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Turning setbacks into stepping-stones for growth in conservation paleobiology

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Conservation paleobiology is a cross-disciplinary field that utilizes the geohistorical record of past life on Earth to inform present-day decisions in conservation and restoration and assist in planning for future natural resource management. However, information on how past ecosystems and species responded to environmental change over decadal to millennial timescales is rarely incorporated into conservation and restoration decision-making. To heighten awareness among conservation and restoration practitioners of the relevance of geohistorical data and to bridge the gap between research and implementation in conservation paleobiology, we proposed a Research Topic titled "*Integrating Conservation Biology and Paleobiology to Manage Biodiversity and Ecosystems in a Changing World*". The 21 articles subsequently published demonstrate the diversity and breadth of geohistorical information available to resource management and the challenges of translating these results into conservation practice and policy. Here we discuss the lessons we learned from editing the Research Topic and suggest a pathway forward for conservation paleobiologists who aspire to generate actionable research results to solve current problems in biodiversity conservation and ecological restoration.

KEYWORDS

biodiversity, conservation biology, ecological restoration, multi-disciplinary collaboration, natural resource management, paleoecology

Introduction

Conservation paleobiology is a growing cross-disciplinary field that seeks to integrate geohistorical information from a variety of disciplines to inform decision-making in conservation and restoration. Practitioners of conservation paleobiology believe that this longer-term perspective is a critical component of planning in natural resource

management because data from current ecosystems capture only a snapshot of responses to perturbations, typically in systems that are already highly altered. The geohistorical perspective allows us to examine past responses to changing conditions over long time periods, providing data on how natural systems functioned prior to anthropogenic alteration. In this way, geohistorical records serve as a natural laboratory of unplanned experiments to explore past states of species and ecosystems and their responses to change over timescales unavailable to researchers of modern systems and under climate conditions that go beyond present-day observations, but that may mimic future changes. Geohistorical records of the recent past also provide an opportunity to examine human impacts on present-day species and ecosystems over decadal to millennial timescales prior to the implementation of systematic monitoring (Dietl et al., 2015; Wingard et al., 2017). Although this window to the past is not a perfect record, geohistorical records remain an invaluable source of information that allows us to examine how biota and ecosystems functioned in the past and to predict how they might respond in the future (Fordham et al., 2023).

So, given the unique perspectives that conservation paleobiology can provide, why is the field not an integral part of natural resource management and decision-making? Paleontologists and geologists have long understood the value of studying the past but have often lacked the research-to-stakeholder connections and training that allow them to collaborate effectively with ecologists, conservation biologists, and resource managers and directly apply their results in measurable ways to conservation and restoration. This lack of engagement diminishes the relevance of conservation paleobiology to conservation practice and sustains the widely held view that a "gap" exists between research and implementation in conservation and resource management (Kelley et al., 2018; Dillon et al., 2022; Dietl et al., 2023; Groff et al., 2023).

In proposing the Research Topic, *Integrating Conservation Biology and Paleobiology to Manage Biodiversity and Ecosystems in a Changing World*, we had hoped to bring the practitioner and research communities together to bridge the research-implementation gap and highlight the application and importance of conservation paleobiology research to a variety of conservation and restoration issues. The guidelines in our call for papers specifically asked for research that demonstrated the direct application of conservation paleobiology to conservation, restoration, and resource management issues. Optimistically, we thought we could foster new cross-disciplinary synergies by encouraging conservation paleobiologists to collaborate with conservation scientists and managers and incorporate geohistorical information into decision-making. Our vision was to demonstrate, through a diversity of submitted articles, how conservation palaeobiological data can be integrated with biological and ecological data, and with modeling efforts, to enhance conservation and restoration decision-making and management (Figure 1). As an additional outcome, we hoped to increase awareness among paleontologists to the needs of the resource management community. Here, we address the question – how successful were we in achieving our goals and what lessons can we learn moving forward?

Did we succeed in our goals?

