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Innovation through Large-Scale Integration of Legacy Records: Assessing the “Value Added” in Cultural Heritage Resources

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Using the Chaco Research Archive (CRA) as a case study, in this article, we discuss the spectrum of intellectual decisions: conceptualization, design, and development, required to make legacy records (accumulated over many years through numerous archaeological expeditions) publicly accessible. Intellectual and operational choices permeated the design and implementation of the digital architecture to provide internet access to the vast information structures inherent in legacy records for the cultural heritage of Chaco Canyon, New Mexico. We explore how an expansive but focused repository can enable opportunities for research and foster communities of co-creation. We also use the CRA as a case study to outline some of the pitfalls of conventional academic metrics for scholarly impact and provide some alternative means to assess the value of digital heritage resources.

CCS Concepts: • **Applied computing** → **Archaeology**; **Anthropology**; *Digital libraries and archives*; *Document metadata*; • **Information systems** → *Relational database model*; *Ontologies*;

Additional Key Words and Phrases: Chaco Canyon, New Mexico, archaeology, slow data

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1 INTRODUCTION

The infrastructures we build in the digital heritage sector are often presumed to simply arrange information packets to make them all available to diverse user groups. The intellectual and technological labor required to accomplish those aims, however, is largely invisible to the scholar accessing the information who may not comprehend the layers of conceptualization, design, and development involved and, thus, implicitly assume that the methods of integrating such heterogeneous resources were self-evident and the computational processes straightforward. In addition, incidental or narrow-question-motivated access of the information architecture may not expose the vast opportunities for research and for fostering communities of co-creation. These dynamics of

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perception are potently revealed in the U.S. academic sector, where such project collaborations often confound traditional evaluation mechanisms based on authorship of conventional scholarly products. As a result, digital heritage projects add a new level of complexity to promotion and tenure decisions where few institutions have guidelines that explicitly account for digital heritage contributions. This is further complicated by conventional measures of scholarly impact and metrics that often fail to capture such research contributions. Fortunately, numerous digital heritage professionals are in the process of educating the broader field of cultural heritage practitioners and funding agencies to acknowledge the labor and necessity of “slow data” (Kansa 2015), “slow archaeology” (Caraher 2013, 2016), and “virtual reunification” (Punzalan 2014). But there is still much to be done to reveal the “value added” factors for all levels of our work: research, conservation, management, education, and communication, ensconced within large-scale digital cultural heritage applications.

Our contribution to this theme issue has three primary aims: First, we discuss the spectrum of intellectual decisions: conceptualization, design, and development, required to make legacy records (accumulated over many years through numerous archaeological expeditions) publicly accessible. Second, we explore how a focused digital heritage resource can enable vast opportunities for research and foster communities of co-creation. And, finally, we explore some alternative means to assess the intellectual impact, and thus importance, of such cultural heritage resources.

1.1 Background

Chaco Canyon, New Mexico, was extensively settled by the ancestors of contemporary Pueblo people. Today, its widespread sphere of prehistoric influence is arguably one of the most important archaeological regions in North America. Chaco is recognized as a National Park, a UNESCO World Heritage Site, and the greater Chacoan landscape in modern-day New Mexico was recently designated one of America’s most endangered historic places by the National Trust for Historic Preservation (2011). For over a century, this chapter of human history has received attention from archaeologists to both understand how Pueblo societies of the Southwest changed over time and as broader a laboratory for understanding the genesis, evolution, and collapse of chiefly societies.

