



## Looking for attitudes related to amphibian species decline: how are peer-reviewed publications of education activities compared to ecological research?

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### ABSTRACT

Biodiversity decline has been the focus of discussions in the last decade, especially on the amphibian species decline. After a scientometric analysis using international databases, we found that the number of peer-reviewed articles considering education practices related to the theme increased along with the number of ecological researches. However, the increase in ecological researches is much higher than the increase in publications of education practices. Studies suggest that conservation attitudes are important and that education practices are an important tool for improving human perceptions on this subject. In this sense, increase the publication of projects and programs results related to local education practices in international journals could help the dissemination of efficient methods for conservation, as well as facilitating access to information internationally, since species decline, especially for amphibians, is a global concern. Then, we suggest that educational practices, at least when related to conservation, should follow a more standardized protocol, and be published in international journals, as the efficiency of such practices should be evaluated and methods once published could help other nations to improve their ecological literacy.

**Key words:** environmental education, conservation practices, teaching activities, amphibian extinctions, theory and practice.

### INTRODUCTION

Habitat loss and overexploitation are the main drivers of species decline (Pounds et al. 1997, Houlahan et al. 2000), which increased in the last decades (Hoffmann et al. 2010). These drivers

are most related to human activities (Pimm et al. 1995, Pimm and Raven 2000) and climate change (Thomas et al. 2004, Araújo et al. 2006), also affecting amphibian extinction rates (Stuart et al. 2004). Such a scenario has been called as the “amphibian decline crisis” (Beebee and Griffiths 2005), which is part of an overall “biodiversity crisis” (Blaustein and Kiesecker 2002).

Advances in understanding species decline have been conducted with global scale (e.g.

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Alford and Richards 1999, Collins et al. 2003, Stuart et al. 2004, Hoffmann et al. 2010) and local dynamics in amphibian populations have been also taken into account (Blaustein and Kiesecker 2002). Additionally, integrative approaches with sampling strategies and model simulations have been fundamental to enhance our knowledge about species decline (Alford and Richards 1999, Stuart et al. 2004, Hoffmann et al. 2010). Independently of the scale or approach that researchers used, article conclusions suggest the urgency to better understand the species decline and that there are fundamental steps to be done towards effective conservation actions (Brooks et al. 2002, Collins and Storfer 2003).

Many ecological article conclusions also indicate that managers or stakeholders should use research results to develop effective conservation strategies (e.g. Paton and Crouch 2002, Hart and Calhoun 2010, Murrieta-Galindo et al. 2013), which is especially important to protect core areas (Cushman 2006). However, beside managers or stakeholders, there are local communities with which researchers and teachers could use environmental education as a powerful weapon to improve conservation strategies (e.g. Fujitani et al. 2016, Pontes-da-Silva et al. 2016). In spite of the importance of environmental education to conservation practices, including for amphibians, this approach is usually neglected (Pontes-da-Silva et al. 2016).

Thus, there is an increasing amount of ecological articles dealing with measuring and predicting amphibian species declines, and also an increasing concern with development of conservation strategies. However, it is worth noting that human attitudes for conservation of nature are intrinsically related to the construction of perceptions about nature, which is strongly affected by school and people's social lives experience (Pontes-da-Silva et al. 2016). Humans are sensitive to biological threatening (Seligman 1971),

especially if it is related to personal factors such as economic values (Serpell 2004), religious practices (Ceríaco et al. 2011) or cultural aspects (Ceríaco 2012). Then, environmental education may have a key role in conservation strategies, because environmental education could change human perception and attitudes, increasing conservation of nature (e.g. Pontes-da-Silva et al. 2016). In fact, lectures related to environmental education are efficient to explain complex ecological topics and modify current human practices (Fujitani et al. 2016).

The main concern here is that results of environmental education or conservation practices, programs, and projects are mostly local activities (e.g. Fujitani et al. 2016, Pontes-da-Silva et al. 2016) and usually are not published in a common international language, which potentially prevent sharing experiences and the development and advance of better conservation strategies. For this reason, we performed a scientometric analysis to evaluate how are the publications of education activities compared to publications of ecological research in two main international databases, the Web of Science and the Scopus.

