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Source: Tropical Conservation Science, 14(1)

Published By: SAGE Publishing

URL: <https://doi.org/10.1177/19400829211057335>


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Tropical Conservation Science
Volume 14: 1–5
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DOI: 10.1177/19400829211057335
journals.sagepub.com/home/trc


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Abstract

Evidence suggests that a decline in people’s exposure to nature corresponds to decreasing support for nature—a phenomenon we call extinction of nature experience. Here, we evaluate three current trends in conservation research and consider if they contribute to a decrease in exposure to nature. We suggest that while using sensors, algorithms, technocentric thinking, conducting meta-analyses, and taking more lab-based approaches all have significant potential to advance conservation goals, they lead to researchers spending less time in the field and an extinction of nature experience. A reduction of researcher field time will mean fewer local field assistants are hired and trained; lower engagement of researchers with ground realities; and a rift in conservation research, planning, and implementation. We suggest that the field of conservation science should balance how it allocates time and rewards to field versus non-field components. If we are not careful, we will select researchers that are distant from the biodiversity itself and the communities that are affecting it locally. Since the pandemic began many researchers were unable to go to their field sites and if care is not taken, the pressures that promote the extinction of nature experience may be promoted by institutions in a post–COVID-19 world.

Keywords

conservation science, meta-analysis, smart forests, community conservation, extinction of experience

Introduction

Conservation biology is a relatively young and highly dynamic field; in fact, it was only recognized as a field in the mid-1980s (Inouye & Ehrlich, 2020). Yet, since the field’s inception, its scope, journals, and publication numbers have grown exponentially (Chapman & Peres, 2021; Evans, 2021). This growth has been fueled by the need to respond to the magnitude of biodiversity loss produced by anthropogenic change. Globally, ~60 million hectares of tropical primary forest were lost between 2002 and 2019 (Weisse & Gladman, 2020). To put this in perspective, an area of old-growth tropical forest larger than Madagascar was lost in 18 years. Furthermore, humans have caused the earth’s climate to warm by 1.2°C since industrialization, and by the end of the 21st century, the earth’s mean surface temperature is projected to increase by at least 1.5°C (IPCC, 2021).

The dynamic nature of the field is illustrated by Redford et al.’s (2013) estimation that since the 1970s, there have been at least 10 approaches or fads related to conducting conservation. They include marketing of natural products; demarcating

biological diversity hotspots; integrated conservation and development projects; ecotourism; ecocertification; community-based conservation; payment for ecosystem services; reduced emissions from deforestation and degradation; conservation concessions; and landscape approaches that integrate agriculture, sustainable uses, and conservation. Such change could represent healthy experimentation and adaptation of a

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young and dynamic field or unhealthy floundering from one fad to the next. Distinguishing between these two alternatives requires careful evaluation of advances toward stated goals. This evaluation is needed to ensure that the conservation field remains on track to meet its goal of guiding the maintenance of biodiversity.

Here, we evaluate the direction conservation research is heading toward by considering if current approaches/fads are contributing to what we call the extinction of nature experience (following Pyle's (1993) term extinction of experience). In the early 2000s, evidence suggested that conservation lacked public support (Kareiva, 2008; Zaradic et al., 2009) and researchers suggested that this was due a decline in people's exposure to nature (Soga & Gaston, 2016). This is expected to exacerbate as the number of people living in cities rises. Already, more than half of the world's population lives in cities (Jacob et al., 2008), and it is estimated that 90% of the world's population growth between 2000 and 2030 will occur in the cities of the developing world (United Nations Population Division, 2008). In Africa, the urban population is projected to triple between 2011 and 2050, with 1.34 billion people living in cities in 2050 (Cartwright, 2015). We consider three current trends in conservation that promote an extinction of nature experience in its practitioners: smart forests, meta-analyses, and lab-based approaches.

