



# 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 previously impossible to address. However, the increasing ease of access to tracking devices (biologgers) may lead to trivializing this technology. As a result, some projects may fail to generate enough scientific knowledge to ethically justify the capture and handling of wild animals. Theoretically, bioethical regulations should be enough to prevent this phenomenon. Nevertheless, given that biologging has developed recently and at a spectacular speed, it is possible that these regulations may not have adapted in a timely manner to the new reality. To illustrate this point, we present as example the biologging projects on Iberian raptors, which show a decrease in their scientific outputs. Furthermore, we show how the general opinion of experts is that current wildlife handling regulations are ineffective. Finally, we propose ten key points which we consider would help to improve these regulations, adapting them to the challenges of biologging.

## Clinical trial

Not applicable.

**Keywords** Biologgers · GPS · Impact assessment · Animal handling regulations · Telemetry

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

Technological advances in animal tracking devices (biologgers) have transformed movement ecology into a distinct discipline (Nathan et al. 2008). However, this novel and powerful tool is not free of inherent risks for the individuals studied. The process of capturing, handling, and tagging an animal is an inherently stressful experience that can compromise individual's health, its physiology, behavior or even the survival probability (Wilson et al. 1986; Dennis et al. 2012; Bodey et al. 2018; Fritz et al. 2020; Clewley et al. 2021). Furthermore, 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 lost in the environment after drop-off or the animal's death. Although this is an almost insignificant contribution to global pollution, it is still another undesirable effect to consider. Overall, the potential undesired consequences are sufficiently high that we must attempt to extract as much knowledge as possible from each project to make these risks worthwhile. Consequently, it is also essential to ensure that the authorization processes for biologging projects are conducted with the utmost rigour. However, there is evidence to suggest that this is not always the case, which would constitute a negligent use of such an important tool as biologgers.

## Biologging projects, scientific outcome and wildlife handling regulations

There is considerable evidence that the data generated by a significant proportion of biologging projects are never published. For example, Campbell et al. 2015 found that nearly half of the animal tagging projects in Australasia were never published.

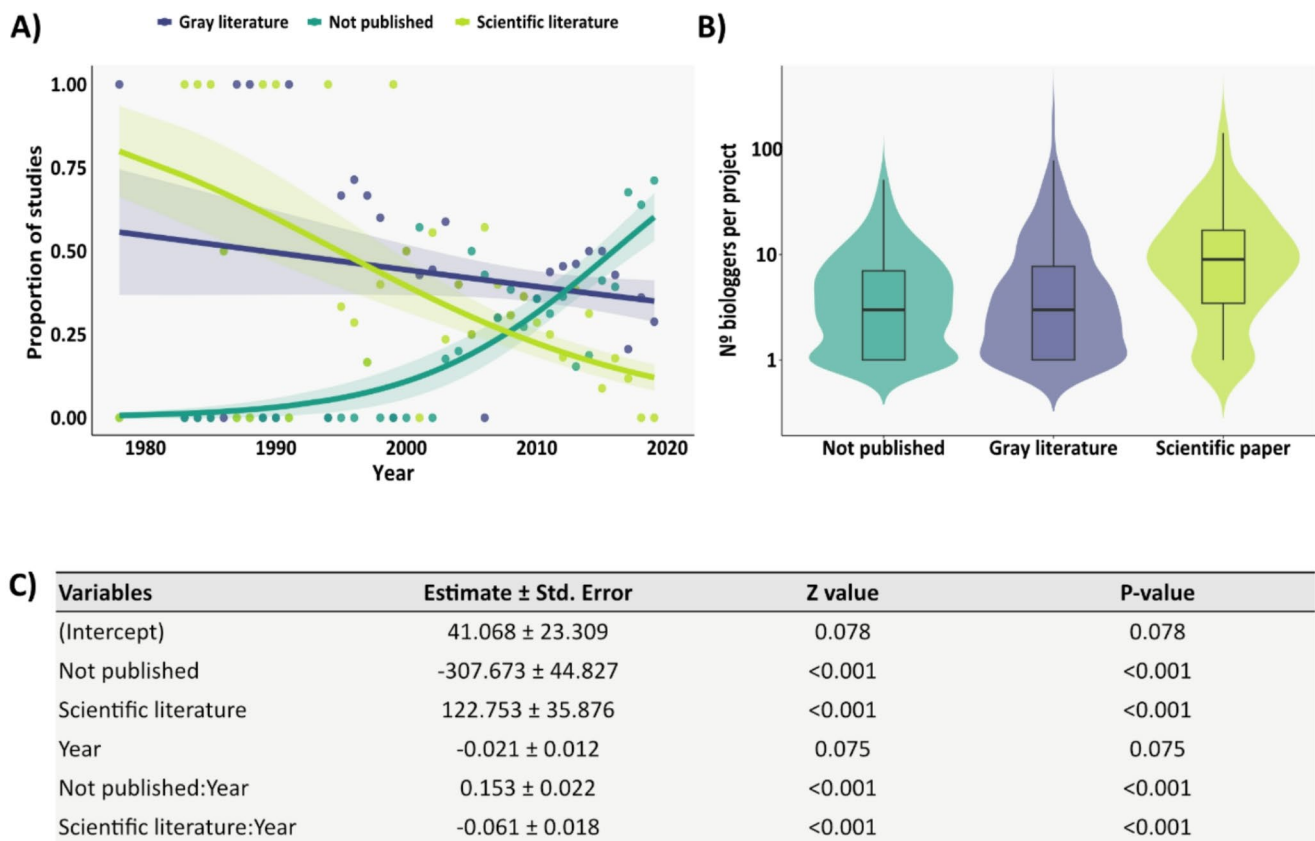
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To ascertain whether there are historical trends and identifiable patterns in this phenomenon, we have used as a study model the biologging projects performed with raptors in Iberia. Raptors were selected as a model species due to their extensive history of monitoring with telemetry devices in these countries, facilitating comparative analysis and leveraging existing datasets. Through public data requests to regional and national administrations, combined with direct inquiries to project managers, we compiled a comprehensive list of biologging projects performed on raptors in the Iberian Peninsula from 2000 to 2020 ( $N=462$ ). We recorded the number of tagged birds (i.e. sample size) used in each project and the project output classified as scientific papers (i.e. peer-review articles), grey literature (i.e. technical reports, popular publications, communications in conferences, etc.) or if, on the contrary, they were not published in any format (a detailed description of methodology were included in supplementary material). Only 22.3% of the projects analyzed have resulted in the publication of a scientific paper. In contrast, 38.1% of the projects have yielded contributions to grey literature, while 39.6% remain unpublished. These findings indicate that most of these projects

