# Ten simple rules to bridge ecology and palaeoecology by publishing outside palaeo-ecological journals

Schafstall, N[1*], Benito, X[2*], Brügger, SO[3,4], Davies, AL[5], Ellis, E[6], Pla-Rabes, S[7,8], Bonk, A[9], Bunting, MJ[10], Chambers, FM[11], Flantua, SGA[12], Fletcher, TL[13], Greiser, C[14], Hernandez, A[15], Keenan, B[16], Koren, G[17], Marcisz, K[18], Montoya, E[19], Quesada-Román, A[20], Ratnayake, AS[21], Sabatier, P.[22], Smol, JP[23], Suárez-Mozo, NY[24] .

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## Statement

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# Abstract

Due to a specialised methodology, palaeoecology is often regarded as a separate field from ecology even though it is essential to understand long-term ecological processes that have shaped ecosystems that ecologists study and manage. Even though advances in ecological modelling, sample dating, and proxy-based reconstructions have enabled direct comparison of palaeoecological data with neo-ecological data, most of the scientific knowledge derived from palaeoecological studies remains siloed. We have surveyed a group of palaeo-researchers with experience in crossing the divide between palaeoecology and neo-ecology, with the goal to provide a set of Ten Simple Rules to publish your palaeo-ecological research in non-palaeo journals. Our ten rules are divided into the preparation phase, writing phase, and finalising phase when the article is submitted to the target journal. These rules provide a suite of strategies, including improved and early-on networking and effective collaborations, transmitting results in a more efficient and cross-disciplinary manner, and integrating concepts and methodologies that appeal to ecologists and a wider readership. Following these Ten Simple Rules can help palaeoecologists ensure that their work is disseminated and understood by mainstream ecological scientists. Although this article shows primarily examples of how palaeoecological studies were published in journals for a broader audience, the rules would apply to anyone who aims to publish outside specialised journals.



**Key words**: 10 simple rules; bridging the gap; ecology; palaeoecology; publication


# Introduction

Like any other science, the field of ecology encompasses numerous disciplines, each fostering and sustaining a diverse array of specialist journals. Trends toward methodological specialisation within disciplines are far from uncommon (Wallen et al., 2019) and as a discipline within ecology, palaeoecology is no exception to this trend. Drawing insights from many fields and disciplines, including biology, chemistry, geography, geology, climatology, and archaeology, palaeoecology offers challenging yet exciting cross-disciplinary approaches focused on understanding long-term ecological patterns, processes, and dynamics under natural and human forcing (Seddon et al., 2014). Palaeoecology addresses research questions and frequently engages with concepts common to both applied and fundamental ecological research such as restoration, human legacies, bioindicators, climate change, and community dynamics (Goodenough and Webb 2022). However, palaeoecology is methodologically distinct, using proxy-based records to reconstruct past environments on longer timescales than is possible through direct observations, and hence, it has cultivated a suite of techniques and a terminology that is unfamiliar

to many neo-ecologists (ecologists working with data based on direct observations, generally not older than a few decades).

These "palaeo" methodological obstacles, summarised in Rull (2010) and Davies et al. (2014), include; 1) technical barriers (such as lack of time constraints in engaging interdisciplinary collaborations and challenges/difficulties in translating unfamiliar information); 2) a lack of awareness and/or limited access to the methodology and associated publications; and 3) preconception barriers that hinder the willingness of other diverse audiences to consider unfamiliar types of evidence, since palaeoarchives (proxy-based records) may produce evidence in formats not directly applicable to neo-ecology, management, and policy. This preconception barrier of diverse audiences to "palaeo" methods and the time constraint in engaging with these audiences often leads to the classification of palaeoecology as a separate field rather than a discipline of ecology (Rull, 2014). Progress in effective collaboration through open science (Koren et al., 2022) and computational palaeoecology (e.g., Anderson et al., 2006; Nieto-Lugilde et al., 2021; Chevalier, 2022), as well as adopting approaches that have so far been applied mainly in for ecological studies (e.g., the use of organismal functional traits; Marcisz et al., 2020; Brown et al., 2023) have enhanced the capability to integrate long palaeo-records of microbiota, plants, animals, and abiotic factors with directly observed modern records (data spanning the last 50 years or less; Dillon et al., 2023) (Fig 1). Still, more effort and input are needed from palaeoresearchers (researchers working with palaeoarchives) to integrate palaeoecology within the broader field of ecology sufficiently to routinely include a palaeo-perspective in scientific discussions about the present and future environmental challenges (Camperio et al., 2023).

