by Olga Soffer and N. D. Praslov, pp. 199–218. Plenum Press, New York.

Arroyo de Anda, Luis Aveleyra, and Manuel Maldonado-Koerdell
1953 Association of Artifacts with Mammoth in the Valley of Mexico. *American Antiquity* 18:332–340.

Goebel, Ted, Michael R. Waters, and Dennis H. O'Rourke
2008 The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science* 319:1497–1502.

Goodyear, Albert C.
2005 Evidence for Pre-Clovis Sites in the Eastern United States. In *Paleoamerican Origins: Beyond Clovis*, edited by Robson Bonnichsen, Bradley T. Lepper, Dennis Stanford, and Michael R. Waters, pp. 103–112. Center for the Study of the First Americans, Texas A&M University Press, College Station.

Halligan, Jessi J., Michael R. Waters, Angelina Perrotti, Ivy J. Owens, Joshua M. Feinberg, Mark D. Bourne, Brendan Fenerty, Barbara Winsborough, David Carlson, Daniel C. Fisher, Thomas W. Stafford Jr., and James S. Dunbar
2016 Pre-Clovis Occupation 14,550 Years Ago at the Page-Ladson Site, Florida, and the Peopling of the Americas. *Science Advances* 2:e1600375. http://advances.sciencemag.org/content/2/5/e1600375

Haynes, Gary
2015 The Millennium before Clovis. *PaleoAmerica* 1:134–162.

Holen, Steven R., Thomas A. Deméré, Daniel C. Fisher, Richard Fullagar, James B. Paces, George T. Jefferson, Jared M. Beeton, Richard A. Cerutti, Adam N. Rountrey, Lawrence Vescera, and Kathleen A. Holen
2017 A 130,000-Year-Old Archaeological Site in Southern California, USA. *Nature* 544:479–483.

Holen, Steven R., and Kathleen Holen
2014 The Mammoth Steppe Hypothesis: The Middle Wisconsin (Oxygen Isotope Stage 3) Peopling of North America. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 429–444. Texas A&M University Press, College Station.

Jenkins, Dennis L., Loren G. Davis, Thomas W. Stafford Jr., Paula F. Campos, Thomas J. Connolly, Linda Scott Cummings, Michael

Hofreiter, Bryan Hockett, Katelyn McDonough, Ian Luthe, Petrick W. O'Grady, Karl J. Reinhard, Mark E. Swisher, Frances White, Bonnie Yates, Robert M. Yohe II, Chad Yost, and Eske Willerslev
2014 Geochronology, Archaeological Context, and DNA at the Paisley Caves. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 485–510. Texas A&M University Press, College Station.

Joyce, Daniel J.
2014 Pre-Clovis Megafauna Butchery Sites in the Western Great Lakes Region, USA. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 467–483. Texas A&M University Press, College Station.

Llamas, Bastien, Lars Fehren-Schmitz, Guido Valverde, Julien Soubrier, Swapan Mallick, Nadin Rohland, Susanne Nordenfelt, Cristina Valdiosera, Stephen M. Richards, Adam Rohrlach, Maria Inés Barreto Romero, Isabel Flores Espinoza, Elsa Tomasto Cagigao, Lucía Watson Jiménez, Krzysztof Makowski, Ilán Santiago, Leboreiro Reyna, Josefina Mansilla Lory, Julio Alejandro Ballivián Torrez, Mario A. Rivera, Richard L. Burger, Maria Constanza Ceruti, Johan Reinhard, R. Spencer Wells, Gustavo Politis, Calogero M. Santoro, Vivien G. Standen, Colin Smith, David Reich, Simon Y. W. Ho, Alan Cooper, and Wolfgang Haak
2016 Ancient Mitochondrial DNA Provides High-Resolution Time Scale of the Peopling of the Americas. *Science Advances* 2:e1501385. http://advances.sciencemag.org/content/2/4/e1501385.full

Lowery, Darrin L., Michael A. O'Neal, John S. Wah, Daniel P. Wagner, and Dennis J. Stanford
2010 Late Pleistocene Upland Stratigraphy of the Western Delmarva Peninsula, USA. *Quaternary Science Reviews* 29:1472–1480.

McAvoy, Joseph M., and Lynn D. McAvoy
2015 *Nottoway River Survey Part II: Cactus Hill and Other Excavated Sites*. Dietz Press, Petersburg, Virginia.

Madsen, David B.
2015 A Framework for the Initial Occupation of the Americas. *PaleoAmerica* 1:217–250.

Meltzer, David J.
2009 *First Peoples in a New World*. University of California Press, Berkeley.

Moreno-Mayar, J. Víctor, Ben A. Potter, Lasse Vinner, Matthias Steinrücken, Simon Rasmussen, Jonathan Terhorst, John A. Kamm, Anders Albrechtsen, Anna-Sapfo Malaspinas, Martin Sikora, Joshua D. Reuther, Joel D. Irish, Ripan S. Malhi, Ludovic Orlando, Yun S. Song, Rasmus Nielsen, David J. Meltzer, and Eske Willerslev
2018 Terminal Pleistocene Alaskan Genome Reveals First Founding Population of Native Americans. *Nature* 553:203–207.

Overstreet, David F.
2005 Late-Glacial Ice-Marginal Adaptation in Southeastern Wisconsin. In *Paleoamerican Origins: Beyond Clovis*, edited by Robson Bonnichsen, Bradley T. Lepper, Dennis Stanford, and Michael R. Waters, pp. 183–195. Center for the Study of the First Americans, Texas A&M University Press, College Station.

Pinotti, Thomaz, Anders Bergström, Maria Geppert, Matt Bawn, Dominique Ohasi, Wentao Shi, Daniela R. Lacerda, Ame Solli, Jakob Norstedt, Kate Reed, Kim Dawtry, Fabricio González-Andrade, Cesar Paz-y-Miño, Susana Revollo, Cinthia Cuellar, Marilza S. Jota, José E. Santos Jr., Qasim Ayub, Toomas Kivisild, José R. Sandoval, Ricardo Fujita, Yali Xue, Lutz Roewer, Fabrício R. Santos, and Chris Tyler-Smith
2019 Y Chromosome Sequences Reveal a Short Beringian Standstill, Rapid Expansion, and Early Population Structure of Native American Founders. *Current Biology* 29:149–157. https://doi.org/10.1016/j.cub.2018.11.029

Pitblado, Bonnie L.
2011 A Tale of Two Migrations: Reconciling Recent Biological and Archaeological Evidence for the Pleistocene Peopling of the Americas. *Journal of Archaeological Research* 19:327–375.

Waters, Michael R., Joshua L. Keene, Steven L. Forman, Elton R. Prewitt, David L. Carlson, and James E. Wiederhold
2018 Pre-Clovis Projectile Points at the Debra L. Friedkin Site, Texas—Implications for the Late Pleistocene Peopling of the Americas. *Science Advances* 4(10):eaat4505. http://advances.sciencemag.org/content/4/10/eaat4505

Waters, Michael R., and Thomas W. Stafford Jr.
2014 The First Americans: A Review of the Evidence for the Late-Pleistocene Peopling of the Americas. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, pp. 541–560. Texas A&M University Press, College Station.

Waters, Michael R., Thomas W. Stafford Jr., Brian Kooyman, and L. V. Hills
2015 Late Pleistocene Horse and Camel Hunting at the Southern Margin of the Ice-Free Corridor: Reassessing the Age of Wally's Beach, Canada. *Proceedings of the National Academy of Sciences* 112(14):4263–4267.

Waters, Michael R., Thomas W. Stafford Jr., H. Gregory McDonald, Carl Gustafson, Morten Rasmussen, Enrico Cappellini, Jesper V. Olsen, Damian Szklarczyk, Lars Juhl Jensen, M. Thomas P. Gilbert, and Eske Willerslev
2011 Pre-Clovis Mastodon Hunting 13,800 Years Ago at the Manis Site, Washington. *Science* 334:351–353.

Webb, S. David (editor)
2006 *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*. Springer, Dordrecht, The Netherlands.

Williams, Thomas J., Michael B. Collins, Kathleen Rodrigues, William Jack Rink, Nancy Velchoff, Amanda Keen-Zebert, Anastasia Gilmer, Charles D. Frederick, Sergio J. Ayala, and Elton R. Prewitt
2018 Evidence of an Early Projectile Point Technology in North America at the Gault Site, Texas, USA. *Science Advances* 4(7):eaar5954. http://advances.sciencemag.org/content/4/7/eaar5954

THE PRE-CLOVIS PEOPLING OF SOUTH AMERICA

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The peopling of America is perhaps one of the longest and most controversial debates in world archaeology, one in which South America has played a central role. There have been several competing models for the first peopling of the Americas, but with the exception of the controversial hypothesis of an Atlantic-Solutrean migration, there is major agreement among archaeologists and ancient geneticists that the first colonizers entered America from Northeastern Asia via Beringia and its shorelines. South America is fundamental to this basic agreement and is considered the final step in the colonization of the Americas.

In the last two decades, the acceptance of Monte Verde II as a site dating ~14,500 cal BP in southern Chile (Dillehay 1997) has broken the "Clovis barrier" (~13,000 cal BP), but deepened the debate: If the first Americans were from Asia via Beringia, why is the oldest site on the continent the most southern? As sites in North and South America were dated at a similar age, these data suggested that America was peopled *before* Clovis and that the colonizing process was very rapid. However, previous and recent claims for a pre-Late Glacial Maximum (LGM, dated between ~25,000 and 18,500 cal BP) age would indicate an alternative view that humans were in America long before ~14,500 cal BP, and therefore several sites during or before this period are the result of a much slower adaptation process to different environments. The tension between these two opposite views is the essence of the debate and perpetuates the arguments.

South American data are crucial to this discussion, although with the exception of Monte Verde II, it is not always fully considered in the continental models. The geographic coverage of research in South America is markedly uneven. Some regions, such as the Central Andes, Patagonia, and Pampas, are relatively well studied, while in others, such as Amazonia and Chaco, the density of early sites remains very low due to low archaeological visibility/preservation and less scientific effort. Therefore, any discussion on the mode of expansion, the preferred environments, the speed of the colonization, and the routes of entry must accept these biases as well as the fact that geographic coverage and data are highly variable.

We must consider the basal timeline of the peopling of South America, a period agreed upon in general terms by the great majority of New World archaeologists. This line is around 14,000–14,500 cal BP and is defined by three sites with similar ages: Monte Verde II, Huaca Prieta, and Arroyo Seco 2 (Figure 1). There are also other sites, dated around 13,000 cal BP, across South America that are the same age as Clovis (for example, Quebrada Santa Julia in Chile; Cerro Tres Tetas, Piedra Museo, and Cueva Casa del Minero in Argentina; Lapa do Boquete and Caverna da Pedra Pintada in Brazil, etc.). Several "classic" sites such as Taima-Taima (13,000 ± 200 BP; 15,453 cal BP) in Venezuela, El Abra 2 (12,400 ± 160 BP; 15,511 cal BP) in Colombia, and Tibitó (11,740 + 110 BP; 13,530 cal BP) in Colombia, provided dates between 13,000 and 15,500 cal BP, but they did not meet contemporary dating accuracy criteria. Nothing is inherently wrong with these sites or with the dates (although the measurement errors are large), but they should be redated to ensure their chronology in contemporary standards, and a re-excavation will be crucial to do geoarchaeological and taphonomic studies. In their present status they cannot be used as proof of pre-Clovis occupations in South America. Also, the human footprints and track from Pehuen Co cannot be considered yet, because despite being intimately associated with the tracks of Pleistocene fauna, they have not been adequately dated (see discussion in Bayón et al. 2011).

The best known and fully published pre-Clovis site is Monte Verde II in southern Chile (Dillehay 1997). The site dates to ~14,500 cal BP, although a recent ^{14}C data analysis suggests that the human occupation of the site is between 14,485 cal BP and 14,160 cal BP (Politis and Prates 2018). The site is interpreted

Figure 1. Map with the sites mentioned in the text.

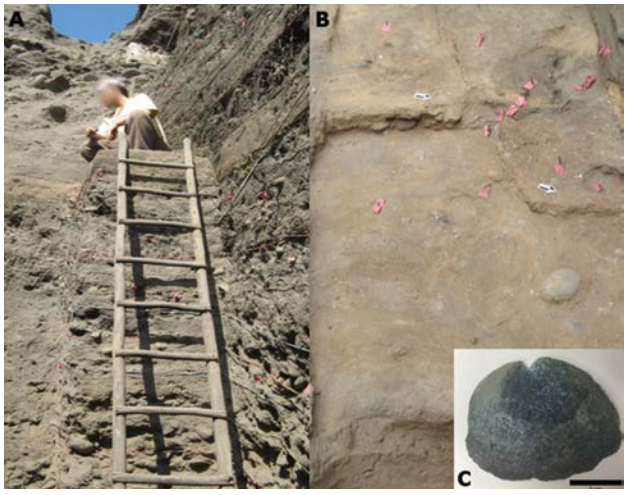

Figure 2. A) Upper portion of 29m deep pit (Unit 15) in the Huaca Prieta mound; B) Late Pleistocene use-surface at the 29m level. Note the burned areas and stone tools, radocarbon dated at ~14,5000 cal BP; C) basalt flake embedded in use-surface. Close-up of flake shows impact scar and bulb of percussion. Photo and caption courtesy of Tom Dillehay.