do not generate easily available scientific knowledge. It is essential to note that although grey literature has significant applied value (e.g. technical reports for environmental managers), but these publications are much more challenging to track and access than peer-reviewed journals. We analyzed trends in output types using a generalized linear model (GLM). The response variable was the annual proportion of projects for each output type, and the explanatory variables included the interaction between project initiation year and output type (see supplementary material for details). This model reveals a declining trend in projects resulting in scientific publications and an increasing trend in projects yielding no outputs (Fig. 1A and C). Our results also showed that projects yielding scientific literature had higher sample size (ANOVA,  $F=10.68$ ,  $p<0.001$ ; see Fig. 1B for details). Sample size per se is not an appropriate metric to assess scientific quality. However, the growing proportion of projects that fail to generate publications combined with the increasing trend in the number of projects with small sample sizes, suggests that a process of biologging trivialization is indeed occurring.



**Fig. 1** Panel A shows the trend in the proportion of Iberian raptor biologger projects producing each type of output (i.e., scientific literature, grey literature, unpublished). Panel B shows the number of biologists (i.e., tagging birds) used in Iberian raptor biologging projects

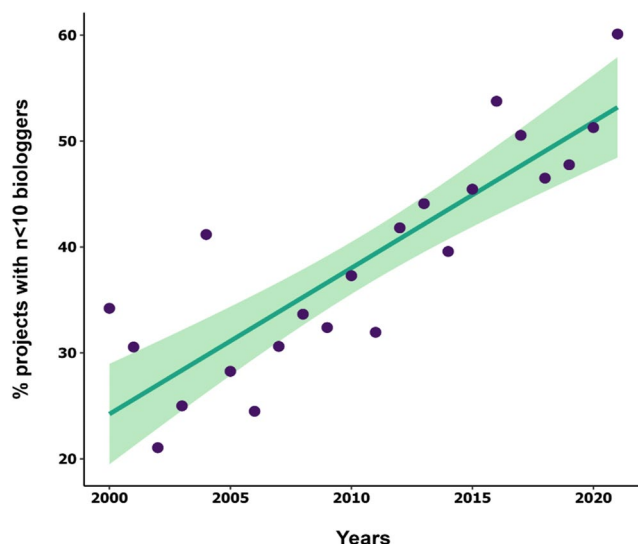
according to the type of output they produce. Finally, panel C is the table of results of the binomial model run to analyze the temporal trends in the proportion of projects producing each type of output (see supplementary material for more details)

Our approach is subject to certain limitations, mainly due to its focus on a single taxonomic group and region. For this reason, in order to take a more global perspective, we conducted a survey of data recorded in Movebank ([www.movebank.org](http://www.movebank.org)), the main animal movement data repository (see supplementary material for details). We used a linear model to examine whether there was a temporal trend in the annual number of projects reporting a low sample size (fewer than 10 biologgers). The results obtained from this analysis revealed a statistically significant rise in the number of projects with low sample sizes ( $p < 0.001$ ;  $R^2 = 0.72$ ; Fig. 2). This finding suggests that the potential trivialization identified in raptor biologging projects might reflect a broader global trend.

