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Quantifying Interdisciplinarity: Subject Librarians as Research Collaborators

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Quantifying Interdisciplinarity: Subject Librarians as Research Collaborators

Abstract

Interdisciplinary research presents unique challenges and unique opportunities for collaboration, but measuring the impact of interdisciplinary research creates particular opportunities for subject librarians. Researchers working in the field of applied zooarchaeology collect data about ancient animal populations by examining animal remains found at archaeological sites. These data provide historic insights that would be of use to scholars working in a variety of disciplines, but the question has lingered among applied zooarchaeologists as to whether their colleagues in other disciplines have been discovering and citing the published data. The authors of the current study designed a citation analysis to measure the impact of applied zooarchaeological publications beyond the traditional disciplinary boundaries of anthropology/archaeology. The authors then reflect on the implications of the findings for not just applied zooarchaeology, but for interdisciplinarity, for discovery and collection management, and for collaboration and demonstrating value.

Keywords

Applied zooarchaeology

Citation analysis

Bibliometrics

Scholarly communication

Interdisciplinary

Introduction

Interdisciplinary research is rightly viewed as an opportunity for researchers to communicate beyond the traditional bounds of academic disciplines and enrich their understandings of complex subjects. Research that is of interest to a variety of related disciplines can have a wider impact by bringing outside perspectives and methods to areas of research in other disciplines. These fresh perspectives foster new conversations and new collaborations that can expand the knowledge base of multiple disciplines. But how can scholars determine whether their research is cited in literature beyond the traditional boundaries of their discipline?

These questions can prove daunting to scholars who are enmeshed in the intricacies of their own disciplines, but they also create interesting opportunities for academic librarians to demonstrate their value. Subject librarians can be effective collaborators as researchers seek to answer questions that tackle thorny issues about interdisciplinarity in research. The specialized understanding of research trends and information architecture of disciplines that subject librarians possess give them an overarching perspective on the disciplines that they work with. Many subject librarians tend to work with multiple disciplines, fostering insight into the interconnectedness of seemingly unrelated disciplines. The knowledge gained from collaborating with researchers can, in turn, inform librarians' own understandings of their users' research practices in previously uncertain areas of disciplinary intersection.

This paper describes just such an opportunity, where a faculty member in Anthropology and Archaeology partnered with two subject librarians to investigate the interdisciplinary reach of his own research. This study will discuss the development of a citation analysis project and how it was tweaked to appropriately assess the research questions, as well as report the results of the study and what it revealed about whether, in what contexts, and to what degree researchers in other

disciplines actively engage with research in the subfield of applied zooarchaeology. The authors will then discuss the implications for interdisciplinarity, for discovery and collection management, and for collaboration and demonstrating value, as well as the limitations of the current study and opportunities for future research.

Project Origins

Scholars of applied zooarchaeology, a growing subfield that explicitly seeks to link the discipline of archaeology with conservation biology, have long recognized the value of a wider audience for their research. Using systematic methods, archaeologists routinely recover animal bones, mollusk shells, and other faunal remains from the sites they excavate, often in enormous numbers. Comparisons of archaeofaunal and modern biological survey data in any given area frequently show drastic differences in species richness and evenness. While many factors might contribute to such differences in any case, archaeofaunal data, especially those derived from remains dating to before modern environmental impacts, ostensibly should be of interest to researchers in other fields, especially conservation biologists. Such interest could take many forms, including recognition and acceptance of potential ecological restoration baselines and/or conditioning of species reintroduction efforts. Applied zooarchaeologists have published their research broadly to make their data available to biologists, with the intention that the applied value of those data will be realized in such a way as to produce beneficial outcomes in natural resource management.

While the "real-world" intent of applied zooarchaeology (and the broader field of conservation paleozoology, which includes non-archaeological remains –e.g., Lyman, 2006; Westaway et al., 2019) is admirable, the extent to which conservation biologists recognize and apply archaeofaunal data has not yet been broadly assessed in formal terms prior to this study.

Noting this concern across conversations with colleagues in his field, a practitioner of applied zooarchaeology raised the question of how to measure the impact of applied zooarchaeological research in conversation with his colleagues in the library. The authors saw an opportunity that librarians (not moored to one particular academic discipline like faculty members in other academic departments) are uniquely poised to address.

Literature Review

A number of prior studies have examined the importance of librarians as research collaborators. Faculty and librarian collaborations often center around issues related to information literacy in the classroom (Perez-Stable et al., 2020; Reynolds et al., 2013). Borrego et al. (2018) found when librarians published outside of library and LIS journals, they published in subjects related to higher education and information literacy; systematic reviews and meta-analysis; and research collaboration in the faculty's areas of expertise. The research focused on faculty and librarian collaboration in research is often discipline specific, particularly in health-related disciplines (Gau et al., 2020; Janke & Rush, 2014; Lackey et al., 2019) or in digital humanities research (Hartsell-Gundy et al., 2015; Y. Zhang et al., 2021).