Figure 3. A) Aerial view of the Arroyo Seco 2 site showing the area excavated 1979-2018; b) Lithic artefacts, made on quartzite (upper row) and basalt seashore cobbles (lower row), associated with megafaunal remains.

as a contemporaneous cultural event: a semipermanent camp resulting from a year-round occupation. Expediency tools made from local cobbles characterize the lithic technology; subsistence was oriented toward a broad spectrum of resources, with plants being dominant. The second site is Huaca Prieta, a famous mound along the Chicama Valley in northern Peru, which has a pre-mound phase with intermittent occupation between ~14,500 and 7500 cal BP (Dillehay 2017; Figure 2). More recently, new dates have been published that extend occupation of the site to ~14,800 cal BP (Dillehay et al. 2017). Stone tools were made primarily from locally available cobbles of rhyolite, basalt, andesite, and quartzite; subsistence was based on marine resources (e.g., sharks, sea lions, marine birds, and bony fish) despite the sea at ~15,000 cal BP being 100 m below today's elevation, and the coastline being 20–30 km from the site (Dillehay et al. 2017). Finally, the Arroyo Seco 2 site in the Argentine Pampas shows evidence of two occupation events that are interpreted as temporary processing camps for megafauna—the former at ~14,000 cal BP when a giant ground sloth (*Megatherium americanum)* and American horse (*Equus neogeus*) were butchered, and the latter, dated at ~13,000 cal BP, when two genera of American horses (*Equus* and *Amerhippus*) were processed (Politis et al. 2016; Figure 3). In both components, lithic tools were unifacial and made from nonlocal raw materials (e.g., quartzite, whose closest outcrop is >100 km from the site) as well as chalcedony, chert, and rounded marine cobbles. No projectile points have been found.

Monte Verde II, Huaca Prieta, and Arroyo Seco 2 indicate that people were contemporaneously occupying and exploiting very different environments, and were using different

technologies, economies, and settlement patterns. This could suggest a previous longer presence of humans in South America and a reason for the different, distinctive adaptive patterns. However, the archaeological record (and the human DNA studies) does not fully support this hypothesis, an argument that is summarized below.

The proposed pre- or contemporaneous-LGM sites in South America are divisible into two groups. The first comprises several sites in northeastern Brazil, in the Piauí state, where French–Brazilian research teams (Niède Guidon, Eric Boëda, Christelle Lahaye, and others) have proposed ages from 15,000 to ~100,000 BP based on thermoluminescence and radiocarbon dating; however, recent papers lower the time to at least 60,000 BP (Parenti 2014). The most famous site is Boqueirão da Pedra Furada, where a Pleistocene human occupation, divided into four phases, has been proposed based on hearths and a lithic industry based exclusively on simple artifacts using local quartz and quartzite (Parenti 2001, 2014; Figure 4). The main criticism about Pedra Furada is that the purported artifacts are made from the same lithic material that is the dominant rock type in the conglomerate forming the cave's roof. Critics also questioned the lack of technological variation over tens of thousands of years and strongly suggested that gravity and falling quartz and quartzite cobbles caused the flaking, not humans. The monograph published by Parenti (2001; see also Parenti 2014) responds to these criticisms; however, some doubts still persist.

New excavations have been performed in the area by Eric Boëda and his team in several interesting sites—Toca do Tira Peia, Sitio do Meio, and Vale do Pedra—all of which date as pre-or contemporaneous-LGM (up to 35,000 cal BP; Boëda et al. 2013, 2016). Each site has specific problems needing clarification in order to evaluate the findings and interpretations (see critique in Borrero 2016; Schmidt Dias and Bueno 2014). For example, the Toca do Tira Peia publication (Lahaye et al. 2013) focuses on Optically Stimulated Luminescence (OSL) dates which, according to the authors, date the human occupation as >22,000 BP. However, little information has been published on the lithics, geology, and taphonomy of these sites, which are crucial to evaluating the context. In a second publication, there are some descriptions (asystematic) of the lithics and geology, although their relationships are confusing (see Boëda et al. 2013:453–454).

Certainly, these sites are promising and would change our view about the peopling of the Americas, opening new opportunities to study the LGM period. It is necessary to recognize the effort to identify new sites, excavate them carefully, and construct chronologies using different dating methods, but specific analyses need to be performed before Boëda and his team's interpretations are accepted. We suggest the following agenda.

Figure 4. View of the Toca do Boqueirão do Pedra Furada after the site was almost completely excavated. Photo taken by Gustavo Politis during the site visit organized by Niede Guidon in December 1993 at the Reunião Internacional Sobre o Povoamento das Américas in São Raimundo Nonato, Brazil.

First, information should be fully published. Systematic description of lithics and features are needed. Because most artifacts are made from naturally outcropping rock at these sites, it is crucial to identify the provenience of the nonlocal raw materials (especially from those interpreted as *manuports*). Second, taphonomy and site formation processes should be included in the research design more systematically; raw data and results should also be available. For example, it is crucial to know the proportion between the natural cobbles and the artifact in each layer to quantify the lithic background noise. The association between the lithics and the dated samples or sediments must be confirmed and documented. Third, a new rock-breakage agent in Serra da Capivara should be considered: the *Sapajus libidinosus* (bearded or black-striped capuchin monkey; Fiedel 2017). As recent papers from primatologists (e.g., Proffitt et al. 2016) have shown, these monkeys recurrently produce sharp-edged flakes and cores with quite similar features and morphologies to human artifacts. New studies need to develop a methodology to clearly discriminate these "artifacts" (biofacts or faunal lithics) from the true, human-manufactured tools. Obviously, capuchin monkeys could not produce all the artifacts found in all levels of these sites, but they might be responsible for some. Ignoring this disconcerting origin for lithics that might not be of human origin will hinder interpreting the prehistory of the area.

A second group of sites in South America has a different degree of resolution and integrity: for example, Pubenza

in Colombia, Pilauco in Chile, and Santa Elina in Brazil. Evaluating these sites requires more published details on basic contextual data (for an exception, see Vialou 2005) and more systematic analyses, specifically on taphonomy and site formation processes. Some of these sites deserve brief discussion: Arroyo del Vizcaíno (Fariña et al. 2014), Chinchihuapi I and II, and Monte Verde I (Dillehay et al. 2015).

The Arroyo del Vizcaíno site in Uruguay has yielded more than 1,000 bones, most from the giant sloth *Lestodon armatus*, in the streambed of Arroyo Vizcaíno. Dates on the site are between ~32,200 and 31,200 cal BP (Fariña et al. 2014). Briefly, the main problems include the following: First, the site is in a streambed where the stream becomes deeper, forming a natural pond on a substrate of a cretaceous silicified rock. This is a typical location for a bone trap. Second, the very few lithic artifacts are not convincing, and even if they were artifacts, their presence in a bone assemblage in a streambed makes any association questionable. Third, the main argument for the human origin of the bone assemblage is the presence of some bones having marks, interpreted as the result of human tool use (Fariña et al. 2014); however, discriminating between trampling and cut marks (in a bone assemblage full of marks of different origin) is extremely difficult because these modifications overlap morphologically. Equifinality cannot be ruled out. Finally, excavation outside the streambed (a place where any association will be difficult to support) is urgently needed in order to evaluate the context and the interpretation.

In a recent paper, Dillehay and others (2015) published new research at the Chinchihuapi I and II and Monte Verde I sites, all in the Monte Verde area (southern Chile). The recent excavation of 30 test pits, 10 block areas, and 54 sedimentary cores yielded 39 lithics, 12 burned features, and 8 taxonomically unidentifiable animal bones. Based on these data, the authors proposed the occurrence of "short term anthropogenic activities that were most likely associated with hunting and gathering, heating food in small hearths, and producing and discarding expedient tools" (Dillehay et al. 2015:21). Dillehay and others dated these findings between ~18,500 and 14,500 cal BP. One limitation of the evidence is the scarcity of archaeological materials at these sites. This problem is magnified by the large extent of the excavated surface, and the wide temporal range of the artifacts. As Dillehay and collaborators have indicated, several studies were still in process and some results were therefore preliminary. Based on the limitations above, we consider that the evidence from Chinchihuapi I and II and Monte Verde I is promising but, at the moment, it is too weak, too chronologically broad, and too spatially sparse to support human presence in southern Chile immediately after the LGM.

Figure 5. A) Panoramic view of the Cerro de los Onas showing the entrance of the Tres Arroyos 1 cave site in Tierra del Fuego (Chile); B) Detail of the excavation of the 12,700 cal BP layer. Bifacial tool associated with a Hippidion saldiasi rib. Photo courtesy of Mauricio Massone.

Final Thoughts

It is clear that humans were in South America when Clovis people expanded in North America and that these populations were there at least 1,500 years before Clovis. No projectile points (except the few broken points in Monte Verde II) were found in any pre-Clovis South American sites, and megamammals constitute a significant occurrence only in Arroyo Seco 2. The first evidence of *continuous* human occupation in South America is found between ~14,500 and 14,000 cal BP. At ~13,000 cal BP, in coincidence with Clovis in North America, there is a significant increase in sites, and these are scattered in the main regions of South America. This rise could be associated with the expansion of Fishtail projectile point technology, and with other less popular types of projectile points such as Paijan or El Jobo, and would be related to a second pulse of peopling and/or the advantages brought by the incorporation of new hunting technologies.

In South America, humans were present in the southern tip of Patagonia at ~12,700 cal BP in Fell's Cave and in Tres Arroyos 1 in Tierra del Fuego, suggesting the final step for the expansion phase of *Homo sapiens* on the continent. Despite active research and dating programs over the last 40 years, and favorable conditions of visibility and preservation for early sites in Patagonia, the ~12,700 cal BP baseline remains firm, suggesting an actual temporal threshold.

Several issues should be resolved in order to test the validity of a pre-LGM human occupation of the continent. First, if the

pre- and contemporaneous-LGM sites were confirmed, the human occupation of South America would reflect a discontinuous signal in both regional and temporal scales. Second, because the most accepted ancient DNA models state that New World humans have Asiatic origins (after a period of isolation in Beringia known as the Beringia standstill during the LGM) and that all known human remains found until now are linked to this population, a pre-LGM occupation would imply a regional extinction of earlier humans throughout South America. There is no evidence of such a process, and it seems unlikely. Third, a pre-LGM peopling would also lead to the consideration of a human occupation of South America prior to or at the same time as the earliest confirmed presence of *Homo sapiens* in Western Beringia, the Yana RHS site (dated to ~30,000 BP). At the present stage of archaeological and genetic knowledge, this hypothesis also seems very unlikely. Finally, because the oldest human remains in South America are dated to ~ 12,300 cal BP, we have to ask this pivotal question: Where are the human bones of the people inhabiting South America before and during the LGM? So far, none have been found.

*Additional suggested readings pertaining to this article may be found at https://www.saa.org/publications/the-saa-archaeological-record.

References Cited

Bayón, Cristina, Teresa Manera, Gustavo G. Politis, and Silvia Aramayo
2011 Following the Tracks of the First South Americans. *Evolution: Education and Outreach* 4:205–217.

Boëda, Eric, Antoine Lourdeau, Christelle Lahaye, Gisele Felice, Sibeli Viana, Ignacio Clemente-Conte, Mario Pino, et al.
2013 The Late-Pleistocene Industries of Piauí, Brazil: New Data. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron and Michael R. Waters, pp. 445–465. Center for the Study of the First Americans, Texas A&M University, College Station.

Boëda, Eric, Roxane Rocca, Amélie Da Costa, Michel Fontugne, Christine Hatté, Ignacio Clemente-Conte, Janaina C. Santos, et al.
2016 New Data on a Pleistocene Archaeological Sequence in South America: Toca do Sítio do Meio, Piauí, Brazil. *PaleoAmerica* 2:286–302.

Borrero, Luis A.
2016 Ambiguity and Debates on the Early Peopling of South America. *PaleoAmerica* 2:11–21.