If we measure success by generating interest across the conservation paleobiology community and soliciting a variety of articles, then yes, we were successful. Furthermore, the 21 contributions to the Research Topic exhibited a wide breadth of what is possible within conservation paleobiology research. Researchers examined issues such as climate and land-use changes, monitoring biodiversity loss and environmental change, shifts in communities and trophic networks, the importance of climate refugia and understanding past migrations, and the effects of resource harvesting. Our contributors used a broad range of geohistorical data sources, including a variety of macro- and microfossils (e.g., mammals, birds, mollusks, corals, crustaceans, diatoms, pollen), isotopic analyses, sediment analyses, ecological indicators, biomarkers, and zooarchaeological records. The majority of the articles were focused on specific species and habitats, time scales reflecting the recent history of human-environmental interactions, and local spatial scales, which is not surprising because these foci are what to date have resonated most with resource managers (Dietl et al., 2015; Groff et al., 2023). The collection of articles demonstrates that conservation paleobiology is an agile and flexible research field.

We failed, however, at our goal for this Research Topic of bringing the conservation paleobiology and conservation practitioner communities together and bridging the research-implementation gap by highlighting success stories of the direct application of geohistorical knowledge. With only a few exceptions, articles were firmly grounded in the *potential* applications of conservation paleobiology to resource management without direct ties to resource management and conservation outcomes. The lack of direct application is by no means the fault of the contributing authors but is rather a reflection of the overwhelmingly academic state of the field. The level of co-authorship with resource managers and decision-makers that we had envisioned for the Research Topic guidelines does not yet exist.

Several authors of articles in the Research Topic are either employees of, or heavily affiliated with, special-interest conservation groups or governmental conservation efforts, indicating that some researchers do indeed hold these crucial ties to resource management. This raises the question, why were these linkages not highlighted? The answer may arise from the central goal of an academic paper itself: to report on the results of research directed primarily to academic peers and a wider academic readership. Thus, the connections to resource management and decision-making were not highlighted as we had envisioned.

The question we cannot answer is whether we have met our goal of reaching the targeted practitioner community. Time will tell if these articles have an impact across the restoration and conservation community. However, from the outset, we could not directly reach the broader conservation research and management community because our Research Topic was rejected for cross-posting in the *Frontiers in Ecology and Evolution: Conservation and Restoration Ecology* section and the *Paleoecology* section. Consequently, from the initial announcement of our Research

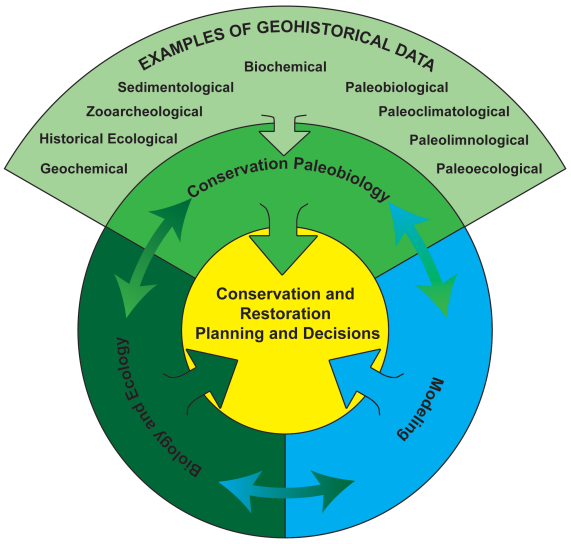

FIGURE 1
Conceptual diagram of the synergy between conservation paleobiology, biology and ecology, and modeling (outer ring of circle) and their contributions to conservation and restoration planning and decision-making (inner circle). Arrows represent the flow of information between fields (outer circle) and towards planning and decision-making (inner circle). Examples of geohistorical data that contribute to conservation paleobiology and were represented by the 21 papers in the Research Topic are listed in the expanded wedge at the top of the diagram. These examples, and other data types not listed (e.g., molecular, ichnological, phylogenetic, and many others), illustrate the cross-disciplinary nature of conservation paleobiology research. Modified from figure 1 in Dietl and Flessa (2011).

Topic, we primarily were reaching only the geohistorical half of our intended audience.

Is our failure a sign of deficiencies in conservation paleobiology?