Various studies have emphasized that collaborations between faculty and librarians can lead to better research outcomes and stronger collaborative partnerships on campus (McBurney et al., 2020; Reynolds et al., 2013; Y. Zhang et al., 2021). Bedi and Walde (2017) found librarians act as a "neutral facilitator among academic units," with "…the librarian often bring[ing] an important perspective to the research team that no one else can provide" (p. 322) when looking at research teams composed of librarians and faculty. Foutch (2016) found the addition of an academic librarian to a faculty research team led to a better understanding of how faculty projects operate, and how the process can lead the way for librarians to be seen as valuable research

partners in the academic landscape. Y. Zhang et al. (2021) posited that, to reposition librarians' role from research supporter to research partner, librarians need to stay connected with scholars and be needs-oriented.

In addition to these examples from the published literature, other studies have focused on librarians as research collaborators in interdisciplinary contexts (Brandenburg et al., 2017; Dilevko & Soglasnova, 2013; Mack & Gibson, 2012; Mi, 2015; Wishkoski et al., 2018), with specific emphasis on how that interdisciplinary collaboration relates to grants, information literacy, and collection development. The library literature is rich with studies that have commented on the interdisciplinarity of various fields of study through citation analysis (Antell, 2012; Dilevko & Dali, 2004; Graziano, 2018; Levitt & Thelwall, 2008; Robinson & Posten, 2005; Strothmann, 2010; Williams & Fletcher, 2006; L. Zhang, 2007a, 2007b), although none of the prior studies have addressed the specific citation patterns of applied zooarchaeology itself. Recognizing the importance of the opportunity to act as collaborators and address questions of interdisciplinary research impact, the authors set out to tailor a citation analysis to the question at hand.

Methodology

Because a large topical literature that spans decades exists, a problem in assessing the impact of applied zooarchaeology on conservation biology was choosing a manageable sample of published works to look at. As a first step in examining the citation landscape of the literature of applied zooarchaeology, the authors conducted a search for highly-cited publications in the field and categorized the citing sources.

In this initial pass, or Phase 1, the authors searched Google Scholar using the phrase "applied zooarchaeology" (in quotation marks to search the terms together as a phrase), stipulating that only Google Scholar results that contained the phrase "applied zooarchaeology" in either the

title or abstract of the item would be included in the analysis in order to create the most relevant and manageable sample. From those results, the authors selected the most-highly cited items for further analysis, which were designated as articles cited 10 times or more in the search results, as indicated by the "cited by" feature in the Google Scholar results. The authors employed Google Scholar for gathering these initial results because it indexes a wider range of materials (including government documents and other reports) than other citation databases and could therefore help document the impact of the research across different fields.

The authors then recorded the citing sources for each of the highly-cited results into an Excel spreadsheet, organizing them by source type (periodical article, book chapter, monograph, conference proceedings, thesis/dissertation, book review, technical report, etc.). Technical reports and other similar items that did not pass through traditional publishing channels were categorized as "gray literature." The authors then used WorldCat records to collect the Library of Congress Subject Headings (LCSH) for the citing sources in order to facilitate analysis of the overall type of discipline of the individual citing source, whether archaeology, conservation biology or any of their related disciplines. LCSH has been described as "the most commonly used and widely accepted subject vocabulary for general application" (O'Neill & Chan, 2003, p. 1), so this controlled vocabulary allowed the authors to most consistently gather and group data by subject. The authors categorized citing sources without WorldCat records (or those lacking records that contained LCSH data) as "unknown" in the subject breakdown.

While a number of prior studies have used the Library of Congress Classification system to establish the primary discipline of a published resource being examined (Dilevko & Dali, 2004; Graziano, 2018; Robinson & Posten, 2005; Strothmann, 2010; Williams & Fletcher, 2006; L. Zhang, 2007a, 2007b), the authors of the current study chose to use LCSH to allow for relational

grouping of disciplines in the overall analysis. The authors used the LCSH search via the Library of Congress Linked Data Service (http://id.loc.gov/authorities/subjects.html) to identify the broader subject categories that certain LCSH terms fell under. By mapping the specific LCSH subject terms to the broader subject categories, the authors were able to identify publications by subject discipline and group similar publications into broad disciplinary categories to facilitate analysis of the data for citation patterns that would indicate citing sources within—or beyond—the traditional disciplinary boundaries of archaeology/anthropology.

For the purposes of this study, the authors decided to categorize any citing source that had been assigned subject headings related to anthropology or archaeology into one category, Anthropology/Archaeology, to provide the greatest contrast between citing sources rooted within the traditional disciplinary boundaries of archaeology and anthropology and those that were in other disciplines. Applied zooarchaeologists have traditionally found publishing venues for their data in journals that focus on topics in anthropology, archaeology, or both. The authors reasoned that any citing source that catalogers had assigned archaeology/anthropology-related LCSH to would be more likely to be an example of a publication by scholars publishing within the traditional venues of scholarly communication within archaeology/anthropology and would be less likely to be evidence of applied zooarchaeological data getting beyond traditional disciplinary boundaries and into the literature of other disciplines. In examining those citing sources in the analysis phase, that hypothesis proved to be true.