One possible explanation for the process of trivialization is that wildlife management regulations might not be effective, allowing projects to be authorized without pre-implementation and post-implementation evaluations. There are no internationally agreed regulations for the deployment of biologgers in wildlife. Thus, to assess the situation on a global scale, we conducted a brief survey distributing it among the researchers we are aware of who have international experience in biologging (see the detailed survey methods in the supplementary material). We asked them: (a) In which countries they deployed biologgers; (b) If in that country, there are regulations for the capture and handling of wildlife including biologgers deployment (responses: yes, no, do not know); (c) In the case there are, we also asked whether the regulation were effective in guaranteeing the welfare of the study animals (responses: ineffective, improvable, excellent), and whether they effectively guaranteed that the data obtained culminated in a scientific

publication (responses: ineffective, improvable, excellent). Finally, e) we asked the respondents to estimate what proportion of the biologging projects they think do not lead to scientific publications (responses: <25%, 25–50%, 50–75%, >75%).

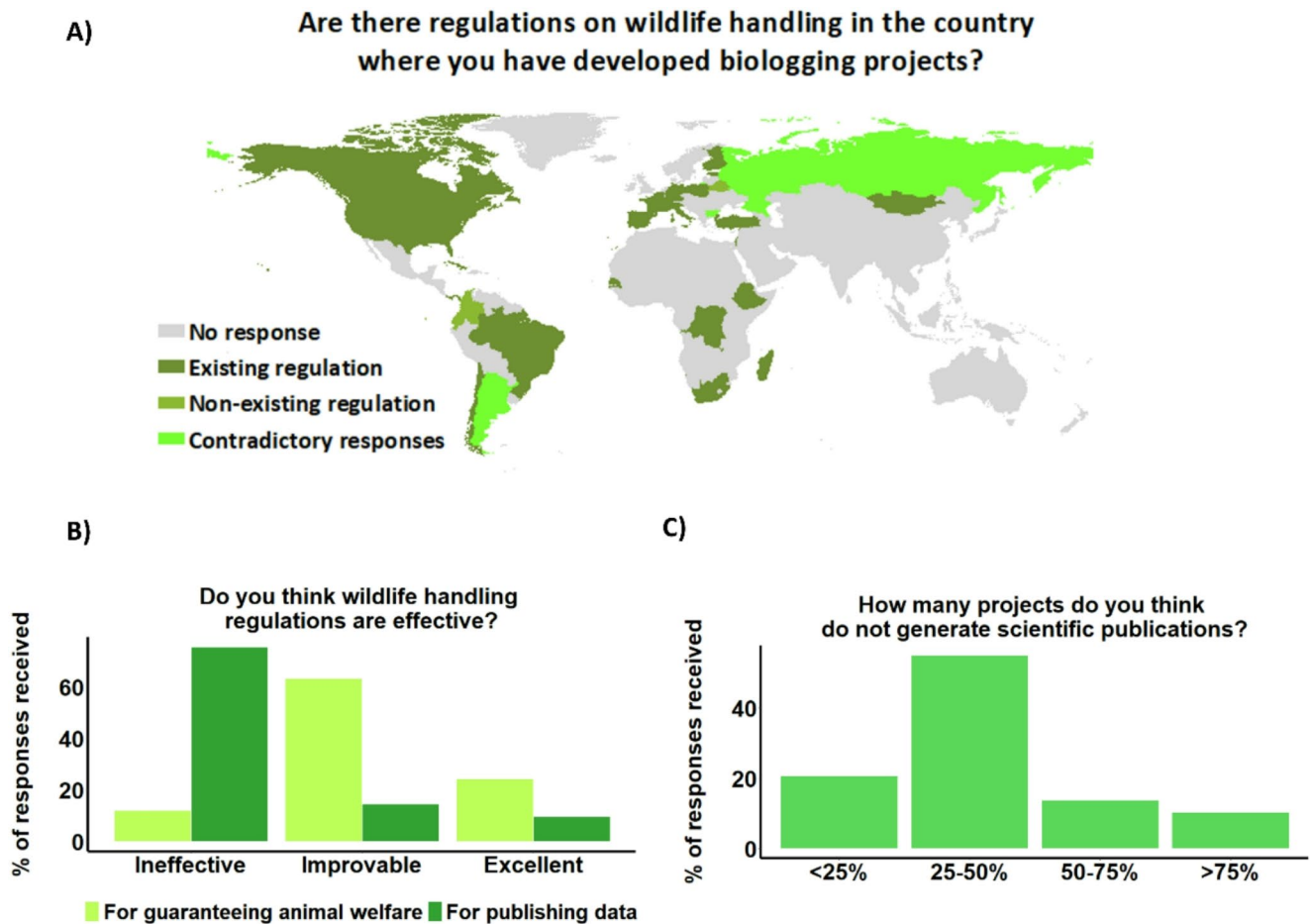
We received responses from 30 researchers providing information about 29 countries. Although it may seem a low sample size, this encompasses 20% of the countries with projects registered in Movebank until 2020 covering 71.5% of the projects registered until that date with useful metadata. The responses indicated that the majority of the surveyed countries ( $N=26$ ) have established regulations for wildlife handling (see Fig. 3A). However, it should be noted that three of these countries do not currently have any regulations in place. We received contradictory information from three countries, with some participants indicating the existence of regulations for a specific country, while others claimed that no such regulations exist. These contradictions can reflect how even the application of existing regulations can be variable and confusing or might depend on regional aspects. In addition, 75.5% of respondents consider that current regulations do not adequately ensure the welfare of the studied individuals or that they require improvement (Fig. 3B). This may indicate that these regulations are failing on a global scale to protect the individuals studied. Additionally, most researchers (75.0%) expressed complete dissatisfaction with the regulations in guaranteeing data publication (Fig. 3B) asserting that regulations poorly evaluate the results of biologging projects. Lastly, most of the surveyed researchers (75.9%) believe that less than half of biologging projects produce scientific publications (Fig. 3C). These findings are limited and should be interpreted with caution but align with our observations in the case of the Iberian raptors, reinforcing our assumption that our study case accurately reflects what happens on a global scale.



