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Archiving primary data: solutions for long-term studies

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The recent trend for journals to require open access to primary data included in publications has been embraced by many biologists, but has caused apprehension amongst researchers engaged in long-term ecological and evolutionary studies. A worldwide survey of 73 principal investigators (PIs) with long term studies revealed positive attitudes towards sharing data with the agreement or involvement of the PI and 93% of PIs have historically shared data. Only 8% were in favor of uncontrolled, open access to primary data while 63% expressed serious concern. Here we present their viewpoint on an issue that can have non trivial scientific consequences. We discuss potential costs of public data archiving and provide possible solutions to meet the needs of journals and researchers.

Keywords: Public data archiving, long term studies

Long-term data sharing

Several funding agencies, international regulatory bodies and many major ecological and evolutionary journals now require raw or primary data to be deposited in a permanent open access archive, such as Dryad or TreeBASE, as a condition for funding or publication. The data must be in sufficient detail to allow the analyses in the paper to be replicated. The rationale for open archiving is that archived data are available to posterity when studies are completed, for error checking, for use in new studies, or for future meta-analysis [1]. In addition it has been argued that the policy would benefit data providers by increasing their citation index through citations by papers with new analyses [1, 2].

Although it is claimed that over 95% of scientists in evolution and ecology believe data should be publicly archived [1], mandatory public data archiving (PDA) is raising many issues in the scientific community as evidenced by debates on websites, in blogs and publications [2-10]. Here we focus on the perspective from long-term individual-based studies of wild populations that often span several decades.

Short and long-term ecological studies differ in several important aspects. For example, in the former, data tend to be collected over a short period of time for one or two papers and once published the data in these papers become less valuable to the collector and can be more useful to others with different perspectives or analytical skills. In contrast, in studies that have followed individuals over their lifetimes, a lot of crucial information is assessed from derived metrics (e.g. survival, lifetime reproductive success) that can only be estimated after many years of fieldwork. Therefore, much value can remain in the primary data even after some of the initial questions are answered.

Long-term studies are rare and have great scientific value since many important questions in ecology and evolutionary biology can only be answered from the life histories of recognizable individuals [11]. A detailed analysis of the importance of individual-based studies has been documented elsewhere [11], but a few examples are given in Box 1.

While group discussions and blog posts on PDA related issues have been flourishing, little is formally known and published about the position and concerns of people collecting long-term data. To fill this gap, a survey was conducted to learn their perspectives, and if current data requirements were perceived as problematic, to identify potential alternative data-sharing policies that could be acceptable to the journals, the scientific community and the Principal investigators.

The survey

To obtain the opinions of scientists with individual-based longitudinal data, a worldwide survey was sent to 146 PIs of long-term research projects. Responses were received from 73 PIs working on 59 bird studies, 13 mammalian studies and 1 plant study. The 92 projects (some PIs have several projects) range in duration from 5 to 68 years (Figure 1), with 55 percent collecting data for more than 30 years. Thirty-five percent of researchers were required to archive data used in a publication by their current funding agency and 19% by their institution. Eight researchers were required to deposit data by both; therefore 59% were not required to archive their data. There was diversity of opinion among PIs about data archiving, but some strong points of consensus emerged. This paper synthesizes the views of all respondents, many of whom have made important contributions to ecology and evolution.

The survey revealed that virtually all PIs were in favor of data sharing with the agreement or involvement of the PI. Historically, 93% of the respondents have shared their data when asked and 80% have collaborated in meta-analyses. In the 1960-70s publications using longitudinal data often involved only one or two authors. However, over the past two decades studies have become more complex and collaborative, with studies commonly involving collaboration among biologists with expertise in a variety of disciplines.