Dillehay, Tom D.
1997 *Monte Verde: A Late Pleistocene Settlement in Chile. Volume II: The Archaeological Context*. Smithsonian Institution Press, Washington, DC.

Dillehay, Tom D. (editor)
2017 *Where the Land Meets the Sea: Fourteen Millennia of Human History at Huaca Prieta, Peru*. University of Texas Press, Austin.

Dillehay, Tom D., Carlos Ocampo, José Saavedra, Andre Oliveira Sawakuchi, Rodrigo M. Vega, Mario Pino, Michael B. Collins, et al.
2015 New Archaeological Evidence for an Early Human Presence at Monte Verde, Chile. *PLoS ONE* 10(11): e0141923. https://doi.org/10.1371/journal.pone.0141923

Dillehay, Tom D., Steve Goodbred, Mario Pino, Víctor. F. Vásquez Sánchez, Teresa Rosales Tham, James Adovasio, Michael B. Collins, et al.
2017 Simple Technologies and Diverse Food Strategies of the Late Pleistocene and Early Holocene at Huaca Prieta, Coastal Peru. *Science Advances* 3(5):e1602778. http://advances.sciencemag.org/content/3/5/e1602778.full

Fariña, Richard. A., Sebastián Tambusso, Luciano Varela, Ada Czerwonogora, Mariana Di Giacomo, Marcos Musso, Roberto Bracco-Boksar, and Andrés Gascue
2014 Arroyo del Vizcaíno, Uruguay: A Fossil-Rich 30-ka Old Megafaunal Locality with Cut-Marked Bones. *Proceedings of the Royal Society B* 281:20132211. https://doi.org/10.1098/rspb.2013.2211

Fiedel, Stuart J.
2017 Did Monkeys Make the Pre-Clovis Pebble Tools of Northeastern Brazil? *PaleoAmerica* 3:6–12.

Lahaye, Christelle, Marion Hernandez, Eric Boëda, Gisele D. Felice, Nièdе Guidon, Sirlei Hoeltz, Antoine Lourdeau, et al.
2013 Human Occupation in South America by 20,000 BC: The Toca da Tira Peia Site, Piauí, Brazil. *Journal of Archaeological Science*: 40:2840–2847.

Parenti, Fabio
2001 *Le gisement quaternaire de Pedra Furada (Piauí, Brésil). Stratigraphie, chronologie, evolution culturelle*. Editions Recherche sur les Civilisations, Paris.
2014 Pedra Furada, Archaeology of. In *Encyclopedia of Global Archaeology*, edited by Claire Smith, pp. 5842–5855. Springer, New York.

Politis, Gustavo G., María A. Gutierrez, Daniel J. Rafuse, and Adriana Blasi
2016 The Arrival of *Homo sapiens* into the Southern Cone at 14,000 Years Ago. *PLoS ONE* 11: e0162870. https://doi.org/10.1371/journal.pone.0162870

Politis Gustavo G., and Luciano Prates
2018 Clocking the Arrival of *Homo sapiens* in the Southern Cone of South America. In *New Perspectives on the Peopling of the Americas*, edited by Katerina Harvati, Gerhard Jäger, and Hugo Reyes-Centeno, pp. 79–106. Words Bones Genes Tools: DFG Center for Advanced Studies Series, Volume 1. Kerns Verlag, Tübingen, Germany.

Proffitt, Tomos, Lydia, Tiago Falótico, Eduardo Ottoni, Ignacio de la Torre, and Michael Haslam
2016 Wild Monkeys Flake Stone Tools. *Nature* 539(7627):85.

Schmidt Dias, Adriana, and Lucas Bueno
2014 More of the Same. *Antiquity* 88:943–945.

Vialou, Águeda V.
2005 *Pré-História do Mato Grosso. Volumen 1: Santa Elina*. Editorial USP, Sao Paulo, Brazil.

THE CLOVIS RECORD

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Clovis is still the best-documented early occupation of North America. Since the initial discovery of the type site Blackwater Draw near Clovis, New Mexico, Clovis points have been recovered from sites, and thousands more as isolated finds, throughout much of North America south of the Wisconsin ice sheets and as far south as Mexico. Clovis hunter-gatherers left behind their culturally diagnostic Clovis projectile point, a lanceolate point with a flute that initiates at the base and terminates about halfway up the biface.

The earliest decades of Clovis research were dedicated to defining the culture based on shared traits. Assemblages from buried sites yielded radiocarbon dates placing Clovis at the end of the Pleistocene, as well as stone assemblages of fluted points and large bifaces, and faunal remains from kill sites suggestive of a subsistence strategy focused on hunting Pleistocene megafauna. More recent research has helped refine the timing of Clovis, identify regional stylistic and adaptive variations in technology, and recognize diversity in settlement and subsistence practices. With this, we now have a more complete picture of the chronology, technology, and adaptations of Clovis populations living throughout North America.

Clovis Chronology and Environment

The discovery of new sites with buried components and the increased precision of radiocarbon dating techniques, allowing for redating of previously discovered sites, has led to significant refinement in Clovis chronology. Clovis dates to a 400-year-span from 13,050–12,650 cal BP. This range was proposed by Waters and Stafford (2007), who redated sites, assessed previously reported dates from early sites, and identified 11 sites they consider to have well-dated Clovis occupations (Figure 1). Their criteria include precision error of 75 years or less, the presence of Clovis diagnostic artifacts, and unambiguous association between the dated material and the Clovis occupation of the site. Since their 2007 study, most new dates from other Clovis sites also fall within this chronological span. Yet, there are a few sites that provide hints of an earlier Clovis record. One new site, El Fin del Mundo, Mexico, has produced a date of 13,390 cal BP (Sanchez et al. 2014). This date is ~350 years older than the oldest of the sites considered by Waters and Stafford (2007). Friedkin, Texas, and Aubrey, Texas, are sites with lithic assemblages that include features typical of Clovis technology and have also produced ages potentially older than 13,050 BP. However, both sites have dating shortcomings. At Friedkin, the Clovis and pre-Clovis assemblages are dated with the optically stimulated luminescence (OSL) technique, which has the limitation of larger error ranges. Dates from Aubrey suffer from questions related to the association between the dated material and the Clovis artifacts (Waters and Stafford 2007). While recognizing these limitations, it is interesting to note that Aubrey, Friedkin, and El Fin del Mundo all occur well south of Beringia, the glacial ice sheets, and the ice-free corridor. When combined with the absence of Clovis points in Beringia and the far northeast (Smith and Goebel 2018), these three Clovis sites provide intriguing evidence that Clovis fluted point technology dates oldest and may have originated in southern North America.

While the start and end of Clovis continues to be refined, it is clear that Clovis populations lived in North America in the late Pleistocene and experienced major environmental changes. Perhaps most significantly, the end of the Ice Age brought with it the extinction of 37 genera of North American mammals (Grayson and Meltzer 2015). Last appearance dates of several species, including ground sloth, giant bear, sabertooth, and gomphothere, coincide with the time of Clovis. Other species such as Pleistocene horse, Yesterday's camel (also known as Western camel or American camel), American mastodon, and mammoth all were alive beyond the time of Clovis and were clearly hunted by humans. Thus, Clovis people witnessed and had to cope with the regional/local, if not continental, loss of four large-game food resources as these animal populations dwindled toward extinction. In addition to extinctions, Clovis groups also experienced the onset of the Younger Dryas, a global cooling event that lasted from 12,850–11,650 BP. Once thought to represent a severe, rapid event uniformly affecting landscapes like river systems and biotic communities

across the continent, it is now clear that the Younger Dryas had time-transgressive effects that varied in severity regionally and locally (Meltzer and Holliday 2010). Like the extinctions, the impacts of the Younger Dryas would have been felt differently and at different times by Clovis hunter-gatherers across the continent. Further, it has been proposed that a cosmic impact may have detrimentally affected environments and Clovis populations throughout the continent. The idea that an extraterrestrial object burst in the atmosphere above North America or impacted the ice sheets and initiated the Younger Dryas has received much attention since its initial proposal. Some researchers continue to find increased concentrations of possible impact-related markers in Younger-Dryas-aged sediments. The most commonly discussed include platinum group elements, magnetic spherules, and nanodiamonds. Other researchers have either failed to replicate increased concentrations of these markers in Younger-Dryas-aged sediments, found equal or greater concentrations in earlier or later sediments, or proposed alternate explanations (such as ordinary cosmic rain becoming concentrated by natural geomorphic processes). Thus, the debate continues, and we are left with three possibilities. Either 1) a comet burst over or impacted North America, spewing fire across the continent, igniting the Younger Dryas, and causing extinctions leading to a Clovis population crash; 2) cosmic and/or geomorphic processes resulted in increased sedimentary concentrations of some extraterrestrial materials that can be used as a geochronological marker for the Younger Dryas onset; or 3) there is no continental pattern, and concentrations and absences need to be explained within local contexts.

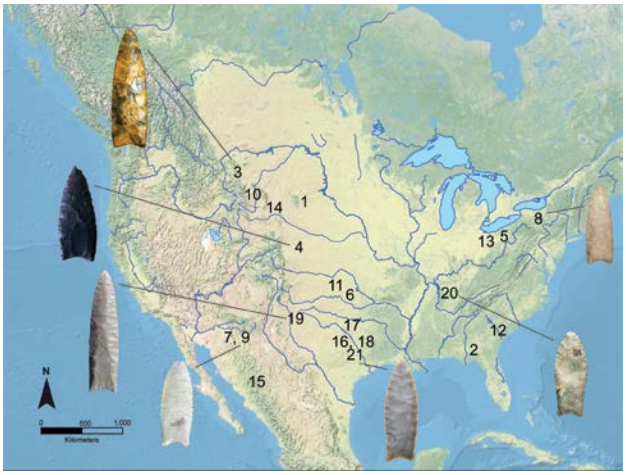

Figure 1. Map showing locations of dated Clovis sites (1–14; after Waters and Stafford 2007), other Clovis sites mentioned in text (15–20), and examples of Clovis points recovered from select sites: 1. Lange-Ferguson, SD; 2. Sloth Hole, FL; 3. Anzick, MT (image permission courtesy of H. Smith); 4. Dent, CO (image permission courtesy of M. Eren); 5. Paleo Crossing, OH; 6. Domebo, OK; 7. Lehner, AZ; 8. Shawnee-Minisink, PA (image by A. Smallwood); 9. Murray Springs, AZ (image by A. Smallwood); 10. Colby, WY; 11. Jake Bluff, OK; 12. Topper, SC; 13. Sheriden Cave, OH; 14. La Prele, WY; 15. El Fin del Mundo, Mexico; 16. Friedkin, TX; 17. Aubrey, TX; 18. Gault, TX; 19. Blackwater Draw, NM (image by A. Smallwood); 20. Carson-Conn-Short, TN (image by A. Smallwood); 21. Hogeye, TX (image permission courtesy of M. Waters and T. Jennings).

Clovis Technology

Lanceolate, concave-based, fluted Clovis points are the most well-recognized and diagnostic artifacts of the Clovis culture. The flute is a distinguishing characteristic of the point's design. By directly striking the base of an unfinished biface with a hammerstone or billet, Clovis flintknappers removed a flake that extends no more than halfway up to the tip, leaving an endthinning or flute scar (Bradley et al. 2010). The features of this flake removal help to distinguish Clovis from later Paleoindian types like Folsom and Cumberland points, which have flutes that run the entire length of the point, and other points, which have no flutes. Clovis points regularly exhibit impact damage on the tip indicating they were thrust or thrown, and microscopic usewear traces suggest Clovis points also served as knives (Smallwood 2015). While the flute is a defining characteristic of the point, archaeologists have not settled on a single explanation for the purpose of fluting in Clovis. Possibilities include that the flute was a form of stylistic expression, may have been associated with ritualistic behavior, or could have helped secure the point in the haft, or that the flute design had shock-absorbing properties that improved point resilience (see Thomas et al. 2017). Though all Clovis points are lanceolate-shaped with incurvate bases, the depth of concavity of the base and the excurvature of the blade varies from region to region (Figure 1). Recent advances with geometric morphometrics have helped document this variation. These studies generally find regional and subregional differences in point shape across North America that were not the result of resharpening and raw material characteristics. Instead, the variation is likely the result of Clovis populations throughout the continent locally adapting to subregions and uniquely altering aspects of their technology (Anderson et al. 2015; Buchanan et al. 2014; Smith and Goebel 2018).

