LETTERS

Edited by **Jennifer Sills**

Inclusive chimpanzee conservation

In their Report "Human impact erodes chimpanzee behavioral diversity" (29 March, p. 1453), H. S. Kühl *et al.* find that chimpanzees in modified landscapes show low behavioral diversity and propose the establishment of "chimpanzee cultural heritage sites" to safeguard behavioral variation. We are concerned that their conclusion propagates a view that some populations are not worth conserving.

At sites with highest modification, such as agricultural landscapes where people and chimpanzees share spaces entirely, human activities are driving chimpanzee behavioral flexibility and diversification, including novel behaviors (*1*, *2*). However, extinction risk in these areas is higher as a result of population isolation and anthropogenic-driven mortality (*3*). Conservationists also have incomplete data; not all chimpanzee behaviors in the wild are demonstrably socially learned and transmitted—and therefore cultural.

We agree that it is important to protect the behavioral diversity of culturally rich wildlife (*4*), but such populations should not always be given blanket priority over those living in closer contact with humans. We must ensure that apes living across the anthropogenic continuum are given a fighting chance.

Kimberley J. Hockings[1]* and Matthew R. McLennan[1,2]
[1]Centre for Ecology and Conservation, University of Exeter, Cornwall, UK. [2]The Bulindi Chimpanzee and Community Project, Hoima, Uganda.
*Corresponding author.
E-mail: k.hockings@exeter.ac.uk

REFERENCES AND NOTES

1. K. J. Hockings *et al.*, *Trends Ecol. Evol.* **30**, 215 (2015).
2. S. Krief *et al.*, *PLOS One* **9**, e109925 (2014).
3. Arcus Foundation, *State of the Apes: Industrial Agriculture and Ape Conservation* (Cambridge University Press, 2015).
4. P. Brakes *et al.*, *Science* **363**, 1032 (2019).

10.1126/science.aax5543

Response

We agree with Hockings and McLennan that, ideally, all wild chimpanzee populations would be equally protected. We do not presume to suggest that culture should be the sole basis for chimpanzee conservation efforts. Rather, we advocate a more integrative approach to conservation in which behavioral diversity of populations is another variable that can be described and quantified and can ultimately contribute to the protection of wildlife (*1*). Cultural and behavioral diversity should be prioritized alongside population size, genetic diversity, and demographic viability.

The proximity of chimpanzee populations to human activity is just one factor in conservation priorities.

Hockings and McLennan are correct that chimpanzees exhibit remarkable behavioral flexibility when living in human-dominated landscapes. To take advantage of new foraging opportunities and increase their chance for survival in fragmented and degraded habitats, chimpanzees have incorporated agricultural crops into their diet (*2*) and nest construction (*3*), as well as adapted their activity patterns to be more nocturnal (*4*). However, such behaviors represent evolutionarily novel traits compared with the behaviors we investigated, which have previously demonstrated cultural (*5*, *6*) or population variation [e.g., (*7*–*9*)]. Of course, larger comparative datasets that include chimpanzees living in human-dominated landscapes will make possible the study of fundamental mechanisms of behavioral and cultural diversification.

We agree with Hockings and McLennan that it is difficult to know the true cultural repertoire of all chimpanzee communities and that, when faced with limited information, we should err on the side of caution

PHOTO: © SHAH ANUP/ANIMALS ANIMALS

when considering conservation actions. However, if we want to protect chimpanzee cultural heritage, which is to protect historically significant traits originating from the past, then we must protect populations in pristine, less-disturbed habitats.