The authors grouped subdisciplines and branches of biology (or any combinations thereof) into the broad category of Biology. The category of Geosciences encompassed geography, geology, earth sciences, and similar discipline categories as reflected in the LCSH terms applied. The authors categorized any citing sources whose LCSH terms mapped to general science or two

or more disciplines that did not fit into the same broad category as “Interdisciplinary.” The authors also placed disciplines like environmental sciences (which is by definition an interdisciplinary field of inquiry) under that same category. For citing sources with LCSH terms that did not fit cleanly into any of the above categories (such as paleontology), the authors used the category of “Other.”

For the next phase of the data collection, one author made contact with known practitioners of applied zooarchaeology in September 2016, requesting that they identify what they considered to be the top three foundational papers in three categories:

1) Theoretical publications, i.e., ones that make the case to practitioners in other disciplines for why applied zooarchaeology matters;
2) Ecosystem-specific publications, i.e., ones that make specific recommendations for the management of multiple species in some particular environment; and
3) Taxon-specific publications, i.e., ones that make specific recommendations for the management of a particular group of organisms, or of a particular species.

The authors then applied the same data gathering methodology for these suggested articles as in Phase 1, searching those titles in Google Scholar, recording the citing sources in Excel spreadsheets, and then recording the LCSH for each citing source.

Results

For Phase 1, the search resulted in 227 results in Google Scholar, with only 7 items from those results having more than ten citing items and containing the phrase “applied zooarchaeology” in either the title or abstract. These seven items were cited by a total of 178 sources for an average of 25.4 citing sources per sample item. The sample item with the fewest number of citing sources had eleven; the sample item with the highest number of citing sources had 64.

For Phase 2, out of the 8 practitioners contacted, 6 responded, generating a total of sixteen recommended publications: six in the theoretical category, three in the ecosystem category, and seven in the taxon-specific category. Of those sixteen, four had already been included in the data for Phase 1 and were thus initially excluded from the data for the second phase.

The twelve items included in Phase 2 were cited by a total of 657 sources for an average of 54.75 citing sources per sample item. The fewest number of citing sources was 18; the highest number of citing sources was 128.

Table 1: Data Profile

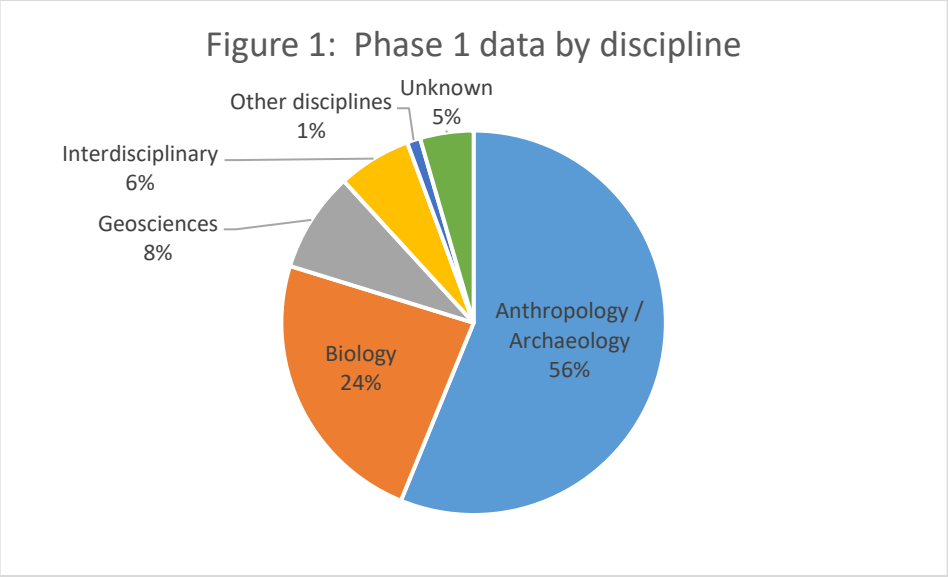
	Number of sample items	Total cited by	Average cited by per sample item
Phase 1	7	178	25.4
Phase 2	12	657	54.75

LCSH analysis

For Phase 1, the authors found the following data regarding the citing sources:

Table 2: Phase 1 raw data by type of citing source and broad discipline

	periodical articles	theses and dissertations	book chapters	books reviewed	conference proceedings	gray literature	monographs	newsletters/ article reviews	unknown	total	percentage
Anthropology/ Archaeology	83	3	9	1	2	1	1	0	0	100	56.18%
Biology	39	1	1	0	0	0	0	1	0	42	23.60%
Geosciences	12	1	1	1	0	0	0	0	0	15	8.43%
Interdisciplinary	8	0	1	0	1	0	1	0	0	11	6.18%
Other disciplines	1	0	1	0	0	0	0	0	0	2	1.12%
Unknown	5	0	2	0	0	0	0	0	1	8	4.49%
Total	148	5	15	2	3	1	2	1	1	178	100.00%