Academic fields are shaped by the systems they are embedded in, particularly their reward systems. Rewards act like the selective pressures on organisms. From one generation to the next, the system rewards individuals with some traits and they increase in frequency through the success of their students and peers, while other individuals with different traits do not continue or do so at a lower level. However, unlike the selective pressures on organisms, academic systems can change the nature of the reward system and thus influence the direction the field takes. However, making such decisions requires careful reflection (Chapman et al., 2019).

Smart Forests

The tools available to conservation biologists have changed dramatically in the last 30 years and there has been a recent proliferation of sensors, algorithms, and technocentric thinking in conservation. For example, it has become possible to estimate habitat productivity in near-real time using satellite images (Pettorelli et al., 2005); to attach sensors to animals to determine location, direction of travel, body temperature, and much more (Hebblewhite & Haydon, 2010); and to use Artificial Intelligence (AI) approach to identify species or individuals from camera traps (Guo et al., 2020; Weam et al., 2019). Extensive habitat loss and climate change have provided the perfect justification for tech companies to present their tools for conservation and develop marketing campaigns that call for the optimization of biodiversity conservation by using smart sensors to collect data and automate processes (Sarkar & Chapman, 2021). Governments and conservation agencies followed the lead of tech companies as the use

of sensors was seen as a means to overcome budgetary austerity. This decision was further justified by the wide-spread perception of technology as a panacea with incredible agency to solve social and environmental problems (Huesemann & Huesemann, 2011).

Some sensors can collect data that are difficult or impossible for human observers to collect, such as monitoring animal calls that people cannot hear (Garstang, 2004; Wrege et al., 2017), determining feeding visitation of nocturnal frugivores (Rivas-Romero & Soto-Shoender, 2015), or determining home range use of cryptic or wide-ranging species (Begg et al., 2005). Similarly, satellite technology can assess forest dynamics on large spatial scales and at speeds that are well beyond what is possible using traditional methods (Goetz et al., 2009; Hansen et al., 2013). These tools have allowed conservation to make significant advances. However, other sensors are used because they are considered cost-effective, they can easily assess large areas, they follow popular trends, or are used prior to appropriate verification of their accuracy. Examples may include using drones to monitor tree phenology or detect the night nests of chimpanzee and orangutans (Marshall & Wich, 2013; Wich, 2015; Wich & Koh, 2018), using camera traps rather than tracking stations (Sarkar & Chapman, 2021), assessing local habitat productivity or species richness using generalized satellite indices (e.g., NDVI) rather than checking on the status of trees and understory or careful calibration of indices (Gautam et al., 2019; Phillips et al., 2008).

Using sensors in such an array of situations will mean that researchers and local field assistants spend less time in the field leading to a greater extinction of nature experience. We cannot anticipate what technological innovations will be developed but it seems inevitable that technology will increasingly offer the opportunity for less field work. For example, researchers have recently extracted DNA from air samples and identified nearby species (Lynggaard et al., 2021; Stokstad, 2021). It is important for the field to consider if and when such techniques should replace traditional methods that require in situ time and what are the consequences of abandoning field-based experience and approaches. One consequence is that the use of sensors means that fewer local field assistants are hired and trained to collect data, which will remove employment benefits associated with conservation efforts (Sarkar et al., 2019). Furthermore, the securitization of resources is a central concept purported by the surveillance capabilities of the smart sensors. This further promotes the extinction of nature narrative and exacerbates the burden of conservation on local communities. Thus, the quick pivot to smart forests is risking undoing the accrued benefits of the previous conservation trends that preceded it which called for greater engagement of local communities in conservation activities and promoting their well-being.

Meta-Analyses

Scholars have convincingly argued that incentives for academics have become increasingly perverse as a result of

universities adopting business models (Alberts et al., 2014; Edwards & Roy, 2017). One such decision that is affecting conservation is the need to chase high h-indices and to publish in high impact factor journals. In this endeavor, researchers are increasingly drawn to write meta-analyses as they are more frequently cited than data papers and editors favor their publications as a means to increase their journal's impact factors (Carpenter et al., 2014). While meta-analysis has been conducted since at least 1904, the term meta-analysis was only coined in 1976. Since that time, the frequency with which meta-analyses have been published has increased exponentially. In fact, an analysis of over 7 million publications between 2004 and 2013 revealed that the relative increase in publications involving meta-analyses was a staggering 285%.