Between 800 and 1100 C.E., a profound social transformation took place in Chaco Canyon, resulting in unprecedented construction of massive masonry buildings or great houses all located within a dense and central “downtown” precinct. Seventeen multi-story great houses (50–650 rooms) along with numerous great kivas (circular communal structures) were erected within a crowded nine-mile stretch of the canyon. These large structures were surrounded by hundreds of more modestly built small houses along the Chaco Wash. Research in recent decades has connected this apparent core of great house and small house sites in Chaco Canyon to an expansive network of roads and approximately 290 outlying great house communities over an 110,000 km² area of the northern Southwest. Material signatures of the Chacoan culture or its influence can be found across the Four Corners states (Colorado, New Mexico, Arizona, and Utah) in an area as large as Ireland. During the peak of its florescence, canyon inhabitants participated in long-distance trade networks to obtain materials such as shell, turquoise, macaws, and, as has been recently shown, cacao (or chocolate) (Crown and Hurst 2009).

Artifacts recovered from Pueblo Bonito, one of the largest great houses in the canyon, also indicate diverse ceremonial practices. These include musical instruments such as flutes, conch-shell trumpets, whistles, rattles and bells; ritual offerings of carved wooden staffs, feathered prayer sticks, cylinder jars and ornaments; costumes including tablitas, feather robes, and tinklers; and preferential burial practices for some elite individuals (Plog and Heitman 2010). Today, 27 American Indian tribes in the Southwest consider the ruins of Chaco Canyon to be sacred ancestral sites and are represented on the Chaco Culture National Historical Park tribal consultation board.

2 BUILDING THE ARCHIVE

Given the evocative nature of this place, it is perhaps not surprising that Chaco Canyon also has one of the longest histories of archaeological research in the Americas with initial professional studies dating to 1887. For almost 125 years, archaeologists have struggled to understand the origins, evolution, and decline of this

unprecedented scalar transformation in Puebloan society. The Chaco Research Archive (CRA, chacoarchive.org) was designed from the outset in 2003 with very specific research questions in mind with regard to the Prehispanic history of Chaco Canyon. Because of its delimited purview, projects such as ours have at times been criticized as data silos—disconnected from the broader digital heritage cyberinfrastructure (Kansa 2010). Other critiques center on concerns over project sustainability or fears of proliferating metadata standards and ontologies. The contributions to this journal issue show we are now moving beyond the perspective of a zero-sum game where the gains of smaller digital heritage projects are seen as a cost to larger cyberinfrastructure projects. As we will endeavor to show, the focused purview of the CRA is precisely what allowed us to succeed in achieving our project goals and continue to grow in various productive directions. Such a model is not a uniform solution for cultural heritage needs, but, as we will argue, this model can be productive and nimbly responsive to diverse communities of use and facilitate communities of shared interest.

The CRA is an online research portal and analytical database that allows the scholarly community and the public at large to access the widely dispersed archaeological data collected from Chaco Canyon, New Mexico, over the past 125 years. The products available through chacoarchive.org are all based on a University of Virginia-built¹ PostgreSQL relational database with a Ruby on Rails application framework. The CRA online database contains over 100,000 searchable records built from archival sources—integrating architecture, artifact, survey, and excavation data into a sophisticated research tool. By providing access to a wealth of archaeological data, this resource creates new possibilities for synthetic research and allows for interpretation over temporal and spatial scales not practical before. For example, the archive contains over 18,000 historic photographs of the original excavations and has made them available online. Scholars can also search over 31,000 artifact records from different sites and construct cross-table queries enabled by the relational database structure. Tree-ring dates and records from site stabilization activities are available as well as over 10,000 original documents that can be accessed as PDFs. Almost all query results can be downloaded in the form of spreadsheet files for individualized analysis.

In July of 2003, the Chaco Research Archive (formerly the Chaco Digital Initiative) began with an Andrew W. Mellon Foundation grant awarded to Stephen Plog, Richard Leventhal, and a group of a dozen scholars (our original steering committee²) to support the creation of a digital archive of material from five key sites in the Chaco Canyon region. These sites included two great houses (Pueblo Bonito and Aztec West) as well as three small house sites (Bc 50, Bc 51, and Bc 53) (for site locations, see <http://www.chacoarchive.org/cra/chaco-sites/>). The intent was to assist scholars endeavoring to answer some of the most significant questions regarding Chacoan history. At the initial meeting in 2002, the steering committee agreed that many of the key issues regarding Chaco—its role in the broader Southwest, the nature of the culture transformation from ubiquitous small farming villages to a combination of small villages and large architectural complexes such as Pueblo Bonito, as well as more basic questions such as room function and great house population levels—demanded an improved understanding of how great houses and small houses functioned in Chaco Canyon. What were the similarities and differences in the social, religious, and economic roles of the Chacoan great houses and the contemporaneous small house sites? And what were the similarities and differences among the great houses themselves? The lack of detailed information on individual rooms within the large Chacoan pueblos, for example, hindered systematic evaluation of the resident populations.