Overall, 63% of PIs were against PDA as currently required. This contrasts with a previous survey of ecological and evolutionary biologists that reported that 95% were in favor of PDA [1]. Among the 36% of respondents in favor of open access data archiving in this survey, only six (8% of 73) were in favor of unconditional data archiving. The reasons given by PIs in favor of PDA were similar to those advocated by the archiving journals. In contrast, 91% of PIs supported data sharing when clear rules for data access were in place. These rules could include i) co-authorship or at least acknowledgment, depending on the level of PI involvement; ii) no overlap with current projects, particularly projects conducted by students or postdoctoral fellows; and iii) an agreement that the data go no further than the person to whom it is entrusted.

General concerns about PDA

The main issues about archiving were centered on what data would be archived and to whom access would be given, as detailed below. However, these concerns are so strong that 41% of respondents said that they have avoided publishing in journals that require data be deposited in open access archives. Furthermore, 53% intend to avoid publishing in them in the future and for those who published a major paper involving long-term data early in their careers, 63% indicated that they would not have submitted it to any journal that required data archiving. Avoiding publishing in a high impact journal can have major consequences in terms of career advancement and could potentially reduce the prospects of obtaining future financial support; therefore the decision would not be taken lightly.

In discussions among the survey respondents, it was suggested that the design and data collection of a long-term study is research infrastructure that is the foundation of the publications which form the lifework and careers of researchers and the PhD students and postdoctoral fellows who work on these programs. The analogy can be made to experimental infrastructures which involve the construction of an apparatus that takes years, or sometimes decades, and requires numerous grant applications, institutional support, and deferred publication effort, all of which involve significant risk, but potentially have profound scientific value, both pure and applied. Developing the infrastructure is a necessary pre-requisite for project completion. In this case it would not be reasonable for other scientists to have immediate access to the fruits of the inventor's labors. Furthermore, compulsory and unrestricted open access to the apparatus would provide a strong disincentive to making the initial infrastructural investment. The same case can be made for long-term ecological studies.

Specific concerns from long-term researchers about PDA

Several concerns about the costs of PDA for researchers and the scientific community were addressed previously [5]. Here we add the perspective of PIs with long-term studies. Three major concerns were identified during the survey.

Potential costs to science

Flawed science: A major cost would be flawed science resulting from a lack of understanding of the database or the biological system. Open access to long-term data might not allow for a full understanding of all the subtle contexts, nuances and issues involved in the biological system and the structure of the database from which the long-term data are collected. It has been argued that if method sections are sufficiently detailed, misunderstanding the system should not be a major source of error [54]. However, not all of the complexities of the biological system can be detailed in a method section without making a paper unwieldy. Hence, without the PI's involvement, crucial contextual information is likely to be lost under open access, leading to the potential for erroneous assumptions and interpretations which could add to the growing retraction rate in scientific journals [55]. For example, although it was not included as a question, three respondents of the survey indicated that on four occasions their data have been misinterpreted in publications, and once published, errors or misinterpretations are hard to remove**.**

More time spent on redundant activities: A potential cost would be simultaneous testing of the same idea on the data. In some cases, hypotheses might have been already investigated but not published by the PIs because they were inconclusive. In addition, the cost of monitoring publications that used PDA and writing replies would be borne by the researcher with long-term data and not the scientific community. These do not seem to be a productive use of research investment.

Fewer long-term studies: Open access archiving could reduce the incentives for carrying out long-term studies and would likely result in researchers suspending ongoing studies and declining to undertake new ones. This is predicted by the producer-scrounger game theory [56] where the producer spends time and energy to develop a resource but is unable to monopolize it, thereby creating opportunities for the resource to be exploited by scrounger(s). Over time as the scrounger strategy increases, the resource decreases. In theory, the fitness of the producer and the scrounger decreases, because at some point there are no more resources to scrounge since no more resources are being produced [57,58].

Less collaboration: New collaborations are extremely valuable to make the most of the data but comparative analyses and meta-analysis among long-term studies would likely suffer because PIs might decline to participate if they are required to archive their data.

