

Fostering synthesis in archaeology to advance science and benefit society

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In 1966 the US Congress passed the National Historic Preservation Act. Its intent: to ensure that the values embedded in historic buildings, archaeological sites, and other important places of the past honored all Americans in ways that would inspire and motivate present and future generations. In the intervening 50 years, archaeologists have diligently discovered, documented, analyzed, and curated our collective past.

However, this rich store of data has untapped potential beyond documenting long-term trajectories of numerous human societies. Archaeological data can be key to expanding scientific understandings of human social dynamics, redressing injustices of the past, empowering local and descendant communities, and aiding in the formulation of solutions to contemporary problems. Collaborative synthetic research, as practiced in ecology and other sciences, has been a powerful driver for advancing interdisciplinary science. But to utilize these advances, archaeologists, as a community, need a means to bring disparate datasets together and interpret them. This entails creating a vehicle by which collaborative synthetic research becomes a routine and institutionalized practice in archaeology—a budding effort we call the Coalition for Archaeological Synthesis. It's an initiative that will not only benefit the discipline but will also enable researchers to communicate to the public the richly detailed stories of humanity itself.

A Problem of Some Complexity

Many nations have laws protecting cultural heritage, and as a result, archaeologists have access to far more data than ever before. In the United States alone, since the federal government started keeping systematic records in 1985, archaeologists have surveyed more than 140,000,000 acres, recorded more than 880,000 archaeological sites and excavated more than 35,000 of them, curated more than 900,000,000 artifacts and related items (1), and spent tens of billions of dollars (2). In the United States, archaeological investigations are



Fig. 1. Public support can expand archeological finds and help tell the stories of people and places. Here, archaeological surveyors work in the Western Papagueria of Arizona. After laws protecting archaeological sites were passed in 1966, the number of recorded sites in the region ballooned from 100 to more than 2,000, which allowed researchers to document 10,000 years of human occupation in one of the hottest, driest parts of the United States.

overwhelmingly performed by private-sector firms to comply with historic preservation laws and mandates, whereas only a small proportion are projects funded by public or private research grants. This chasm is best highlighted by comparing the main provider of academic research grants, National Science Foundation's (NSF's) archaeology program, which has an annual budget of about \$15 million, with the annual \$1 billion estimate of US cultural resource management services, most of it on archaeology.

Even in the face of sustained, and recently heightened, attacks on National Monuments and environmental regulations that underlie protection of

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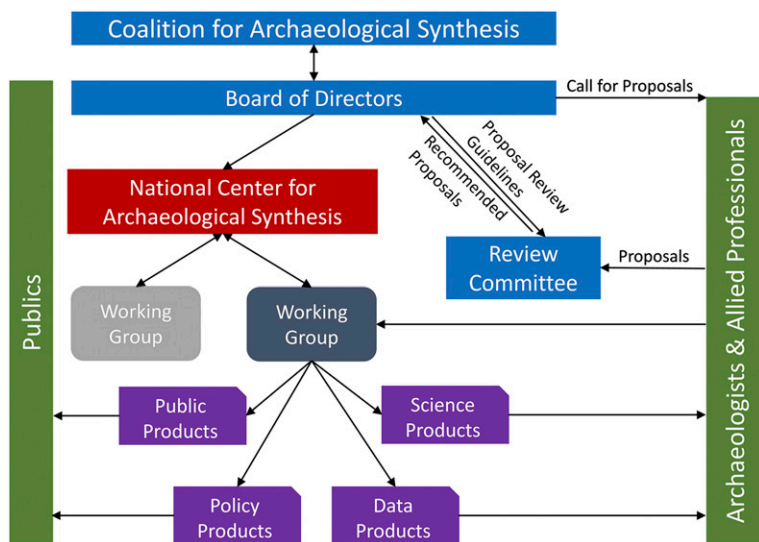


Fig. 2. The Coalition will evaluate and select proposals for funding, while the Center will facilitate working groups and help disseminate results to the scientific community and the public.

archaeological resources, public support for archaeology is strong and unwavering (3). In the latest Harris poll (2013) more than 90% of Americans agree that information from archaeological sites is critical for understanding humanity’s past and that more than 75% agree that the US government should do more to preserve archaeological sites and should provide additional funding for scientific research and site protection.

Underlying the public’s support is an implicit compact between archaeology and the public. That compact is composed of two elements: (i) archaeologists thoroughly document those components of the archaeological record that they investigate, and (ii) they share the knowledge gained in ways that benefit society (4). Archaeologists are certainly succeeding in accomplishing the first element, but few would argue they are accomplishing the second as effectively as they could.