To help resolve these debates, the goal of the CRA has been to build detailed room-by-room catalogs of materials and features discovered during early excavations at key Chacoan sites and to provide access to field notes, unpublished manuscripts, photographs, field drawings, and other resources held in institutional repositories around the country. Until now, anyone interested in the early excavation data from Chaco Canyon had to travel

¹Institute for Advanced Technology in the Humanities, <http://www.iath.virginia.edu/>.

²Original Chaco Digital Initiative steering committee members included Wendy Bustard, Linda Cordell, Dabney Ford, Jillian Galle, Jim Judge, John Kantner, Richard Leventhal, Worthy Martin, Joan Mathien, Fraser Neiman, Steve Plog, Kim Tryka, Gwinn Vivian, and Wirt Wills.

hundreds or thousands of miles to over a dozen repository institutions, thereby hindering the productive use of curated collections and legacy resources.

3 COLLABORATION

Creating the archive involved a host of collaborations among 15³ anthropological museums and federal agencies to re-associate objects and excavation contexts with their documentary records and make that information publically available. This process required several iterative stages. The first stage involved creating an inventory database that could track archival sources so we could record, for example, that an 1896 Hyde Exploring Expedition specimen log was located in folder 3, of box 24, in the George Pepper collection at Tulane University's Latin American Library. The second stage of the project required extensive travel to key repositories to locate and record the locations of important intellectual resources in collections around the country. This process provided an unprecedented opportunity to build relationships with a broad network of Southwestern archaeologists, preservation specialists, and museum professionals.

During the third stage of the project, we prioritized intellectual resources and collaborated and negotiated with institutions to obtain digital surrogates of textual and photographic materials (e.g., [Figure 1](#)). This effort required creative solutions so project resources could be invested in a way that was mutually advantageous to the goals of the project as well as the preservation, access, and education missions of the respective institutions. In some cases, this meant altering our project design and reallocating resources where necessary. In other cases, we were delighted to find institutional collaborators willing to find creative solutions that actually lowered projected costs while helping attain specific preservation goals for entire collections.

In the fourth stage of the project, we designed an analytical database structure (integrated with our previous inventory database) that allowed us to extract archaeological observations and datasets and reassociate them with relevant contexts. This process required a design that could both capture original classifications and enrich those observations through analysis. For example, late-19th-century archaeologists like George Pepper would often describe contextual associations of artifacts and features within given cultural deposits in their field notes, but they were not necessarily excavating those distinct deposits as separate stratigraphic levels. To capture both the original excavation provenience and the descriptive differentiation of, for example, roof fall layers from intact floor contexts, we designed data tables that could capture both the original excavation provenience for all artifacts and features while also providing the "value added" differentiation of descriptive strata levels revealed in the historic records.