Research funding

Several financial issues have been overlooked by advocates of PDA. Archiving mutualizes the benefits, but not the costs of long-term studies, because there is no cost to the person accessing the data. This might be a sustainable model when recurrent funding is available, but not when funding is granted on a per project basis. Also, PDA could incur some new costs for long-term studies since Dryad, for example, has required extra payment for large data sets. Researchers with scarce funding might not be able to absorb this additional cost. Maintaining constant funding is a critical issue for long-term studies to avoid fatal gaps in the data [11, 59], contrasting once again with short-term studies that can be restarted at a later time. Long-term studies of all durations experienced difficulties with funding (Figure 2) as only 33% were fully funded in all years with the remainder having funding gaps varying in duration from 1 to 19 years (Figure 2). To maintain funding, PIs with long-term projects have to keep identifying new uses of the data to obtain short-term funding because recurrent funding is essentially nonexistent [11]. Therefore, PDA could lead to a loss of funding opportunities if data for their next project are routinely mined by other researchers.

Student experience and training

A major contribution of long-term studies is that they often provide training to PhD and other postgraduate students and postdoctoral fellows. The PIs that responded to the survey, reported that from their 92 projects, 630 PhDs were awarded (Figure 3a) and 658 postgraduates and 257 postdoctoral fellows participated, for a total of 1,545 trainees. This represents a substantial contribution to the training and development of the ecological and evolutionary biology research community. Survey respondents expressed a particular concern that PDA would negatively impact this important feature of long-term studies because negotiations take place among study participants before the onset of new research areas (such as MSc and PhD thesis or postdoctoral research projects) to avoid overlap. Such planning is undermined if outsiders are entirely free to work with available data from long-term studies without taking ongoing and planned analyses by insiders into account. The risk is especially strong for PhD students as part of their training involves courses, and they need more time to complete the research project and publish papers than senior researchers.

Possible solutions

The verification of results is a very important requirement by journals; however, the costs of mandatory archiving of data by ongoing long-term projects could outweigh the expected benefits. Having imposed a requirement for PDA, journals are asking researchers to give up rights to what many consider to be their intellectual property. In fact some scientists are considering copywriting their data. Journals are rightly vigilant in combating plagiarism and copyright infringement; it would be appropriate for journals to be just as vigilant in respecting and protecting the scientists' data.

A resolution to this conflict would benefit scientific progress; high quality long-term studies have been responsible for a disproportionate number of publications in journals with the highest impact factors [11]. Many of the 5,378 papers from 90 studies in this survey (Fig 3b) were published in prestigious journals that now require PDA. To initiate a discussion about how resolution might be achieved, we suggest six potential solutions.

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Promoting collaboration

Opportunities for collaboration that provide added-value to science and communication between data generators and potential users should be encouraged [5] rather than compulsory archiving. Most survey respondents see collaborations as the most satisfactory route to data sharing. For substantial requests, the original researcher can expect and deserve co-authorship. To promote better use of data and collaboration with PIs, a website could be created referencing long-term studies with information such as species, duration of study, location, traits measured, protocols used, etc.

Providing primary data on a confidential basis

A solution that would satisfy most PIs would be to provide tabulated summary data initially, and if that data were insufficient for editors to evaluate a submitted paper, primary data could be provided on a confidential basis. After the review process, the data could be destroyed and would not be available to be used for any other purpose. Once the paper is published, people who want to use the data could contact the PIs of the long-term study for additional data. As the survey has shown, 93% of the respondents have indicated that they have supplied data on request. For example, researchers have used summary data from the 40-year study on Darwin's finches [45, 60] by Peter and Rosemary Grant which was deposited in Dryad, and raw data have been supplied to four others upon request.

Providing a longer embargo

Some journals have indicated a willingness to embargo the data for a period of one to five years from publication, allowing the original researcher time to complete any related papers. This can reduce concerns in the case of smaller data sets from which only a limited number of questions can be answered. However, this is unlikely to solve the problem for long-term data sets, from which many questions can be addressed from different perspectives and over differing lengths of time.

For active long-term studies (i.e. with ongoing data collection) a minimum of 10-15 years might be considered more appropriate [5]. By comparison, pharmaceutical companies have a twenty-year patent to recoup their investment. A similar argument could be made for the decades of research by long-term project scientists [9]. Furthermore, a longer embargo would encourage data users to contact the PIs for rapid access to the most up-to-date version of the database, thereby encouraging collaboration. For non-active studies where data collection has ended, the case for an earlier release is stronger.

