frontiers | Frontiers in Conservation Science

TYPE Perspective
PUBLISHED 29 July 2022
DOI 10.3389/fcosc.2022.921895

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Human-Wildlife Interactions, a section of the journal Frontiers in Conservation Science

RECEIVED 16 April 2022
ACCEPTED 11 July 2022
PUBLISHED 29 July 2022

CITATION
Jouzi Z, Leung Y-F and Nelson S (2022) Addressing the food security and conservation challenges: Can be aligned instead of apposed? *Front. Conserv. Sci.* 3:921895. doi: 10.3389/fcosc.2022.921895

Addressing the food security and conservation challenges: Can be aligned instead of apposed?

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This perspective article provides an overview of the interaction between food security and conservation as two of the most important challenges of our time. To provide a better understanding of the topic, a conceptual framework for the possible pathways of positive and negative impacts of protected areas (PAs) on four dimensions of food security is proposed. Considering the importance of hunting and shifting agriculture in food security and the challenges caused by them in conservation, the cases of hunting and shifting agriculture were explored. Finally, the rights-based approaches in conservation and food security, as a new approach with the potential to protect people and the planet as a synergistic approach is discussed.

KEYWORDS

conservation, food security, protected areas, right based approaches, sustainable development goals

Introduction

Contextualizing the global challenges of food security and conservation

Nature and food production are inherently interconnected. Food security relies on ecosystem services, and in return, at the same time, it is one of the biggest reasons for the loss of ecosystem services (Wittman et al., 2017). Agriculture as the dominant form of land management in the world, relies heavily on ecosystem services such as regulation of

the nutrient and hydrologic cycles, pollination, biological pest control, and soil fertility (Power, 2010). In addition to agriculture, for more than 1 billion people in tropical countries, nature is the primary source of providing their basic needs including food, energy, and clean water (Fedele et al., 2021).

The current global food system is the main contributor to climate change, land-use change, and biodiversity loss. It is also the main consumer of freshwater and the source of pollution in aquatic and terrestrial ecosystems. Keeping the status quo in the food system until 2050 will increase all of these environmental impacts by 50–92% (Springmann et al., 2018).

Within the research field of environmental impacts of food production and agriculture, the relationship between forest and agriculture is specifically complex and concerning. Forests are home to terrestrial biodiversity and provide habitat for 80% of amphibians, 75% of birds, and 68% of mammal species (FAO and UNEP, 2020). Agricultural expansion is the main cause of forest loss and in many developing countries converting a forest to a farm is the cheapest option for farmers to have access to the fertilize soil and increase their production in short term (Benhin, 2006). Studies show that 80 percent of agricultural land in the tropics was the result of the conversion of forests to farms. In Africa for example, 60% of farms came from intact forests, 35% from disturbed forests, and 5% from shrublands (Gibbs et al., 2010). A recent study at the global scale indicated that cropland was rapidly expanding in the first two decades of the twenty-first century, especially in Africa. Almost half of this new cropland was the result of converting natural vegetation land covers and forests (Potapov et al., 2021).

While the current food system is crossing the environmental limits in a serious way, it has failed to feed the population adequately. According to the state of food security and nutrition in the world, FAO estimated that around 12% of the global population, which is ~928 million people were hungry in 2020 (FAO et al., 2021). However, it is important to note that more agricultural production, does not necessarily lead to better food security. In many situations, issues such as food distribution or the lack of economic access due to poverty are the main reasons for food insecurity (Wittman et al., 2017). Food availability will not guarantee food access (physical and economic access) and enough calories does not mean enough nutrition (Pinstrup-Andersen, 2009). Studies show the overlap between areas rich in biodiversity that are suffering from poverty and food insecurity (Fisher and Christopher, 2007). Hence, not only nature and food security are tied together, but also conservation and food security have a lot of overlaps. PAs in many tropical regions are located where poor people are living and their livelihood is relied on the nature (Naughton-Treves and Holland, 2019).

This perspective paper aims to provide a better understanding of the relationship between food security and conservation through different lenses, including protected areas (PAs), wildlife hunting, and the Right-Based Approaches (RBAs). Such an understanding is crucial in finding potential pathways to converge the two important sustainable development goals: food security and conservation. This paper provides inputs into the designs of synergistic policies that protect people and planet.