Once we had obtained digital surrogates of all relevant documents and images, the fifth stage was the most time intensive as it required us to devise a way of indexing, analyzing, and extracting key archaeological observations into relevant data fields so CRA analysts could then use that information. We needed to first inventory and then compare and synthesize all of the extant archival sources into normalized data fields for each defined excavation context (e.g., room). Here again we needed to carefully capture both original excavator observations without intrusion and provide normalized fields for things like room sizes converted to metric measurements and controlled feature type categories to enable more complete query results. For the images, this process required assigning standard and custom metadata values that would allow us integrate those digital resources into the analytical database structure (e.g., associating images with specific rooms). The sixth stage involved building a

³The American Museum of Natural History, Aztec Ruins National Monument, Chaco Culture National Historical Park, Chaco Culture NHP Museum Collection, Maxwell Museum of Anthropology, The Middle American Research Institute, Museum of Indian Arts and Culture & Laboratory of Anthropology, University of Colorado Museum of Natural History, Smithsonian Institution National Anthropological Archives, New Mexico History Museum, Smithsonian Institution The National Museum of the American Indian, Smithsonian Institution The National Museum of Natural History, Peabody Museum of Archaeology and Ethnology, Robert S. Peabody Museum of Archaeology, Center for Southwest Research at the University of New Mexico, Latin American Library at Tulane University