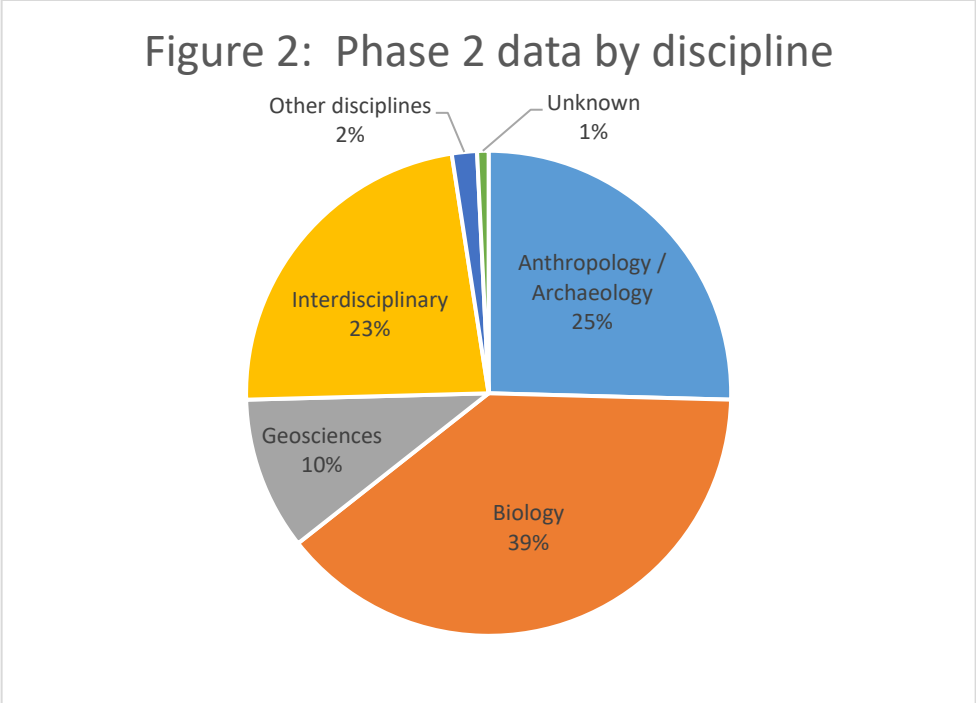
In terms of types of citing sources, most citations to the sample items came from periodical articles. The authors did not differentiate between peer-reviewed and non-peer-reviewed periodicals. No one periodical title stood out as a predominant source of citing sources. The authors classified roughly half of all the citing sources (56%) as anthropological or archaeological sources, validating an early hypothesis that applied zooarchaeological research is well-established and recognized within that disciplinary context. The 24% of citing sources from biology (as well as the remaining 20% from other disciplines) came as something of a surprise to the authors as they had anticipated far fewer citations coming from other disciplines in the initial sample.

As with the data in Phase 1, the vast majority of citing sources in Phase 2 are periodical articles (see Table 3). Like in Phase 1, no one periodical title or other publication represented a majority of citing sources. In terms of disciplinary orientation, the data for Phase 2 exhibited an even broader range of disciplines, with citing sources broadly categorized as biological (39%) being the largest single category. The anthropology/archaeology category was the next largest

group with 25% of the overall citing sources, but citing sources broadly categorized as interdisciplinary (23%), and geosciences (10%) represented significant groups as well.

Table 3: Phase 2 raw data by type of citing source and broad discipline

	periodical articles	theses and dissertations	book chapters	books reviewed	conference proceedings	gray literature	monographs	newsletters/ article reviews	unknown	total	percentage
Anthropology/ Archaeology	123	14	19	5	2	1	3	0	0	167	25.42%
Biology	172	32	15	0	1	31	5	0	0	256	38.96%
Geosciences	46	16	5	0	0	0	0	0	0	67	10.20%
Interdisciplinary	117	11	8	1	1	3	9	1	0	151	22.98%
Other disciplines	6	0	4	0	0	1	0	0	0	11	1.67%
Unknown	2	0	0	0	0	0	0	0	3	5	0.76%
Total	466	73	51	6	4	36	17	1	3	657	100.00%



To provide greater nuance to the data, the authors looked for additional patterns within the broad data categories. The authors broke down the citing sources categorized as biology, geosciences, and interdisciplinary in Phase 1 into the most commonly found component subdisciplines within each category.