Conservation, protected areas, and food security

Conservation in a way that is defined nowadays, is rooted in the western perspective of nature that looks at humans as a separate component from nature and neglects the interwoven link between humans and their surrounding environment (Sunderland and Vasquez, 2020). Conservation in the nineteenth century established PAs as the main mechanism for biodiversity conservation, without considering the impacts of conservation on communities living inside and around the PAs that their livelihoods relied on nature (McShane, 1990). However, after the Rio Summit in 1992, the notion of potential negative impacts of conservation has been recognized, while studies have been conducted mostly on the economic impacts of PAs on humans (McKinnon et al., 2016).

PAs have positive and negative impacts on different aspects of human well-being including food security (Pullin et al., 2013). Studies show that PAs can lead to restriction over consumption of wild food (Golden et al., 2011) and make limitations over people's traditional livelihood options such as hunting (Cobbinah et al., 2015). PAs can exacerbate human wildlife conflicts, increase farm raids by wildlife (Cobbinah et al., 2015; Givá and Raitio, 2017) and increase the transmission of disease to domestic livestock (Matseketsa et al., 2019; Guerrini et al., 2019). Finally, PAs contribute to the displacement of people (Agrawal and Redford, 2009) that can lead to the spatial disconnection between communities inside and around PAs and the resources they used to use to meet their basic needs such as food. On the other hand, PAs can improve the food security through providing wild food for consumption or market, providing fuel and fostering ecosystem services for farmers (FAO, 2014), providing safety net in time of crisis (Naughton-Treves and Holland, 2019) and providing the alternative livelihood options such as tourism (Pullin et al., 2013).

The positive and negative pathways that PAs can impact food security is illustrated in a conceptual framework (Figure 1). According to this framework, each positive or negative characteristic of PAs can impact four different dimensions of food security. For instance, restriction over the consumption of wild foods (e.g., fruits, vegetables, wild meat, mushrooms, etc.) will decrease food availability, accessibility, utilization, and

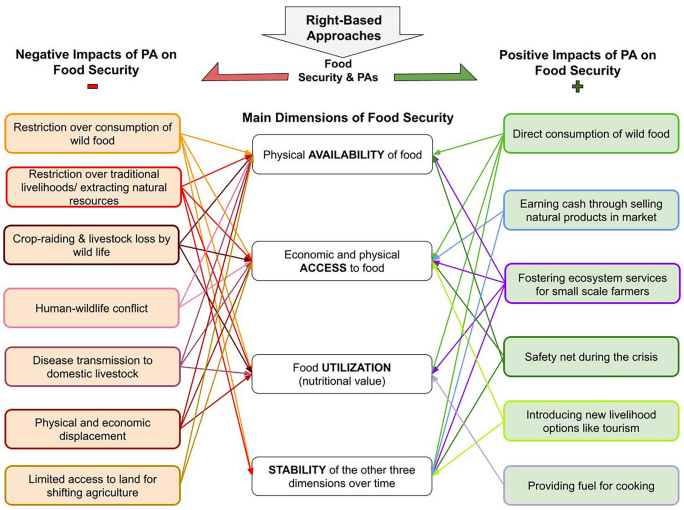

FIGURE 1
The conceptual framework for the possible pathways of positive and negative impacts of PAs on four dimensions of food security.

stability. Moreover, due to the restrictions imposed by PAs, people inside and around the PAs cannot continue their traditional livelihoods such as hunting or extracting other natural resources and this will negatively impact all four dimensions of their food security.

The case for wildlife hunting in food security and conservation

Hunting, fishing and gathering are the oldest way that human feed themselves and are permitted activities in some categories of PAs (FAO, 2014). It is estimated that about 150 million households that are mostly the poorest households in developing countries are hunting to meet their dietary needs and to generate income (Nielsen et al., 2018). While wild meat is the most accessible source of micronutrients, protein, and income for millions of households in the tropic and subtropical regions, overhunting coupled with other threats such as deforestation and habitat loss can lead to the extinction of species (Nasi et al., 2021). For instance, agricultural expansion in Indonesia increased the human-wildlife conflict such as crop riding and consequently increased wild pig hunting in the region (Semiadi and Meijaard, 2006; Luskin et al., 2014). Hunting animals for people with very limited access to the market and alternative sources of protein such as livestock is the most affordable and accessible source of providing micronutrients and protein and should not be banned (Nasi et al., 2021). Studies in rural northeastern Madagascar showed a significant positive association between wild meat consumption and hemoglobin concentrations in children. Moreover, Golden et al. (2011) estimated that removing the access to wild meat would increase the number of anemic children especially among the children of the poorest households (Golden et al., 2011). However, studies show that subsistence hunting in a subsistence economy can lead to market-based hunting for the consumption of city dwellers. This is especially a concerning fact in Africa, with a very fast urban population growth (Nasi et al., 2021). Hence policymakers should consider the appropriate policies to govern the hunting for subsistence use and reduce the risk of hunting for the city markets.

