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Call for a critical review of widespread use of animal tracking devices

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Abstract

Animal tracking has undergone a technological revolution providing insight into biological details that were impossible to address until now. However, the increasing ease of access to tracking devices (biologgers) may lead to trivializing this technology. Consequently, many projects may not extract as much scientific knowledge as possible and neglect the ethical duties towards the tagged animals. Here we demonstrate this process of trivialization empirically on a local and global scale and propose some guidelines to avoid it.

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Abstract

Animal tracking has undergone a technological revolution providing insight into biological details that were impossible to address until now. However, the increasing ease of access to tracking devices (biologgers) may lead to trivializing this technology. Consequently, many projects may not extract as much scientific knowledge as possible and neglect the ethical duties towards the tagged animals. Here we demonstrate this process of trivialization empirically on a local and global scale and propose some guidelines to avoid it.

Keywords: biologgers; GPS; impact assessment; regulations; telemetry.

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The golden age of animal tracking also has a dark side.

Technological advances in animal tracking devices (biologgers) have turned movement ecology into a discipline itself (Nathan et al. 2008). This area has drastically grown, as evidenced by the 13.5% annual growth rate in the number of studies registered during the last two decades in Movebank, the main repository for animal movement data (www.movebank.org). However, many of these projects are characterized by small sample sizes, and often they do not generate any scientific knowledge (Campbell et al. 2015), which could lead to a trivialization of biologging and its ethical implications.

Potential undesired effects associated with biologging.

The process of capturing an animal is always a stressful experience and potentially harmful to the individual's health (Denis et al. 2012). In addition, the attachment of biologgers forces the animal to carry an artificial device that conditions its physiology, behavior and ecology or even causes injuries (Wilson et al. 1986; Bodey et al. 2018; Fritz et al. 2020; Clewley et al. 2021). Thus, carrying a biologger represents an individual disadvantage that can cause adverse effects in both the short and long term, ultimately affecting both reproductive success and survival (e.g. Bodey et al. 2018; Gillies et al. 2020; Portugal & White 2020; Puehringer-Sturmayr et al. 2020; Homberger et al. 2021). Cannot excluded that the accumulation of these effects may condition population trends and even become a conservation problem in the case of rare or endangered species. But even in the case of non-endangered or abundant species, we must not lose the ethical duty to preserve the welfare of study animals. Therefore, we must ensure that the number of animals marked complies with the ethical pillars of the three Rs of Reduce, Replace and Refine (Russell & Burch 1959).

In addition, biologgers are high-tech devices composed of potentially polluting elements, such as lithium, plastics or carbon fiber (Akram et al. 2019). These materials are often difficult to recover or recycle, so they will most likely be abandoned in the environment. Although despicable in a global context, this is an additional undesirable effect that should be considered when planning a biologging project.

Overall, the sum of the risks to the individuals and species under study and the possibilities of contamination are sufficiently high that we must ensure that the scientific knowledge generated by a biologging project is the maximum possible. Therefore, the trivialization of biologging and its use for anecdotal purposes or for mere personal curiosity is a phenomenon which should be avoided.

Small sample sizes, the first symptom of trivialization

This decoupling between the information generated and the achieved scientific knowledge could be partly due to the increasing accessibility of biologgers, which facilitated its use by non-research organizations like NGOs, administrations, foundations, or private companies. The objectives of such organizations are often non-scientific, which means that the experimental design rarely responds to scientific criteria and goals. For these reasons, sometimes these organizations promote studies with small sample sizes and random device settings which in the end hinders the standardization and sharing of information (Williams et al. 2020). However, these problems are not exclusive to non-research organizations as researchers also incur on them, especially when the tagging of individuals is done in an exploratory way and with no prior background or without a solid proposal for future development. Of course, sample size *per se* may not always be an appropriate metric to assess scientific quality because a few individuals might suffice to answer some pressing questions (Sequeira et al. 2019). This could be the case of species whose ecology impedes other techniques or species to which little scientific attention has been paid to date. Nevertheless, small sample sizes constrain examining in depth fundamental ecology and conservation biology questions such as the response to different threats of different age classes and sexes or whether there are differences in the use of space between different populations or species.

In this context, the current increase in the proportion of projects with a few tagged individuals (Figure 1) might be considered as a symptom of the trivialization of equipping wild animals with biologgers without considering their potentially adverse consequences.