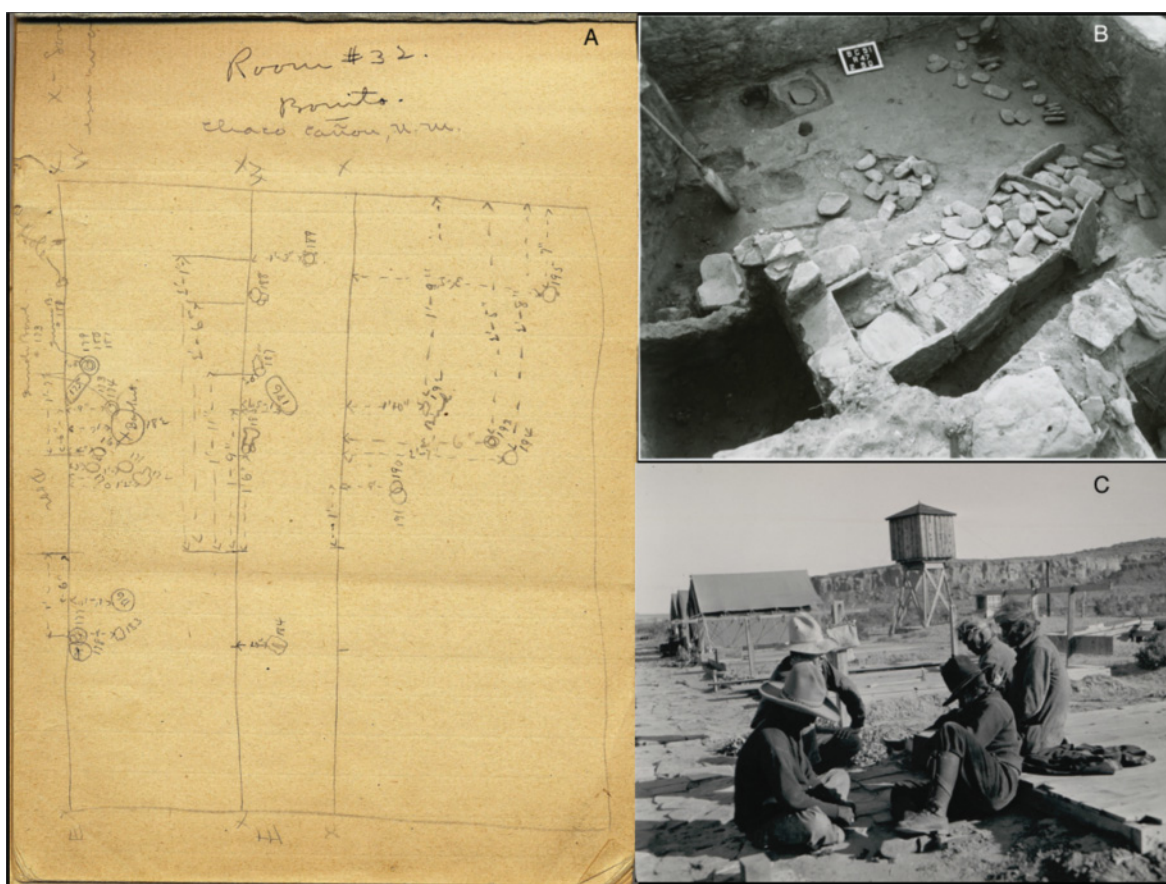


Fig. 1. A few examples of archival, legacy data sources contained in the Chaco Research Archive. (A) A page from George Pepper's field notebook (1896) for rooms 32 and 33 at the site of Pueblo Bonito showing locations and field numbers assigned to specific artifacts and features (CRA Accession 000157). Courtesy of the Division of Anthropology, American Museum of Natural History. (B) A 1950 photograph showing intact mealing bins and discarded (unrecorded) manos for corn grinding recovered from room 47 of site Bc 51. Ruins Stabilization Records 1933–1976. Courtesy of Chaco Culture National Historical Park, Ruins Stabilization Records 1933–1976, CC393. (C) Image from the 1927 National Geographic Expedition to Chaco Canyon showing the contexts under which archaeological interpretations were built in conversation with Native American interlocutors. Original Image Caption: "N.M.J. talking with old Wello & Padilla N.G.S. pueblo camp, Chaco Canyon, 1924 (?). K. Ruppert Neg. 2 Interpreters, foreground, Neg. 17." Neil M. Judd Collection. National Anthropological Archives, Smithsonian Institution judd_1921-27_064.

query interface that was both robust enough to address key research questions and provide tools to help educate the public. Last, we designed and built a website that would seamlessly integrate with CRA resources (Figure 2).

After completing these stages (Phase 1), the CRA was awarded a second Andrew W. Mellon Foundation grant in 2009 to expand the archive to increase the range of available legacy data to include additional historically excavated sites as well as data from modern survey projects. The three goals of Phase 2 were as follows: (1) To add information on two additional great houses to the existing Analytical Database, (2) to add information on four other unpublished excavations including three additional small house sites and an earlier village site known as Shabik'eshchee, and (3) to develop and expand the existing Analytical Database to incorporate non-excavation

The figure consists of two side-by-side screenshots from the Chaco Research Archive website. The left screenshot shows the 'Query the Database' interface, which features a search bar at the top and a grid of search filters for various data tables. The right screenshot shows the 'Chaco Sites' page for 'Talus Unit #1', which includes a photograph of the site, an interactive map, and detailed text sections for 'Site and Sites Data', 'Site Description', 'Site-Level Data', 'Excavation History', and 'Size and Dates'.

Fig. 2. Query interface for the Chaco Research Archive (left) (<http://www.chacoarchive.org/cra/query-the-database/>) and an example of a site page (Talus Unit #1) with interactive map capabilities (right) (<http://www.chacoarchive.org/cra/chaco-sites/talus-unit-1/>).

data on over 3,000 sites recorded during two comprehensive Chaco Culture National Park surveys. Incorporating these new data structures required us to again capture variability native to the legacy data sources while simultaneously creating semantic structures and ontologies that could hierarchically reconcile disparate classifications.

For example, during the 1971–1975 Chaco Project, survey teams were given a controlled vocabulary of site types they could use to classify sites on their site survey forms. As is common in handwritten formats, these site types tended to vary in actual usage. The site type “Sweat Lodge,” for instance, had numerous permutations on the site survey forms, including Sweat Lodge, sweatlodge, Sweatbath, Sweat bath, Sweat House, and sweathouse. To group these permutations under a single heading (as was originally intended by the project director Alden C. Hayes), the CRA team both transcribed all original text and introduced a normalized site type field. This was also done for site size, site area, min/max number of rooms, min/max number of kivas, min/max number of great kivas, and time period fields. All such fields are clearly designated with a “CRA” prefix in the Chaco Project site survey form data table to differentiate our interventions from the original data. Phase 2 was completed and made available online in 2012 thereby successfully extending the temporal scale of CRA records from the archaic to the historic period.