Among the benefits that archaeologists should deliver to the public are rigorous, evidence-based narratives of what happened in the past and how these events shaped today’s world. Archaeology provides such narratives. The field is also uniquely positioned with its scientific approach and long-term perspective to develop knowledge about the operation of human societies, insights that can contribute to solving seemingly intractable contemporary problems.

For example, the vulnerability of human societies to a climatic or other environmental disturbance is a function not only of the nature and magnitude of the disturbances but also of the resilience of different societal configurations (institutions, policies, and practices). Archaeologists have documented the role humans play in building social systems over long periods; these, in many cases, exacerbate rather than mitigate the effects of disturbances, and in doing so prevent people from responding effectively to them (5, 6). Understanding this relationship can inform present decision making, which

is today based on historical data of a few hundred years at best. Archaeological input may also inform why and how social inequalities emerge, grow, and diminish, as well as the role of conflict in the evolution of complex cultural formations (7).

Accomplishing transformative research requires archaeologists to do more than analyze and interpret data on a project-by-project basis; they also must synthesize the large databases resulting from numerous projects into scientific knowledge of value to society. Although synthetic research is not new to archaeology, the research needed to address the pressing social issues of today transcends archaeology and reaches into the domains of other social, computational, and natural sciences. Collaborative synthetic research would also help open up relevant archaeological and paleoenvironmental data collected during archaeological projects to other scientists, realizing the potential of archaeological records to serve interdisciplinary research (8, 9).

Collaborative Synthesis

It is essential that archaeologists continue to discover and document endangered cultural heritage and pursue problem-oriented field research. However, it is equally important that archaeologists devote much more effort to accessing, analyzing, and comparing disparate data sets to produce explanations and insights about human behavior that could never emerge from the analysis of individual projects. In collaboration with scientists in other disciplines, archaeologists need to conduct synthetic research that enjoys institutional and infrastructural support beyond what could be accomplished through grant-funded initiatives at individual universities or research institutes. But how?

The field of ecology grappled with similar problems in the 1990s and came to an innovative solution. In 1995 the National Center for Ecological Analysis and Synthesis (NCEAS) was established, supported largely by NSF funds. The goal of NCEAS was not only to make transformative advances on major issues confronting ecology and society but to make these advances quickly (10). In essence, NCEAS strives to speed up the scientific process of synthesis.

To do so, NCEAS brings together 8 to 15 people from different fields, at different career stages, and with different life experiences, and joins them as a team to produce results that transcend their individual talents, skills, and expertise. Each team attacks a problem (proposed by the leaders of the team and approved by the NCEAS steering committee) and has 2 to 3 years to work on the problem. Over that time, the team meets at NCEAS three or four times for intense collaborative research sessions of 5 to 10 days. In between, team members continue collaboration remotely. The working groups integrate multiple sources of data and different perspectives to generate explanatory insights that are impossible to achieve through the study of a single case or from a single perspective. For example, one NCEAS working group drew together researchers from academia, federal agencies, and the nonprofit sector to assess the state of global fisheries (11), whereas another integrated diverse data to calculate the total value of the

earth's ecosystem services (12). By any measure, NCEAS has been extremely successful (13), and its model has been copied wholly or in large part in a number of scientific fields (e.g., the National Evolutionary Synthesis Center, the National Socio-Environmental Synthesis Center, and the National Institute for Mathematical and Biological Synthesis).

Although archaeology has never tried an NCEAS-type approach, several intensive, multiyear, multiinvestigator, NSF-funded, archaeology-focused projects (6, 14, 15) illustrate the power of a team-oriented synthesis for the field. In these cases, success entailed integrating large amounts of primary data from multiple sources and with collaboration of researchers from different fields who worked together from research design to interpretation. These projects achieved remarkable results.

For example, across several archaeologically documented cases Nelson and her coauthors (6) assessed the societal vulnerability to food shortage before a challenging climate event and found a consistent relationship with the severity of its observed impact. Mills et al. (14) showed how population aggregation and long-distance migration reshaped social networks across large areas of the late pre-Hispanic US Southwest. Combining an interdisciplinary analysis of large amounts of data with agent-based modeling, Kohler and his colleagues (15) revealed how climate change, population size, interpersonal conflict, resource depression, and changing social organization explain the dramatic depopulation of the Mesa Verde region of Southwestern Colorado in the mid-to-late AD 1200s. Similarly, the European Research Council Synergy project, Nexus1492, was a collaborative, multidisciplinary project focused on Amerindian-European-African dynamics at different spatial-temporal scales across the 1492 divide, resulting in locally inspired, evidentially based heritage-management strategies (16).