No. We fervently believe in the value of conservation paleobiology and the role the field could play in restoration and conservation. The failure is not in the science, but in the current collective inability to relay this knowledge to the broader conservation community and to realize the cross-disciplinary collaborations needed to meet the needs and concerns of resource managers and decision makers (Figure 1). Perceptions of failure can be illogical, particularly if we assume we have more control over outcomes than we actually do. For example, rejection of the Research Topic for cross-posting in *Conservation and Restoration Ecology* is different than failure – it was out of our control.

Also out of our control is the reality of short-term political and funding cycles. Restoration and conservation efforts have decadal impacts and need long-term funding to be effective. However, it is often difficult for resource managers to obtain support for any efforts that do not fall within election and budget cycles and that do not align with current priorities. This failure applies to any resource management research, but it is magnified when geohistorical data are introduced. Given their funding limitations and priorities, resource managers are often hesitant to try what they consider new and untested methods. It is not a failure then that most conservation paleobiology research has not yet moved from potential to implementation. Rather, failure emphasizes an opportunity for growth and the need for conservation paleobiology researchers and especially present and future students to be mindful of having to do things differently.

Our failure at achieving our Research Topic goal of bridging the research-implementation gap is not surprising. Groff et al. (2023) found that only about 10% of 444 conservation paleobiology publications cited specific conservation impacts. Half of those studies with conservation impacts had coauthors with direct affiliations to conservation organizations, illustrating the importance of working collaboratively to achieve implementation. This problem is not unique to conservation paleobiology, but also persists among other conservation related sciences (Dillon et al., 2022; Dietl et al., 2023; Groff et al., 2023). In addition, a consensus has not been reached among conservation paleobiologists as to how applied versus academic the field should be, with many conservation paleobiologists not viewing implementation as a prerequisite for the field (Dillon et al., 2022). This lack of consensus suggests that our request for submitted articles to demonstrate applied conservation paleobiology was most likely broadly interpreted by researchers working in conservation paleobiology.

Another failure was the low number of conservation practitioner authors on Research Topic articles, but this should be tempered by the fact that author lists and affiliations may not be accurate indicators of collaboration and co-production. Over half of the authors of conservation paleobiology studies that Groff et al. (2023) surveyed indicated that their research was co-designed with practitioners and/or their results considered by resource managers, despite the absence of practitioners on the author lists. Perhaps undocumented collaborations occurred in the production of articles for this Research Topic and may have occurred through other media, such as internal reports, direct delivery of data, etc. Furthermore, among some global private and governmental organizations, scientific publication is of less importance than evidence of application. Therefore, publication is not encouraged or may even be suppressed, especially if financial constraints or confidentiality of results are involved. Additionally, application of results often lags publication by several years (Groff et al., 2023), so the potential impact of these Research Topic articles may emerge in future years.

Failing forward: what can we learn from failure?

Failing forward means learning from setbacks, taking responsibility, and understanding that failure is part of the process of moving forward toward progress (Maxwell, 2000). It also means keeping the big picture in mind. The diverse range of

articles in this Research Topic demonstrates the potential of conservation paleobiology and the depth and breadth of geohistorical data that the field can access. The failure in achieving our initial goals for this Research Topic is an opportunity for growth within the field. It is a chance to reflect on the way we practice our science. While we acknowledge the value of pure conservation paleobiology research, we agree with the 61% (n=54) of conservation paleobiologists who responded to a recent survey of the community that conservation paleobiology is an applied field (Dillon et al., 2022) and that striving toward co-production of knowledge will increase the use of geohistorical data in conservation practice (Dietl et al., 2023). So, what does the conservation paleobiology community need to do? The following are our suggestions, based on our own experiences and an assessment of the outcomes of our Research Topic (Figure 2).