Decreasing scientific outcome in biologging projects

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Despite the increasing use of online repositories such as Movebank, the information on publications generated by each biologging project is difficult to track, especially in the case of grey literature. Consequently, it is challenging to analyze to what extent the use of biologgers is really being trivialized. To solve this lack of information, we have conducted an exhaustive search to review all the biologging projects performed on diurnal and nocturnal raptors (hereinafter raptors) in the Iberian Peninsula from 1978 to 2020 (N=462). Raptors are one of the groups of birds in which, historically, more biologgers have been installed because, due to their size, they offer fewer limitations in terms of the type of device to install. Consequently, they have received more attention from researchers compared to other groups of animals. For this reason, they are an excellent study model to examine the evolution of the output of biologging projects. We recorded the number of biologgers used in each project and if they generated scientific papers (i.e. peer review articles), grey literature (i.e. technical reports, popular publications, communications in conferences or congresses, etc.) or if, on the contrary, they were not published in any format. To assess whether there have been any changes in publication trends, we divided our dataset into projects which started before (N=45) and after the year 2000 (N=401). We established this threshold to make the periods more comparable to the period analyzed in Movebank database (See Figure 1). For these analyses, projects with an uncertain starting date were excluded (N=16).

Only 22.3% of the raptor projects analyzed have led to any scientific paper, while 38.1% of the projects contributed to grey literature, and 39.6% have not been published (Figure 1). Based on these results, most of these projects do not generate easily available scientific knowledge. In this regard, it is essential to highlight that although grey literature may have an important applied value (e.g. technical reports for environmental managers), this kind of publications is much more difficult to track than a peer-reviewed journal which keep from extending their application beyond the local scale. Therefore, their impact is more limited. Also, it is noticeable that there has been a drastic increase (χ^2= 106.74, df = 2, p < 0.001) in projects that do not generate any publications and a decrease in projects that generate publications, especially scientific publications (Figure 1).

Our results also showed that biologging projects including more devices (i.e. a larger number of tracked animals) are more likely to generate scientific publications (ANOVA, F=10.68, p<0.001; Figure 1). In this sense and considering the average number of biologgers per project in each of the categories of publication output, the threshold of 10 biologgers that we established in our analysis of Movebank's data (Figure 1) seems to be a good reference to predict if a project will generate publications or not. In addition, this result may be useful in establishing a minimum sample size limit that is both ethically acceptable and scientifically productive (Hebblewhite & Haydon 2010). Based on our findings, we can conclude that the rise in projects with limited sample sizes is not aligned with the primary objective of advancing scientific knowledge and making it available globally. Therefore, results at local scale in our raptors dataset reinforce concerns about the global trend in Movebank data (Figure 1) and evidence the process of trivialization of biologging.

Wildlife handling regulations and their effectiveness

There are no internationally consensual regulations for the installation of biologgers in wildlife. Consequently, it is challenging to delineate recommendations to minimize the risks associated with indiscriminate biologging and, at the same time, to get the maximum possible scientific knowledge from the data obtained.

To assess the situation on a global scale, we conducted a brief survey distributing it among our collaborators with expertise in biologging. We asked them: a) in which countries they installed biologgers; b) if in that country, there are regulations for the capture and handling of wildlife including biologgers installation (yes, no, do not know); in the case there are regulations, c) if they are effective in guaranteeing the welfare of the study animals (ineffective, improvable, excellent); d) if they effectively guarantee that the data obtained culminate in a scientific publication (ineffective, improvable, excellent). Finally, and to compare with the results obtained in our example of Iberian raptors tracking projects, we asked them in their opinion what proportion of the biologging projects they think do not produce scientific publications (<25%, 25-50%, 50-75%, >75%).

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We received responses from 29 researchers from 30 countries. Most of these countries (N=27) have regulations for wildlife handling (Figure 2). Only three of the countries do not exit any regulation at all. Surprisingly, we received contradictory information from 3 countries. In these instances, some participants answered that there are regulations for their country, while others claimed the opposite for the same country. These contradictions can reflect how even the application of existing regulations can be variable and confusing or might depend on regional aspects, as occur in the Galapagos Islands, where it applies a much more restrictive regulation than the rest of Ecuador (pers. comm.). Only 10% of participants considered the current legislation to be adequate (Figure 2), which may indicate that, on a global scale, existing regulations designed to prevent adverse impacts for tagged individuals do not perform their tasks properly. In parallel, most researchers (75%) responded that they considered it completely ineffective in guaranteeing data publication (Figure 2) and suggested that regulations poorly evaluate the results of biologging projects. This lack of control is probably the main reason why we find such high rates of projects conducted with Iberian raptors that do not generate any publication (Figure 1). Finally, the general opinion of the researchers surveyed (53.6%) is that between 25% and 50% of biologging projects do not produce scientific publications (Figure 2). This result agrees with what we observed in the case of the Iberian raptors (see above and Figure 1) and reinforces our assumption that our study model represents accurately what happens on a global scale.

The way forward

Biologging has become indispensable for ecologists. Thus, we must guide it towards a rational use that further deepens animal knowledge while minimizing the associated risks. Stakeholders could face this challenge in two ways. First, authorities should implement more efficient evaluation committees for biologging projects which should only be authorized if their objectives and potential results are duly justified. To simplify this task, authorities may utilize decision rules based on expert knowledge, as occur with wildlife translocations (IUCN 2013). Second, data sharing enables common goals without undermining individual objectives, as demonstrated, for example, by collaborative projects emerged from COVID-19 pandemic (Rutz et al. 2020). These initiatives are roadmaps for collaborations promoting the exchange of experiences. Additionally, projects supported with public funds should include the mandatory requirement to make their data public after a reasonable embargo period. Recent European Directives, such as Directive 2019/1024/EU, point in this direction promoting the reuse of public information.