Hjalmar S. Kühl[1,2]*, Christophe Boesch[1,3], Lars Kulik[1], Fabian Haas[1], Mimi Arandjelovic[1], Paula Dieguez[1], Gaëlle Bocksberger[1], Anthony Agbor[1], Samuel Angedakin[1], Emmanuel Ayuk Ayimisin[1], Mattia Bessone[1], Gregory Brazzola[1], Rebecca Chancellor[4,5], Heather Cohen[1], Charlotte Coupland[1], Emmanuel Danquah[6], Tobias Deschner[1], Dervla Dowd[3], Annemarie Goedmakers[7], Anne-Céline Granjon[1], Josephine Head[1], Daniela Hedwig[8,9], Veerle Hermans[10], Sorrel Jones[1,11,12], Jessica Junker[1], Kevin E. Langergraber[13], Juan Lapuente[1], Kevin Lee[1,13], Manuel Llana[14], Sergio Marrocoli[1], Rumen Martin[1], Maureen S. McCarthy[1], Amelia C. Meier[1], David Morgan[15], Mizuki Murai[1], Emily Neil[1], Emma Normand[3], Lucy Jayne Ormsby[1], Liliana Pacheco[14], Alex Piel[16], Sebastien Regnaut[3], Aaron Rundus[5], Crickette Sanz[17], Fiona Stewart[16], Nikki Tagg[10], Virginie Vergnes[3], Adam Welsh[1], Erin G. Wessling[1,2], Jacob Willie[10,18], Roman M. Wittig[1,19], Yisa Ginath Yuh[1], Kyle Yurkiw[1], Ammie K. Kalan[1]*

[1]Max Planck Institute for Evolutionary Anthropology, 04103 Leipzig, Germany. [2]German Centre for Integrative Biodiversity Research, Halle-Leipzig-Jena, 04103 Leipzig, Germany. [3]Wild Chimpanzee Foundation, 04103 Leipzig, Germany. [4]Department of Anthropology & Sociology, West Chester University, West Chester, PA 19382, USA. [5]Department of Psychology, West Chester University, West Chester, PA 19382, USA. [6]Department of Wildlife and Range Management, Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. [7]Chimbo Foundation, Amstel 49, 1011 PW Amsterdam, Netherlands. [8]The Aspinall Foundation, Port Lympne Wild Animal Park, Hythe, Kent, UK. [9]Elephant Listening Project, Bioacoustics Research Program, Cornell Lab of Ornithology, Cornell University, Ithaca, NY 14850, USA. [10]Centre for Research and Conservation, Royal Zoological Society of Antwerp, B-2018 Antwerp, Belgium. [11]Royal Holloway, University of London Egham Hill, Egham Surrey TW20 0EX, UK. [12]Royal Society for the Protection of Birds, Sandy SG19 2DL, UK. [13]School of Human Evolution and Social Change & Institute of Human Origins, Arizona State University, Tempe, AZ 85281, USA. [14]Instituto Jane Goodall España, Station Biologique Fouta Djallon, Dindéfélo, Région de Kédougou, Senegal. [15]Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago, IL 60614, USA. [16]School of Natural Sciences and Psychology, Liverpool John Moores University, Liverpool L3 3AF, UK. [17]Department of Anthropology, Washington University in Saint Louis, St. Louis, MO 63130, USA. [18]Terrestrial Ecology Unit, Ghent University, 9000 Ghent, Belgium. [19]Taï Chimpanzee Project, Centre Suisse de Recherches Scientifiques, Abidjan 01, Cote d'Ivoire.
*Corresponding author. Email: kuehl@eva.mpg.de (H.S.K.); ammie_kalan@eva.mpg.de (A.K.K.)

REFERENCES AND NOTES

1. P. Brakes *et al.*, *Science* **363**, 1032 (2019).
2. K. J. Hockings *et al.*, *Trends Ecol. Evol.* **30**, 215 (2015).
3. M. S. McCarthy, J. D. Lester, C. B. Stanford, *Int. J. Primatol.* **38**, 321 (2017).
4. N. Tagg *et al.*, *Am. J. Phys. Anthropol.* **166**, 510 (2018).
5. A. Whiten *et al.*, *Behaviour* **138**, 1481 (2001).
6. A. Whiten, *Proc. Natl. Acad. Sci. U.S.A.* **114**, 7790 (2017).
7. H. S. Kühl *et al.*, *Sci. Rep.* **6**, 22219 (2016).
8. C. Boesch *et al.*, *Am. J. Primatol.* **79**, e22613 (2017).
9. J. Pruetz, P. Bertolani, *PaleoAnthropology* **2009**, 252 (2009).