Depositing data on institutional servers

Centralizing the data in a single database in one location will prevent fragmentation of data on different archiving sites and ensures that the data are completely secure and up to date. Data could be archived on institutional servers and the institution and its staff could control access and determine if collaboration is appropriate. An example of an effective approach to the management of archived data held by institutions is practiced by The Netherlands Institute of Ecology where people can request the data and data extraction is done by members of the Institute, provided that the applicant will use the data for a well described project, commit to not sharing the data with others, and offer co-authorship to the collector if the data forms an essential part of the publication. Another example of effective use of institutional servers is the Archibold Biological Station in Florida. Such institutional databases also allow the preservation of data and their accessibility after the Pl retires [11].

Increasing notification and communication

If online archiving should be preferred for the physical safety of data, two improvements to present practices could be made. First, as the survey demonstrated, PIs are concerned with inappropriate use of data and overlap with ongoing or future projects of their own. A clear policy should be implemented by journals concerning conflicts of interest between the researchers collecting and organizing the data, and those who would use the data. For example, there are currently no binding protocols or codes of conduct covering the presentation of, or access to, complex data that underpin analyses in publications. A process with guidelines should be established by journals to ensure that PIs are aware of potential studies and are satisfied with a paper based on the data they generated prior to the review process.

A possibility would be to implement data tracking, allowing data collectors to obtain information on who is using the data and why. For example, any request for data to the Climate Change, Agriculture and Food Security Data Portal, triggers an email to be sent to the PI who deposited the data. Journals should have a rule that no paper is considered where the data users have not corresponded with the data owners and included appropriate acknowledgement of the source of the data within the paper. A rule set by journals would have a lot of clout with data users. Data tracking would also allow the PI to be systematically asked to review papers based on their data. Another option would be to send an e-mail to the PI every year asking whether they wish the data to be private or open access.

Concluding remarks

Long-term studies currently generate science with high impact in all major fields of biology. These longitudinal studies began during an era when PDA did not exist. Whilst we agree that it is essential to archive data so that they are not lost to science, a key concern is that recently introduced data archiving regimes combined with difficulty in obtaining continuous financial support will be a disincentive both for the initiation of long-term studies, and for maintenance of ongoing studies. It would be appropriate for journals and data archiving institutions to enter into a dialogue with researchers about how best to meet the objectives of data archiving while allowing valuable long-term studies to thrive.

Specifically, we recommend the development of a formal code of conduct which respects the data generated through long-term studies, and i) allow tabulated summaries to be provided in the first instance backed up by the confidential submission of primary data if required by editors, ii) encourage collaborative research with the data collector by people wishing to use the data, iii) extend embargoes on the use of archived data [5], iv) consider allowing archiving on institutional servers rather than open access servers and iv) develop enforceable procedures that enable the researcher to be contacted when someone wishes to access primary data. Through these modifications, a compromise could be crafted that provides an advantage to the scientific community, journals, and researchers generating long-term data, as well as benefiting science.

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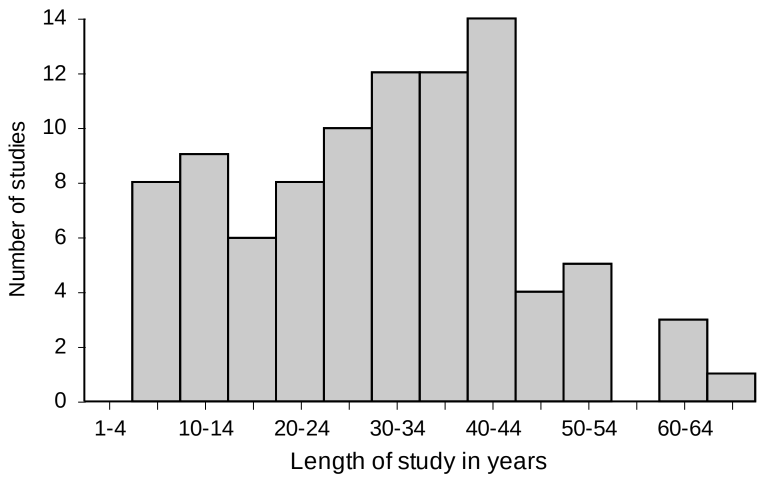