Wildlife hunting can be considered as an example of common-pool resources, which are finite resources that one person's consumption will decrease the share of others. Wildlife studies can utilize and benefit from the common scholars to find a governance system to meet the needs of conservation and food security (Smith et al., 2019). However, despite the promising opportunity to apply the concept and theory from common scholarship in wildlife hunting, due to some limitations such as the criminalization of hunting, and eradication of customary right system and local institutions, there is a very limited example of this application (Smith et al., 2019).

Although hunting has positive contributions to food security, there are important challenges associated with that. Increasing the flow of wild meat from rural area to urban area (Nasi et al., 2021) can reduce the availability of these sources of protein for local consumers in rural areas, especially where alternative sources of protein are not available locally. Another important health concern associated with hunting is the emergence and spread of Zoonotic disease. It is estimated that

around 75% of emerging infectious diseases are zoonotic (Wolfe et al., 2005). HIV-1 and -2, influenza virus, Ebola virus, hantaviruses, Nipah virus, severe acute respiratory syndrome [SARS]-associated coronavirus, are some examples of Zoonotic disease (Wolfe et al., 2005). Human interactions with wildlife in different stages of hunting and wild meat consumption including handling, storage, etc. will increase the risk of transition and spreading of Zoonotic disease which require urgent attention to be managed controlled (Wolfe et al., 2005).

The case for shifting agriculture and conservation

Shifting agriculture, which is defined as converting small to medium size forest land into cropland and then abandoning the land after several years, is one of the drivers of global deforestation and the dominant driver in Sub-Saharan Africa (Curtis et al., 2018). Forest fragmentation through different activities such as agricultural expansion, can decrease the biodiversity up to 75% and initiate a long-term change in ecosystems (Haddad et al., 2015). With population growth, the demand for food will increase and this will be an alarming threat for the land competition over different land uses such as conservation and agricultural expansion (Smith et al., 2010). This competition over the land and pressure on forests is uneven in the world as the projected population growth rates vary. Studies show that the largest growth is expected to happen in Sub-Saharan Africa as one of the poorest regions. It is estimated that by 2100, Sub-Saharan will experience 300% growth in its population (Bongaarts, 2016). Considering shifting agriculture as the dominant driver of deforestation in this region and its fast-growing population and consequently need for more food, the competition over land in Sub-Saharan will accelerate. To protect the forests, some forests are managed as PAs. However, studies show that shifting agriculture is happening inside the PAs. It is estimated that cropland represents about 18% of all human activities inside the PAs (Vijay and Armsworth, 2021). In Africa and South America, croplands mostly emerged in the recently established PAs. In regions with low food security, effective and realistic PAs management should integrate conservation goals with the programs to address hunger and malnutrition (Vijay and Armsworth, 2021).Regarding the impacts of human activities in PAs such as hunting and shifting agriculture, it is worth mentioning that studies show industrial scale natural resource extractions are the biggest concerns with more negative impacts compared to small scale, subsistence activities (Naughton-Treves and Holland, 2019). Moreover, since many poor people rely on ecosystem services for their basic needs, the environmental degradation will exacerbate their situation and lead to more unsustainable natural resources extraction as their last resort (Fisher and Christopher, 2007; Jouzi et al., 2020).

The emerging rights-based approaches to conservation and food security

The Rights-Based Approaches (RBAs) in conservation and food security, is a relatively new perspective to facilitate the collaboration between conservation and food security. National and internationally recognized rights can be categorized into two main categories of substantive and procedural rights. Right to life, food, water, and health are some examples of substantive rights, and the right to access to information and decision-making are some examples of procedural rights (Greiber, 2009).

RBAs in conservation started from the third IUCN World Conservation Congress in 2004 with recognition of the importance of human rights in the conservation of nature (Greiber, 2009). RBAs in conservation acknowledges the impacts of conservation on human rights and promotes conservation with justice that secure the rights of all affected populations by conservation projects and activities (Greiber, 2009). Integrating the right to conservation means adding a human dimension to the discipline that traditionally excluded humans (Campese et al., 2009). In a traditional/dominant view to conservation that excludes humans from nature, restrictions imposed by the PAs deprived people from the food and their basic needs provided by nature. This situation is very similar to the famous statement by Amartya Sen in his seminal book of Poverty and Famines, "The law stands between food availability and food entitlement" (Devereux, 2001). While this approach is relatively new in conservation, several research initiatives have been established to address this issue due to its importance. For example, the research and policy initiatives led by the Bushmeat Research Initiative (the BRI-CIFOR team), is actively working on this subject since 2021 (Nasi et al., 2021).