While some of the increase can be attributed to open data repositories, the rest can be attributed to the reward models operationalized by institutions. As obtaining academic positions and grant funding are increasingly dependent on metrics, there is strong selective pressure to write papers involving meta-analysis as they often have higher citation rates (Chapman et al., 2019; Dinsmore et al., 2014). Meta-analyses and the chase for high h-index scores will draw researchers out of the field, which consequently will lead to a greater extinction of nature experience among conservation scientists. Of course, there is the need for the synthesis that meta-analyses bring and we are encouraged to see the push toward open access, making data available online, and novel ways of building data stores (e.g., movebank); however, people who have on-the-ground conservation experience might be able to provide context which further enriches such efforts (<https://www.conservationevidence.com/>, <https://environmentalevidence.org/>). But what this calls for is a balance of approaches and a reassessment of how academic merit is assigned (Buxton et al., 2020; Reed et al., 2021).

Lab-Based Approaches

The last example we present deals with the trend to merge field and lab efforts. This topic is likely the least controversial but provides a segue to our conclusion. There is little doubt that endocrinological research has made significant contributions to conservation by providing a better understanding of how endangered species cope with changing environments (McCormick & Romero, 2017). Non-invasive techniques have been used to determine environmental stressors and reproductive status, which has been used to predict population responses to environmental change (Chapman et al., 2015; Creel et al., 2002). It is also very clear that by combining traditional field endocrine and physiological approaches with new approaches in genomics and transcriptomics, new conservation advances will be made.

However, being a researcher is a highly competitive profession (Alberts et al., 2014; Edwards & Roy, 2017). This is illustrated by the fact that only 43.2% of all PhD scientists and engineers in the United States are employed in

institutions of higher education, and full-time faculty positions have declined steadily for four decades (National Science Board, 2018). Thus, time is a limited and valuable commodity and time invested into advancing a career can compromise personal lives (Alves et al., 2019). As a result, for the individual researcher, time spent learning lab techniques and conducting the lab work will mean there is less time available to be in the field. This is particularly the case for PhD students, who have traditionally conducted field research of a year's duration, although this appears to be decreasing (data available from C. Chapman). As a result, while lab-based research can make significant contributions to conservation biology and will likely aid researchers publishing in high impact journals, it will likely reduce the time in the field. This can be partially offset by effective collaboration, but not totally as field researchers must understand the lab techniques to effectively collect samples. Furthermore, students are typically not only required to understand the techniques but must spend significant time at the lab bench. As more time is spent in the lab, less time will be spent in the field, which will lead to a greater extinction of nature experience.

Implications for Conservation

These three examples illustrate that new technologies, analyses, and approaches will allow conservation scientists to make swift and significant advances in our understanding of how to protect the earth's biodiversity and the processes that maintain it. However, we believe that the field of conservation biology must balance how it allocates time and rewards to field versus non-field components. If we are not careful, we will select researchers that are distant from the biodiversity itself and unaware of the ground realities of the communities their action directly or indirectly impact. This will contribute to an extinction of nature experience in the next generation of conservation scientists. It is all about obtaining the right balance. However, on a positive note, many of the forces that influence this balance are under the control of academics, and we can take many positive actions. For example, we can expose our students to the wonders of nature through field courses, we can easily justify the need for field time to granting agencies, we can positively support robust field studies when reviewing grants and journal articles, and we can make it clear that spending sufficient time with local communities and working with field assistants is a requirement for many conservation programs. Additionally, lack of field time hampers the progress of insights engendered through collaborations made through field work (Sarkar et al., 2021). Since COVID-19 began, researchers who usually spend time in the field have spent significant efforts in alternative endeavors due to the inability to travel to their respective field sites. For the last 2 years, students who would have gone to the field have had to come up with alternatives. Unless care is taken, these trends can be further promoted by

institutions in a postCOVID-19 world. An issue that needs emphasizing is that conservation requires people to invest a great deal of time in the field to build community trust. Thus, if employing sensors, doing meta-analyses, or being more engaged in lab work means that the scientist spends less time in the field, it will not only hinder conservation efforts requiring community support, but reverse decades of progress in developing equitable conservation efforts.