A key challenge for palaeoecology is securing publication in outlets intended for neo-ecological audiences, as this is an important means of building and maintaining cross-disciplinary connections with neo-ecologists. The concept of "belonging", in which one feels safe and secure in a community without fear of rejection, has been used to explain the attraction of publishing in specialised journals (Gaynor et al., 2022). Therefore, challenges related to synthesising and cross-fertilizing knowledge persist, even though they often lead to multi-authored papers which contribute meaningfully to our understanding of "wicked" problems (Lönngren and Van Poeck, 2021). Such cross-disciplinary publications can be very effective in transferring knowledge between different disciplines within ecology (Raja et al., 2022; Borer et al., 2023). Currently, a growing number of palaeoecologists, especially early-career researchers (ECRs), are searching for practical guidance to aid the dissemination of palaeoecological knowledge for uptake in the broader field of ecology (Dillon et al., 2023). Here we offer "Ten Simple Rules" as guidelines to facilitate publishing in journals outside the discipline of palaeoecology.

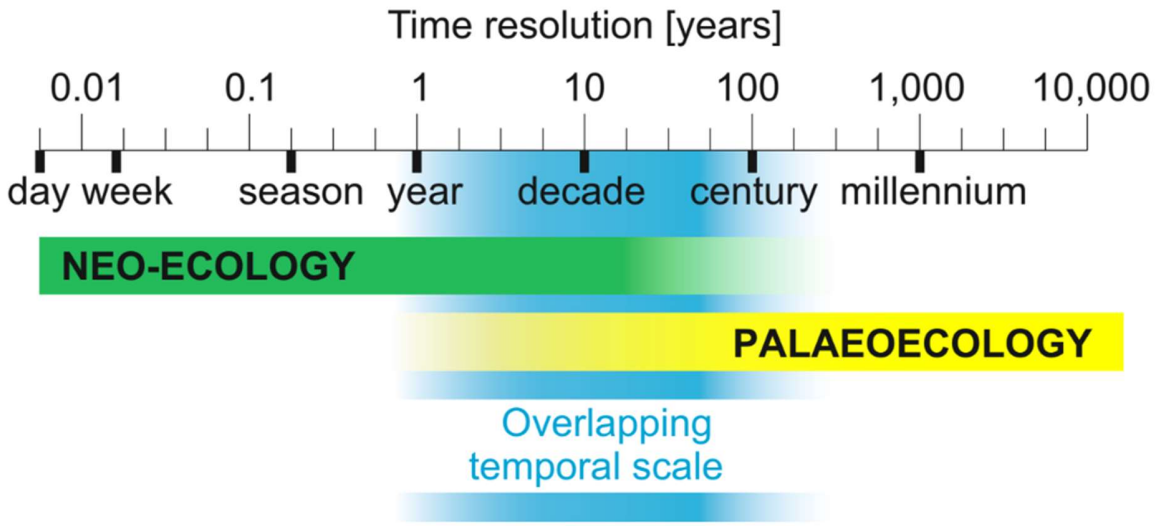


**Fig 1** Palaeoecology can show the variability of species assemblages and ecosystems over a longer timescale (10,000 years and further back) but certain proxy records also provide decadal or yearly resolution and overlap with the temporal resolution used in neo-ecological studies. Adapted from Rull (2014).