Engage

If the collective goal is to apply our knowledge to specific conservation and restoration issues, then the biggest challenge for conservation paleobiologists is to do a better job of engaging with the conservation and restoration community of practice. We need to change the way we develop research projects so that we work with and seek input from practitioners at the outset (Wingard et al., 2017; Dietl et al., 2023). Prior to any discussions with resource managers, we need to do our homework and identify places and systems where resource conservation is needed, planned, or underway and ask ourselves what gaps our research could fill. Then, review resource management plans as available, attend public meetings, and learn the background behind management needs, perspectives, and constraints through historical documents, government reports, surveys, and prior studies. When we meet with managers and officials, we should ask questions – what are their management goals and information gaps, and how could information from the past benefit their decision-making process? And we need to be willing to listen to their answers and develop research goals collaboratively.

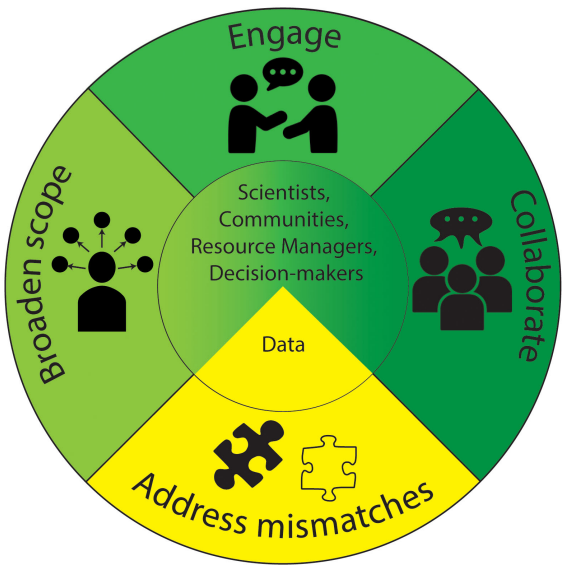

FIGURE 2
Actions conservation paleobiologists can take to advance the co-production of knowledge between conservation paleobiologists and stakeholders (scientists, resource managers, decision-makers, and communities). Three actions (shades of green) are outward-looking strategies that relate to how conservation paleobiologists interact with stakeholders beyond their field and one action (yellow) is an inward-looking strategy that concerns the geohistorical data conservation paleobiologists provide to stakeholders. By broadening our scope (e.g., social networks) as individuals, seeking out opportunities to engage and collaborate with stakeholders, and addressing mismatches in data, conservation paleobiologists can co-produce geohistorical data and insights that meet stakeholder needs and concerns. These actions do not have to occur in any specific order, but together work toward fostering productive, longer-lasting, and trusting relationships between conservation paleobiologists and stakeholders.

Collaborate

Once a research effort is initiated in an area, resource managers for that system should be considered partners and collaborators in the effort and kept informed with updates and progress reports. Parks, refuges, and other resource management units often have onsite or affiliated ecologists and biologists. Working collaboratively with these scientists could build relationships and enhance cross-disciplinary exchange of information. As part of the collaborative process, we should be open to adjusting research directions if resource managers pose new questions with the goal of keeping our research relevant to management needs and questions. Adaptive management is a critical component of resource management guidelines (Williams and Brown, 2012), so mirroring this management style in conservation paleobiology research efforts can help improve the relevance of our results and contribute to co-production of knowledge.

Broaden scope

We recommend that conservation paleobiologists broaden our networks and the scope of our social interactions. Frequently, interactions occur only within the geohistorical community – organizing sessions and giving talks and posters at geology and paleontology conferences or guest lectures at geology departments. Participation in conferences that draw resource managers, ecologists, and conservation biologists (for example, the International Congress for Conservation Biology, or the National Conference on Ecosystem Restoration) would be a start towards broader awareness and understanding of conservation paleobiology. Such meetings could allow us to forge new collaborations and build toward co-production of solutions. This will be a slow process, but the hope is that we can gradually build interest and attract a broader audience outside of the geohistorical community by capturing the attention of those who need our research. The key is to be a

continued and persistent presence and a voice at relevant conferences and resource management meetings.

Address mismatches

Mismatches make it more difficult for researchers and practitioners to align their work. The largest mismatch conservation paleobiologists face is the timescale of our data. While geohistorical records from the familiar past — the last several decades, centuries, and millennia — are beginning to resonate with resource managers (Smith et al., 2018; Groff et al., 2023), the longer timescales of the distant past remain underutilized despite their great potential for assessing responses to environmental changes outside human influences (Dietl et al., 2015; Tyler and Schneider, 2018). Communicating the value of this longer time perspective to resource managers and reporting data in formats that are compatible with conservation practice (Dillon et al., 2022) could cultivate and strengthen the relevance of geohistorical data on these longer timescales to conservation practitioners.