Clovis flintknappers crafted their points using bifacial reduction, and the debris from this reduction process and remnant flake scars on bifaces have helped Paleoindian archaeologists describe their reduction techniques. Clovis bifaces were thinned and shaped using overface flaking and endthinning, and these flaking strategies were used throughout the

reduction process. The creation of overshot flakes—removals that travel across the biface and remove a portion of the biface edge—has long been identified as a feature of Clovis biface and debitage assemblages (Bradley et al. 2010; Figure 2). However, recent research has highlighted the risk of biface width loss associated with these removals and proposed that overface flaking, the removal of flakes that travel past the midline but terminate prior to the opposite bifacial edge (Smallwood 2012), may have been the primary goal. Overshots may be frequently produced diagnostic mistakes of this strategy. Endthinning, the removal of blade-like flakes parallel to the long-axis, was used to longitudinally thin bifaces. To create the characteristic Clovis point flute, some point bases were shaped around earlier-stage endthin removals; for others, the removal of an endthinning flake to create a flute scar was one of the last steps of production. Like variation in point morphologies, the application of these thinning strategies by Clovis knappers varied regionally (Smallwood 2012). These reduction techniques were also used to craft bifacial cores, large disc-shaped bifaces with edges prepared for the removal of wide, thin flakes. Bifacial cores were important parts of the mobile toolkit because they could serve as tools and cores; bifacial cores had sharp, durable edges, and thinning flakes struck from bifaces were often retouched and used as flake tools (Kelly and Todd 1988). However, recent experiments have shown that bifacial cores were not the most efficient core reduction technology in terms of the amount of usable flakes produced. With smaller initial core sizes, the reduction process becomes increasingly inefficient. Bifacial reduction creates an abundance of flakes that are too small to be effectively used as tools and significantly fewer usable flakes than amorphous cores, cores reduced from multiple edges or many directions (Jennings et al. 2010). Still, bifacial cores are commonly found in Clovis assemblages (Bradley et al. 2010; Waters et al. 2011), suggesting Clovis hunter-gatherers may have favored other advantages of bifacial cores and been less concerned with minimizing stone transport costs and efficiently conserving stone.

Clovis technology is also characterized by the production of blades—flakes that are twice as long as they are wide (Bradley et al. 2010; Waters et al. 2011; Figure 3). Clovis blades were struck from conical and wedge-shaped cores; both were specifically prepared core technologies designed for the removal of elongated, parallel-sided blades that had trapezoidal cross sections and were often curved from the proximal to distal ends. Conical blade cores were prepared for the removal of multiple blades from a single platform surface around the entire circumference of the core, converging at the distal end to create a cone shape. Wedge-shaped cores were prepared for the removal of blades from the acute edge of two intersecting core surfaces. Blades were removed from the intersecting

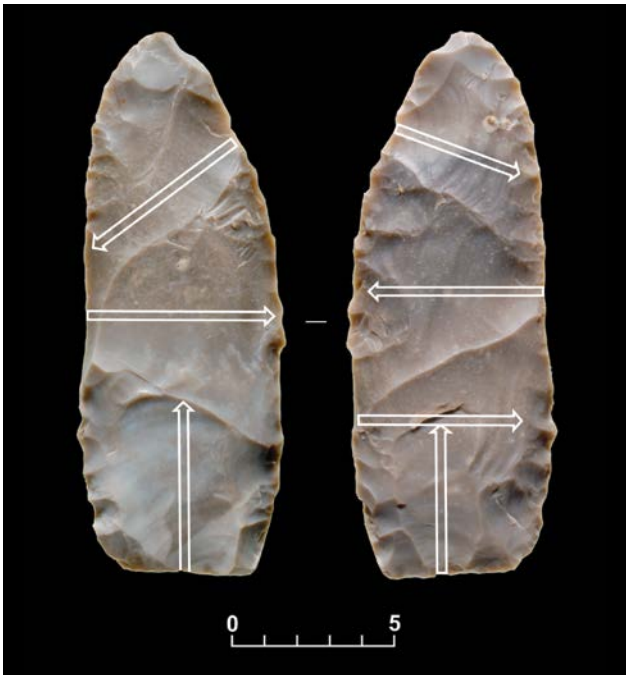

Figure 2. Clovis biface from the Hogeye site, TX, with arrows indicating the direction of overshot/overface and endthinning flake scar removals. Image permission courtesy of M. Waters and T. Jennings.

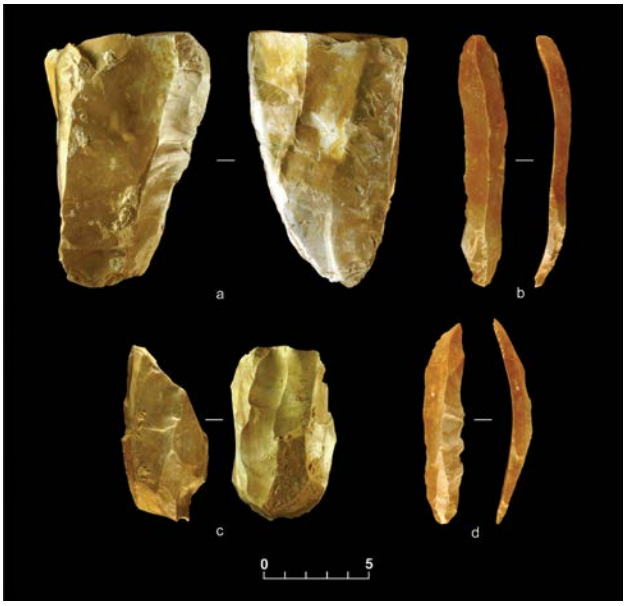

Figure 3. Clovis blade cores and blades from the Gault site, TX (images permission courtesy of M. Waters): (a) conical blade core; (b) blade; (c) wedge-shaped blade core; (d) blade.

edge in one or multiple directions, creating a wedge shape. Clovis blade edges were modified to create a variety of tools, including endscrapers, gravers, and serrated blades, and unmodified blades also show evidence of use. Like bifacial cores, experimental studies show that blade cores were not efficient in terms of transport weight costs; large blade cores produce many usable blanks, but with smaller initial core size, the production efficiency of usable tool blanks decreases. Based on assemblages from sites in the Southern Plains and Southeast, Clovis people produced blades at sites immediately next to raw material sources where stone was abundant.

Clovis assemblages also include a variety of other formal tools (Eren and Buchanan 2016; Figure 4). Toolkits vary from site to site, as a product of site use, and researchers have noted that some tool types are more commonly found in some regions than others. For example, high densities of endscrapers occur at sites in the Great Lakes and Northeast. These tear-drop or triangular-shaped flake tools have steep bits and abraded lateral edges, suggesting they were hafted and possibly used to scrape materials like hides. Denticulated scrapers, with teeth-like projections along the edges possibly used for processing plant materials, occur in collections from the Southeast. Adzes, once thought to have originated with later Paleoindians, have now been found at Clovis sites in the Southern Plains, Southeast, and Great Lakes, providing evidence that Clovis hunter-gatherers also created robust tools for woodworking. Though more rare than stone tools due to preservation issues, points and foreshafts crafted from bone and ivory are found at Clovis sites across the continent, and ivory points and foreshafts are particularly common in collections from Florida (Bradley et al. 2010). Bone points were split, beveled, and tapered on the one end, and foreshafts were beveled and cross-hachured on both ends. Ivory was carved and polished into points and foreshafts, like bone, and some specimens were incised at the base.

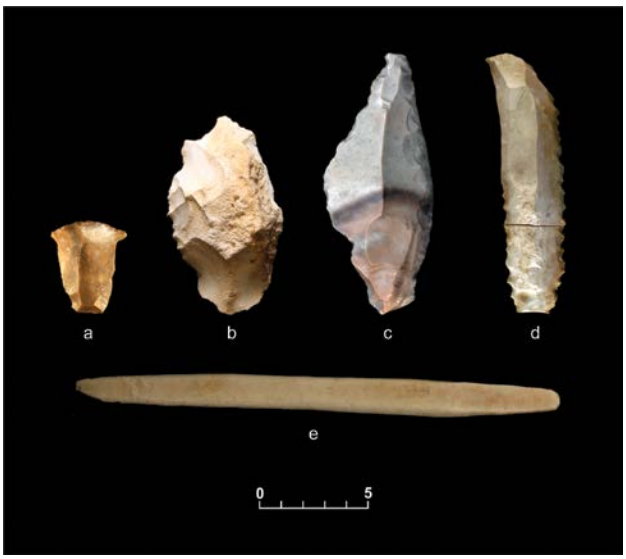

Figure 4. Clovis tools from various Clovis sites: (a) endscraper from Gault, TX (image permission courtesy of M. Waters); (b) denticulate from Topper, SC (image by A. Smallwood); (c) sidescraper from Blackwater Draw, NM (image by A. Smallwood); (d) serrated blade from Gault, TX (image permission courtesy of M. Waters); (e) bone artifact from Blackwater Draw, NM (image by A. Smallwood).

Clovis Adaptations

Clovis hunter-gatherers have long been recognized as some of the most highly mobile in North America, in some cases carrying stone hundreds of kilometers across the landscape (Kelly and Todd 1988). Once thought to be a consistent, continent-wide pattern, it is now clear that regional variation also existed in how Clovis populations organized their settlement and subsistence strategies.

In the Southern Plains and periphery, the Clovis record is characterized by large and medium-sized camp sites, megafauna kill sites, and caches. Camp sites tend to be concentrated along the periphery close to stone sources while kill and cache sites are located out in the Plains proper. Caches are places where Clovis people intentionally placed small collections of stone together in an isolated location on the landscape. Clovis settlement in the region appears to have been organized, at least seasonally, with a logistical mobility strategy to target megafauna refugia and cache stone as insurance supplies in favored hunting grounds. Small groups would venture into the Plains on hunting trips, cache stone for future excursions, and return to southern base camps. At other times of the year, Clovis bands may have moved residential camps to target other seasonal resources. Raw material and site distribution studies show that Clovis populations intensively occupied the region and created a tightly knit "small-world" social network created and maintained by the logistical movements from peripheral camps into the Plains (Buchanan et al. 2019).

The Great Lakes is unique because it represents the only region where Clovis people were clearly colonizers of recently deglaciated landscapes (Ellis 2011)—neighboring Northeastern fluted point populations, whose points are morphologically distinct from classic Clovis points and whose sites postdate Clovis by hundreds of years, also appear to have later colonized unglaciated lands. In the Great Lakes, the presence of caches, large camp sites, and long-distance stone transport provides evidence for similar logistical mobility organization to that of

the Southern Plains. However, rather than primarily targeting megafauna refugia, Clovis populations may have instead been seasonally targeting caribou herds in logistical hunts.

In the Southeast, some important regional differences are evident. Like elsewhere, Clovis populations established relatively large camps at sites in Kentucky, Tennessee, South Carolina, and Virginia. Described as staging areas (Anderson et al. 2015), large camps are located in resource-rich locations near major rivers and high-quality stone outcrops. Southeastern Clovis knappers also relied on the relatively transport-inefficient strategies of biface and blade reduction. However, caches are absent in the region. Thus, logistically targeting large-game herds, and caching stone to support logistical hunts, may have been less common. Instead, staging areas could represent seasonally occupied, subregional macroband centers utilized by relatively more residentially mobile bands (Miller 2016). In other words, perhaps mobile bands periodically came together at larger staging areas for social rather than purely subsistence needs. The Southeast has also produced the greatest density of Clovis points, which suggests the region may have been occupied by the highest populations or for the longest duration. Elsewhere in the Southeast, the lower Gulf Coastal Plain of Louisiana and Mississippi has produced very few Clovis points and no large sites, suggesting that this stone-poor landscape was minimally occupied by Clovis populations.

The Southwest is one region that stands out for its untapped research potential. While Clovis sites, particularly megafauna kill sites, have been repeatedly documented in the US side of the region, collaborative efforts to explore the record in Mexico are showing that Clovis populations ranged much further south (Sanchez et al. 2014). No doubt this ongoing work will continue revealing the extent to which Clovis behaviors in the Southwest are similar to or different from other regions.

Three extensively studied regions have provided evidence for the geographic frontier of Clovis—the Northern Plains, Northwest, and Great Basin. The Clovis record in these regions includes points in relatively low densities, some caches, including ritual caches associated with burials, and few, small camp sites. The Clovis network in the Northern Plains region is also much more dispersed and disconnected than in the Southern Plains (Buchanan et al. 2019). Thus, it appears that small groups of Clovis bands explored the Northern Plains, Northwest, Great Basin, and surrounding Rocky Mountains but never settled these areas to the extent or intensity seen in the neighboring Southern Plains and Great Lakes.