## Methodology and target audience

The guidance presented here was collaboratively developed with input from the wider palaeo-community. Initially, a call was sent to various communities of palaeoresearchers soliciting guidelines that they would recommend to ECRs aiming to publish their research in journals outside specialist palaeo-journals. The call was initiated by the two lead authors of this paper and was sent to mailing lists with wide geographic membership and spanning a range of proxies within the palaeoenvironmental sciences remit (e.g., aquatic, terrestrial, ecological, geological, and climatic indicators). We received responses from 45 contributors from various parts of the world and with differing backgrounds, which included suggestions, guidelines, and recommended readings spanning various stages of research development, writing, and publishing. The instigating ECRs thematically grouped these contributions into topics and added explanatory subtext to these topics based on the input of the contributors. Subsequently, all contributors were invited to review and comment on the recommendations to refine them into "simple rules" on how to publish outside one's own research specialisation. The original contributions were structured into 10 broad thematic guidelines ("10 simple rules"), arranged in chronological order from designing a study, to writing a manuscript, and ultimately submitting the manuscript to a scientific journal outside the field of palaeoecology (summarized in Fig 2). The examples provided here focus on publishing palaeoecological work to reach a wider ecological audience; however, these rules are transferable to other research fields as well.

## Rule 1: Immerse yourself in other research fields

Engage in active learning from fields or disciplines you are not trained in by delving into publications and upper-level textbooks or participating in relevant courses, seminars, or conference sessions. Such activities can help you identify 'hot topics', emerging technologies, and pressing questions in your target field. A number of publications offer an overview of how palaeoecology is applied to address questions in ecology, touching upon topics such as lake restoration (e.g., Perga et al., 2015), moorland management (e.g., Chambers 2022), or browsing pressure by herbivores (e.g., Morales-Molino et al., 2019), and more general issues in science policy (e.g., Sutherland et al., 2011). To identify how palaeoecology can best contribute to a broader understanding of biosphere functioning, Seddon et al. (2014) co-developed a list of 50 priority research questions.

## Rule 2: Start collaborating as early as possible

Building effective collaborations with researchers from other fields and disciplines is critical for connecting your specialisation to other disciplines and extending the reach of research beyond individual fields. Consider joining a working group in an area of shared interest to find collaborators and contribute to existing efforts as early as possible in your career. Engaging in scientific societies that foster cross-disciplinary networking and interdisciplinarity in palaeosciences (e.g., British Ecological Society Special Interest Group, Past Global Changes (PAGES) working group) can help inititiate collaboration and lead to co-designed research questions that generate improved understanding across palaeoecology, neo-ecology, and other disciplines. Some connections may not result in a sustained working partnership, in projects or publications, but these can still be a valuable part of the learning process. Examples of fruitful multidisciplinary collaborations include the combination of archaeological records with palaeoecological records to measure the past impact of humans on their surrounding landscapes (Hernández-Almeida et al., 2016; Rey et al., 2019), cross-community efforts to model the responses of past civilisations to past ecological, climatic, and environmental changes (Lima et al., 2020), and analysing modes of climate variability through the Holocene (Hernández et al., 2020a). Such studies have generated deeper insight into the functioning and interactions of climatic, ecological, and social systems.

## Rule 3: Learn from previous publications

Examine the word choice, writing conventions, and style of articles in the journals where you would like to publish. It is valuable to examine who has cited palaeoecological articles published in ecology journals to identify examples that have achieved traction, rather than those that are popular within palaeoecology.

Regardless of the journal, you can dissect how the data and main messages are communicated as a model for improving your field-targeted writing. For example, Gregory-Eaves and Beisner (2011) approached how palaeolimnology could be used in biodiversity studies by defining widely used ecological concepts in their palaeoecological context (e.g., temporal beta diversity, functional diversity), while Wolfe et al. (2013) review stratigraphic expressions that could mark the Anthropocene transition using sentinel remote lakes. Benito et al. (2022) investigated concepts from complex dynamic theory such as regime shifts, by applying palaeo-community time-series approaches. Additionally, you can broaden your knowledge by exploring disciplines that share (parts of) methodology and terminology with palaeoecology. For this reason, publications from the disciplines of palaeoclimatology (e.g., Olsen et al., 2012; Schneider et al., 2018) and palaeogeography (e.g., Yasuhara et al., 2017) are frequently successful in reaching a wider readership within their respective field.

