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Author(s): Timothy H. Parker , Shinichi Nakagawa , Jessica Gurevitch , and IIEE
Source: The Auk, 133(4):779-782.
Published By: American Ornithological Society
https://doi.org/10.1642/AUK-16-122.1
URL: http://www.bioone.org/doi/full/10.1642/AUK-16-122.1

The Auk
Ornithological Advances
AmericanOrnithology.org

Volume 133, 2016, pp. 779–782
DOI: 10.1642/AUK-16-122.1

COMMENTARY

Promoting transparency in evolutionary biology, ecology, and ornithology

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Submitted June 16, 2016; Accepted July 2, 2016; Published September 14, 2016

ABSTRACT
Transparency regarding methods, data, and results is essential to scientific progress. However, in ecological, evolutionary, and ornithological research, transparency is often insufficient, and the distribution of published results may often be biased. To address this issue, we advocate adoption of editorial policies that explicitly promote transparency. We hope that *The Auk*, as a leading ornithological journal, will lead the way in promoting transparency in the study of birds.

Keywords: archiving, pre-registration, replication, TOP, transparency

Promover la transparencia en la biología evolutiva, la ecología y la ornitología

RESUMEN
La transparencia en relación con los métodos, datos y resultados es esencial para el progreso científico. Sin embargo, en la investigación ecológica, evolutiva y ornitológica la transparencia es a veces insuficiente, y la distribución de los resultados publicados a menudo podría estar sesgada. Para abordar este problema abogamos por la adopción de políticas editoriales que promuevan la transparencia explícitamente. Esperamos que *The Auk*, como una publicación líder en investigación ornitológica, liderará el camino de promover la transparencia en el estudio de las aves.

Palabras clave: archivado, pre-registro, replicación (o reproducibilidad?), TOP, transparencia

A hallmark of effective science is transparency. If results are not openly shared, or if others don't know how we derived those results, the progress of science is impeded. Most of us understand this core principle, but the benefits of transparency have implications that are not always recognized. These benefits include not only the ability to interpret results accurately, but also a reduction in bias, greater capacity to include results in data syntheses, and facilitation of updates and replications of studies. However, without institutional support, practices that promote transparency are not nearly as common as they should be, despite the commitment of many individuals in the scientific community.

Science is a uniquely effective way of understanding the world, and the disciplines of ecology, evolutionary biology, and ornithology have made, and continue to make, progress in resolving important questions. However, inadequate transparency can slow progress. For instance, papers often fail to report basic information such as sample sizes, directions of effects, and measures of uncertainty for at least a subset of the results they report (e.g., Fidler et al. 2006, Zhang et al. 2012, Parker 2013, Ferreira et al. 2015). Further, this underreporting of results has been found to be more likely in cases of weak and nonsignificant relationships (Cassey et al. 2004, Parker 2013). This bias in data reporting can alter the interpretation of conclusions and undermine the validity of reviews and future research syntheses. Similarly, various sources of evidence suggest that weaker effects are more likely to go entirely unreported (Csada et al. 1996, Møller and Jennions 2002, Fanelli 2010), again presenting a misleading picture of scientific outcomes in the published literature. Important details of methods, such as experimental design, study location, and statistical models, are also often missing (Mislan et al. 2016), further hindering interpretation, evaluation, and replication. Bias can be introduced not only in reporting methods and data, but also when collecting data. For instance, studies in which observers are not "blinded" to treatment or expected outcome report larger effect sizes, on average, and a higher proportion of significant *P* values than studies with blinding (van Wilgenburg and Elgar 2013, Holman et al. 2015). Although blinding is not possible in all studies in ecology and evolution, it is unfortunately quite rare even when feasible (Kardish et al. 2015).

How can we more effectively promote transparency? Journals are institutions that are well poised to play a pivotal role. Journal articles already include methods and results sections, and authors are held to strict standards as conditions for publication. Journals can thus easily ask that authors adhere to specific standards of transparency. In the digital era, there are relatively few intrinsic barriers to sharing the additional information required for improved transparency. Recognition of the role of journals in promoting transparency has led to widespread adoption of data-sharing policies by journals in ecology and evolutionary biology in recent years (Whitlock et al. 2010). Although promotion of data sharing has been a strong step toward transparency, we advocate adoption of more comprehensive transparency guidelines in ecology, evolutionary biology, and ornithology.

In November 2015, representatives (mostly editors-in-chief) from nearly 30 journals in ecology and evolution joined researchers and funding-agency panelists to identify ways to improve transparency in these disciplines. This workshop (funded by the U.S. National Science Foundation and by the Laura and John Arnold Foundation and hosted by the Center for Open Science) identified general principles and specific tools that journals can adopt to encourage greater transparency of the science they publish. Most of the ideas that emerged from the workshop fit well within the recently developed Transparency and Openness Promotion (TOP) framework (https://cos.io/top/; Nosek et al. 2015). The TOP framework contains eight editorial guidelines for journals (Table 1), each designed to be useful across the breadth of empirical disciplines. Some of these general guidelines require additional, discipline-specific explanations. Accordingly, the workshop produced a document called "Tools for Transparency in Ecology and Evolution" (TTEE), designed to help journals in our discipline adopt TOP guidelines, and this content is now posted publicly and available for use by any journal (https://osf.io/g65cb/). Further, both the general TOP guidelines and the discipline-specific TTEE interpretation are living documents that will be updated through formal review processes. Journals that implement the TOP framework can choose to adopt any combination of the eight guidelines as well as the level of stringency (1 = most lenient, 3 = most stringent) for each guideline adopted. Journals can also choose to award badges to acknowledge individual papers that follow open practices (https://osf.io/tvyxz/; Kidwell et al. 2016), indicating that the paper conforms to one of three specific transparency standards: open data, open materials, or pre-registration.