Finally, debate continues over the relative importance of megafauna in the Clovis diet and the extent to which Clovis hunters "overkilled" or contributed to the extinction of some species (Grayson and Meltzer 2015; Surovell et al. 2016). As noted, the environmental changes accompanying the end of the Pleistocene regionally and locally varied in significance and timing (Meltzer and Holliday 2010). Some species appear to have gone extinct prior to human colonization while other extinctions, including animals clearly hunted by Clovis groups, directly overlap with the earliest human occupation of the continent. There is, however, broad agreement that Clovis populations relied on megafauna, with particularly abundant evidence for mammoth hunting, as an important component of their diet and that they also consumed smaller animals as well as gathered plant resources.

Enduring Questions

For all that we have learned about Clovis in recent decades, key questions remain unanswered. Two of these have been at the heart of Clovis research since the earliest discoveries at Blackwater Draw and other sites 90 years ago. When and where did the suite of characteristics we now call "Clovis" originate? How did Clovis spread throughout much of North America?

Chronology data and comparisons to pre-Clovis are providing hints that Clovis point and bifacial reduction technologies may have originated in southern North America. It is also likely that not all elements of what we now consider distinctive Clovis technologies evolved simultaneously. The process might have varied spatially and temporally. For example, Clovis blade techniques may have developed independently from (and earlier than?) point and biface reduction techniques.

Tracking and explaining the spread of Clovis has been equally challenging. Mapping the spread chronologically has been unsuccessful because core Clovis settlement regions such as the Southeast have produced so few dated sites. It is also not clear whether the spread resulted from migration, diffusion, or some combination. Paleoindian archaeologists are interested in the social contexts surrounding how Clovis bands across the continent retained shared technologies while also modifying design templates and production recipes to create regional variants and local traditions. With the continued work of dedicated researchers and a little bit of archaeological luck, it hopefully will not take another 90 years to answer these and other enduring Clovis questions.

References Cited

Anderson, David G., Ashley M. Smallwood, and D. Shane Miller
2015 Pleistocene Human Settlement in the Southeastern United States: Current Evidence and Future Directions. *PaleoAmerica* 1(1):7–51.

Bradley, Bruce A., Michael B. Collins, and Andrew Hemmings
2010 *Clovis Technology*. International Monographs in Prehistory, Archaeological Series 17, Ann Arbor, Michigan.

Buchanan, Briggs, Michael J. O'Brien, and Mark Collard
2014 Continent-wide or Region-specific? A Geometric Morphometrics-based Assessment of Variation in Clovis Point Shape. *Archaeological Anthropological Sciences* 6:145–162.

Buchanan, Briggs, Marcus J. Hamilton, and J. David Kilby
2019 The Small-World Topology of Clovis Lithic Networks. *Archaeological and Anthropological Science*. https://doi.org/10.1007/s12520-018-0767-7

Ellis, Christopher
2011 Measuring Paleoindian Range Mobility and Land-Use in the Great Lakes/Northeast. *Journal of Anthropological Archaeology* 30:385–401.

Eren, Metin I., and Briggs Buchanan
2016 Clovis Technology. In *eLS: Citable reviews in the life sciences*. John Wiley & Sons Ltd, Chichester. http://www.els.net/WileyCDA/ElsArticle/refId-a0026512.html

Grayson, Donald K., and David J. Meltzer
2015 Revisiting Paleoindian Exploitation of Extinct North American Mammals. *Journal of Archaeological Science* 56:177–193.

Jennings, Thomas A., Charlotte D. Pevny, and William A. Dickens
2010 A Biface and Blade Core Efficiency Experiment: Implications for Early Paleoindian Technological Organization. *Journal of Archaeological Science* 37:2155–2164.

Kelly, Robert L., and Lawrence C. Todd
1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53:231–244.

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.

Miller, D. Shane
2016 Modeling Clovis landscape use and recovery bias in the Southeastern United States using the Paleoindian Database of the Americas (PIDBA). *American Antiquity* 81:697-716.

Sanchez, Guadalupe, Vance T. Holliday, Edmund P. Gaines, Joaquín Arroyo-Cabrales, Natalia Martínez-Tagüeña, Andrew Kowler, Todd Lange, Gregory W. L. Hodgins, Susan M. Mentzer, and Ismael Sanchez-Morales
2014 Human (Clovis)–Gomphothere (*Cuvieronius* sp.) Association ~13,390 Calibrated yBP in Sonora, Mexico. *Proceedings of the National Academy of Sciences* 111(30): 10972–10977.

Smallwood, Ashley M.
2012 Clovis Technology and Settlement in the American Southeast: Using Biface Analysis to Evaluate Dispersal Models. *American Antiquity* 77:689–713.
2015 Building Experimental Use-wear Analogues for Clovis Biface Functions. *Archaeological and Anthropological Sciences* 7(1):13–26.

Smith, Heather L., and Ted Goebel
2018 Origins and Spread of Fluted-Point Technology in the Canadian Ice-Free Corridor and Eastern Beringia. *Proceedings of the National Academy of Sciences* 115(16):4116–4121.

Surovell, Todd A., Spencer R. Pelton, Richard Anderson-Sprecher, and Adam D. Myers
2016 Test of Martin's Overkill Hypothesis Using Radiocarbon Dates on Extinct Megafauna. *Proceedings of the National Academy of Sciences* 113(4):886–891.

Thomas, Kaitlyn A., Brett A. Story, Metin I. Eren, Briggs Buchanan, Brian N. Andrews, Michael J. O'Brien, and David J. Meltzer
2017 Explaining the Origin of Fluting in North American Pleistocene Weaponry. *Journal of Archaeological Science* 81:23–30.

Waters, Michael R., and Thomas W. Stafford Jr.
2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315(5815):1122–1126.

Waters, M. R., C. D. Pevny, D. L. Carlson, W. A. Dickens, A. M. Smallwood, S. A. Minchak, E. Bartelink, J.M. Wiersema, J.E. Wiederhold, H.M. Luchsinger, D.A. Alexander, and T.A. Jennings
2011 *A Clovis Workshop in Central Texas: Archaeological Investigations of Excavation Area 8 at the Gault Site*. Texas A&M University Press, College Station.

We Want You! Volunteers Needed for the Annual Meeting!

SAA is currently seeking enthusiastic volunteers for the 85th Annual Meeting in Austin, TX. Volunteer opportunities are open to both members and non-members who are eager to connect with colleagues.

In order for volunteers to have more meeting flexibility, SAA will again require two 4-hour blocks of volunteers' time! The complimentary meeting registration is the exclusive benefit for your time.

Training for the meeting will be provided via a detailed manual sent to you electronically prior to the meeting. On-the-job training will also be provided. As always, SAA staff will be on hand to assist you with any questions or problems that may arise.

For additional information and a volunteer application, please go to https://www.saa.org/annual-meeting/volunteer or contact Solai Sanchez at Phone +1(202) 559-7382, or e-mail solai_sanchez@saa.org.

Applications will be accepted on a first-come, first-served basis until Feb 15, 2020.

See you in Austin!

CALENDAR

May 1, 2019
Submissions Open for SAA's 85th Annual Meeting in Austin, TX

June 2019
The SAA Press releases **Oaxaca: Arqueología de una Región Mesoamericana** por Nelly Robles García

July 2019
The SAA Press releases **Using and Curating Archaeological Collections**, edited by Terry Childs and Mark Warner

September 5, 2019
Submissions Close for SAA's 85th Annual Meeting in Austin, TX

September 26, 2019
Online Seminar: International Heritage Management
22:00 p.m.–2:00 p.m. EST

The SAA Press is accepting preorders for their summer releases.
Preorder a copy to receive the discounted advance order price.
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Learn more about the Online Seminars and register
www.saa.org/OnlineSeminars

REPORT FROM THE SAA BOARD OF DIRECTORS

Teresita Majewski

Teresita Majewski is the secretary of the Society for American Archaeology.

The SAA Board of Directors met on April 10 and 13, 2019, at the Annual Meeting in Albuquerque, New Mexico. SAA President Susan Chandler chaired the meeting on April 10, and the other officers and directors present were President-elect Joe Watkins, Secretary Emily McClung de Tapia, Secretary-elect Teresita Majewski, Treasurer Ricky Lightfoot, and Directors Eva Jane Baxter, Luis Jaime Castillo Butters, Patricia Garcia-Plotkin, Heather Lapham, Lynne Sullivan, and Steve Tomka. Executive Director Oona Schmid participated *ex officio*. The meeting on April 10 began with the standard conflict of interest inquiry. Incoming Director Sylvia Salgado was unable to attend, and Director Baxter left the meeting after lunch due to illness. Guests included Treasurer-elect designate Stephen Nash and incoming director Cynthia Herhahn. President Joe Watkins took office at the Annual Business Meeting on April 12 and chaired the meeting on April 13. In attendance were Secretary Majewski, Treasurer Lightfoot, and Treasurer-elect Nash; Directors Baxter, Herhahn, Lapham, Sullivan, and Tomka; and Executive Director Schmid *ex officio*. Director Salgado was not present.

President Chandler provided a report to the Board summarizing SAA activities during 2018–2019. She reported that SAA has been active on many fronts through the work of staff and over 40 committees and task forces. SAA's government affairs efforts continued internationally with the World Bank as well as domestically. The importance of SAA's advocacy work can be measured by the numbers of members who reach out to Society leadership for help whenever a problem is identified at the state or federal level. Details of SAA's activities in this area, including a timeline, are available on the Government Affairs portion of the website under the SAA Positions and Actions tab. The Government Affairs Network State Representative system continues to be fully engaged and of great utility to SAA. On Native American Graves Protection and Repatriation Act (NAGPRA) issues, SAA successfully urged the Department of the Interior to allow the National NAGPRA Review Committee to resume its duties under the act, which had been suspected by the administration since 2017. In February, President Chandler and President-elect Watkins met with legislators in Washington, DC, to advocate for increased funding for archaeological programs and to stress the importance of continuing to follow cultural resource regulations for any infrastructure bills under consideration.

Executive Director Oona Schmid reported on activities that she and staff have completed since September 2018, when she joined SAA. She dedicated herself to the current programs and services of the organization, in particular all of the tasks leading up to the annual meeting in Albuquerque. She introduced herself to many of SAA's volunteers through phone calls and emails, including Board members, every past president of the Society, and most committee chairs and many interest group organizers. She facilitated the governance of the Society, which included the launch of the H. and T. King Grant for Precolumbian Archaeology, and worked with Treasurer Lightfoot on making improvements to the organization's accounting and financial reporting practices. She led her team in late 2018 in updating and relaunching the SAA website, and other communications efforts included creation of a YouTube channel and an Instagram account.

Secretary Emily McClung de Tapia reported the results of the recent election: Stephen Nash, Treasurer-elect; Cynthia Herhahn and Sylvia Salgado, Directors; Patricia Crown and T. J. Ferguson, Nominating Committee members.

Treasurer Ricky Lightfoot reported on the SAA's current financial position and summarized his written report. SAA continues to be in a strong financial position with total assets of approximately $8,647,000 at the end of 2018. This figure is down $266,000 from the end of 2017 due to unrealized losses in the organization's investments. In 2018, the Society had approximately $2,513,000 in revenue, compared to $2,485,000 in expenses, for a modest positive bottom line. A total of 332 donors contributed $365,583.83 in 2018, making it the second-largest gift total ever received in a single year in the organization's history. That total includes the largest non-estate gift ever received by SAA, which was a pledge of $300,000 for the new H. and T. King Grant for Precolumbian Archaeology, which will provide grants totaling $60,000 a year for five years. The grant program supports archaeological research throughout Latin America. A Board-appointed task force developed a committee composition and charge and set up grant

guidelines and procedures. A grant committee was then established, and the first H. and T. King Grants have been awarded. A five-year pledge of $20,000 from Charles Stanish established the Charles Stanish SAA Annual Meeting Travel Award, which will provide a $4,000 award each year for five years to support early career archaeologists in Peru and Bolivia to travel to the United States to attend and participate in the SAA annual meeting. SAA continued to work with its investment advisor, DiMeo Schneider & Associates, and developed new policies to reorganize SAA's financial structure to facilitate accounting and accessibility to funds for the organization's programs. These were adopted by the Board.

The Board also adopted a revised Gift Acceptance Policy and adopted new policies around named endowments.

The Board reviewed the competitive and impressive pool of candidates for the next editorship of *Latin American Antiquity* and asked the Executive Director to work on getting a signed agreement with the top candidates from these formidable applicants.

The Board did not approve the request of the Valuing Archaeology Task Force to establish a Committee on the Public Benefits of Archaeology. The Board recognizes the importance of ensuring that the public benefits of archaeology are communicated. Several years ago, SAA created a staff position (manager, Education and Outreach) with this objective in mind, and in 2019 relaunched the organization's website to further this goal. The task force's final report will be used to develop annual work goals for this staff position.