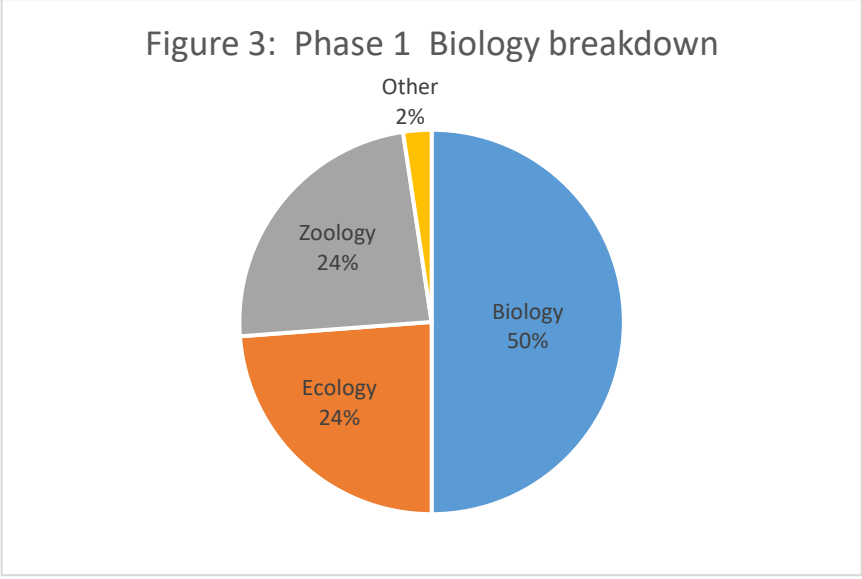


Figure 4: Phase 1 Geosciences breakdown

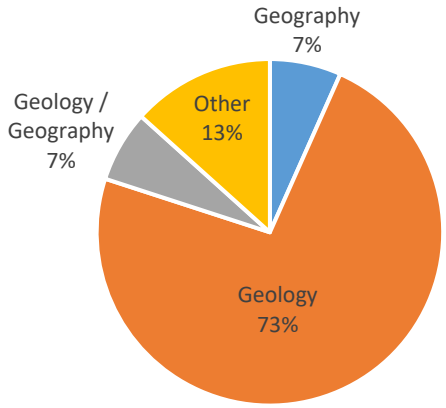
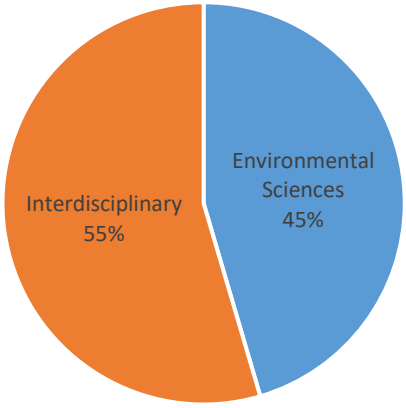
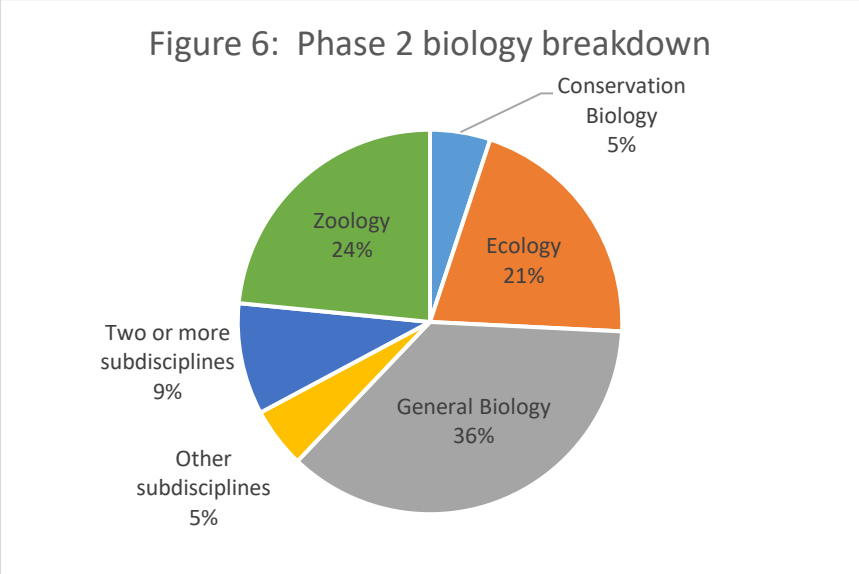


Figure 5: Phase 1 Interdisciplinary breakdown



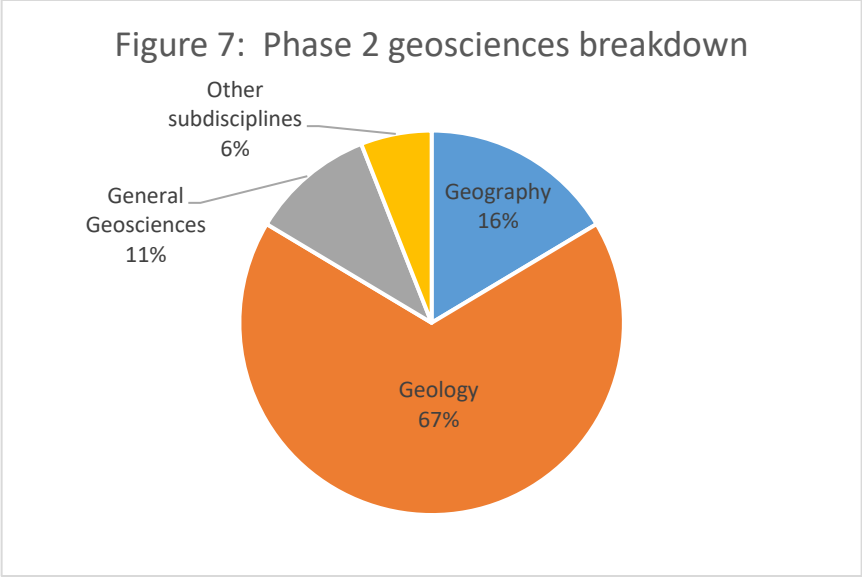
In the data for biology (Figure 3), zoology and ecology were well represented, with general biology making up the largest proportion of the data. Geology was the largest subdiscipline category in the data for geosciences (Figure 4). Broadly interdisciplinary materials made up the majority of those resources in the interdisciplinary data, but citing sources with LCSH data mapping to environmental sciences represented a substantial portion as well (Figure 5).