Characteristically, these synthetic projects were expensive and regionally focused, and each had to work out, for itself, how to find, transform, and analyze large, complex datasets. We see the next logical step to be development of institutionalized support for collaborative synthetic research. Such an effort should leverage data from multiple cultures and from multiple spatial and temporal scales to address important social issues and problems.

Coalition for Archaeological Synthesis

For reasons both of potential funding and of archaeology's history and culture, we propose, and have started to implement, the NCEAS approach using a "bottom-up" structure predicated on two new, linked institutions: the Coalition for Archaeological Synthesis and the National Center for Archaeological Synthesis (NCAS). The Coalition will use the expertise, services and facilities of existing US and international organizations that are committed to promoting synthesis. The Coalition will be open to all institutions interested in partnering to support archaeological synthesis. These include universities, museums, professional organizations, and nongovernmental organizations as well as government agencies and private cultural resource

management firms. The Coalition's Board of Directors, to be elected from the member organizations, will solicit working group proposals, set the review criteria, and establish a broad-based Review Committee that will evaluate the proposals and recommend working groups for funding.

NCAS will coordinate the efforts of the Coalition. The NCAS host university will house the Center's Executive Director and small staff and will supply administrative and logistical support. With the assistance of the Board and other members, NCAS will seek funds to support the working groups' efforts. NCAS will administer the funding; provide guidance on working group leadership, structure, and operation; as well as coordinate logistical, analytical, and computational support for the individual working groups. Assisted by its partner organizations, NCAS will ensure that the results of the Coalition's research are disseminated in ways that affect both academic research and public policy and that reach descendant communities and other segments of society.

Unlike NCEAS, we do not envision a single locus for meetings. Instead, we intend to leverage the long history of seminars hosted by potential Coalition member organizations, such as the Amerind Foundation or the School for Advanced Research, to provide

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the facilities for teams to meet and advance their research topics. Key cyberinfrastructure support can be provided by other Coalition members that now supply these services, such as Digital Antiquity, the Archaeological Data Service, Open Context, and the Network for Computational Modeling in Social and Ecological Sciences. (All of the above institutions have, through personal correspondence, expressed interest in participating in the Coalition.)

From Concept to Reality

This fall, the Coalition will be formally established. Presentations on collaborative synthesis are scheduled at national and international meetings (17) accompanied by invitations to join the Coalition. Simultaneously, the SRI Foundation, which will serve as the interim host for NCAS, has committed to funding two proof-of-concept working groups. A Review Committee has been established and a request-for-proposal developed, which is scheduled to be released in October 2017 (18) with an award date in early 2018. As these demonstration projects proceed, we expect NCAS will make the transition to a host university that will provide some core support (e.g., for an Executive Director and core staff).

Although start-up funding and administrative support has been secured from the SRI Foundation, additional support for NCAS, and program funding for

the Coalition's synthesis working group efforts, will be sought from multiple sources, including private foundations and individual donors. We will seek program funding for synthesis working groups from the NSF, which has a record of funding major synthetic research projects. In addition, we anticipate support from heritage-management mitigation projects from United States and other national federal agencies as well as international organizations, such as the European Union.

We believe this effort can succeed despite the current administration's apparent hostility toward science and congressional efforts to defund social science over the last several years. Unlike NCEAS and other synthesis centers, we have laid out a path by which the establishment of the Coalition and NCAS are not premised on a large and continuing outlay of federal monies.

Although we are convinced that we are on the right path, we realize that there are major challenges ahead. As students of culture, we know that cultures, including that of archaeology, are resistant to change. If successful, the Coalition will be a major impetus that moves archaeological synthesis from a reliance on individual synthesizers to teams that emphasize collaborative scholarship. Although this transformation is already underway on the project level, to achieve archaeology's potential and to fulfill our end of the public compact, it must be given an institutional foundation.

The success of the Coalition will be measured by how well evidentially based arguments involving archaeology address who we are as a diverse, multicultural

society while at the same time confronting the challenges facing our society today. Collaborative synthetic research in archaeology will illuminate the long-term trajectories associated with alternative societal solutions to problems that humanity has repeatedly faced, such as healing the wounds of slavery and colonialism or adapting to a hotter and drier climate. In this way, contemporary society can benefit from a global set of completed, long-term social experiments.