At the end of the April 10 portion of the meeting, the Board thanked outgoing committee and task force chairs and SAA representatives for their service to the Society. President Chandler acknowledged the contributions of outgoing Secretary Emily McClung de Tapia and Directors Patricia Garcia-Plotkin and Luis Jaime Castillo Butters and thanked them for their exemplary service and contributions to the Society.

The Board met with several guests during the April 13 Board meeting. SAA's representative to the Register of Professional Archaeologists, Amy Ollendorf, could not attend, but Director Eva Jane Baxter reported on her behalf. She noted RPA's revision of the Code of Conduct concerning Sexual Harassment, standards for field school certification, RPA's continuing professional education (CPE) initiative, and their plan to hire an executive director. Donn Grenda, chair of the Government Affairs Committee, and David Lindsay, SAA's manager, Government Affairs, discussed the committee's completed and ongoing activities, including arranging field visits for legislators; staying abreast of potential threats to the National Historic Preservation Act (NHPA); monitoring activities of the Historic Preservation Caucus; developing an NHPA flyer in conjunction with Elizabeth Pruitt, manager, Education & Outreach; and continuing advocacy for federal cultural resource programs. They noted that SAA's contract with Clark/Hill, a Republican lobbying firm, has increased SAA's ability to reach out to conservative legislators to educate them about national historic preservation issues and the importance of retaining existing laws and regulations. Grenda is pleased with the fact that SAA is able to communicate with the over 4,500 members that have opted in to receive government affairs updates, as well as with the committee's relationship with the Coalition for American Heritage and the other partners that contribute to and participate in the coalition. The SAA has very effective software that members can use to easily communicate with their legislators. Fundraising Committee Chair Phillip Neusius reported on his activities since being appointed chair and noted that his goal was to strengthen SAA's fundraising program and especially to increase communication with potential new donors and those who have created established SAA funds.

Representatives of Cambridge University Press (CUP) Kristian Turner and Jaime McIntyre met with the Board to discuss CUP's second year as the Society's publishing partner. The partnership is going well, and they noted that there has been a dramatic increase in circulation. Also discussed were distribution to developing economies, facilitating open access, marketing efforts for SAA journals, and how to encourage authors to help promote their articles.

During lunch on April 13, the Board met with Lynn Gamble, editor of *American Antiquity*; Geoffrey Braswell and María Gutiérrez, co-editors of *Latin American Antiquity*; Anna Prentiss, editor, and Christopher Rodning, incoming editor of *The SAA Archaeological Record*; Sarah Herr and Sjoerd van der Linde, co-editors of *Advances in Archaeological Practice* (co-editor Christina Reith was unable to attend); and Lynne Goldstein, chair of the Publications Committee. The editors in attendance report being highly satisfied with the CUP arrangement. Michelle Hegmon, editor of the SAA Press, was unable to attend the lunch, but noted in her written report to the board that two volumes are expected to come out in 2019, with several more in 2020.

The Board is working with the Committee on Awards to review and revise charges and procedures for the numerous committees that work to select the various SAA awards. The Board adopted a revised charge and guidelines for the Cheryl L. Wase Scholarship Committee. The Executive Director organized a "Wase Toast" at the meeting to celebrate past winners of the Cheryl L. Wase Scholarship and engage the New Mexico community who will most benefit from the scholarship.

Receipt of the report of the Annual Meeting Program Committee was acknowledged, and Committee Chair E. Christian Wells and all of the committee members were thanked for creating an excellent meeting program for Albuquerque. This was a daunting challenge given the number of accepted sessions.

SOCIETY FOR AMERICAN ARCHAEOLOGY 84TH ANNUAL BUSINESS MEETING

MINUTES OF THE MEETING

Emily McClung de Tapia, Secretary

President Susan Chandler called the Society for American Archaeology's 84th Annual Business Meeting to order at 5:20 pm on Friday, April 12, 2019 after the secretary determined that a quorum was present. The president requested approval of the minutes of the 2018 Annual Business Meeting in Washington, District of Columbia. The motion was moved, seconded, and approved by the members who were present.

President Chandler thanked the Nominating Committee, chaired by Deborah Nichols, for putting together an excellent slate of candidates, and she thanked all who ran, whether elected or not, for their willingness to serve the society. The president also recognized and thanked the outgoing members of the Board of Directors, including Secretary Emily McClung de Tapia and Directors Patricia García-Plotkin and Luis Jaime Castillo Butters.

The President especially recognized the excellent work of Oona Schmid, Executive Director, and the SAA staff, including Cheryl Ardovini, Jonathon Koudelka, David Lindsay, Elizabeth Pruitt, Amy Rutledge, Solai Sanchez, and Cheng Zhang. President Chandler also thanked outgoing chairs as well as the hundreds of members who serve voluntarily on SAA's committees and task forces, working behind the scenes, devoting their talents and energies to accomplish the important goals of the Society. She recognized the chairs of committees and task forces who are cycling off this year and thanked them for their service to the Society: E. Christian Wells, 2019 Program Committee chair; Matthew Schmader, Local Advisory Committee Chair; Carol E. Colaninno-Meeks, RPA, Public Archaeology Webpages Task Force Chair; John G. Douglass, RPA, and Gordon F. M. Rakita, RPA, Task Force on Review of the SAA Principles of Archaeological Ethics: Stage I co-chairs; Dean Snow, Ceremonial Resolutions Committee chair; Danielle Benden, Committee on Museums, Collections and Curation chair; William Doelle, Investment Committee chair; Mark Slaughter, Committee on Awards chair; Laurie Webster, Committee on Award for Excellence in Archaeological Analysis chair; Michael Trimble, Excellence in Curation, Collections Management, and Collection-based Research and Education chair; Christopher Stevenson, Fryxell Award Committee chair; Zachary Nelson, Gene S. Stuart Award Committee chair; Scott MacEachern, International Government Affairs Committee; Christopher Pool, Search for Co-editors of LAQ Task Force; and Frances M. Hayashida, Cheryl L. Wase Scholarship Committee chair. Appreciation was expressed for the important role of the current and outgoing editors in SAA's publication program and to Cambridge University Press, SAA's publishing partner.

In the interest of time, rather than detailing the activities of the Society since the last annual meeting, President Chandler referred to her columns in the *SAA Archaeological Record* and the monthly government affairs newsletter. She also urged members to check in frequently with SAA's new website, which is updated regularly with news about the Society's initiatives and publications. She noted that SAA has maintained its core archaeological programs while also keeping a strong focus on advocacy through the government affairs program and through SAA's partnership with the Coalition for American Heritage. SAA also renewed a contract with the Republican lobbying firm Clark Hill to help gain access to key members of Congress, a strategy that has worked well for advocacy efforts. President Chandler also highlighted the establishment of the H. and T. King Grant to support archaeological research in Latin America, as well as the Charles Stanish Travel award to facilitate the attendance of archaeologists from Peru and Bolivia at the SAA annual meeting, both of which were granted for the first time in 2019. More than 5,304 members attended the 2019 Annual Meeting, a new registration maximum.

Ricky Lightfoot, Treasurer, reported that the SAA remains in robust financial health, with total assets for the year of $8.65 million. In 2018, 332 donors contributed a total $366,000, making it the second-largest gift total ever received in a single year in SAA's history. The society's primary sources of revenue continue to be membership dues and the Annual Meeting, including registration, exhibits, and sponsorships. SAA's investments during 2018 were reduced with respect to 2017 as a result of a less favorable

market. Investments overall were down about 3.6 percent, with a year-end value of $7.8 million, including $2.4 million in Short Term Funds, $2 million in Reserve Funds, and $3.4 million in Endowment Funds. Approval by the Board of a new Endowment Spending Policy, a revised SAA Reserve Fund Policy and changes in the Board Designated Funds Policy will contribute to facilitating the SAA's funding of programs to benefit the membership and provide for transparency.

Emily McClung de Tapia, Secretary, announced the results of the election: Stephen Nash, Treasurer-elect, Silvia Salgado and Cynthia Herhahn, Director Positions, and Patricia Crown and T.J. Fergusen as members of the 2020 Nominating Committee. Ballots were distributed to 8,425 members in January 2019, and 1,451 (17.22 percent) were returned.

Executive Director Oona Schmid, at her first annual meeting of SAA, provided a perspective on SAA's goals going forward. She expressed the position that leadership involves listening to members, capitalizing on common themes, and addressing underlying needs The Albuquerque meeting hosted members from 30 different countries, and SAA represents archaeologists working in private practice, for state governments, in academic settings, large corporations, and federal governments. SAA benefits from this diversity of experience and exchange of ideas. The Society must look for inclusive positions that unify the diversity among archaeologists. Members have expressed concern that the Society not just speak with archaeologists but engage with people who are in positions to impact archaeology funding and historic preservation, making the case to Republican controlled agencies about the value of cultural resources and how they enrich us all. There is concern that the media misrepresent the origins and meaning of some sites, and the Society should educate the public about the rigor of archaeological knowledge and the value of the archaeological record to politicians and local communities. She expressed her "open-door" policy to attend to SAA's membership and the needs of the Society.

President Chandler presented several Presidential Recognition Awards as well as various awards and scholarships (see list of awards). The SAA Lifetime Achievement Award was presented to Lynne G. Goldstein for her scholarship and service to the profession of archaeology and to the SAA.

The president then asked the membership for any new business. Comments were received concerning the importance of SAA's position and actions regarding creation and maintenance of a safe environment for all SAA members, at the Annual Meeting and in other venues.

Paul Welch, incoming Chair of the Ceremonial Resolutions Committee, read the Ceremonial Resolutions, thanking outgoing and continuing members of the Board of Directors as well as committee and task force chairs, members completing their service, and the many members who have served the Society on its committees and in other ways. Welch offered sincere wishes that those members of the Society who are now serving in the armed forces return safely. A resolution of sympathy was expressed to the families and friends of Michael Riddle, Michael Harner, George L. Cowgill, Rick Turner, David Fraley, G. William Monaghan, Stewart Peckham, Janet Elizabeth Rafferty, Michael E. Roberts, Willow Powers, Saul Hedquist, Nancy Patterson Troike, Joseph Luther, Jamie Chad Brandon, Wendy Ashmore, Martin Biskowski, Steve Daron, Robert Powers, Jon Young, Pete Mehringer, and Patricia J. O'Brien. The members in attendance rose for a moment of silence in remembrance of our departed colleagues.

President Chandler passed the gavel to incoming President Joe Watkins, who began by presenting a plaque of appreciation to Susan M. Chandler for her commitment to expanding collaboration between the Americas and Europe, the performance of her duties with skill, élan, and vivacity, and her well-reasoned reactions to the uncertainties caused by the current federal administration. He then acknowledged the traditional owners of the land on which the Albuquerque meeting took place. President Watkins noted that while the SAA has strengthened its relationships with descendant, academic, student, professional, avocational, governmental, and contracting communities, among others, we must commit to increasing public awareness of the value of archaeology and heritage preservation and increasing public benefits derived from our profession. Today SAA is increasingly global in scope, not only facing local or regional issues, but issues that impact us all over the world: climate change, rising sea levels, shifting weather patterns, raising questions that can benefit from the time depth that archaeology can offer. Archaeology also faces issues of social concerns such as gender equity and cultural diversity; professional issues dealing with ethics, public outreach, and improved communication; and legislative issues with the current administration that impact archaeology. Recent legislative attacks on the foundations of historic preservation prove how necessary it is for us to be more proactive.

President Watkins concluded with a motion to adjourn, presented at 6:32 pm. The motion was seconded, and the meeting was adjourned.

EXECUTIVE DIRECTOR'S REMARKS

Oona Schmid

Good evening. My name is Oona Schmid and I am your new Executive Director. I know the traditional thing that I am supposed to do now is describe my achievements like the new website, my efforts to bring public legislators to the annual meeting, our robust membership numbers, and the new King grant program. But I have heard from many people that the Business Meeting feels long and I have no desire to add to the tedium.

I thought I would try something different.

When the SAA conducted a survey of past presidents, committee chairs, board members to identify the qualities they felt the Society needed in an Executive Director, among other things, these survey respondents said they wanted a good listener. This makes sense to me: a lot of leadership is about being able to hear people, think about common themes, and address underlying needs. But as I began to prepare comments for this evening, I became confounded. How to stand up and babble about what a terrific listener I am? I spent some time contemplating this paradox. I hope my way out of the koan is to share two broad messages I've heard in scores of interviews. I invite you to educate me more, in other venues, about what these two overarching ideas mean to you.