In Phase 2, the authors further broke down the citing sources categorized as biology, geosciences, and interdisciplinary into their component subdisciplines as follows:

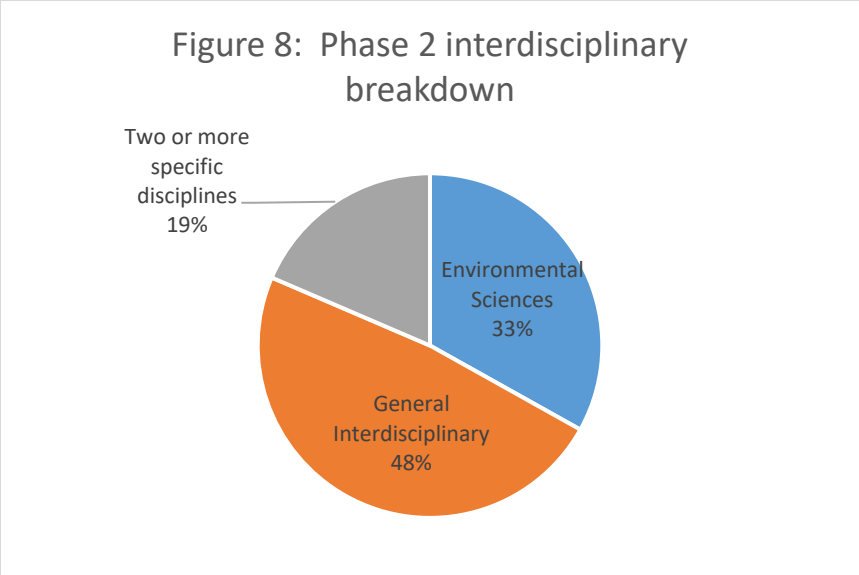


The authors categorized most of the citing sources in biology as general biology (36%), but both zoology (24%) and ecology (21%) also represented large segments of the data. Nine percent of the citing sources consisted of those representing some combination of biological subdisciplines, primarily in combinations of general biology, zoology, and ecology. Conservation biology, one of the subdisciplines identified by applied zooarchaeologists as potentially having special interest in data from the field, represented 5% of the citing sources. The remaining 5% contained sources that the authors categorized as primarily being related to specific subdisciplinary categories such as integrative biology or botany.

As in Phase 1, the sources categorized as geosciences represented a similar proportion of the data in Phase 2 and manifested a similar breakdown into subdisciplines, with sources categorized as geology making up the majority of citing sources (see Figure 7).



The authors categorized very few sources in Phase 1 as interdisciplinary because most citing sources fit more neatly into existing broad discipline categories. However, the interdisciplinary category proved to be much larger in the data gathered in Phase 2. The authors found that nearly 23% of the citing sources in Phase 2 could be classified as interdisciplinary. Of those sources, most were publications that were intentionally interdisciplinary and could not be readily mapped to particular constituent disciplines, so the authors simply categorized them as general interdisciplinary (48%—see Figure 8). The authors identified 33% of those citing sources as belonging in the interdisciplinary category of environmental sciences, with the remaining sources in that category featuring a combination of two or more LCSH terms from distinct subject categories (such as economics and environmental sciences).

