





NEW APPROACHES

Open-access platform to synthesize knowledge of ape conservation across sites

Stefanie Heinicke^{1,2,3}  | Isabel Ordaz-Németh¹ | Jessica Junker^{1,2} |
 Mona E. Bachmann^{1,2,4} | Sergio Marrocoli⁵ | Erin G. Wessling⁶  | Dirck Byler⁷ |
 Susan M. Cheyne^{8,9,10} | Jenny Desmond¹¹ | Dervla Dowd¹² |
 Maegan Fitzgerald¹³ | Marc Fourrier¹⁴ | Annemarie Goedmakers¹⁵ |
 R. Adriana Hernandez-Aguilar^{16,17} | Annika Hillers¹⁸ | Kimberley J. Hockings¹⁹ |
 Sorrel Jones^{20,21} | Michael Kaiser¹ | Kathelijne Koops²² | Juan M. Lapuente²³ |
 Fiona Maisels^{24,25} | Julia Riedel^{1,12} | Emilien Terrade²⁶ | Clement G. Tweh^{18,27} |
 Virginie Vergnes¹² | Tina Vogt²⁸ | Elizabeth A. Williamson²⁵  | Hjalmar S. Kühl^{1,2} 

¹Department of Primatology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

²German Centre for Integrative Biodiversity Research (iDiv) Halle-Leipzig-Jena, Leipzig, Germany

³Transformation Pathways, Potsdam Institute for Climate Impact Research (PIK), Member of the Leibniz Association, Potsdam, Germany

⁴Department of Geography, Humboldt University, Berlin, Germany

⁵Yozu Ltd., Liverpool, UK

⁶Department of Human Evolutionary Biology, Harvard University, Cambridge, Massachusetts, USA

⁷Section on Great Apes, IUCN SSC Primate Specialist Group, Washington, District of Columbia, USA

⁸Section on Small Apes, IUCN SSC Primate Specialist Group, Oxford, UK

⁹Borneo Nature Foundation, Palangka Raya, Central Kalimantan, Indonesia

¹⁰Department of Social Sciences, Oxford Brookes University, Oxford, UK

¹¹Liberia Chimpanzee Rescue & Protection, Monrovia, Liberia

¹²Wild Chimpanzee Foundation (West Africa Representation), Abidjan, Côte d'Ivoire

¹³Wildlife Research Center, Kyoto University, Kyoto, Japan

¹⁴Jane Goodall Institute, Vienna, Virginia, USA

¹⁵Chimbo Foundation, Oudemirdum, the Netherlands

¹⁶Department of Social Psychology and Quantitative Psychology, University of Barcelona, Spain

¹⁷Jane Goodall Institute Spain and Senegal, Dindefelo Biological Station, Dindefelo, Kedougou, Senegal

¹⁸Wild Chimpanzee Foundation, Monrovia, Liberia

¹⁹Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn, Cornwall, UK

²⁰RSPB Centre for Conservation Science, The Royal Society for the Protection of Birds, Sandy, UK

²¹School of Biological Sciences, Royal Holloway University of London, Egham, UK

²²Department of Archaeology, University of Cambridge, Cambridge, UK

²³Comoé Chimpanzee Conservation Project, Comoé National Park, Kakpin, Ivory Coast

²⁴Global Conservation Program, Wildlife Conservation Society, Bronx, New York, USA

²⁵Faculty of Natural Sciences, University of Stirling, Stirling, Scotland, UK

²⁶Mongolian Bankhar Dog Project, Hustai National Park, Ulaanbaatar, Mongolia

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2020 The Authors. *American Journal of Primatology* published by Wiley Periodicals LLC

²⁷School of Biological Sciences, University of Nairobi, Nairobi, Kenya

²⁸Elephant Research and Conservation, Saal/Donau, Germany

Correspondence

Stefanie Heinicke, Department of Primatology, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103 Leipzig, Germany.
Email: stefanie_heinicke@eva.mpg.de

Funding information

Max-Planck-Gesellschaft; Robert Bosch Stiftung

Abstract

Despite the large body of literature on ape conservation, much of the data needed for evidence-based conservation decision-making is still not readily accessible and standardized, rendering cross-site comparison difficult. To support knowledge synthesis and to complement the IUCN SSC Ape Populations, Environments and Surveys database, we created the A.P.E.S. Wiki (<https://apeswiki.eva.mpg.de>), an open-access platform providing site-level information on ape conservation status and context. The aim of this Wiki is to provide information and data about geographical ape locations, to curate information on individuals and organizations active in ape research and conservation, and to act as a tool to support collaboration between conservation practitioners, scientists, and other stakeholders. To illustrate the process and benefits of knowledge synthesis, we used the momentum of the update of the conservation action plan for western chimpanzees (*Pan troglodytes verus*) and began with this critically endangered taxon. First, we gathered information on 59 sites in West Africa from scientific publications, reports, and online sources. Information was compiled in a standardized format and can thus be summarized using a web scraping approach. We then asked experts working at those sites to review and complement the information (20 sites have been reviewed to date). We demonstrate the utility of the information available through the Wiki, for example, for studying species distribution. Importantly, as an open-access platform and based on the well-known wiki layout, the A.P.E.S. Wiki can contribute to direct and interactive information sharing and promote the efforts invested by the ape research and conservation community. The Section on Great Apes and the Section on Small Apes of the IUCN SSC Primate Specialist Group will guide and support the expansion of the platform to all small and great ape taxa. Similar collaborative efforts can contribute to extending knowledge synthesis to all nonhuman primate species.