10.1126/science.aax6339

Romanian carnivores at a crossroads

In October 2016, in an unexpected move, the Romanian government provisionally suspended the hunting of brown bears and wolves, shaking the decades-old wildlife management system of regulated hunting (*1*, *2*). This decision provided an opportunity to reset Romanian wildlife management and conservation and to implement science-based management. A year later, a new management system was implemented, allowing only the removal of problem animals at the epicenter of human-wildlife conflict, based on a case-by-case approval process (*3*). However, there is increasing pressure, fueled by a politically charged climate and a negative campaign focused on wildlife damage, to substantially reduce the abundance of large carnivores (*4*, *5*). The role of scientific evidence is still missing from the discussions about protecting Europe's largest large-carnivore populations, which is not an uncommon situation for wildlife management systems (*6*). Romania should seize this opportunity to enhance the scientific knowledge about carnivore ecology and human-carnivore coexistence (*7*) and enact science-based policy.

Past management of large carnivores in Romania has been based on biologically unrealistic data collected through a flawed methodology lacking scientific oversight. As in other countries, misguided strategies have highlighted data gaps and the need to infuse science into large-carnivore management (*8*–*10*). In recent years, Romania has been building up the science around carnivore population ecology and habitat conservation (*7*, *11*, *12*), yet nationwide data critical for management, such as population size or demographic structure, are still missing. The absence of reliable biological and ecological data makes it difficult to prioritize the best management and conservation measures to promote long-term viability while alleviating human-wildlife conflict.

Resource managers, hunters, environmental groups, and citizens should work together with Romanian and foreign academics to set up a long-term large-carnivore research program, which should be backed by the Romanian government and the European Union. Such a program could combine regional initiatives (*7*) with national-level monitoring (*4*). It could address long-term ecological and social science questions as well as immediate needs for solving human-carnivore conflict and enabling science-based policy. Transparent science accepted by all parties could be the catalyst for Romania to reconcile its own large-carnivore conservation strategies. We are at a crossroads. Romania can either serve as an example of human-carnivore coexistence in the European Union or become a cautionary tale of politics driving wildlife management and miss an opportunity to safeguard Europe's last wild frontier.

Viorel Popescu[1,2], Mihai Pop[2,3], Silviu Chiriac[4], Laurentiu Rozylowicz[2]

[1]Biological Sciences, Ohio University, Athens OH 45701, USA. [2]Centre for Environmental Research (CCMESI), University of Bucharest, Bucharest, Romania. [3]Association for Biodiversity Conservation, Focsani, Romania. [4]Vrancea Environmental Protection Agency, Focsani, Romania.
*Corresponding author.
Email: popescu@ohio.edu

REFERENCES AND NOTES

1. Romanian Government, "Emergency Ordinance 57" (2007); http://legislatie.just.ro/Public/DetaliiDocument/83289 [in Romanian].
2. V. Salvatori *et al.*, *Wild. Biol.* **8**, 3 (2002).
3. Romanian Ministry of Environment, "Order 1169" (2017); http://legislatie.just.ro/Public/DetaliiDocument/192825 [in Romanian].
4. Romanian Ministry of Environment, "Order 625" (2018); http://legislatie.just.ro/Public/DetaliiDocumentAfis/202150 [in Romanian].
5. Romanian Parliament, "Proposal 260" (2019); www.cdep.ro/pls/proiecte/upl_pck2015.proiect?cam=2&idp=17797 [in Romanian].
6. K. A. Artelle *et al.*, *Sci. Adv.* **4**, eaao0167 (2018).
7. T. Hartel *et al.*, *Cons Biol.* 10.1111/cobi.13334 (2019).
8. V. D. Popescu, K. A. Artelle, M. I. Pop, S. Manolache, L. Rozylowicz, *J. Appl. Ecol.* **53**, 1248 (2016).
9. K. A. Artelle *et al. PLOS One* **8**, e78041 (2013).
10. L. E. Ogden, *BioSci.* **67**, 691 (2017).
11. B. Cristescu, C. Domokos, K. J. Teichman, S. E. Nielsen, *PeerJ.* **7**, e6549 (2019).
12. M. I. Pop, R. Iosif, I. Miu, L. Rozylowicz, V. D. Popescu, *Anim. Conserv.* **21**, 352 (2018).