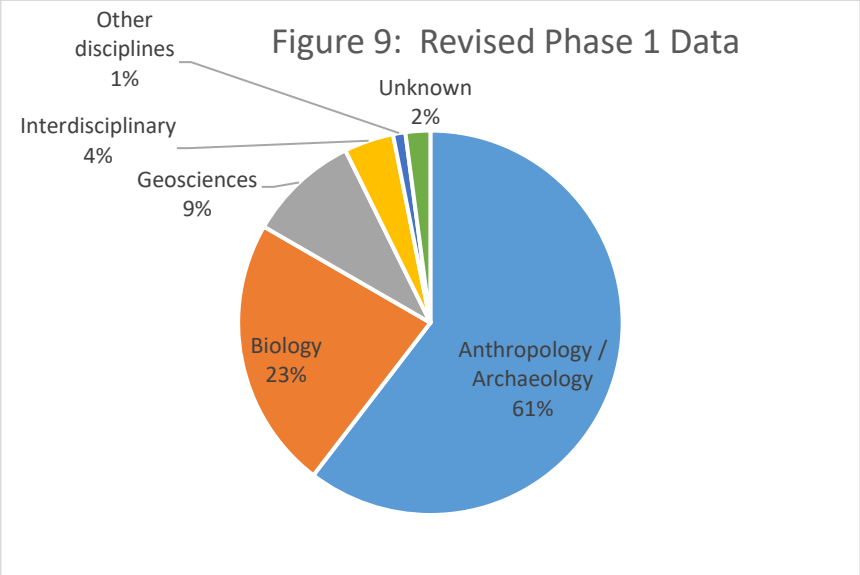


Further analysis

In an effort to explore nuances in the data, the authors parsed the data in a different way to examine a potential direction for future research. Four of the highly-cited publications discovered in the initial Google Scholar search in Phase 1 were also titles that known practitioners of applied zooarchaeology listed among the top foundational papers in Phase 2 of the data gathering. The authors of the current study removed the data for those publications from Phase 1 and grouped them with Phase 2 data for a revised analysis. The citation patterns of publications explicitly targeted beyond the traditional disciplinary boundaries (those listed by practitioners of applied zooarchaeology) and those of publications appearing in more traditional anthropology/archaeology publishing venues remained mostly the same.

Table 4: Phase 1 revised raw data by type of citing source and broad discipline

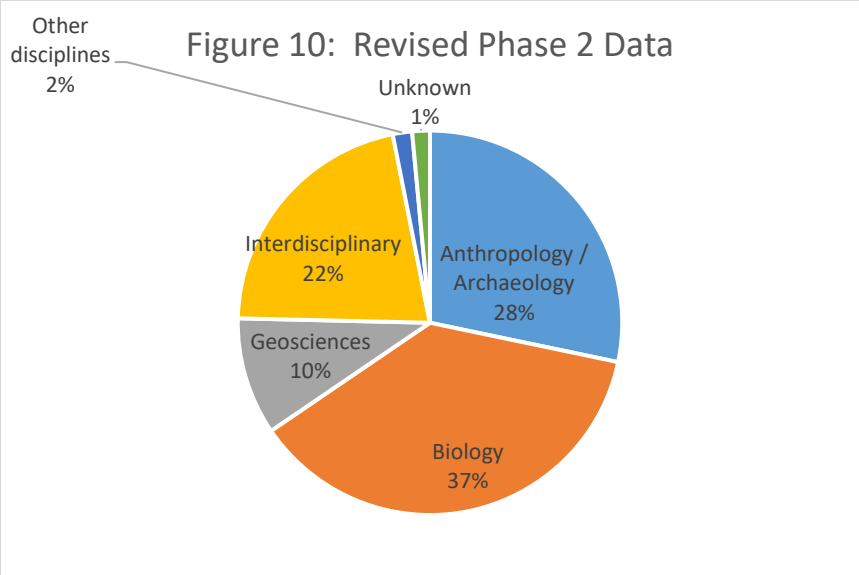
	periodical articles	theses and dissertations	book chapters	book reviewed	conference	gray literature	monographs	newsletter/ article review	unknown	total	percentage
Anthropology/ Archaeology	45	2	7	0	2	1	1	0	0	58	60.42%
Biology	21	0	1	0	0	0	0	0	0	22	22.92%
Geosciences	7	1	0	1	0	0	0	0	0	9	9.38%
Interdisciplinary	2	0	0	0	1	0	1	0	0	4	4.17%
Other disciplines	0	0	1	0	0	0	0	0	0	1	1.04%
Unknown	1	0	0	0	0	0	0	0	1	2	2.08%
Total	76	3	9	1	3	1	2	0	1	96	100.00%



As illustrated in Table 4 and Figure 9, the proportion of citing sources that the authors categorized as anthropology/archaeology is only slightly higher in the smaller data set. Likewise, the overall proportions of the data in Phase 2 changed by very little with the inclusion of the additional data that was originally included in Phase 1 (see Table 5 and Figure 10). As in the revised data for Phase 1, the proportion of citing sources coded to anthropology/archaeology rose only slightly with the inclusion of the additional data in the expanded data set.

Table 5: Phase 2 revised raw data by type of citing source and broad discipline

	periodical articles	theses and dissertations	book chapters	book reviewed	conference	gray literature	monographs	newsletter/ article review	unknown	total	percentage
Anthropology/ Archaeology	161	15	21	6	2	1	3	0	0	209	28.28%
Biology	190	32	15	0	1	31	5	1	0	275	37.21%
Geosciences	51	16	6	0	0	0	0	0	0	73	9.88%
Interdisciplinary	123	12	9	1	1	3	9	1	0	159	21.52%
Other disciplines	7	0	4	0	0	1	0	0	0	12	1.62%
Unknown	6	0	2	0	0	0	0	0	3	11	1.49%
Total	538	75	57	7	4	36	17	2	3	739	100.00%



Limitations and Opportunities for Further Research

As with any study of this kind, there are limitations that must be considered when drawing conclusions from the data. First of all, the subjective nature of grouping publications into broad discipline categories could result in differences if other researchers were to look at the same data and use the same procedures. Likewise, the use of other terms beyond LCSH and other tools (such as textual analysis tools) might lead to other conclusions. In addition, the use of another database (instead of Google Scholar) for the initial searching and the searching for citing sources could result in very different citation patterns, depending on the types of material indexed and retrieved.