KEYWORDS

data platform, evidence-based conservation decision-making, knowledge synthesis, open access, *Pan troglodytes verus*, West Africa, western chimpanzee

1 | INTRODUCTION

It is well established that conservation planning and practice should be informed by data and scientific evidence (Junker et al., 2020; Sunderland et al., 2009). To be effective, conservation practitioners and decision-makers need access to the best available up-to-date information on the status of a species (e.g., geographical distribution, abundance, and population trends), on human practices that are threatening a species, on suitable conservation interventions, and on barriers to implementing interventions. There are ongoing efforts to compile such information and make it more accessible to relevant audiences. Notably, a growing number of databases curate quantitative information on the status of multiple species, such as the Global Biodiversity Information Facility (species occurrence data;

GBIF, 2020), BioTIME (longitudinal data on species' abundances in assemblages, Dornelas et al., 2018), and TetraDENSITY (population density estimates; Santini et al., 2018). Similarly, information on threats, such as deforestation and fires, are available for many regions, particularly since accessibility of satellite data at high spatial and temporal resolution has improved through platforms such as Global Forest Watch (GFW, 2020). More recently, information on conservation activities has been compiled and made accessible, for example, by the Conservation Evidence Project (Conservation Evidence, 2019) and the Global Database on Protected Area Management Effectiveness (Geldmann et al., 2019). Centralizing and standardizing information needed for conservation decision-making has been instrumental in informing conservation planning and policy, most notably the IUCN Red List of Threatened Species

(Mace et al., 2008; Rodrigues et al., 2006), and the World Database on Protected Areas (Bingham et al., 2019).

Data gaps persist for many taxa, including detailed species occurrence and distribution data (Boakes et al., 2010), time-series of abundance estimates (Dornelas et al., 2018), or community composition (Peterson & Soberón, 2018). In addition, a lack of data on the types of conservation interventions implemented at specific locations persists, as available data typically focus on protected area creation and management (Fishburn et al., 2013; Geldmann et al., 2019). This gap leads to insufficient information on the effectiveness of conservation interventions for some taxa, including primates (Junker et al., 2020). However, additional data and information available in unpublished reports and from experts working at specific sites can contribute to closing some of these gaps (Corlett, 2011).

Networks of specialists, including the IUCN Species Survival Commission and its Specialist Groups, Red List Authorities, task forces and conservation committees, regularly compile information for status assessments for the IUCN Red List of Threatened Species (IUCN, 2020), conservation action plans, or CITES reports. Species- and site-specific information is also important for setting conservation priorities and is often used by funding agencies to guide resource allocation. In addition, site-level information is needed by governmental agencies for environmental impact assessments, for example, for industrial project planning. However, when these data are not compiled and curated on a public platform, relevant information may be overlooked, resulting in unnecessary repetition of studies of the same area or species, or to biases and omissions in priority setting and funding allocation.

Small and great apes are well-studied threatened taxa (Wich & Marshall, 2016) with numerous stakeholders (e.g., government agencies, conservation practitioners from local and international NGOs, and researchers) working towards their protection. Collaboration between these actors and meta-analyses have been facilitated by the IUCN SSC Ape Populations, Environments and Surveys (A.P.E.S.) database (<http://apesportal.eva.mpg.de>), which curates quantitative field survey data on apes (Heinicke et al., 2019; Kühl et al., 2007). Primate

Info Net (<https://primate.wisc.edu/primate-info-net/>) is another online resource that compiles information on primate taxonomy, ecology, threats, and possible solutions at the species level, but it is not spatially explicit (Jacobsen, 1994). Despite these initiatives, data gaps persist for apes, especially with regard to the information on threats undetectable from satellite data (e.g., hunting pressure, infectious diseases, degazettement of protected areas, civil conflict), as well as spatially explicit information on implemented interventions.

2 | DESCRIPTION

2.1 | A.P.E.S. Wiki

To complement the information curated by the IUCN SSC A.P.E.S. database, we created an open-access platform in a wiki format—the A.P.E.S. Wiki (<https://apeswiki.eva.mpg.de>). The A.P.E.S. Wiki is envisioned as a platform for synthesizing knowledge gained through the efforts of the ape research and conservation community by providing open access to information that supports evidence-based conservation decision-making. It is a tool to support collaboration between practitioners and scientists, as anyone with knowledge about a site can contribute to the Wiki by adding information (Figure 1). The process of updating the conservation action plan for western chimpanzees (IUCN SSC Primate Specialist Group, 2020) mobilized researchers and conservation practitioners to compile current knowledge of this Critically Endangered taxon. We thus began work on the A.P.E.S. Wiki with this subspecies. Here we illustrate the process of information compilation, curation, and verification, and discuss how the platform can be used to support conservation decision-making.