To succeed, collaborative synthetic research must be embraced not just by archaeologists, but it must incorporate other members of the scientific community and must address issues of concern to civil society. Applied and academic archaeologists need to be equal partners in this endeavor. Members of descendant communities must be engaged as cultural experts. Information regarding complex issues must be conveyed to policy makers and the general public in clear and understandable language. This is a tall task, and none of it will be easy. But for archaeology to move effectively beyond project-by-project interpretation to synthesis, all of it is necessary.

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- 1 National Park Service Archeology Program (2017) 2017 Secretary of the Interior's Report to Congress on Federal Archeology. Available at <https://www.nps.gov/archeology/SRC/index.htm>. Accessed February 26, 2017.
- 2 Altschul JH, Patterson TC (2010) Trends in employment and training in American archaeology. *Voices in American Archaeology*, eds Ashmore W, Lippert DT, Mills BJ (SAA Press, Washington, DC), pp 291–316.
- 3 Archaeological Institute of America (2013) Poll shows strong public support for archaeology and robust opposition to site looting and artifact smuggling. Available at <https://www.archaeological.org/sites/default/files/files/AIA%20Study%20Data%20Final%20May%202014.pdf>. Accessed August 17, 2017.
- 4 Altschul JH (2016) The role of synthesis in American archaeology and cultural resource management as seen through an Arizona lens. *J Ariz Archaeol* 4:68–81.
- 5 Nelson MC, et al. (2012) Long-term vulnerability and resilience: Three examples from archaeological study in the southwestern United States and Northern Mexico. *Surviving Sudden Environmental Change: Answers from Archaeology*, eds Cooper J, Sheets P (University of Colorado, Boulder, CO), pp 197–221.
- 6 Nelson MC, et al. (2016) Climate challenges, vulnerabilities, and food security. *Proc Natl Acad Sci USA* 113:298–303.
- 7 Kintigh KW, et al. (2014) Grand challenges for archaeology. *Proc Natl Acad Sci USA* 111:879–880.
- 8 d'Alpoim Guedes JA, Crabtree SA, Bocinsky RK, Kohler TA (2016) Twenty-first century approaches to ancient problems: Climate and society. *Proc Natl Acad Sci USA* 113:14483–14491.
- 9 Sandweiss DH, Kelley AR (2012) Archaeological contributions to climate change research: The archaeological record as a paleoclimatic and paleoenvironmental archive. *Annu Rev Anthropol* 41:371–390.
- 10 Hackett EJ, Parker JN, Conz D, Rhoten D, Parker A (2008) Ecology transformed: The National Center for Ecological Analysis and Synthesis and the changing patterns of ecological research. *Scientific Collaboration on the Internet*, eds Olson GM, Zimmerman A, Bos N (MIT Press, Cambridge, MA), pp 277–296.
- 11 Worm B, et al. (2009) Rebuilding global fisheries. *Science* 325:578–585.
- 12 Costanza R, et al. (1997) The value of the world's ecosystem services and natural capital. *Nature* 387:253–260.
- 13 Carpenter EV, et al. (2009) Accelerate synthesis in ecology and environmental sciences. *Bioscience* 59:699–701.
- 14 Mills BJ, et al. (2013) Transformation of social networks in the late pre-Hispanic US Southwest. *Proc Natl Acad Sci USA* 110:5785–5790.
- 15 Kohler TA, Varien MD, eds (2012) *Emergence and Collapse of Early Villages: Models of Central Mesa Verde Archaeology* (University of California, Berkeley, CA).
- 16 Hofman CL (2015) The Caribbean challenge. *Fernweh: Crossing Borders and Connecting People in Archaeological Heritage Management*, eds van den Dris M, van der Linde S, Strecker A (Sidestone Press, Leiden, Netherlands), pp 105–109.
- 17 Altschul JH, Kintigh KW (2017) Fostering synthesis in archaeology. *Proceedings of the Twenty-third Annual Meeting of the European Association of Archaeologists, Maastricht, Netherlands*, eds Bazelmans J, Klinkhamer Group (Schrijen-Lippertz, Voerendaal, Netherlands), p 198.
- 18 SRI Foundation (2017) SRI Foundation to Fund Two Collaborative Synthetic Projects, Fall 2017. Available at www.srifoundation.org. Accessed August 17, 2017.