Acknowledgments

We thank Pengfei Fan and Claire Hemingway for perspectives and comments on our work.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article; CC was supported by the Wilson Center while writing this paper.

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References

- Alberts, B., Kirschner, M. W., Tilghman, S., & Varmus, H. (2014). Rescuing US biomedical research from its systemic flaws. *Proceedings of the National Academy of Sciences*, *111*(16), 5773–5777. <https://doi.org/10.1073/pnas.1404402111>
- Alves, P. C., Oliveira, A. d. F., & Paro, H. B. M. d. S. (2019). Quality of life and burnout among faculty members: How much does the field of knowledge matter? *Plos One*, *14*(3), e0214217. <https://doi.org/10.1371/journal.pone.0214217>
- Begg, C. M., Begg, K. S., Du Toit, J. T., & Mills, M. G. L. (2005). Spatial organization of the honey badger *Mellivora capensis* in the southern Kalahari: Home-range size and movement patterns. *Journal of Zoology*, *265*(1), 23–35. <https://doi.org/10.1017/S0952836904005989>
- Buxton, R. T., Bergman, J. N., Lin, H. Y., Binley, A. D., Avery-Gomm, S., & Schuster, R. (2020). Three lessons conservation science can learn from the COVID-19 pandemic. *Conservation Biology*, *34*(6), 1331–1332. <https://doi.org/10.1111/cobi.13652>
- Carpenter, C. R., Cone, D. C., & Sarli, C. C. (2014). Using publication metrics to highlight academic productivity and research impact. *Academic Emergency Medicine*, *21*(10), 1160–1172. <https://doi.org/10.1111/acem.12482>
- Cartwright, A. (2015). Better growth, better cities: Rethinking and re-directing urbanisation in Africa. The New Climate Economy Working Paper. <https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/NCE-APP-final.pdf>
- Chapman, C.A., Bicca-Marques, J.C., Calvignac-Spencer, S., Fan, P., Fashing, P. J., Gogarten, J., Guo, S., Hemingway, C. A., Leendertz, F., Li, B., Matsuda, I., Hou, R., Serio-Silva, J. C., & Stenseth, N. C. (2019). Games academics play and their consequences: How authorship, h-index, and journal impact factors are shaping the future of academia. *Proceedings of the Royal Society B: Biological Sciences*, *286*(1916). <https://doi.org/10.1098/rspb.2019.2047>
- Chapman, C.A., & Peres, C.A. (2021). Primate conservation: Lessons learned in the last 20 years can guide future efforts. *Evolutionary Anthropology: Issues, News, and Reviews*, *30*(5), 345–361. <https://doi.org/10.1002/evan.21920>
- Chapman, C. A., Schoof, V. A. M., Bonnell, T. R., Gogarten, J. F., & Calmé, S. (2015). Competing pressures on populations: Long-term dynamics of food availability, food quality, disease, stress and animal abundance. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *370*(1669), 20140112. <https://doi.org/10.1098/rstb.2014.0112>
- Creel, S., Fox, J. E., Hardy, A., Sands, J., Garrott, B., & Peterson, R. O. (2002). Snowmobile activity and glucocorticoid stress responses in wolves and elk. *Conservation Biology*, *16*(3), 809–814. <https://doi.org/10.1046/j.1523-1739.2002.00554.x>
- Dinsmore, A., Allen, L., & Dolby, K. (2014). Alternative perspectives on impact: The potential of ALMs and altmetrics to inform funders about research impact. *Plos Biology*, *12*(11), e1002003. <https://doi.org/10.1371/journal.pbio.1002003>
- Edwards, M. A., & Roy, S. (2017). Academic research in the 21st century: Maintaining scientific integrity in a climate of perverse incentives and hypercompetition. *Environmental Engineering Science*, *34*(1), 51–61. <https://doi.org/10.1089/ees.2016.0223>
- Evans, M.C. (2021). Re-conceptualizing the role(s) of science in biodiversity conservation. *Environ Conserv*, *48*(3), 151–160. <https://doi.org/10.1017/S0376892921000114>
- Garstang, M. (2004). Long-distance, low-frequency elephant communication. *Journal of Comparative Physiology A*, *190*(10), 791–805. <https://doi.org/10.1007/s00359-004-0553-0>
- Gautam, H., Arulmalar, E., Kulkarni, M. R., & Vidya, T. N. C. (2019). NDVI is not reliable as a surrogate of forage abundance for a large herbivore in tropical forest habitat. *Biotropica*, *51*(3), 443–456. <https://doi.org/10.1111/btp.12651>
- Goetz, S. J., Baccini, A., Laporte, N. T., Johns, T., Walker, W., Kellndorfer, J., Houghton, R. A., & Sun, M. (2009). Mapping and monitoring carbon stocks with satellite observations: a comparison of methods. *Carbon Balance Manage*, *4*, 2 (2009). <https://doi.org/10.1186/1750-0680-4-2>
- Guo, S., Xu, P., Miao, Q., Shao, G., Chapman, C. A., & Chen, X. (2020). Automatic identification of individual primates with deep learning techniques. *Iscience*, *23*(8), 101412. <https://doi.org/10.1016/j.isci.2020.101412>
- Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, *342*(6160), 850–853. <https://doi.org/10.1126/science.1244693>
- Hebblewhite, M., & Haydon, D. T. (2010). Distinguishing technology from biology: A critical review of the use of GPS