Concerning the RBAs in food security, there are several international laws related to food as a human right. One of the first and most important ones is the Universal Declaration of Human Rights, article 25, which stated "*Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care…*" (United Nations General Assembly, 1948). Operationalizing international laws concerning food and nutrition security to the national laws with clear accountability mechanisms for the state duty-bearers has critical importance. Integrating the right to food into the national constitutions and national legislations, provide the opportunities to promote food security and a legal framework to keep the duty-bearers accountable to the people (Ayala and Meier, 2017). To promote this relatively new approach in the food security sector, a recent initiative entitled "People-centered Food Systems: Fostering Human Rights-based Approaches" has been initiated since 2021. This project is aimed to build capacity and facilitate the implication of the UN Declaration on the Rights of

Peasants and Other People Working in Rural Areas. The core of this UN declaration is the right to land, seed, biodiversity, and food sovereignty which is the people's right to choose their food production system and the right to healthy food (John Hopkins news website).

Adopting a human rights-based approach can open up a series of national and international legal mechanisms to protect and uphold human rights to food, nutrition, and a healthy environment. Moreover, the legal framework can transfer the discussion from the aspiration without commitment and accountability mechanism to the legal obligation with commitment (Ayala and Meier, 2017).

Conclusion

Finding a balance between securing food security for poor and vulnerable communities and conservation goals in areas that those communities are living is a challenge that requires urgent attention. Concerning the diversity of environmental and socio-economic situations in the world, there is no one-size-fits-all approach to this issue. There are some opportunities including RBAs to both conservation and food security with the promising potential to bridge the gaps and converge the goals. The entire food system has been designed to maximize production and profit. However, now this system is expected to meet the needs of human and environmental health (National Academies of Sciences, Engineering, and Medicine. 2020). Hence, the sole emphasis on increasing food production cannot be the priority anymore. The scientific community has recognized the need to find solutions to a sustainable food system that meets the needs of growing populations with the minimum cost to the environment.

Conservation and food security historically and currently work as two separate disciplines with a different agenda, set of goals, definitions, and priorities. However, as discussed earlier both disciplines are interconnected. Considering the impacts of PAs on food security (Figure 1), more studies to include the PAs as a part of solution in food security specially for marginalized communities living around on inside the PAs seemed a promising approach with potential to address the goals of food security and conservation. Moreover, exploring the opportunities and challenges of hunting in food security and conservation, will help foster collaborations between these two disciplines. Finally, RBAs can be considered as boundary objects or a bridging concept to provide the shared understanding and opportunity for collaboration in food security and conservation.

Author contributions

All authors contributed to the article and approved the submitted version.

Funding

This work was partially supported by the Future Leader award to ZJ from the Association for International Agriculture and Rural Development (AIARD). AIARD has no role in conceptualization, interpretation, writing of this paper, or the decision to submit the paper for publication.

Acknowledgments

The authors wish to thank Dr. Erin Sills from the Department of Forestry and Environmental Resources, North Carolina State University, for her insightful comments on the earlier version of this paper. This perspective article is a part of ZJ's doctoral dissertation at North Carolina State University.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Agrawal, A., and Redford, K. (2009). Conservation and displacement: an overview. *Conserv. Soc.* 7 (1), 1–10. doi: 10.4103/0972-4923.54790

Assembly, U. G. (1948). Universal declaration of human rights. *UN. Gen. Assembly.* 302 (2), 14–25. Available at: https://www.un.org/en/about-us/universal-declaration-of-human-rights

Ayala, A., and Meier, B. M. (2017). A human rights approach to the health implications of food and nutrition insecurity. *Public Health Rev.* 38 (1), 1–22. doi: 10.1186/s40985-017-0056-5

Benhin, J. K. (2006). Agriculture and deforestation in the tropics: a critical theoretical and empirical review. *AMBIO.: A. J. Hum. Environ.* 35 (1), 9–16. doi: 10.1579/0044-7447-35.1.9

Bongaarts, J. (2016). Development: Slow down population growth. *Nature* 530, 409–412. doi: 10.1038/530409a