The taxonomic focus of a significant amount of conservation paleobiology research is not aligned with concerns about threatened and endangered species and their habitats (Dillon et al., 2022). Thus, selection of different focal taxa for paleontological investigation might increase the relevance of fossil data. However, geohistorical information from proxies often provides data on environmental change that translates to improved understanding of the stressors on threatened and endangered taxa and overall biodiversity, which is valuable information for restoration efforts. Emphasizing ecological function in conservation paleobiology research instead of specific taxa could increase the utility of geohistorical records (Dillon et al., 2022), and this is best achieved by combining data from the various proxies and tools available to conservation paleobiologists.

Another issue is a mismatch between the research protocols and tools used by resource managers to monitor species populations and habitats and those used by conservation paleobiologists (Smith et al., 2022). For example, modern ecologists have proposed "essential biodiversity variables" to form a consistent basis for monitoring biodiversity change worldwide (Pereira et al., 2013). A subset of these metrics could be used to estimate paleo-biodiversity and provide resource managers with the ability to directly translate information on past changes in species, habitats, and ecosystems into the information needed to derive conservation management plans under future climate conditions (Fordham et al., 2023). By incorporating geohistorical data into the research protocols and tools already familiar to conservation practitioners, we can enhance the relevance of geohistorical data (Dietl et al., 2023).

Seeking out opportunities to engage and collaborate with conservation practitioners, broadening the scope of interactions with the conservation community, and addressing mismatches between geohistorical data and management needs are just a few of the ways we can learn from our setbacks and fail forward toward bridging the research-implementation gap.

Where do we go from here?

Conservation paleobiologists have much to be optimistic about. We have seen significant growth in recent years of researchers identifying their work as conservation paleobiology and of publications focused on conservation paleobiology (Tyler and Schneider, 2018; Dillon et al., 2022). The Conservation Paleobiology Network (https://conservationpaleorcn.org/) was formed in 2019 as a community of practice and now includes members from around the world. Several bright spots where conservation paleobiology research has been utilized by resource managers demonstrate that the research-implementation gap can be bridged (Wingard et al., 2017; Dietl et al., 2023; Groff et al., 2023). Fortunately, the field is skewed toward early career professionals who are enthusiastic about the potential applications of conservation paleobiology (Dillon et al., 2022). Their enthusiasm is promising and suggests future growth of our field and increased efforts to establish successful conservation collaborations is likely. Also, there are a growing number of university departments that are focused on cross-disciplinary conservation research and that are incorporating conservation paleobiology in the curriculum (Kelley et al., 2018; Dillon et al., 2022). Cross-disciplinary departments are more likely to be able to train and prepare the next generation of researchers with the relevant skills and competencies (Kelley and Dietl, 2022) to work with practitioners to accomplish restoration and conservation goals.

Failure is a great teacher if we are willing to be students; in this case, the failure was to achieve our goals as editors of this Research Topic. Part of failing forward is to persevere, so collectively we, as conservation paleobiologists, need to seek new and better ways to engage and collaborate with conservation practitioners, broaden the scope of our interactions with the conservation community, and address mismatches to utilize geohistorical information in solving conservation problems (Figure 2). Many attempts to experiment with these strategies will inevitably fall short simply because failure in life is far more common than success — some attempts will succeed. A high priority therefore is finding new and innovative ways to replace the current gap between research and practice in conservation paleobiology with a bridge (desired reality) that fosters new connections and synergies between communities and shares the vast knowledge of Earth's past with the people who make decisions. Otherwise, we risk looking down at the gap that currently stands between research and implementation in conservation paleobiology only to realize that there is nothing beneath our feet to cross it. Such a bridge will be built by conservation paleobiologists and conservation practitioners who are open to building on their setbacks and using them as stepping-stones for success.