10.1126/science.aax6742

TECHNICAL COMMENT ABSTRACTS

Comment on "Global pattern of nest predation is disrupted by climate change in shorebirds"

Martin Bulla, Jeroen Reneerkens, Emily L. Weiser, Aleksandr Sokolov, Audrey R. Taylor, Benoît Sittler, Brian J. McCaffery, Dan R. Ruthrauff, Daniel H.

Catlin, David C. Payer, David H. Ward, Diana V. Solovyeva, Eduardo S. A. Santos, Eldar Rakhimberdiev, Erica Nol, Eunbi Kwon, Glen S. Brown, Glenda D. Hevia, H. River Gates, James A. Johnson, Jan A. van Gils, Jannik Hansen, Jean-François Lamarre, Jennie Rausch, Jesse R. Conklin, Joe Liebezeit, Joël Bêty, Johannes Lang, José A. Alves, Juan Fernández-Elipe, Klaus Michael-Exo, Loïc Bollache, Marcelo Bertellotti, Marie-Andrée Giroux, Martijn van de Pol, Matthew Johnson, Megan L. Boldenow, Mihai Valcu, Mikhail Soloviev, Natalya Sokolova, Nathan R. Senner, Nicolas Lecomte, Nicolas Meyer, Niels Martin Schmidt, Olivier Gilg, Paul A. Smith, Paula Machín, Rebecca L. McGuire, Ricardo A. S. Cerboncini, Richard Ottvall, Rob S. A. van Bemmelen, Rose J. Swift, Sarah T. Saalfeld, Sarah E. Jamieson, Stephen Brown, Theunis Piersma, Tomas Albrecht, Verónica D'Amico, Richard B. Lanctot, Bart Kempenaers

Kubelka *et al.* (Reports, 9 November 2018, p. 680) claim that climate change has disrupted patterns of nest predation in shorebirds. They report that predation rates have increased since the 1950s, especially in the Arctic. We describe methodological problems with their analyses and argue that there is no solid statistical support for their claims.

Full text: dx.doi.org/10.1126/science.aaw8529

Response to Comment on "Global pattern of nest predation is disrupted by climate change in shorebirds"

Vojtěch Kubelka, Miroslav Šálek, Pavel Tomkovich, Zsolt Végvári, Robert P. Freckleton, Tamás Székely

Bulla *et al.* dispute our main conclusion that the global pattern of nest predation is disrupted in shorebirds. We disagree with Bulla *et al.*'s conclusions and contest the robustness of their outcomes. We reaffirm our results that provide clear evidence that nest predation has increased significantly in shorebirds, especially in the Arctic.

Full text: dx.doi.org/10.1126/science.aaw9893

ERRATA

Erratum for the Report "Conformationally supple glucose monomers enable synthesis of the smallest cyclodextrins" by D. Ikuta *et al.*, *Science* **364,** eaay0378 (2019). Published online 17 May 2019; 10.1126/science.aay0378

Erratum for the Report "Protein assemblies ejected directly from native membranes yield complexes for mass spectrometry" by D. S. Chorev *et al.*, *Science* **364,** eaax7485 (2019). Published online 26 April 2019; 10.1126/science.aax7485

Published by AAAS

Romanian carnivores at a crossroads

Viorel Popescu, Mihai Pop, Silviu Chiriac and Laurentiu Rozylowicz

Science **364** (6445), 1041.
DOI: 10.1126/science.aax6742