Theme 1: SAA is a big tent. Thirty different countries are represented at this meeting in Albuquerque. SAA is proud to be home to archaeologists who work in private practice, for state governments, in academic settings, large corporations, and federal governments. The organization creates structures—like this meeting—where we all benefit from this diversity of experience and exchange of ideas. Because we are home to such an expanse of archaeologists—and proud to be inclusive of these different opinions and experts—the Society has to be cautious not to take positions that divide. Rather the Society must look for positions that unify archaeologists. Some will say that this means the SAA is not as outspoken on their issue as they wish. But there is no way around it: the Society's strength comes from representing so many archaeologists. The vigor of our meeting and our publications come from these differences. I trust the organization will seek to embrace these conversations, realize they strengthen our individual knowledge basis, and also understand that the Society should not seek to silence or drive out any one of these perspectives.

Theme 2: Many of the members I have met are very interested and concerned that the Society not just speak with archaeologists but also engage with people in positions to impact archaeology funding and historic preservation. I have heard interest that we make the case to the Republican controlled agencies about the value of cultural resources and how they enrich us all. I have heard concern that some TV shows misrepresent the origins and meaning of some sites. I hear that members desire for the Society to help educate about the rigor of archaeological knowledge and the value of the archaeological record to politicians and local communities.

I did not want to be at this podium for long. I mostly wanted to tell you that I hope you will embellish on these themes and share more about how you see the Society as an individual with me. I encourage you to reach out to me by email or phone.

2019 AWARDS

Each SAA award recipient is selected by a dedicated and knowledgeable award committee—one for each award—made up of SAA member volunteers. Presidential Recognition Awards are bestowed by the SAA president to honor exemplary service to the Society. The Board of Directors wishes to thank the award committees for their hard work and excellent selections, and to encourage any members who have an interest in a particular award to volunteer to serve on a future committee.

Presidential Recognition Awarded in September 2018 to Retiring SAA Executive Director

TOBI BRIMSEK

For over 22 years of dedicated service as Executive Director, where her skillful leadership, professionalism, and sensitivity to the needs of our members enhanced the Society's financial stability and sustainability, expanded the Society's standing, membership, and services nationally and internationally, and where her guidance made the Society a better organization.

Presidential Recognition Award

DEBORAH L. NICHOLS

We proudly present this award to Deborah Nichols for her exceptional service to the Society during this past year. After finishing her term as Treasurer, Nichols chaired the Nominating Committee, was a key member of the Executive Director Search Committee, and chaired both the Task Force and Archaeological Review Committee for the H. and T. King Grant for Precolumbian Archaeology. She performed all of her duties with enthusiasm and wisdom. Her leadership in assembling a task force and review committee to develop guidelines for the grant program and to solicit and review research grant proposals allowed SAA to launch the new grant program in record time, thus fulfilling the wishes of the donors to begin funding research in Latin America as soon as possible.

Presidential Recognition Award

JOHN G. DOUGLASS and GORDON F.M. RAKITA

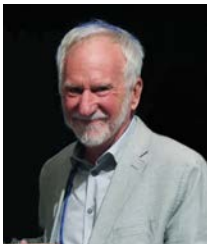
We proudly present this award to John Douglass and Gordon Rakita as co-chairs of the Task Force on Revision of the SAA Principles of Archaeological Ethics: Stage One. Douglass and Rakita assembled a diverse group of hard-working volunteers and guided their efforts to develop a detailed strategy of how to move forward with

revising and updating of the ethical principles in a manner that will ensure that the Society's membership has meaningful input about what ethical concerns they wish to consider. As part of that process, Douglass and Rakita organized the Opening Session and President's Forum, "Learning from the Past, Looking Towards the Future: Archaeological Ethics and the SAA." Douglass and Rakita are also both continuing to assist this effort by serving as members of the Task Force on Revision of the SAA Principles of Archaeological Ethics: Stage Two.

Presidential Recognition Award

JERRY D. SPANGLER

We proudly present this award to Jerry Spangler, who generously contributed his time and expertise to SAA by preparing a declaration supporting the position of the plaintiffs in the Grand Staircase-Escalante National Monument lawsuit. For the *amicus brief* filed by SAA, AAA, and AIA, Spangler carefully documented the significance of the archaeological resources in the areas rescinded from monument status by President Trump. His long history of research on the anthropogenic impacts to cultural resources on public lands allowed him to provide important details about how the development of natural resources and the corresponding infrastructure will cause irreversible damage to archaeological sites that are no longer afforded the level of protection provided by the monument designation.



Presidential Recognition Award

TIM A. KOHLER

We proudly present this award to Tim Kohler, for his efforts in helping SAA examine ways in which professional archaeologists can better share the benefits of our archaeological research with the public. Kohler volunteered to organize the 2018 SAA President's Forum, "What We Have Learned," bringing together a diverse panel of archaeologists to discuss what the archaeological record has taught us that is important and useful for society today and how our research might inform the future. Kohler subsequently shepherded these papers to timely publication in *The SAA Archaeological Record*. He also chaired the Task Force on Valuing Archaeology, which examined what the Society is currently doing to engage with non-archaeological constituencies and how we can enhance SAA's effectiveness in spreading the word about the importance of archaeology in the contemporary world.

Presidential Recognition Award

DANIEL H. SANDWEISS and THOMAS H. MCGOVERN

We proudly present this award to Dan Sandweiss and Thomas McGovern, who played key roles in helping create the SAA Committee on Climate Change Strategies and Archaeological Resources. Together with a large group of enthusiastic, energetic, and dedicated group of committee members, they helped form a group that continues to be engaged with researchers in the hard sciences, creating and sustaining interdisciplinary networks via dozens of presentations made annually throughout the world. The committee has cooperated with major national heritage groups in numerous countries to raise awareness and to take action about climate threats to heritage and science. They have succeeded in getting people outside of archaeology to listen about how humans impact the environment and how climate impacts humans and landscapes. The vision of Sandweiss, McGovern, and others has become a model of collaborative science, education, and outreach.

Gene S. Stuart Award

GAYLE KECK

The Gene S. Stuart Award for journalism about archaeology was awarded to Gayle Keck. Her excellent article entitled "Discovering the Archaeology of Tattooing," published by *American Archaeology*, was an amazing article on a seldom explored topic. She covered the topic with an engaging style that united different strands of a worldwide phenomenon into a coherent whole.

SAA Student Poster Award

NICOLETTE EDWARDS

Nicolette Edwards has earned the 2019 SAA Student Poster Award for her research, "Croxton Site Faunal Assemblage: Pre- and Post-Deposition Disturbance Analysis." Nicolette's work examines the past behaviors and processes that have impacted this particular faunal assemblage, incorporating several geoarchaeological, experimental, and taphonomic concepts. She specifically examined the evidence for blood letting, burning, warping, and weathering, linking the traces on the bones to each of these potential processes. Her work not only helps to better understand this particular site and assemblage but has broader applications to interpreting faunal assemblages and how we identify past behavior and natural site formation processes during analysis and interpretation.

SAA Student Paper Award

MEAGAN DENNISON

Meagan E. Dennison's paper "Stable-Isotope Analysis and Dental Micro-Wear Texture Analysis of Domestic Dogs from the Tennessee River Valley" integrates well established (stable carbon and nitrogen analysis) and novel (dental micro-wear texture analysis) applications of archaeological science to answer a social question: the changing diet and role of dogs among communities the Tennessee River Valley. The thoughtful and well-argued integration of analyses to address a question of broad relevance to human societies across time and space renders this study a most worthy winner of the 2019 SAA Student Paper Award.

Ethics Bowl

UNIVERSITY OF KENTUCKY

The University of Kentucky team members are Gertrude Kilgore, Daniel Vallejo Cáliz, Gabriela Montero Mejía, Alberto Ortiz Brito, and Elizabeth Straub. Their coach is Scott Hutson.

Dienje Kenyon Memorial Fellowship

WERONIKA TOMCZYK

Weronika Tomczyk is the recipient of this year's Dienje Kenyon Memorial Fellowship. She received her BA and MA degrees from the University of Warsaw, Institute of Archaeology, and is currently a PhD student at Stanford University. Her project is focused on assessing whether bone assemblages within Wari Empire archaeological sites were the result of a strict imperial economic policy, an adaptable policy which depended on existing local situations and environmental conditions, or a fusion of influences from multiple societies with variable acceptance of Wari cultural traditions. Wari's unprecedented conquest of a large part of the Andean world may have been motivated not by an interest in gathering power or spreading their particular religious beliefs, but rather by the acquisition of new natural resources, perhaps insufficient in their Ayacucho Valley heartland. To reveal information about animal management in Wari culture, she will combine standard zooarchaeological with stable isotope analyses and geometric morphometrics.

Fred Plog Memorial Fellowship

MEGAN ANNE CONGER

Megan Anne Conger's work investigates the nature and tempo of culture change of Indigenous and European worlds in Southern Ontario, Canada (ca. AD 1550–1650). Her work asks: Did all Indigenous nations in Ontario begin to engage with Europeans at the same time, in the same way, and how did this relationship change over time? She will answer these questions by applying archaeological science techniques to the Wendat, Tionontate, and Attiwandaron archaeological sites in Southern Ontario occupied ca. AD 1550–1650. Here she will create chronologically grounded community level databases to better understand Indigenous-European trade and exchange in Southern Ontario and Southern Québec. Her work is a reassessment of 16th & 17th C normative models of culture change that have dominated Iroquoian archaeology for the last forty years.

Paul Goldberg Award

CAYLA D. KENNEDY

For her project developing a model of Late Holocene alluvial cycles at Cub Creek, Dinosaur National Monument, Utah that will be widely applicable across the Uinta Basin's Fremont farming localities, we proudly present the 2019 Paul Goldberg Award for master's research in Earth science and archaeology to Cayla Kennedy (Utah State University).

Douglas C. Kellogg Award for Geoarchaeological Research

JACOB P. WARNER

For his project developing the bivalve, *Donax obesulus*, as a proxy for El Niño Southern Oscillation dynamics in archaeological contexts in north-central coastal Peru.

SAA/Institute for Field Research Undergraduate Student Travel Awards

REBECCA DOLAN

SASKIA GHOSH

ARTHUR WOLD

Charles Stanish SAA Annual Meeting Travel Award

DIANA CARHUANINA

Arthur C. Parker Scholarship for Archaeological Training for Native Americans and Native Hawaiians

JACQUE KOCER

SAA Native American Undergraduate Archaeology Scholarship

AKA BENDTSEN

Native American Graduate Archaeology Scholarship

A. LEIOKEKO'OLANI BROWN

Historically Underrepresented Groups Scholarships—Undergraduate

JAZMIN JONES

ARIANA ROBLES

Historically Underrepresented Groups Scholarships—Graduate

JENAIL MARSHALL

ASHLEY VANCE

Cheryl L. Wase Memorial Scholarship for the Study of Archaeology

APRIL BROWN

MARIAH MEDINA

SAMANTHA MORLEY

SORAYAH ROMERO

FIONA SHAFFER

SAA-Sponsored RPA Field School Scholarship

GREENLAND NATIONAL MUSEUM AND ARCHIVES: ARCTIC VIKINGS

H. and T. King Grants for Precolumbian Archaeology

ANAHÍ BANEGAS AND ARIADNA SVOBODA

DAVID M. CARBALLO

LILIANA MANZI

REBECCA MENDELSOHN (pictured)

Dissertation Award

HAO ZHAO

Hao Zhao's dissertation offers a comprehensive new understanding of economic institutions and relationships within early Chinese urban capitals previously studied primarily from a political or religious perspective. It offers a new synthesis of massive bone-working industries at the city of Zhouyan and employs a holistic, interdisciplinary approach that incorporates historical sources, art history, bone chemistry analysis, and a battery of zooarchaeological techniques. The bone industry workshops at sites like Zhouyan include, literally, tons of bone debris derived from the manufacture of millions of implements. Bone craftsmanship operated within patronage relationships with nearby elites. The bones of domestic animals, especially cattle, were acquired from diverse locations, attesting to webs of economic interdependency. Zhao also documents the animal ages and element representation linked to manufacturing trajectories. Bone hairpins represent the majority of items made at the workshops, which entered into complex consumption realms related to social status, adornment, and masculine and feminine identity.

Book Award: Scholarly (Connecting Continents: Archaeology andHistory in the Indian Ocean World)

KRISH SEETAH

Krish Seetah has produced an edited volume on a much neglected area in archaeology, the Indian Ocean World, a region that spans from southern Africa across the waters to Australia. He has brought together archaeologists, historians, artists, and other researchers who collectively increase our knowledge in a truly interdisciplinary fashion. Larger topics of colonialism, slavery, migration, heritage construction, climate change, economy, disease, and religion are presented by scholars from across the globe. Different types of evidence are used effectively through several approaches of understanding the past and relating the past to contemporary situations. Ecological considerations underlie various chapters on a wide range of topics. *Connecting Continents: Archaeology and History in the Indian Ocean World* makes a substantial contribution to anthropology, archaeology, history, and the Indian Ocean World. The author furthers our awareness of how this part of the world connects with other continents.