## Rule 4: Target appropriate journals

Interdisciplinary journals might be more receptive to your manuscript than highly specialised ecological journals. Alternatively, a specialised journal outside your research field, but dedicated to your geographical region, study system, or environmental processes may be open to your work. Journal choice will affect the approach taken in the paper to convey the main idea to the journal's audience, so should be made at an early stage in writing. If this is your first article for a wider audience, target a journal that has previously published articles in your specific field. The choice of journal is important since it determines how the study is presented (e.g., choice of language, formatting of diagrams) and what level of detail is appropriate. For instance, writing a palaeoecology article with a focus on biogeography (Nogué et al., 2021) will require a different emphasis on details about methodology and results than one for pollen specialists (e.g., Kattel et al., 2017). Likewise, palaeolimnological findings can be published for limnologists (e.g., Catalan et al., 2006), palaeoclimatologists (e.g., Hernández et al., 2020b), or a broader Earth system readership (Ficetola et al., 2018; Raposeiro et al., 2021) and each different readership could be interested in different details from your study. Many journals accept pre-submission inquiries to evaluate the manuscript's fit, so contact the chief editor to clarify any uncertainties. It could also be rewarding to send a draft of your manuscript to someone in the readership of your target journal, asking if they would find your manuscript appropriate for that journal and whether your draft contains the information that they would expect (Rule 5-7).

## Rule 5: Keep the message simple

Once you start writing, keep the message clear and direct. Defining how your work relates to topics of relevance to the journal audience is crucial at an early stage in writing. Avoid lengthy descriptions of methods, results, or issues (e.g., taphonomy, age-depth modeling) that are not specifically needed to communicate the main message you wish to convey. Such specialised details can find a good home in the supplementary material to maintain appropriate messaging in the main text for a broader audience. Keep terminology consistent throughout the manuscript, and ensure that key concepts are clearly defined, or provide a glossary with the terminology used in your manuscript (Flantua et al., 2023). This is particularly important if they differ from accepted ecological terminology and definitions owing to the nuances of palaeo-data (e.g., spatial scales, time scales). Multiple studies exist in the literature as model examples from which to learn. For instance, Blois et al. (2013) offer a concise analytical account of the methods and findings of the complex numerical analyses implemented to apply their space-for-time substitution approach in the main text, while reserving some finer details for the supplementary materials. Bush et al. (2022) quantified human-induced species extinction in a straightforward manner and provided an excellent example of a study that applies conceptual models to shed light on ecological theory using palaeo-data, of wide interest to e.g., conservation ecologists.

## Rule 6: Highlight the importance and relevance of your research

After identifying key research questions and knowledge gaps in your target field (Rule 1), state clearly how your palaeo-perspective adds value to this theme. A common starting point is to set out how the longer timeframes provided by palaeosciences contribute to knowledge developed from shorter environmental or ecological time series (Fig. 1). When palaeoecology focuses on millennial timeframes, integration with shorter ecological datasets can pose challenges (Fig. 1), especially if the manuscript intends to offer management or policy recommendations. Reference to high-resolution examples using multi-decadal sampling intervals or even annually laminated sediment records can be used to bridge the temporal gap between neo- and palaeoecological studies (Engels et al., 2015; Bruel and Sabatier, 2020; Poraj-Górska et al., 2021) and support the choice of methods and longer time scales. Alternatively, focus on the contrast – what long timescales provide that high-resolution, modern studies cannot. Various concepts have been employed to underscore the relevance of palaeo-works in general ecology journals, such as identifying reference baselines to assess the degree of impact on ecosystems, filling knowledge gaps about introduced species, establishing long-term system trends to inform biomonitoring programmes or disentangling natural fluctuations in mean

climate states from human-altered environmental regimes. These themes are well-established, and there are many examples to draw on, including studies of the feasibility of monitoring aquatic diversity and human impact on the diversity using palaeoarchives (Pla-Rabes et al., 2011), patterns of tree succession from pollen records to inform forest ecology (Rey et al., 2019), and biomonitoring to assess how measuring the resilience of ecosystems could be improved (Müller et al., 2019).