Biologging may be a powerful tool for ecology and biodiversity conservation. However, it has developed so quickly that its ethical limits have not been properly addressed. Thus, it is time to reflect on and look for the most optimal and ethical way to continue studying animal movement.

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Figure 1: Panel A shows the proportion of studies with small sample size (less than ten individuals equipped with biologgers) registered annually in Movebank. Results show a significantly increasing trend during

the period 2000-2021 (linear model, $R^2 = 0.72$; $p < 0.001$). Panel B compares raptor biologging projects conducted in the Iberia Peninsula (N=462 between 1978 and 2020) before and after the year 2000 according to their scientific output: scientific papers, grey literature or not published in any format. Panel C represents the number of tracked birds in each raptor biologging project performed in the Iberia peninsula. Projects with insufficient metadata were excluded.

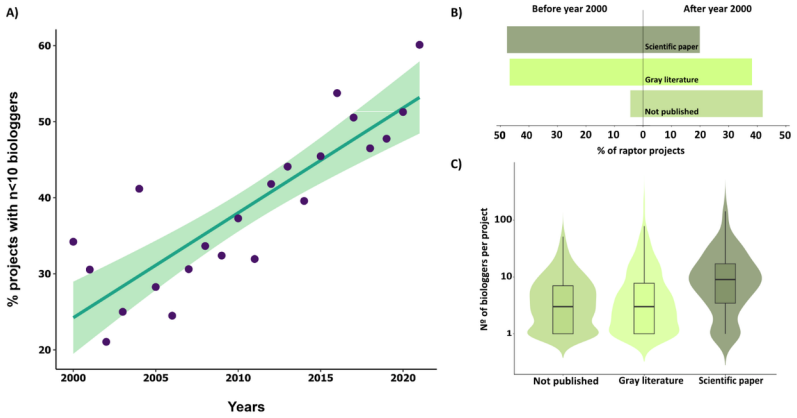
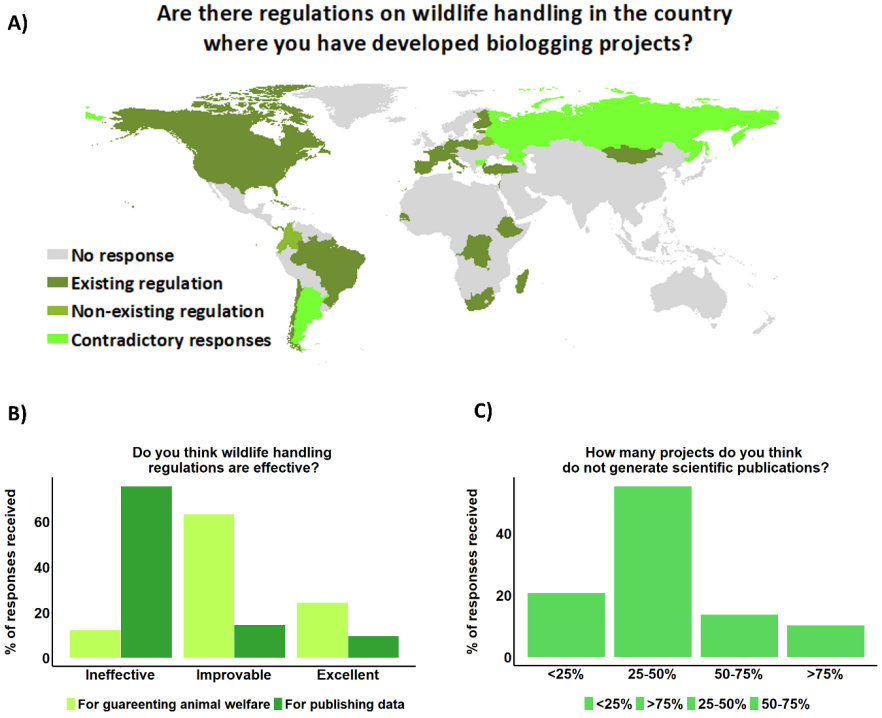


Figure 2. Results of the questionnaires on wildlife handling regulations and publication of research outcomes by countries. Information was obtained from 29 countries and 30 researchers. Panel A: represents the geographic variation in the existence of animal handling regulations per countries. They were identified as "contradictory responses" when several participants from the same country responded in opposite terms. Panel B: shows researchers' opinions on the effectiveness of animal handling regulations. Panel C: shows the proportion of projects with no publication results in the opinion of the researchers surveyed.



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