The CRA became a reality through a multi-phase process of design, implementation, collection, and curation. Details of that process have been discussed elsewhere (Martin et al. 2012), but it is important to note that the intellectual methodologies of selection, collaborative acquisition, data normalization, and organization have been crucial through all stages. Our ability to complete these two phases of work required explicitly bounding the goals of the project, untangling the complex histories behind various institutional collections, and building relationships with numerous repositories in ways that were mutually beneficial. Bringing these data to light in

a way that facilitates comparative analysis also required area experts and a cumulative knowledge of collection histories. In short, CRA's overall success in making legacy collections accessible, while staying responsive to the needs of our partners and collaborators, depended on establishing and holding to a limited purview for the project.

3.1 The Intervention of the Archive

The ethical and scientific imperative for museum collection use and reuse has steadily grown in anthropology over recent decades. But as scholars increasingly (re)turn to these legacy collections, there remains a parallel need to critically engage with the complex layers of selection and exclusion that characterize their life histories (Geismar 2012). The digital infrastructure for cultural heritage projects frequently result in web-based platforms and applications. Perhaps unwittingly, these products become part of our contemporary internet archive—even after a project “twilights.” But archives are problematic constructs; an archive of archives even more so. Derrida (1995) and Foucault (1970, 1977) have argued that we cannot escape from archival hegemony. Others have argued that archives can serve as “instruments of subversion” (Foucault 1980; Zeitlyn 2012). Archives are mediated at all levels, and in the case of the Chaco Research Archive we have taken scattered, mediated records and mediated them again for a specific purpose. While there can be no illusion of completeness in any archive, we can productively historicize the materials and probe aspects of bias and positionality revealed therein (e.g., Heitman 2017). Archives, as Zeitlyn (2012:475) contends, are surrogates for anthropology. In the case of the CRA, where the 19th- and 20th-century materials sometimes potently reveal historic racial, ethnic, and gender inequities, we argue that a dimension of added value must include an anthropology of the archive (e.g., Heitman 2016).

4 SCHOLARLY IMPACT

We have presented articles elsewhere on the involvement and impact of the CRA on various non-academic stakeholders including descendent communities represented on the Chaco Culture National Historical Park's Tribal Consultation Board (Heitman 2014a, 2014b; Heitman and Martin 2014). Here, we will focus on proxy measures with which to gauge the impact of digital heritage projects on academic scholarship. In the United States, there is a systemic problem with conventional methods of evaluation for digital projects. These problems extend beyond disciplinary boundaries and are particularly acute in the transdisciplinary space of cultural heritage. How do administrators evaluate digital products and does the academy value those products as scholarly contributions?⁴ There is broad recognition that conventional measurements like “impact factor” are not accurate for traditional scholarly products (e.g., Bollen et al. 2009). But if such measures fail in the sciences (the domain they were designed to serve), what hope is there for these same measure to accurately capture the research impact of digital heritage and digital humanities projects? This is an active area of research (e.g. Ochsner et al. 2016), but the way forward is still uncertain.

A resource like the CRA is no more individually authored than, say, a consumer product that's been brought to market. Such products transcend individual contributions; the whole is greater than the sum of its parts. When called on to use conventional metrics to evaluate the “impact” of digital heritage projects, how do we quantify this form of added value? We realized at the outset of our project that younger scholars (particularly graduate students) would be more likely to embrace an online research portal as a tool to help them develop and address their research questions. To test this hypothesis, we can use databases like ProQuest Dissertations & Theses Global to search for works that make use of chacoarchive.org resources. According to ProQuest (accessed on March 11, 2016), there are six dissertations to date from various institutions and multiple disciplines that used the CRA.⁵ The willingness of junior scholars to embrace this heritage resource marks a generational shift. It also shows that the CRA is helping to shape future scholarship, albeit in a way that falls outside of most conventional

⁴A new Society for American Archaeology Task Force on Academic Promotion and Tenure is currently examining these issues.

⁵Anecdotally, we know of at least 6 more currently in process.