## Rule 7: Provide clear explanatory figures

Effective and clear visualisation of your research approach, methods, results, and implications will help editors, reviewers, and especially readers outside your research field to understand the value of a palaeo-contribution. There is a wealth of general literature on data visualisation, and a recognized shortage of scientific training in this area (McInerny et al., 2014). Prioritize visualising concepts and results that may be foreign to some audiences, such as stratigraphic plots and age models. Providing explanatory workflows and interpretations, especially when different numerical or statistical methods are applied, can also improve the readability of your paper (e.g., Maezumi et al., 2018; Flantua et al., 2023). Multivariate palaeoecological diagrams are a complex form of data display that can benefit from creative rethinking and innovative approaches of visualisation. For example, Milner et al. (2021) provided conventional multivariate stratigraphic diagrams alongside infographics to focus on key ecological shifts through time. Using both explanatory and exemplary figures, Gaüzère et al. (2020) generated community response diagrams that show non-equilibrium dynamics between plant functional responses and Holocene warming. Nogué et al. (2021) illustrate global island pollen trends following human arrival, aiding a broader audience in understanding the relevance of complex pollen datasets in support of the overarching biodiversity focus of the paper.

## Rule 8: Be clear about the strengths and limitations of your data

Clearly and transparently acknowledging the strengths and limitations of your data will enhance the value of your manuscript in the eyes of the editor, reviewers, and the journal's audience. This acknowledgment should include communicating the unique benefits offered by palaeo-data (Rule 6). Making the limitations explicit also gives potential collaborators or data users realistic expectations. For instance, combining disparate datasets across multiple sedimentary records and proxies often involves data adjustments to accommodate rigorous statistical analysis (Yasuhara et al., 2017). Recent data syntheses have been published in parallel with protocols to assess biases and uncertainties when analysing palaeoecological data (Morris et al., 2015; Dillon et al., 2023). Moreover, acknowledging the conceptual barriers to the integration of palaeoscience data with environmental sciences maintains rigour in the

field (Jackson 2012). Relevant examples include Baker and Fritz (2015) and Hoorn et al. (2010), which assess how terrestrial palaeoclimate records inform contested theories on past climatic variability and biotic evolution in South America. Similarly, Jackson and Blois (2015) examine whether ecological processes have fundamentally changed during the Anthropocene. To do so, they offer examples grounded in theory to identify and bridge temporal mismatches between ecological and palaeoecological datasets.

## Rule 9: Make the title, abstract, and cover letter clear and compelling

Do not underestimate the importance of a cover letter: this will likely be the first part of your manuscript that is scrutinised by the editor of the journal. State clearly how your palaeo-approach fulfils and aligns with the interests of the target journal's readership and explain how your study's findings address a critical research gap within the aims and scope of the journal, justifying the wider ecological or neo-ecological community for which your study is intended. Present informative counterarguments to previously published results, highlight any advances in the state-of-the-art, or introduce novel ideas that may be unfamiliar to this readership. Remember that for subscription-based journals (non-Open Access), the title, abstract, and keywords are the only components freely available and are the components sourced by search engines. Test your draft title and abstract with colleagues from different fields and consult available guidance on getting published, both from the target journal's personal guidelines and from freely available guides (e.g. BES, 2015). Examples of cover letters are not readily available, so ask your peers, supervisors, or collaborators to share with you examples of a 'winning' cover letter. The writing of an abstract is central to the manuscript and should not differ from an abstract for a palaeo-journal, to provide a compact summary of your article (i.e., content, context, and conclusion; Mensh and Kording 2016) and incentivise the reader to continue reading. However, an eye-catching title could increase the readership of your work as more potential readers will open your article to see what it is about. Some examples of articles with, arguably, a compelling title are "Ecological Restoration in the Light of Ecological History" (Jackson and Hobbs, 2009), "Diversity in time and space: wanted dead and alive" (Fritz et al., 2013), and "Ancient human disturbances may be skewing our understanding of Amazonian forests" (McMichael et al., 2017).

## Rule 10: Suggest reviewers strategically

When allowed by the journal, always recommend reviewers as part of the submission process. Suggest individuals whose work is primarily non-palaeo-focused, but who are familiar with long-term or palaeostudies. Additionally, suggest experts in your

field or study region who have previously published outside palaeo-journals. Consider the reviewing process a virtual conversation between your work and the community, with the reviewers as your collaborators. Their experience and critical insight can improve the clarity and accessibility of your manuscript, ultimately broadening its impact on the target audience (Zhang, 2014).