Book Award: Popular (A Future in Ruins: UNESCO, World Heritage, and the Dream of Peace)

LYNN MESKELL

Lynn Meskell has successfully produced a definitive book on UNESCO and its involvement in archaeology and the impact of the World Heritage designation. The historical context of this international organization and its influence on archaeology are illuminated through in-depth first-hand research, ample documentation, and insights that provide eye-opening revelations. The superbly written synthesis of massive amounts of materials is truly astounding. The successes and failures of UNESCO are many, and they continue today. *A Future in Ruins: UNESCO, World Heritage, and the Dream of Peace* positions archaeology in a larger, intertwined, and meaningful context. Politics, economics, and current events all factor into whether and how particular sites are deemed worthy of designation or investigation. It is a compelling read for archaeologists and those interested in our collective past.

Award for Excellence in Archaeological Analysis

JONATHAN MARK KENOYER

Jonathan Mark Kenoyer has earned the SAA's Award for Excellence in Archaeological Analysis for his detailed empirical analyses of a broad range of archaeological materials, guided by rigorous elemental and microscopic methods and an innovative interpretive framework grounded in

experimental and ethnoarchaeological approaches. His analyses of the morphology, production techniques, and styles of a wide variety of artifacts, including stone beads, inscribed seals, shell objects, textiles and cordage, ceramics, stone tools, and copper/bronze and iron materials have generated new insights into the social dynamics of South Asia's first urban, state-level society. His focus on the complex relationships among craft production and the social, economic, and political spheres in which it takes place provides an important method to examine the organizational dynamics of ancient states, especially when written records are unavailable. This award recognizes the significant global impact and enduring contributions of Dr. Kenoyer's research and teaching to archaeological analysis.

Award for Excellence in Cultural Resource Management

DUANE E. PETER

Duane is a graduate of Southern Methodist University and has been involved in cultural resource management for over 40 years. He joined Geo-Marine, Inc. (now part of Versar, Inc.) in 1987 as their first archaeologist. Thirty years later he retired from the company having built a program that included archaeologists, architectural historians, and GIS specialists in three primary offices. He promoted the development of innovative and cutting research techniques, including photogrammetry, 3D laser scanning, predictive modeling and remote sensing. He brought these techniques to projects in 45 states, the evaluation of over 2,000 archaeological sites and 700 Cold War-era resources, the survey of over 323,000 acres, and the preparation of over 900 technical reports. Duane built a CRM program known for excellence and quality research across the nation. Finally, Duane was a founding member of the American Cultural Resources Association and has helped guide the growth of that organization.

Award for Excellence in Curation, Collections Management, and Collections-based Research and Education

S. TERRY CHILDS

Dr. Childs has distinguished herself as one of the leading experts on national archaeological curation and collections management through numerous books and publications over the last twenty-five years. As Manager of the Department of Interior's Museum Program Terry inspired countless students and scholars across the United States and has made immeasurable and long-lasting contributions to the stewardship of our national archaeological collections. In her role as Chair of the SAA's Committee on Museums, Collections, and Curation, the Archaeological Collections Consortium, and as SAA Board Member she has promoted an "archaeological curation ethic" for the discipline. She is an inspiration to her colleagues and the profession.

Award for Excellence in Public Education

MAGIC MOUNTAIN COMMUNITY ARCHAEOLOGY PROJECT

Magic Mountain Community Archaeology Project (MMCAP) earned the 2019 Award for Excellence in Public Education for exemplary involvement of local communities in an archaeological research project. This was accomplished through a partnership between the Denver Museum of Nature & Science and Paleocultural Research Group under the direction of Drs. Michele Koons and Mark Mitchell. MMCAP stands out among community archaeology projects because of the impressive scope of its public programming: during the 2017 and 2018 field seasons 3,000 participants partook in thoughtfully designed programs. MMCAP not only invited the public to the site, but actively reached out and provided access to people who might not otherwise engage with archaeology. This included providing lunch and transportation for underserved youth groups, hosting a dedicated intertribal day, and creating Native American teen internships. MMCAP demonstrates best practices in how to stimulate the public's excitement for and understanding of the past through community archaeology.

Crabtree Award

PETER BOYLE and JANINE HERNBRODE

Peter Boyle and Janine Hernbrode have followed their passion as avocational archaeologists and conducted research to document, interpret, and preserve rock art sites in Arizona over the last 15 years, involving numerous volunteers from the Arizona Archaeological and Historical Society (AAHS). They have made significant contributions to our understanding and preservation of rock art of the American Southwest through their research, scholarly publications

(15) and conference presentations, and have promoted archaeology as executives for the AAHS and Archaeology Southwest. Since 2009, Dr. Boyle and Ms. Hernbrode have engaged tirelessly in collaborative archaeological survey and site documentation and publication, creating an inventory of thousands of rock art features in southern Arizona. Peter Boyle and Janine Hernbrode are highly deserving of the Crabtree Award for their exemplary archaeological teamwork that engages both the interested public and professional archaeologists.

Fryxell Award for Interdisciplinary Research

M. STEVEN SHACKLEY

The Fryxell Award is presented in recognition for interdisciplinary excellence of a scientist whose research has contributed significantly to American archaeology. For the 2019 award the category was Physical Sciences. Because of a career-long devotion to obsidian studies in the American Southwest that has included decades of fieldwork to document the geological landscape, multiple high-caliber books on the method, theory, and application of obsidian studies, and exemplary service to his professional colleagues, M. Steven Shackley has been selected as the Fryxell Award recipient.

Lifetime Achievement

LYNNE G. GOLDSTEIN

Lynne G. Goldstein has earned the SAA's Lifetime Achievement Award for her combination of scholarship and service to the profession. Dr. Goldstein's superb contributions to mortuary studies have moved this area of study beyond its early focus on reconstructing prehistoric social organization to more nuanced understandings of identity and variability. She also has made significant contributions to Midwestern and historic archaeology, and her advocacy for public engagement with archaeology has had a significant impact on the profession. She has excelled as a teacher and trainer of archaeologists. Beyond her own students, she has mentored hundreds of other anthropologists through her annual careers workshop at the AAA meetings. Moreover, Dr. Goldstein's service to the SAA, including the Task Force on Repatriation, Secretary, editor of *American Antiquity*, co-chair of the Task Force on Gender and Research Grants Submission, and chair of the SAA Publication Committee, has been recognized by five Presidential Recognition Awards—certainly a record!

SAA 2020 Call for Nominations

The 2020 Nominating Committee of the Society for American Archaeology requests nominations for the following positions:

President-elect
(2020–2021) to succeed to the office of President (2021–2023)

Secretary-elect
(2020–2021) to succeed the office of the Secretary (2021–2023)

Board of Directors member
Position 1 (2020–2023), replacement for current member, Jane Eva Baxter

Board of Directors member
Position 2 (2020–2023), replacement for current member, Dawn Rutecki

If SAA is to have effective officers and a representative Board, the membership must be involved in the nomination of candidates. Members are urged to submit nominations and, if they so desire, to discuss possible candidates with the 2020 Nominating Committee Chair Diane Gifford-Gonzalez (SAA.Nominations.Chair@gmail.com).

Please send all nominations, along with an address and phone number for the nominated individual, to:
Chair, 2020 Nominating Committee
Diane Gifford-Gonzalez, SAA.Nominations.Chair@gmail.com

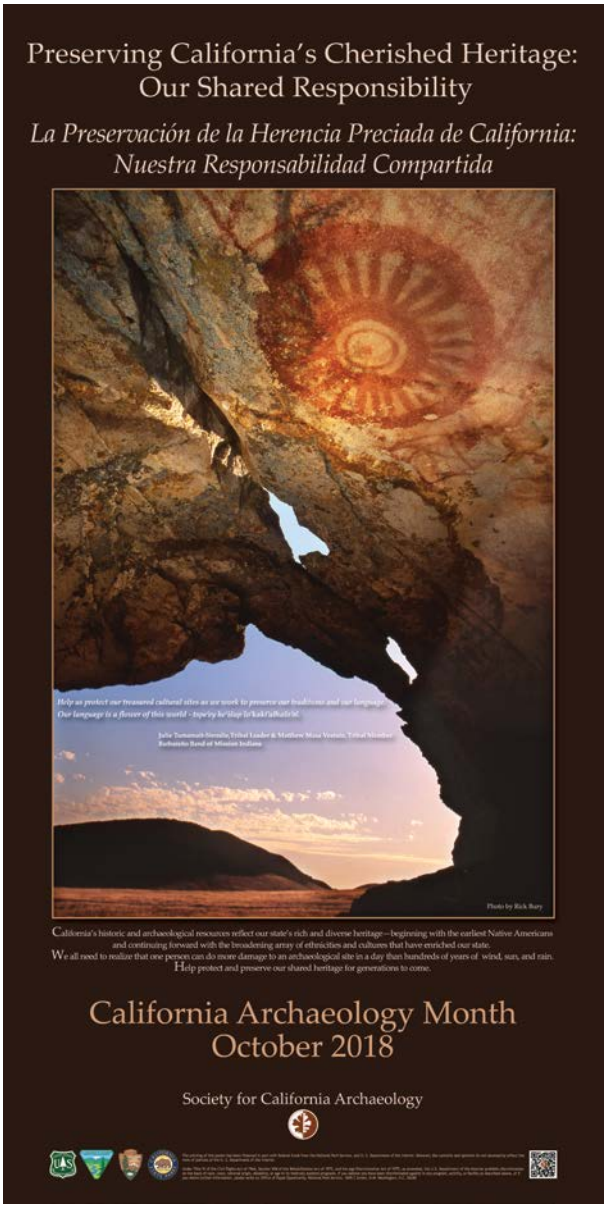
Please note that nominees must be current members of SAA. Nominations must be received no later than July 31, 2019.

2019 State Archaeology Celebration Poster Awards

FIRST PLACE: ALASKA

SECOND PLACE: WYOMING

THIRD PLACE: CALIFORNIA



CEREMONIAL RESOLUTIONS

The Resolutions Committee offers the following resolutions:

Be it resolved that appreciation and congratulations on a job well done be tendered to the

Retiring OFFICERS
President Susan M. Chandler
Secretary Emily S. McClung de Tapia

and the retiring **BOARD MEMBERS**
Patricia Garcia-Plotkin and Luis Jaime Castillo

To the Staff, and especially to Oona Schmid, the Executive Director, who planned the meeting, and to all the volunteers who worked at Registration and other tasks;

To the **Program Committee**, chaired by
E. Christian Wells

and to the other 48 **Committee Members of the Program Committee**
AND
To the **Annual Meeting Local Advisory Committee**, chaired by
Matthew Schmader

And to other **committee chairs and members completing their service** and to the many

members who have served the Society on its committees and in other ways;

And sincere wishes that those members of the society who are now serving in the armed forces return safely.

Will the membership please signal approval of these motions by a general round of applause.

And be it further resolved that thanks again be given to those who inform us of the deaths of colleagues, and finally,
A resolution of sympathy to the families and friends of

Michael Riddle	Janet Elizabeth Rafferty	Wendy Ashmore
Michael Harner	Micahel E. Roberts	Martin Biskowski
George Cowgill	Willow Powers	Steve Daron
Rick Turner	Saul Hedquist	Robert Powers
David Fraley	Nancy Patterson Troike	Jon Young
G. William Monaghan	Joseph Luther	Pete Mehringer
Stewart Peckham	Jamie Chad Brandon	Patricia J. O'Brien

Will the members please rise for a moment of silence in honor of our departed colleagues.
Respectfully submitted,
Dean Snow
on behalf of the Resolutions Committee,
April 12, 2019

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Society For American Archaeology
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CALL FOR SUBMISSIONS

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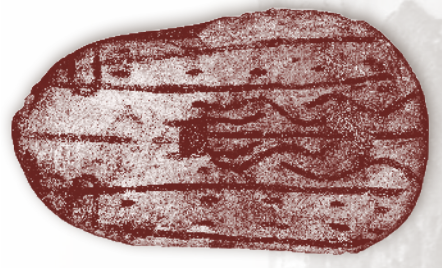
85th Annual Meeting

April 22–26, 2020 • Austin, TX



The 2020 Submission Guidelines are now available at www.saa.org/submissions

The Guidelines contain detailed information on submission policies and requirements. Here you can find information about the roles and submissions formats available, read a letter about the meeting from SAA's President, and access the online submissions system. We hope you will participate in SAA's 85th Annual Meeting!

QUESTIONS?
E-mail us at **meetings@saa.org** or call us at **+1 (202) 559-7382**

Submissions deadline is 3 p.m., September 5, 2019