## MATERIALS AND METHODS

We downloaded a dataset of articles published in journals linked to the Core Collection of the Web of Science (WoS) and in the Scopus database from 1992 to July 2016. We used these two databases because they are complementary since some journals are available only in the Scopus, while others are available only in the WoS, and also because only peer-reviewed journals are indexed in both database. After download the articles, we selected only research articles and review articles to be screened.

Our publication analysis was based on two steps. Firstly, we used "amphibian\* and conservation" as key words to identify records

of articles that possibly worked with this subject (hereafter ecological researches) in both database. Records found after this search were screened to evaluate (i) the temporal distribution of published articles; (ii) the country that mostly contributed to this subject; (iii) what is the subject area and journals that mostly published articles related to these key words; (iv) how are the citations and what is the most cited article related to these key words.

Secondly, we performed another search using a word combination (amphibia\* and teach\* or education\* or scientific education\* or environmental education\* or elementary school\* or high school\* or secondary school\* or primary school\*) to identify records of articles that possibly worked with amphibians in an education context. Records found in this search were screened to evaluate whether the articles explored education approaches working with amphibians. We analyzed the same four aspects used to ecological research records, and additionally, we separated records according to type (review or not); relationship to the conservation subject; use of amphibians as the main article focus; use of teaching activities with teachers, students or local community; if teaching activities were developed, what were the students degree; and finally, if articles presented theoretical or practical approach.

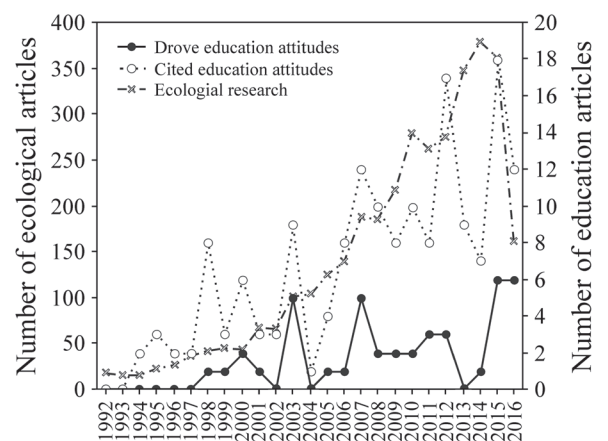
## RESULTS

In the first analysis of article records, we found 3,542 article and reviews related to the key words “amphibian\* and conservation”. The number of records increased 10 times in average from the 90s to the last decade, reaching 369 published articles with this subject in 2014. United States of America stands as the country that published more articles, with almost four times more records than the other countries. Most records were related to Ecology, Zoology and Biodiversity Conservation categories, and published in the journal Biological

Conservation and Conservation Biology. Finally, to the 3,542 article records we found 81,265 citations and the most cited article was Stuart et al. (2004) published in Science (1,700 citations).

In our second analysis, we found 166 records of articles and reviews using the key words related to attitudes towards amphibian conservation in an education context. However, only 42 records were related to attitudes towards amphibian conservation indeed, and the others only cited the need for some education activity, for example. Despite we found fewer records of education articles and reviews compared to ecological research, there is a positive and significant correlation between ecological research and education records through time ( $r = 0.78$ ,  $p < 0.05$ ; Figure 1), even considering only the 42 records that showed attitudes towards amphibian conservation indeed ( $r = 0.61$ ,  $p < 0.05$ ).

Regarding the 42 education records, United States of America still stands as the country that published more articles than other countries. Article records in this second search were most related to Educational Research, Developmental Biology and Environmental Science, and journals such as



**Figure 1** - Record trends to ecological and education articles from 1992 to July 2016.

International Journal of Developmental Biology and International Journal of Science Education published more articles than others within this theme. To the 42 article records related to education

activities we found 1,317 citations and the most cited articles were Crawford (2000 - Embracing the essence of inquiry: New roles for science teachers) and Randler et al. (2005 - Cognitive and emotional evaluation of an amphibian conservation program for elementary school students).

Analyzing in deep the 42 education records, eight were review articles, 22 discussed amphibian conservation, in 27 amphibians stand as the main focus and in 14 amphibians stand as a secondary focus. Moreover, eight records were related to teaching activities with teachers, while 31 performed teaching activities with students and eight performed teaching activities with local community. Article records related to teaching activities with students involved all student degrees (one record with preschool, four records with elementary school, seven records with high school, 10 records with undergraduate, four records with elementary and high school, one record with pre and high school, and three records with elementary, high and undergraduate students). Finally, seven records presented theoretical approaches, while 27 presented practical approaches and eight used both theoretical and practical approaches.