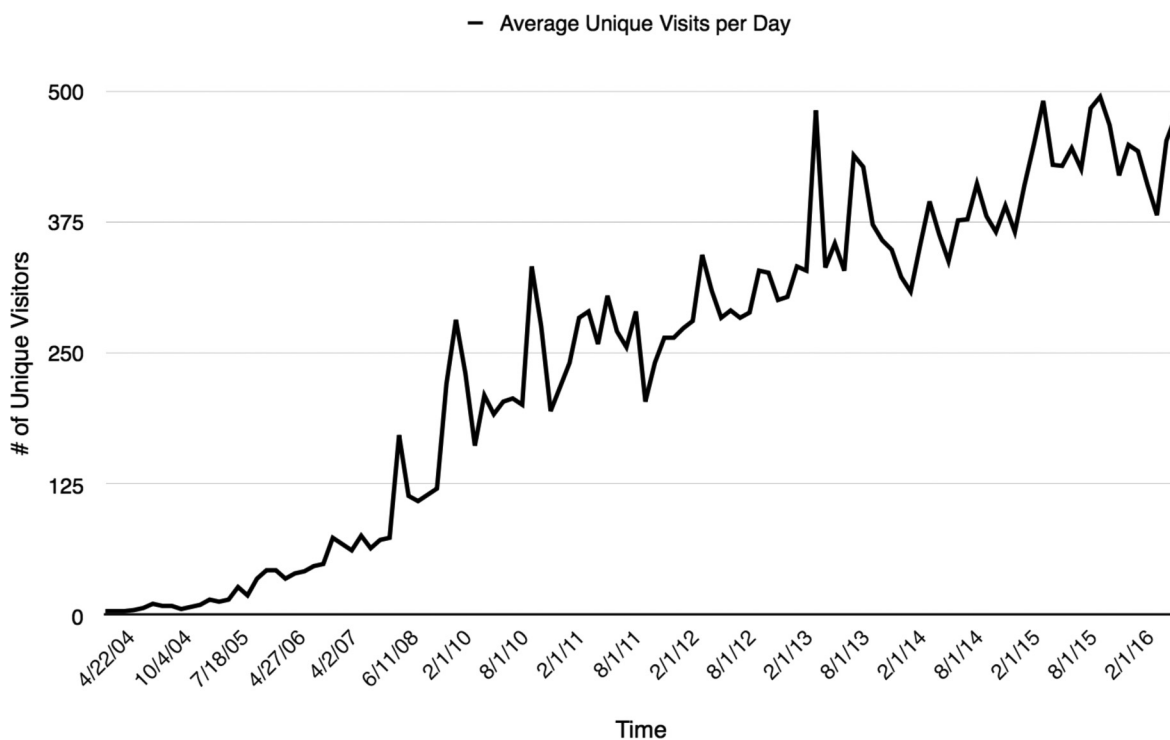


Fig. 3. Average unique visitors per day to chacoarchive.org.

metrics for research impact. If we look beyond specific user groups, then search tools like Google Scholar (GS) help cast the widest net for references to the CRA resource domain. The tendency for GS to yield false positives (de Winter et al. 2014), however, creates a different set of challenges.

Website statistics help too, of course. If we look at our now 12-year arc for this project, then the CRA has shown continued growth in its usage statistics. Since the October 2010 launch of our redesigned webpage and the unveiling of its full range of digital assets, database content, and query interface, the CRA now averages 443 unique visitors per day and over 2,000 megabytes of data transferred every day (Figures 3 and 4).

The website statistics show a robust user community for this specific cultural heritage resource and a consistent pattern of engaging with the data. But users do not always cite the online resource where they accessed the materials/data that results in a disconnect between citation counts and usage statistics. Hopefully, in time, citation analysts will help provide more guidance on how usage and download figures play into research impact (Zuccala 2016).