One of the main limitations of the study that also points to opportunities for further research is that the data gathered in Phase 1 and Phase 2 do not constitute comparable samples. The inclusion of publications targeted to a wider audience in Phase 1 (and the small number of publications that were published within traditional anthropological/archaeological venues) makes it difficult to accurately compare citation patterns between traditional applied zooarchaeology publications and those intentionally going beyond the discipline. Future researchers may be able

to achieve a more direct comparison by examining the most cited publications in traditional applied zooarchaeological literature versus those published in venues outside the discipline.

Finally, one possible limitation is that many applied zooarchaeologists have published their findings in non-anthropological/archaeological academic journals in an attempt to present their data to scholars working in other disciplines. In doing so, they have typically cited the existing literature of archaeology and anthropology. The authors of this study did not specifically track whether the citing authors of applied zooarchaeological studies were applied zooarchaeologists themselves (publishing in journals beyond their traditional disciplinary boundaries), so it is conceivable that the proportions of citations from other disciplines could reflect a lower percentage of disciplinary crossover than what they appear to show in this analysis.

Discussion and Implications

The findings of this study have generated further conversation on many levels. For the authors, the conclusion of the study provided an opportunity to share this research with practitioners of applied zooarchaeology so that they could better understand the interdisciplinary impact of their research. Because of this research study, applied zooarchaeology researchers now have preliminary answers in their ongoing conversations about the value and impact of their research. Most were pleasantly surprised by the greater outflow of the applied zooarchaeology data into disciplines beyond anthropology/archaeology, while also noting that there was still much work to be done in communicating with scholars in other relevant disciplines.

Another finding that has generated further conversation is that the real traction for research getting beyond the discipline came by way of targeted publications beyond the discipline itself—the sample items from Phase 1 that appeared in more traditional

archaeology/anthropology venues did not get cited *as frequently* beyond the discipline in spite of their relevance to researchers in other disciplines. On the other hand, the data published beyond traditional archaeology/anthropology venues did get picked up and did show up in the citations of other disciplines. While providing interesting insight into strategies for interdisciplinary communication, it also reflects a difficult barrier for researchers in this field—they had to learn the publishing customs and norms of other disciplines or partner with researchers in other fields to get their data beyond their home discipline. The reality of this barrier has implications for any scholars interested in engaging in interdisciplinary research or librarians working with interdisciplinary research and researchers. Traditional disciplinary boundaries may remain intact in spite of seemingly natural affinities with other disciplines, and so researchers seeking an interdisciplinary audience may not be able to count on scholars outside the discipline discovering their work if it is simply published in their own traditional venues.

This has particular implications for librarians engaging interdisciplinary scholars. Librarians are perfectly poised to assist interdisciplinary researchers in the discovery process because of their knowledge of discovery tools that cut across disciplinary silos. Recognizing that researchers will sometimes struggle to engage with research beyond their traditional discipline allows librarians to collaborate with other scholars to create broader and deeper searches of potentially relevant literature.

This collaborative discovery process can also help inform librarians' perspectives on collection development in support of interdisciplinary researchers on their campus. Traditionally, librarians would not necessarily have considered the relationships between anthropology/archaeology and conservation biology when considering journal evaluation processes or database acquisitions. However, with new-found consciousness of the needs of

researchers in disparate disciplines, librarians can make more informed decisions about how any changes to resource holdings will impact the campus as a whole.

Conclusion

As emphasis on interdisciplinary research continues to grow, these interdisciplinary perspectives that librarians bring to the table present a perfect opportunity to reinforce their value in academe. Subject librarians can and should leverage their multi-disciplinary expertise when working with faculty on assessing and quantifying the interdisciplinarity of publishing avenues in their field. Research methodologies that librarians are particularly well-versed in (like citation analysis) can be used across a wide-array of disciplines to not only help demonstrate the value and impact of publications that are intentionally interdisciplinary, but also indicate the value of information specialists and information science research.

The concrete measurement of impact that citation data provide can help researchers appreciate the value of their own research and even target their publications to have the maximum impact in related disciplines. Librarians who are able to assist faculty in navigating that process earn an enhanced appreciation for their work and expertise as fellow scholars. Understanding where the intersections of interdisciplinary research occur helps to cultivate the necessary conversations to bring new research data and perspectives to relevant audiences beyond traditional disciplinary boundaries, and librarians have the opportunity to be at the forefront of this process of discovery.

Antell, K. (2012). The Citation Landscape of Scholarly Literature in LGBT Studies: A Snapshot for Subject Librarians. *College & Research Libraries*, *73*(6), 584–602.

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