## DISCUSSION

Our main findings indicate a positive publication rate of peer-reviewed articles related to education activities, which is correlated with ecological articles dealing with amphibian species decline and conservation. However, records are strongly increasing in ecological researches, while records of education activities are slightly increasing. Most citations are also attributed to the ecological articles instead of education activities. Moreover, independent of the scientific approach used (ecological research or education activity) United States of America stands as a leading country in publication records. Finally, we found a huge

variety of methods and approaches within education records.

On one hand, we highlight that our results are related to articles and reviews published in journals indexed in the WoS and Scopus, and many local journals specialized in education practices have not been considered here. On the other hand, our results suggest that records of education activities related to amphibian conservation, published in peer-reviewed journals and indexed in international databases could be increasing together with ecological research, despite still be a step back of ecological researches on amphibian conservation. This relationship could be occurring because performing a scientific education activity depends on the primary knowledge created with scientific research (e.g. Cachapuz et al. 2004), and also because the evaluation of education activity results could take long time. However, we also suggest that this discrepancy between ecological and education records is related to the nature of both disciplines. Differently from ecological research, education activities are most focused in the practice of develop a project instead of generate data that ends in a scientific article. Thus, practitioners could be making and developing their projects without a proper evaluation of the project results. The lack of project results evaluation ends in the lack of project efficiency evaluation, and lack of peer-reviewed article, which if published, could indicate a standard method to be followed in other similar occasions.

It is clear that education activities are important to improve conservation practices (Fujitani et al. 2016), and that is why education activities should increase its synchrony with ecological research. Additionally, considering the world extent, these education activities are potentially presenting a great variety of methods, which should be published more frequently in a common international language to be more easily shared around the world, helping others to

develop and advance conservation strategies. This process is most important in an Era of biodiversity decline, and particularly of amphibian decline, which constitute an international “crisis”. Local practices with standardized methods should be applied and published in international journals, to help inspiring teachers to rethink their actions and needs at school (e.g. Brito Filho 2004). In fact, many education researches that promote awareness and changes in human attitudes related to wild life were published (e.g. Nisbet et al. 2009, Drissner et al. 2013, Alves et al. 2014, Nates and Lindemann-Mathies 2015), but it seems that amphibians are not well incorporated in these activities.

Facing the amphibian species decline, a strong step forward could be ‘tear down the walls’ between science and the common sense at classrooms (e.g. Drissner et al. 2013). For example, teachers should emphasize the ecological role of amphibians and how they are important to human beings, trying to develop a positive attitude regarding amphibian species conservation (Souza and Souza 2005). Amphibians may be horrifying and disgusting to many young students, but it may be related to school and people’s social lives experiences (Pontes-da-Silva et al. 2016), what is a potentially changeable perception.

The needs of a teacher/researcher with active participation during the education process of create students and local community environmental perception (e.g. Crawford 2000, Coll and Taylor 2009) is imminent to enhance conservation practices. We understand that to achieve this goal, a new education program should be applied (Coll and Taylor 2009) to create a more critical and practical view on the environmental problems (Leff 2001). Perhaps, follows the idea of Capra (2006) to include teachers and students in a more active practice of ecology, the ecoliteracy, could be a good solution. However, these education programs should be always scientifically evaluated as an attempt to measuring their efficiency to change students or

community perceptions, and this evaluation should be published to help communicating the program efficiency and avoid repeating mistakes in future programs.

In summary, records of ecological research are increasing very fast and showing the need to conservation practices. However, records of education practices with amphibian are increasing slower or at least, could not be published in peer-reviewed international journals indexed in WoS and Scopus databases. For us, conservation practices could starts at school by hands of biology teachers for example, but also should have standardized methods to be applied and have their efficiency evaluated, resulting in peer-reviewed article publications. This approach could increase records on education practices related to amphibian conservation and could help spreading the concern with species decline, also creating new active ways to reach and change students and local community perceptions on species decline. The amphibian species decline is not only an ecological concern but also constitute an international education and social problem that should be more often addressed to increase the efforts to change students and people perceptions related to amphibian conservation.

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