Campese, J., Sunderland, T, Greiber, T, and Oviedo, G (eds.)(2009). Rights-based approaches: Exploring issues and opportunities for conservation (Bogor, Indonesia:CIFOR and IUCN). Available at: https://www.cifor.org/publications/pdf_files/Books/BSunderland0901.pdf

Cobbinah, P. B., Black, R., and Thwaites, R. (2015). Biodiversity conservation and livelihoods in rural Ghana: Impacts and coping strategies. *Environ. Dev.* 15, 79–93. doi: 10.1016/j.envdev.2015.04.006

Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., and Hansen, M. C. (2018). Classifying drivers of global forest loss. *Science* 361, 1108–1111. doi: 10.1126/science.aau3445

Devereux, S. (2001). Sen's entitlement approach: critiques and counter-critiques. *Oxford. Dev. Stud.* 29 (3), 245–263. doi: 10.1080/13600810120088859

FAO (2014) *Protected areas, people and food security: An FAO contribution to the world parks congress, Sydney*. Available at: http://www.fao.org/3/a-i4198e.pdf.

FAO and UNEP (2020). The State of the World's Forests 2020 *Forests, biodiversity and people.* (Rome, Italy: :FAO and UNEP). doi: 10.4060/ca8642en

FAO, IFAD, UNICEF, WFP and WHO (2021). "In brief to the state of food security and nutrition in the world 2021," in *Transforming food systems for food security, improved nutrition and affordable healthy diets for all* (Rome: FAO). doi: 10.4060/cb5409en

Fedele, G., Donatti, C. I., Bornacelly, I., and Hole, D. G. (2021). Nature-dependent people: Mapping human direct use of nature for basic needs across the tropics. *Global Environ. Change* 71, 102368. doi: 10.1016/j.gloenvcha.2021.102368

Fisher, B., and Christopher, T. (2007). Poverty and biodiversity: Measuring the overlap of human poverty and the biodiversity hotspots. *Ecol. Econ.* 62, 93–101. doi: 10.1016/j.ecolecon.2006.05.020

Gibbs, H. K., Ruesch, A. S., Achard, F., Clayton, M. K., Holmgren, P., Ramankutty, N., et al. (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *Proc. Natl. Acad. Sci.* 107 (38), 16732–16737. doi: 10.1073/pnas.0910275107

Givá, N., and Raitio, K. (2017). Parks with people' in Mozambique: Community dynamic responses to human–elephant conflict at Limpopo national park. *J. South. Afr. Stud.* 43, 1199–1214. doi: 10.1080/03057070.2017.1374810

Golden, C. D., Fernald, L. C. H., Brashares, J. S., Rasolofoniaina, B. J. R., and Kremen, C. (2011). Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proc. Natl. Acad. Sci.* 108, 19653–19656. doi: 10.1073/pnas.1112586108

Greiber, T. (2009). *Conservation with justice: A rights-based approach (No. 71)* (Gland, Switzerland: IUCN) xiv + 118 pp. Available at: https://www.iucn.org/sites/default/files/import/downloads/eplp_071.pdf

Guerrini, L., Pfukenyi, D. M., Etter, E., Bouyer, J., Njagu, C., Ndhlovu, F., et al. (2019). Spatial and seasonal patterns of FMD primary outbreaks in cattle in Zimbabwe between 1931 and 2016. *Vet. Res.* 50 (1), 1–12. doi: 10.1186/s13567-019-0690-7

Haddad, N. M., Brudvig, L. A., Clobert, J., Davies, K. F., Gonzalez, A., Holt, R. D., et al. (2015). Habitat fragmentation and its lasting impact on earth's ecosystems. *Sci. Adv.* 1 (2), e1500052. doi: 10.1126/sciadv.1500052

John Hopkins news. Available at: https://bioethics.jhu.edu/research-and-outreach/projects/global-food/current-projects/people-centered-food-systems-fostering-human-rights-based-approaches/.

Jouzi, Z., Leung, Y. F., and Nelson, S. (2020). Terrestrial protected areas and food security: A systematic review of research approaches. *Environments* 7 (10), 83. doi: 10.3390/environments7100083

Luskin, M. S., Christina, E. D., Kelley, L. C., and Potts, M. D. (2014). Modern hunting practices and wild meat trade in the oil palm plantation-dominated landscapes of Sumatra, Indonesia. *Hum. Ecol.* 42 (1), 35–45. doi: 10.1007/s10745-013-9606-8

Matseketsa, G., Muboko, N., Gandiwa, E., Kombora, D. M., and Chibememe, G. (2019). An assessment of human-wildlife conflicts in local communities bordering the western part of save valley conservancy, zimbabwe. *Global Ecol. Conserv.* 20, e00737. doi: 10.1016/j.gecco.2019.e00737