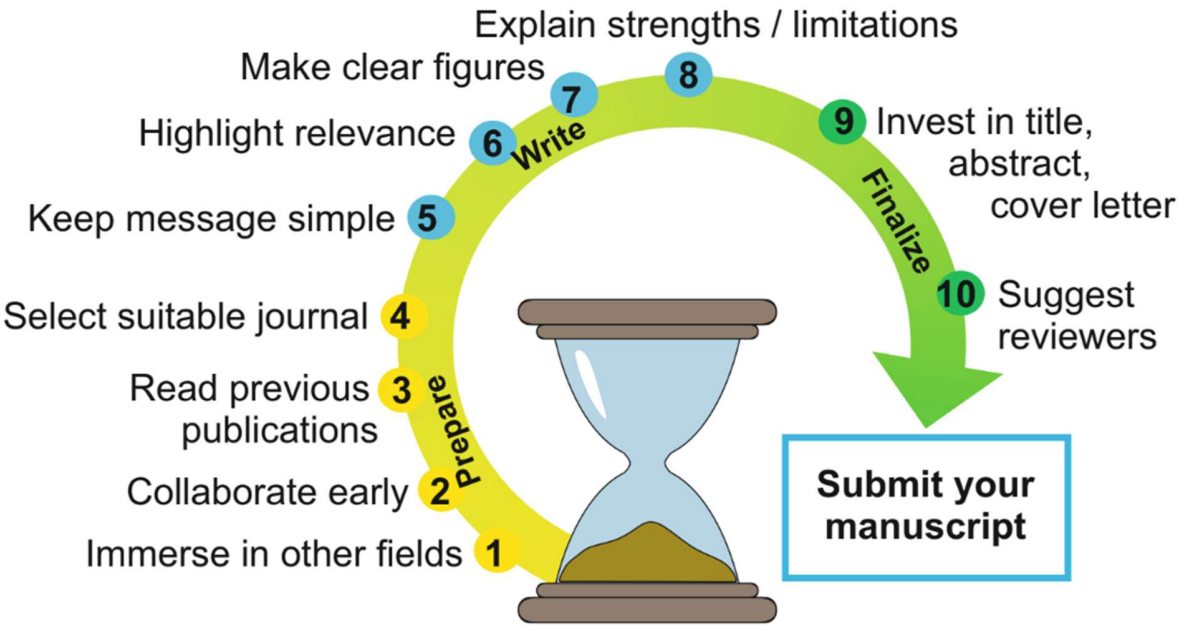


**Fig 2** Ten Simple Rules to bridge neo-ecology and palaeoecology by publishing outside palaeoecological journals. The three colours of the arrow represent the three main phases of preparation, writing, and finalising your article. For every new study, it is important to start again with the preparatory immersion phase.

## Conclusion

Even the most seasoned and highly cited cross-disciplinary scholars began as ECRs who had to master the art of publishing outside their own research discipline or field. Based on the personal experience of many of these (former) ECRs, the main take-home message from this set of Ten Simple Rules is the importance of remaining open and receptive to ideas and learning from a wide range of disciplines. This openness fosters the development of well-rounded scientists and aids in better deciding when publishing outside specialist, discipline-oriented (palaeo) journals is a high priority. When aiming for a publication in a neo-ecological or broader journal, the writing process may demand additional time and effort, particularly to tune the messages and presentation to suit an audience that needs to be convinced of the merits of palaeo-data and palaeo-analysis. However, connecting ideas and evidence across different fields and disciplines can improve the quality of research and has the potential to advance the wider research field as a whole. Many theories and issues

central to palaeoecology also find resonance in the wider field of ecology. In conclusion, publishing palaeoecological studies in neo-ecological and interdisciplinary journals is a crucial step in generating and maintaining conversations across the methodological differences that divide palaeoecology and neo-ecology. Following these Ten Simple Rules can stimulate open-minded, cross-disciplinary conversations for palaeoecologists to ensure that their work is disseminated and understood by mainstream ecological scientists, as well as encouraging ecologists to challenge their own assumptions about the suitability and relevance of long-term palaeoecological records to ecological questions and applications. We suggest that these simple rules will be useful for researchers in any field of science who aim to publish in journals that serve a broader audience.

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