TABLE 1. A list, with brief explanations, of the eight existing Transparency and Openness Promotion (TOP) guidelines (https://cos.io/top/).

TOP guideline
1. Citation standards (citation of datasets, etc.).
2. Data transparency (data archiving).
3. Analytic methods (code) transparency (code archiving).
4. Research materials transparency (materials archiving).
5. Design and analysis transparency (reporting of details of methods and results).
6. Pre-registration of studies (registering study prior to initiation).
7. Pre-registration of analysis plans (registering analysis plan prior to study initiation).
8. Replication (a study designed to replicate a previously published study).

Some of the eight TOP guidelines (Table 1) will be more immediately familiar than others to ecologists and evolutionary biologists. The most familiar is likely "data transparency," which encourages data archiving, a practice that is now suggested or required by many journals and by a growing number of funding agencies (Whitlock 2011). In addition to archiving of data, TOP guidelines promote archiving of both analysis code and a set of detailed materials and methods. The arguments in favor of data archiving have been well made elsewhere (Tenopir et al. 2011, Whitlock 2011), and the arguments in favor of archiving analysis code (Mislan et al. 2016) and materials are similar. Furthermore, to help those who archive useful content obtain recognition for their contributions, the first TOP guideline encourages citation of archived content.

Setting standards for thorough reporting of methods and results has clear benefits, and this is the purpose of the fifth TOP guideline, "design and analysis transparency." What qualifies as thorough design and analysis transparency varies among disciplines, so this guideline requires substantial disciplinary interpretation to be useful. Providing this disciplinary interpretation for ecology and evolution is one of the primary purposes of the TTEE document posted online (https://osf.io/g65cb/) as a supplement to TOP. The TTEE consists largely of questions that journals can provide to authors, reviewers, and/or editors as checklists to foster adherence to this and other TOP guidelines.

One of the major goals of the November 2015 workshop was to tailor transparency standards for the implementation and reporting of meta-analyses in ecology and evolution. The design and analysis transparency standards described above will help make data from original studies more useful for meta-analysis, but the workshop also developed design and analysis transparency standards for meta-analyses themselves. To this end, discipline-specific checklist questions are available in the TTEE document to guide the conduct and publication of meta-analytic syntheses (https://osf.io/g65cb/). The meta-analysis questions are presented as a separate checklist because meta-analysis is such a distinct and important undertaking. Meta-analysis is a tool used across much of ecology and evolutionary biology to assess the generality of phenomena (Koricheva et al. 2013), so encouraging a rigorous and transparent meta-analytic process should lead to more robust inferences about generality in these disciplines.

The TOP guidelines also encourage replication of previously published studies. Not all studies merit replication, replication is sometimes impractical, and it may not be appropriate for all journals to publish replications, but in many circumstances replications can make valuable contributions to empirical progress (Nakagawa and Parker 2015). Replication is a useful tool for exploring effects of environmental variability and, along with meta-analysis, can play an important role in building confidence in our inferences.

The concept of pre-registration, which is central to two TOP guidelines, is new to our discipline, though it has existed in medical biology for well over a decade. Pre-registration involves publicly archiving (with the option of an embargo) a study design or an analysis plan prior to initiating the research. Pre-registering the plan for a study, including the questions or hypotheses to be addressed, reduces several types of bias. For example, it can identify studies on a particular topic that were initiated but never published. This can help interpretation of the published range of effect sizes or when seeking unpublished results for meta-analysis (i.e. combating the "file drawer problem"; *sensu* Rosenthal 1979). Pre-registering an analysis plan is even more useful. When interpreting results of statistical tests, confidence in individual tests depends on the number of alternative hypotheses examined simultaneously. By providing information about the a priori analysis plan, pre-registered analyses substantially increase confidence that a result has not been cherry-picked from a larger series of unreported analyses (Nosek et al. 2015). Pre-registration does not prevent changes in study design or analyses, it just makes these changes more transparent. Journals can opt to award a badge to identify papers that include pre-registered content.

The fields of ecology, evolutionary biology, and ornithology stand to derive major benefits as journals move to adopt transparency standards. Relying on individuals to define and adhere to transparency standards leads to inconsistent outcomes. A deliberate, institutional approach from this journal and others to promote transparency will facilitate clearer interpretation of published methods and results, reduced bias in results available to the scientific community, more effective meta-analytical synthesis, and improved opportunities to update and replicate studies. These outcomes will be an important legacy for the future of ecology, evolutionary biology, and ornithology.

ACKNOWLEDGMENTS

Funding statement: The workshop on Improving Inference in Evolutionary Biology and Ecology that produced the Tools for Transparency in Ecology and Evolution was funded by the Laura and John Arnold Foundation and the U.S. National Science Foundation (DEB: 1548207). The Center for Open Science hosted the meeting and provided valuable logistical support.

Author contributions: T.H.P., S.N., and J.G. wrote and edited the manuscript. Most of the ideas in this paper were developed or refined by discussions at the IIEE workshop.

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