**Fig. 2** Annual trend in the percentage of projects registered in Movebank ([www.movebank.org](http://www.movebank.org)) per year with less than 10 biologgers (i.e. tagged animals)

### Ten points to reflect on

Our results, while limited, indicate a possible trivialization of biologgers use and highlight the need for wildlife management regulations to adapt to this evolving reality and to ensure animal welfare. In the last two decades, the principles of the three Rs (Replace, Reduce and Refine) for animal protection in experimentation (Russell and Burch 1959) have been incorporated into various legislative actions worldwide (e.g. Directive 2010/63/EU). The 3R implementation in wildlife studies not only helps to maximize the safety of the species studied but also to reduce the effect of the researcher (Lindsjö et al. 2016). The overarching objective should be to develop a tool that allows managers to quickly and easily assess



**Fig. 3** Results of the questionnaires on wildlife handling regulations and the publication of research outcomes by country. Information was obtained from 29 countries and 30 researchers. Panel **A** represents the geographical variation in the existence of animal handling regulations per country. These were identified as “contradictory responses”

when several participants from the same country gave conflicting answers. Panel **B** shows researchers’ opinions on the effectiveness of animal handling regulations. Panel **C** shows the proportion of projects that yielded no publication results in the opinion of the researchers surveyed

whether a biollogging project should be authorized. This evaluation process would not only apply to projects submitted by external organizations, such as NGOs, research groups, or companies, but would also encompass those managed by the authorities themselves. In this sense, drawing upon the decision-making process used to assess whether a species should be introduced or translocated (IUCN 2013) could serve as a useful benchmark. In this framework, the responsible authorities would base their decision to authorize a biollogging project on several factors, including the project’s objectives, three R principles, the conservation status of the species involved, and the final use of the data generated. While acknowledging that creating such a tool necessitates extensive discussion and consensus, we propose ten points that we consider essential to assess.

1. **Objectives:** The core of the authorization process should involve a robust justification of the objectives of a biollogging project. There should be priority objectives and inevitably lower priority objectives. For example, in our opinion, conservation or research projects should have a higher priority than compensatory measures for environmental impacts or educational programs.
2. **Alternatives:** Efforts should be made to replace biollogger deployments with alternative techniques. It is acknowledged that loggers provide unparalleled information; however, situations where such extensive data is unnecessary should prompt the exploration of valid non-invasive alternatives. For instance, camera-traps can be used to estimate occupancy, while radar can be employed to monitor local movement patterns.
3. **Sample size:** In one hand, continuing with the principles of the three Rs, reducing or minimizing the number of biologgers needed for a project should be a priority.