- telemetry data in ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1550), 2303–2312. <https://doi.org/10.1098/rstb.2010.0087>
- Huesemann, M., & Huesemann, J. (2011). *Techno-fix: Why technology won't save us or the environment*. New Society Publishers.
- Inouye, D. W., & Ehrlich, P. R. (2020). Michael Soulé (1936–2020). *Science*, 369(6505), 777. <https://doi.org/10.1126/science.abd69215>
- Jacob, A. L., Vaccaro, I., Sengupta, R., Hartter, J., & Chapman, C. A. (2008). Integrating landscapes that have experienced rural depopulation and ecological homogenization into tropical conservation planning. *Tropical Conservation Science*, 1(4), 307–320. <https://doi.org/10.1177/194008290800100402>
- Kareiva, P. (2008). Ominous trends in nature recreation. *Proceedings of the National Academy of Sciences*, 105(4), 2757–2758. <https://doi.org/10.1073/pnas.0800474105>
- Lynggaard, C., Bertelsen, M.F., Jensen, C.V., Johnson, M. S., Frøslev, T. G., Olsen, M. T., & Bohmann, K. (2021). Airborne environmental DNA for terrestrial vertebrate community monitoring. *BioRxiv*. <https://doi.org/10.1101/2021.07.16.452634>
- Marshall, A. J., & Wich, S. (2013). Characterization of primate environments through assessment of plant phenology. In E. Sterling, M. Blair, and N. Bynum (Eds.), *Primate ecology and conservation: A handbook of techniques* (pp 103–127). Oxford University Press.
- IPCC (2021). Climate change 2021: The physical science basis. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- McCormick, S. D., & Romero, L. M. (2017). Conservation Endocrinology. *Bioscience*, 67(5), 429–442. <https://doi.org/10.1093/biosci/bix026>
- National Science Board (2018). *Science and engineering indicators 2018*. NSB-2018-1. <https://www.nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf>
- Pettorelli, N., Vik, J. O., Mysterud, A., Gaillard, J.-M., Tucker, C. J., & Stenseth, N. C. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. *Trends in Ecology & Evolution*, 20(9), 503–510. <https://doi.org/10.1016/j.tree.2005.05.011>
- Phillips, L. B., Hansen, A. J., & Flather, C. H. (2008). Evaluating the species energy relationship with the newest measures of ecosystem energy: NDVI versus MODIS primary production. *Remote Sensing of Environment*, 112, 4381–4392. <https://doi.org/10.1016/j.rse.2008.08.002>
- Pyle, R.M (1993). *The thunder tree: Lessons from an urban wildland*. Houghton Mifflin.
- Redford, K. H., Padoch, C., & Sunderland, T. (2013). Fads, funding, and forgetting in three decades of conservation. *Conservation Biology*, 27(3), 437–438. <https://doi.org/10.1111/cobi.12071>
