Conservation Biology

*Diversity*

# Ending the citation of retracted papers

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Science and its advancement are based on trust. Trust between funders, scientists, and publishers. Hundreds of scientific articles are published every day, many of which are the result of years of work. Eventually, however, some of these papers are retracted. Retractions are the consequence of honest mistakes or scientific misconduct, including plagiarism, data falsification (i.e., manipulating research materials, equipment, or processes, or changing or omitting data or results), or fabrication. Scientific misconduct represents a severe breach of the trust science is built on and can have a serious negative impact in scientific advancement, functioning, and credibility (Lewis et al. 2011). Thus, the scientific community is increasingly advocating for more accountable and transparent science practices, in what has become the open-science movement. This movement encourages scientists to improve the way scientific findings are reported and published, to ensure that science is accessible to all levels of enquiry, from scientists to the public. Yet, the trends in scientific misconduct are not encouraging.

Approximately 2% of scientists admit to having falsified research results at least once, and up to 34% admit to conducting other questionable practices, such as graph manipulation and unjustified removal of data points (Fanelli 2009). In some cases, however, the extent of the misconduct reaches serious proportions. For instance, a series of peer-review frauds discovered in recent years led to the retraction of over 100 articles (e.g., Ferguson et al. 2014). Retractions occur across different scientific fields and are abundant in the medical literature, possibly because of the implications for human health. There have been a number of high-profile retractions in this field, including the retraction in 2010 of Wakefield et al. (1998), a study that linked measles–mumps–rubella vaccines to autism. Despite that the lead author was found guilty of data falsification and had his medical license revoked, the anti-vaccine movement continues to use the results of this study as an argument against vaccination (e.g., Goldstein 2014). The movement is increasing steadily worldwide and poses a risk to human health.

Despite claims that scientific misconduct is rare in conservation science, the field is not exempt of unethical behavior. In 2012, Jesus Angel Lemus, a Spanish veterinarian working in Doñana National Park, was found guilty of data fabrication. Thirteen of his articles were retracted, some from prestigious journals familiar to those working in conservation: *Animal Conservation*, *Journal of Applied Ecology*, *Biological Conservation*, *Proceedings of the Royal Society B* and *Biology Letters*. The retracted articles, some of which had already been cited nearly 50 times by the time they were retracted, reported on research on the relationships between avian immunology and environmental toxins, disease, and veterinary drugs, specifically, for example, the possible transference of antibiotics to wild birds from carcasses of dead domestic animals.

These retractions have important implications for those working on bird conservation. If these retractions had not occurred, the common practice of providing wild vultures with carcasses from dead domestic animals medically treated with commonly used antimicrobials may have been discontinued (Marcus 2012). Ceasing this activity could have had a large negative effect on vulture populations, many of which live on agricultural landscapes, where this food source constitutes a major portion of their diet (Marcus 2012). The research associated with the retracted papers could be confused with the widely supported work of other scientists in the same field. For example, research has demonstrated how the veterinary use of the anti-inflammatory drug diclofenac in cattle is the driving force behind the dramatic decline of vulture populations on the Indian subcontinent, which depend on carrion from domestic cattle (Shultz et al. 2004). Even a decade after publication of these results,

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diclofenac continues to be a key threat to populations of vultures worldwide. Misunderstanding by political actors, for example, of contradictory messages from the scientific community could have dramatic effects on the translation of conservation science into policy.

Unfortunately, many cases of scientific misconduct are never discovered (Fanelli 2009; John et al. 2012). The number of retracted papers is increasing even when one accounts for the increasing number of papers being published (Cokol et al. 2008). The retraction rate rose from 0.001% to 0.02% in recent years (Van Noorden 2011). This 20-fold increase may be driven by an improvement in detection rate (Cokol et al. 2008), or by an increase in scientific misconduct. Nearly, 75% of retracted articles in the 2000s were due to scientific misconduct, whereas in the early 1990s the majority of retractions were driven by unintentional errors (Budd et al. 2011; Fang et al. 2012). However, these numbers may be skewed given that they were voluntarily self-reported by publishers, and that one detection of misconduct can lead to the retraction of dozens of articles.