Additionally, our results indicate that overly small sample sizes may not yield the desired output. Therefore, we believe that during the authorization process, project managers should justify the appropriateness of the proposed sample size (i.e., number of biologists used) in relation to the objectives. It is important to clarify that the goal is not to set a minimum or maximum number of biologists required, as this could potentially disadvantage low-funded research groups or pilot studies. Moreover, in certain cases, a small number of devices may be enough, for example when monitoring cryptic or understudied species. Instead, the emphasis should be on ensuring that authorities verify the existence of well-founded reasons for the proposed number of devices.

4. **Refine methods:** Refinement of procedures should include not only the tagging, but also the methods of capture, anesthesia and handling. It is essential to promote the utilization of the most recent and evidence-based techniques, knowledge sharing, and the dissemination of the outcomes of the various techniques (including negative results). Furthermore, improvement of capture, handling, anesthesia and tagging techniques would minimize accidental casualties, and reduce the effects of biologists devices on experimental results. For example, using smaller or more aerodynamic devices could improve the survival of the species under study and lead to unbiased results.
5. **Study species:** Some species are known to be more sensitive to handling or deploying of biologists. Since environmental managers may not have knowledge of all species likely to be equipped with biologists, it is the responsibility of the project promoters to demonstrate that there is sufficient evidence that it is safe to equip the species under study with a biologist and/or protocol specifying the measures to minimize the risks.
6. **Existing information:** Currently, there are a multitude of ongoing or concluded biollogging projects. Reusing this information should be a priority. Therefore, during the authorization of a new project, it must be explicitly communicated whether there is no useful information available or that if it exists, it was not accessed or remains insufficient for the proposed objectives. To facilitate this process, the authorities should provide a database with information (e.g. study area, study species, number of biologists deployed, setting of the biologists, etc.) on the projects previously authorized.
7. **Results evaluation:** Our results suggest that the evaluation and accessibility of biollogging project outcomes is inadequate. Therefore, project outputs (e.g. technical reports, scientific papers, etc.) must be publicly available alongside the relevant information provided by authorities. In addition, promoters who consistently fall short of their commitments should face penalties in subsequent evaluation processes.
8. **Data availability:** Many biollogging projects, often funded by private entities (e.g. NGOs, foundations, or private companies) but even those funded by public funds, are not required to make data publicly available. Despite emerging initiatives, such as the 2019/1024/EU of the European Union, to encourage promoters to make their data publicly available for reuse in other projects, it is clear that these initiatives are not yet having the desired effect. Therefore, it is essential that the authorities prioritize projects committed to this practice and that they take action to ensure that all data is made publicly available after a reasonable embargo period. It is also worth emphasizing that this question extends beyond the animal's movement data and should encompass additional critical metadata, such as sex, age, morphometric measurements, and other relevant variables.
9. **Standardization:** Following the example of other tools commonly used in ecology (e.g. camera trapping), biollogging should aim at the standardization of protocols and methods. In many cases, the sampling schedule of the devices (e.g. fix interval) is so specific that it makes it impossible to standardize and reuse the data (Williams et al. 2020). This is particularly evident, but not exclusively, in the case when the project promoters are private entities (e.g. NGOs, foundations or private companies). In these cases, their objectives are not strictly scientific and, therefore, they do not need homogeneity in the data. Following the previous section, authorities must prioritize projects that are committed not only to making their data public, but also, to adhering to standardized guidelines.
10. **Efficiency:** It is essential to underscore that changes in wildlife handling regulations should focus on improving the performance of biollogging projects. Therefore, it is necessary to avoid that the modification of the current regulations result in bureaucratic delays to the projects. This could be achieved by incorporating the new requirements into existing evaluation processes (e.g. environmental or bioethical authorizations).

Biollogging stands to be a powerful tool that has become indispensable for scientists, managers and conservationists. It is our responsibility to guide it towards a rational use that not only enhances our understanding of animal behavior but also minimizes the associated risks. Now is the time to reflect on and look for the most effective and ethical way to continue studying animal movement.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s10344-025-01906-7>.



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**Author contributions** E.A. conceptualized the main idea, J.M.P.G. collected the data and both contributed equally to the drafting of the text.

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**Data availability** No datasets were generated or analysed during the current study.

## Declarations

**Competing interests** The authors declare no competing interests.

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