- Reed, M. S., Ferré, M., Martin-Ortega, J., Blanche, R., Lawford-Rolfe, R., & Dallimer, M. (2021). Evaluating impact from research: A methodological framework. *Research Policy*, 50(4), 104147. <https://doi.org/10.1016/j.respol.2020.104147>
- Rivas-Romero, J. A., & Soto-Shoender, J. R. (2015). Filling in the gaps: Evaluating the use of camera traps in the canopy to examine frugivore visits to *Oreopanax echinops* in the highlands of Guatemala. *The Southwestern Naturalist*, 60, 366–370. <https://doi.org/10.1894/0038-4909-60.4.366>
- Sarkar, D., & Chapman, C.A. (2021). The smart forest Conundrum: Contextualizing pitfalls of sensors and AI in conservation science for tropical forests. *Tropical Conservation Science*, 14, 19400829211014740. <https://doi.org/10.1177/19400829211014740>
- Sarkar, D., Chapman, C. A., & Sengupta, R. (2021). Mapping research networks supported by the National Geographic Society through spatial social networks, *International Journal of Geographical Information Science*, 1–21. <https://doi.org/10.1080/13658816.2021.1880588>.
- Sarkar, D., Chapman, C. A., Valenta, K., Angom, S. C., Kagoro, W., & Sengupta, R. (2019). A tiered analysis of community benefits and conservation engagement from the Makerere University Biological Field Station, Uganda. *The Professional Geographer*, 71(3), 422–436. <https://doi.org/10.1080/00330124.2018.1547976>
- Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment*, 14(2), 94–101. <https://doi.org/10.1002/fee.1225>
- Stokstad, E. (2021). DNA plucked from air identifies nearby animals. *Science*. 373(6553), 376. <https://doi.org/10.1126/science.373.6553.376>
- United Nations Population Division (2008). *World urbanization prospects: The 2007 revision*.
- Wearn, O. R., Freeman, R., & Jacoby, D. M. P. (2019). Responsible AI for conservation. *Nature Machine Intelligence*, 1(2), 72–73. <https://doi.org/10.1038/s42256-019-0022-7>.
- Weisse, M., & Gladman, E.D. (2020). *We lost a football pitch of primary rainforest every 6 seconds in 2019*. World Resource Institute.
- Wich, S.A. (2015). *Drones and conservation. Drones and aerial observation: New technologies for property rights, human rights, and global development* (pp. 63–70). New America.
- Wich, S.A., & Koh, L.P. (2018). *Conservation drones: Mapping and monitoring biodiversity*. Oxford University Press.
- Wrege, P. H., Rowland, E. D., Keen, S., & Shiu, Y. (2017). Acoustic monitoring for conservation in tropical forests: Examples from forest elephants. *Methods in Ecology and Evolution*, 8(10), 1292–1301. <https://doi.org/10.1111/2041-210X.12730>
- Zaradic, P. A., Pergams, O. R. W., & Kareiva, P. (2009). The impact of nature experience on willingness to support conservation. *PLoS One*, 4(10), e7367. <https://doi.org/10.1371/journal.pone.0007367>.