McKinnon, M. C., Cheng, S. H., Dupre, S., Edmond, J., Garside, R., Glew, L., et al. (2016). What are the effects of nature conservation on human well-being? A systematic map of empirical evidence from developing countries. *Environ. Evid.* 5, 1. doi: 10.1186/s13750-016-0058-7

McShane, T. O. (1990). Wildlands and human needs: Resource use in an African protected area. *Landsc. Urban. Plan.* 19, 145–158. doi: 10.1016/0169-2046(90)90050-C

Nasi, R., Fa, J. E., van Vliet, N., Coad, L., Pinedo-Vasquez, M., and Swamy V and Lee, T. M. (2021). *Wild meat. FTA highlights of a decade 2011–2021 series. highlight No.6* (Bogor, Indonesia: The CGIAR Research Program on Forests, Trees, and Agroforestry (FTA). doi: 10.17528/cifor/008216

National Academies of Sciences, Engineering, and Medicine (2020). "Building a more sustainable, resilient, equitable, and nourishing food system," in *Proceedings of a workshop–in brief*. Ed. M. Maitin-Shepard (US: National Academies Press). Available at: http://www.ncbi.nlm.nih.gov/books/NBK564950/.

Naughton-Treves, L., and Holland, M. B. (2019). Losing ground in protected areas? *Science* 364, 832–833. doi: 10.1126/science.aax6392

Nielsen, M. R., Meilby, H., Smith-Hall, C., Pouliot, M., and Treue, T. (2018). The importance of wild meat in the global south. *Ecol. Economics.* 146, 696–705. doi: 10.1016/j.ecolecon.2017.12.018

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food Secur.* 1 (1), 5–7. doi: 10.1007/s12571-008-0002-y

Potapov, P., Turubanova, S., Hansen, M. C., Tyukavina, A., Zalles, V., Khan, A., et al. (2021). Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. *Nat. Food* 3(1), 19–28. doi: 10.1038/s43016-021-00429-z

Power, A. G. (2010). Ecosystem services and agriculture: tradeoffs and synergies. *Philos. Trans. R. Soc. B.: Biol. Sci.* 365 (1554), 2959–2971. doi: 10.1098/rstb.2010.0143

Pullin, A. S., Bangpan, M., Dalrymple, S., Dickson, K., Haddaway, N. R., Healey, J. R., et al. (2013). Human well-being impacts of terrestrial protected areas. *Environ. Evidence.* 2 (1), 1–41. doi: 10.1186/2047-2382-2-19

Semiadi, G., and Meijaard, E. (2006). Declining populations of the javan warty pig sus verrucosus. *Oryx* 40 (1), 50–56. doi: 10.1017/S003060530600007X

Smith, P., Gregory, P. J., Van Vuuren, D., Obersteiner, M., Havlík, P., Rounsevell, M., et al. (2010). Competition for land. *Philos. Trans. R. Soc. B.: Biol. Sci.* 365, 2941–2957. doi: 10.1098/rstb.2010.0127

Smith, H., Marrocoli, S., Garcia Lozano, A., and Basurto, X. (2019). Hunting for common ground between wildlife governance and commons scholarship. *Conserv. Biol.* 33 (1), 9–21. doi: 10.1111/cobi.13200

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., et al. (2018). Options for keeping the food system within environmental limits". *Nature* 562, 519–525. doi: 10.1038/s41586-018-0594-0

Sunderland, T. C., and Vasquez, W. (2020). Forest conservation, rights, and diets: Untangling the issues. *Front. For. Glob. Change* 3, 29. doi: 10.3389/ffgc.2020.00029

Vijay, V., and Armsworth, P. R. (2021). Pervasive cropland in protected areas highlight trade-offs between conservation and food security. *Proc. Natl. Acad. Sci.* 118. doi: 10.1073/pnas.2010121118

Wittman, H., Chappell, M. J., Abson, D. J., Kerr, R. B., Blesh, J., Hanspach, J., et al. (2017). A social–ecological perspective on harmonizing food security and biodiversity conservation. *Regional. Environ. Change* 17 (5), 1291–1301. doi: 10.1007/s10113-016-1045-9

Wolfe, N. D., Daszak, P., Kilpatrick, A. M., and Burke, D. S. (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. *Emerging. Infect. Dis.* 11 (12), 1822. doi: 10.3201/eid1112.040789