Author contributions

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References

Dietl, G. P., Durham, S. R., Clark, C., and Prado, R. (2023). Better together: Building an engaged conservation paleobiology science for the future. *Ecol. Solut. Evid*. 4, e12246. doi: 10.1002/2688-8319.12246

Dietl, G. P., and Flessa, K. W. (2011). Conservation paleobiology: putting the dead to work. *Trends Ecol. Evol.* 26, 30–37. doi: 10.1016/j.tree.2010.09.010

Dietl, G. P., Kidwell, S., Burney, D., Brenner, M., Flessa, K. W., Jackson, S. T., et al. (2015). Conservation paleobiology: leveraging knowledge of the past to inform conservation and restoration. *Annu. Rev. Earth Planetary Sci.* 43, 79–103. doi: 10.1146/annurev-earth-040610-133349

Dillon, E. M., Pier, J. Q., Smith, J. A., Raja, N. B., Dimitrijević, D., Austin, E. L., et al. (2022). What is conservation paleobiology? Tracking 20 years of research and development. *Front. Ecol. Evol.* 10. doi: 10.3389/fevo.2022.1031483

Fordham, D. A., Jackson, S. T., Brown, S. C., Huntley, B., Brook, B. W., Dahl-Jensen, D., et al. (2023). Using paleo-archives to safeguard biodiversity under climate change. *Science* 369, 1072. doi: 10.1126/science.abc5654

Groff, D. V., MacKenzie, C. M., Pier, J. Q., Shaffer, A. B., and Dietl, G. P. (2023). Knowing but not doing: Quantifying the research-implementation gap in conservation paleobiology. *Front. Ecol. Evol.* 11. doi: 10.3389/fevo.2023.1058992

Kelley, P. H., and Dietl, G. P. (2022). Core competencies for training conservation paleobiology students in a wicked world. *Front. Ecol. Evol.* 10. doi: 10.3389/fevo.2022.851014

Kelley, P. H., Dietl, G. P., and Visaggi, C. C. (2018). "Training tomorrow's conservation paleobiologists," in *Marine Conservation Paleobiology: Topics in Geobiology*. Eds. C. L. Tyler and C. L. Schneider (Cham Switzerland: Springer International Publishing), 209–225. doi: 10.1007/978–3-319–73795-9_9

Maxwell, J. C. (2000). *Falling Forward: Turning Mistakes Into Stepping Stones for Success* (Nashville TN: Harper Collins Leadership, Nashville TN), 266.

Pereira, H. M., Ferrier, S., Walters, M., Geller, G. N., Jongman, H. G., Scholes, R. J., et al. (2013). Essential biodiversity variables. *Science* 339, 6117. doi: 10.1126/science.1229931

Smith, J. A., Durham, S. R., and Dietl, G. P. (2018). "Conceptions of long-term data among marine conservation biologists and what conservation paleobiologists need to know," in *Marine Conservation Paleobiology: Topics in Geobiology*. Eds. C. L. Tyler and C. L. Schneider (London: Springer International Publishing), 23–54.

Smith, J. A., Pruden, M. J., Handley, J., Durham, S. R., and Dietl, G. P. (2022). Assessing the utility of death assemblages as reference conditions in a common benthic index (M-AMBI) with simulations. *Geological Society London Special Publ.* 529, 1. doi: 10.1101/2022.08.30.505344

Tyler, C. L., and Schneider, C. L. (2018). "An overview of conservation paleobiology," in *Marine Conservation Paleobiology: Topics in Geobiology*. Eds. C. L. Tyler and C. L. Schneider (Cham Switzerland: Springer International Publishing), 1–10.

Williams, B. K., and Brown, E. D. (2012). *Adaptive Management: The U.S* (U.S. Department of the Interior, Washington, DC: Department of the Interior Applications Guide. Adaptive Management Working Group).

Wingard, G. L., Bernhardt, C. E., and Wachnicka, A. H. (2017). The role of paleoecology in restoration and resource management – the past as a guide to future decision-making: review and example from the greater everglades ecosystem, U.S.A. *Front. Ecol. Evol.* 5. doi: 10.3389/fevo.2017.00011