Metrics aside, we know the CRA is having a direct impact on emerging scholarship on Chaco Canyon in venues like the *Proceedings of the National Academy of Science* (e.g., Heitman 2016; Plog and Heitman 2010; Watson et al. 2015) and through new studies of legacy collections (e.g., Heitman and Plog 2015). Perhaps more importantly, the collaborations that built the CRA are now yielding greater fruit in terms of new projects. With funding from the National Endowment for the Humanities, we are in the process of augmenting the CRA to include the Salmon Pueblo Archaeological Research Collection from one of the largest Chacoan great houses outside of the canyon. Partnerships with the National Park Service have also resulted in a new mobile application that integrates CRA resources into visitor experiences. And our work to aggregate and share information is also helping support NPS

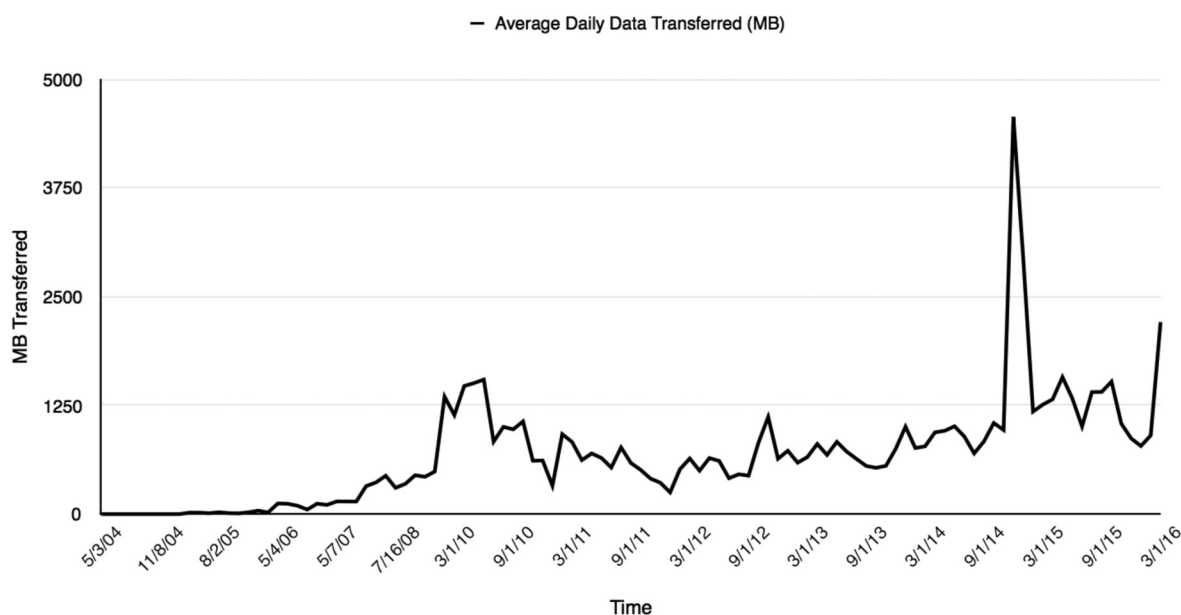


Fig. 4. Average daily data transferred from chacoarchive.org.

efforts to describe, document, and protect cultural resource in the greater San Juan Basin (Heitman et al. 2016; Van Dyke et al. 2016).

In closing, we could highlight any number of small-scale digital curation and research projects that tell a similar story. Often these are resources that respond directly to the needs of specific communities of use and successfully arise only through sustained communities of collaboration. As we embrace the era of linked open data, we can now move beyond the critique of data silos to acknowledge the research-driven work and impact of focused projects such as the CRA. The expanding scale of CRA resources, its impact, and the added value of these collections could not have come into existence without the dedicated and focused expertise of collaborative communities of co-creation. In the coming years, we look forward to our continued collaborations with Digital Antiquity to share records and materials with the Digital Archaeological Repository (tDAR) and to working with the Digital Index of North American Archaeology and Open Context to share record identifiers to increase access to these materials.

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