Retracting an article is not easy, especially in the case of misconduct because authors and editors may not collaborate in the process (Van Noorden 2011). Depending on the reason for retraction, many years (up to 25) may pass between publication and retraction (Budd et al. 2011). Unfortunately, a retraction does not represent the end of the life of a paper. Retracted articles are often cited for many years, even decades, after retraction (Budd et al. 2011; Van Noorden 2011; Davis 2012). For example, Budd et al. (1999) found that 235 articles retracted from 1966 to 1996 received 2034 postretraction citations. Of these citations, 142 (6.9%) made an explicit mention of the retraction (Budd et al. 1999). Due to the different ways journals deal with retracted articles (Davis 2012; Grieneisen & Zhang 2012) and the way scientists access the scientific literature, many of these papers remain available on public websites and in private libraries (Davis 2012) and in institutional libraries or institutional online archives.

The continued citation of retracted papers is a major issue because it spreads misinformation throughout the scientific literature, providing a false premise for future research, and thus seriously affecting the advancement of science. This is especially true when data are falsified or fabricated (Budd et al. 2011). For example, in the 12 years that it took to retract Wakefield et al. (1998), the article was cited over 1000 times. Currently, individual authors are responsible to ensure that retracted papers are no longer cited and their results perpetuated. To ensure they have not cited a retracted paper, researchers need to (and of their own free will) search online databases, such as PubMed or Web of Science, for every reference they cite or used during their research before submitting a manuscript. Moreover, researchers should regularly conduct web searches to ensure that their work is not based on research that has been retracted. Although online databases have made this process much easier than in the past, this process is still too time-consuming for the majority of researchers and has been shown to be largely ineffective.

Many databases maintain an index of retracted papers. For example, MEDLINE keeps an index on biomedical literature since 1984 (Davis 2012). Unfortunately, journals are not consistent in the way they deal with retractions. Some make subtle announcements, whereas others make more obvious statements, and the reason for retraction is not always clearly stated (Van Noorden 2011). Recognizing the inability of individual researchers to deal with this problem, a few systems have been put in place to avoid citation of retracted papers (Davis 2012). CrossRef offers a system called CrossMark that includes a logo on PDFs that, when clicked, shows updates including retractions and corrections (Davis 2012). However, CrossMark relies on agreements between CrossRef and the publishers; thus, it is not available for every article, and the use of the logo is optional, which makes this a complementary but not a comprehensive tool.

A more systematic and encompassing solution to this issue is needed, in particular one that is accurate but does not rely on the good will of individual scientists. Considering that citations in a scientific article are simply a string of words presented in a relatively standardized format, a solution may already exist. One form of scientific malpractice that a number of major scientific publishers are already well equipped to deal with is plagiarism. This is commonly done through the use of software that recognizes word strings that are similar to others in existing publications. For example, Elsevier uses CrossCheck, which is powered by the Ithenticate software from iParadigms, the providers of Turnitin, used in the academic community. We propose that, without additional costs, these same software packages, coupled with a database of retracted articles, could be used to recognize citations of scientific articles that have been retracted.

In 2010, the journalists Ivan Oransky and Adam Marcus launched Retraction Watch (http://retractionwatch.wordpress.com), a blog devoted to the examination of retracted articles. They are currently leading a specialized team working to develop the first comprehensive and freely available database of retracted scientific articles, which is expected to be finished by the end of 2016. CrossRef and CrossMark, developed specifically to detect specific strings of characters, could easily be linked to the retracted-article database to identify citations of retracted papers, and the results of the search could be a part of the evaluation report for a submitted article.

Software developed to detect plagiarism, such as Turnitin, can be used to detect the citation of retracted papers by cross-checking with a relevant database. This method represents a fast and cost-effective way to

ensure that retracted papers are not cited as valid work. Our proposal would require little additional investment, and could be crucial in keeping fraudulent research from negatively affecting the development of future knowledge. We urge journal publishers in conservation and other scientific fields to take this small but an important step toward achieving a transparent and honest publication system that governments and the public can trust.

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