Figure 1. Duration of studies undertaken by the respondents in this survey

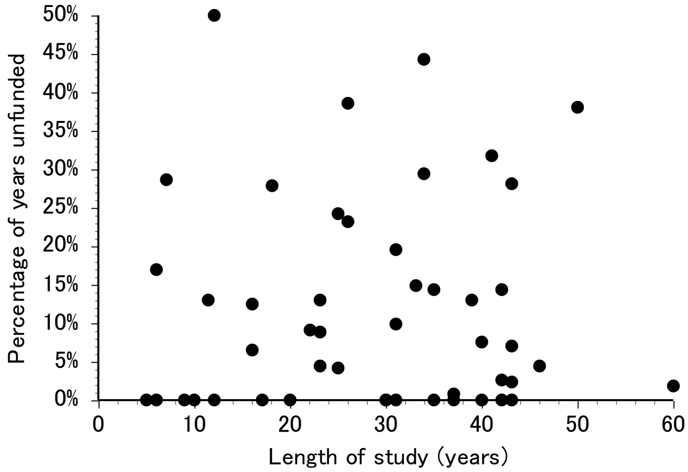
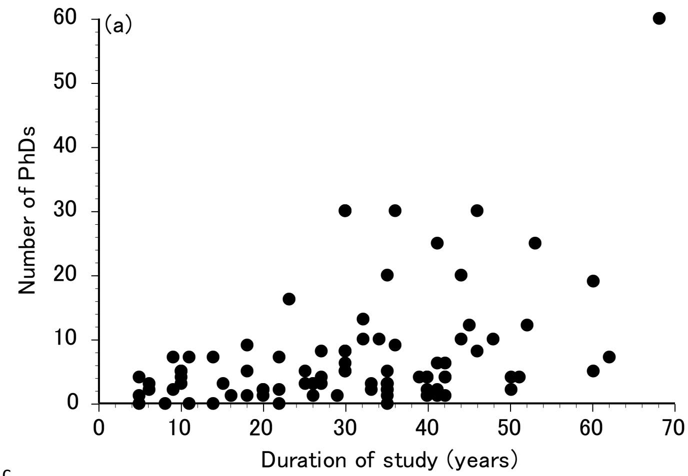


Figure 2 Duration of the study and the percentage of years unfunded



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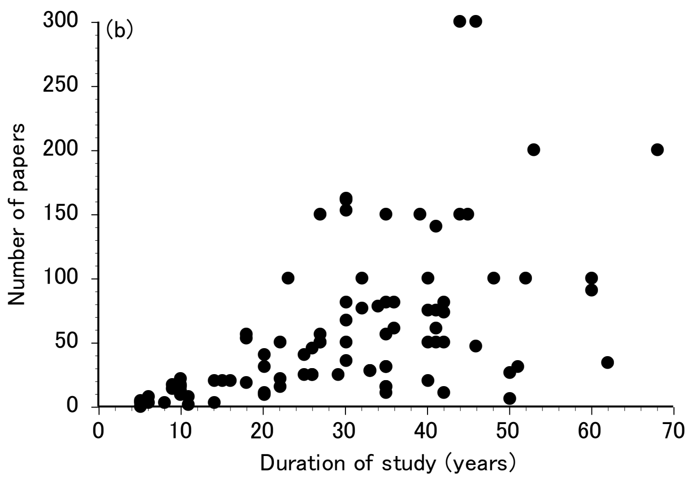

Figure 3 (a) The total number of PhD students in relation to the duration of research programs (b) The number of papers produced in relation the duration of the study