2.2 | Process of knowledge synthesis

The A.P.E.S. Wiki is an online resource holding spatially explicit information on apes at the site-level scale at which conservation

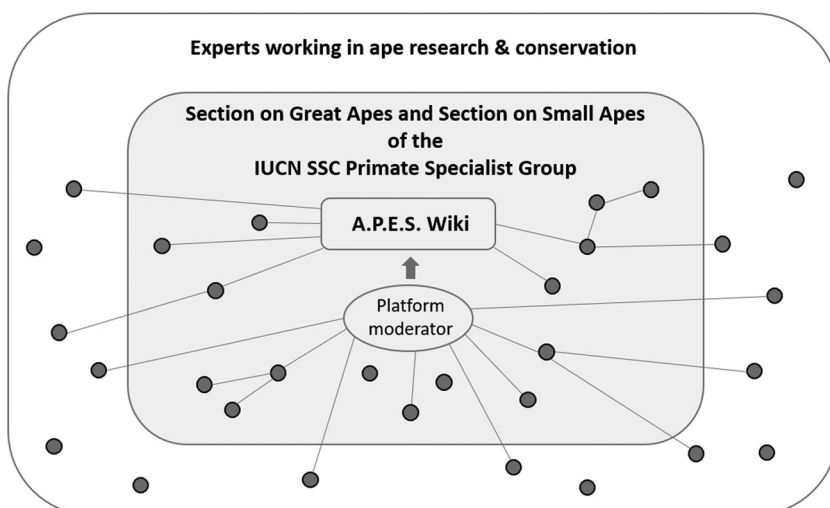


FIGURE 1 Schematic representation of the A.P.E.S. Wiki. Filled dots represent people who have or are working in ape research and conservation, some of them members of the Section on Great Apes or the Section on Small Apes of the IUCN SSC Primate Specialist Group. Experts can directly contribute information to the Wiki, which is then reviewed by the platform moderator, or via the platform moderator. Subnetworks of experts might coordinate their contribution to the Wiki

interventions are typically implemented. We defined a site as an area that can be delineated as a management unit (e.g., a protected area). In some cases, a site was an area where either ape monitoring was taking place or where conservation interventions were being implemented, although not officially protected. The flexibility of the wiki format (details below) allows us to update or rectify site names, which might be especially relevant for sites that have not yet been officially designated. For each site, we searched for published articles and reports that contained relevant information. Many reports were accessed via the IUCN SSC A.P.E.S. database. We then searched for the site name on Google Scholar and Google Search to identify additional reports. Further sources of information included Protected Planet (UNEP-WCMC & IUCN, 2019), and the BirdLife International database on Important Bird and Biodiversity Areas (IBAs, BirdLife International, 2019). In a second step, we sent the compiled information to experts on each site and invited them to collaborate by verifying and complementing the gathered information (a total of 69 experts on western chimpanzees were contacted). Specifically, we contacted people who have previously conducted, or are now conducting research or conservation activities at the respective site, including members of government agencies, conservation NGOs, and researchers.

The Wiki was created in collaboration with the Section on Great Apes (SGA) and the Section on Small Apes (SSA) of the IUCN SSC Primate Specialist Group and several authors are SGA or SSA members. The SGA and SSA are supporting the Wiki by promoting its maintenance, use and expansion to eventually cover all 34 small and great ape taxa. In an ongoing process, the SGA requested that its members review and up-date site descriptions, and add new sites to the Wiki.

2.3 | Technical implementation

The format of a wiki has several advantages: wikis are easily found by online search engines, they can be continuously edited and updated, and due to the popularity of Wikipedia, many people are familiar with the general structure (Page, 2010). This format makes it easy for people to contribute and facilitates the emergence of a community collectively curating a data platform (Page, 2010). Simultaneously, the wiki format enables enough flexibility to incorporate other types of information as needed, such as adding sections on new topics, as well as photos and maps. The simplicity and ease with which wiki pages can be created and modified means that they require little web development, which makes them inexpensive to set up and maintain. The trade-off of this simplicity is a lack of a database, but table data can be extracted from the page text and processed into spreadsheet format using web scraping (Wickham, 2016). Efforts to compile ecological information in wikis are well established, for example, the Coastal Wiki (Flanders Marine Institute, 2020) or Wikispecies (2020).

The information available on the A.P.E.S. Wiki is both quantitative and qualitative in nature. For each site, the Wiki summarizes the population status of the apes present, threats they face, conservation

and research activities implemented, and impediments (i.e., challenges) to their conservation (Table 1). While satellite data are an important resource in providing information on threats to apes (e.g., in terms of forest loss, fires, expansion of human settlements, and roadbuilding), site-specific information from ground level is needed to describe threats not detectable by remote sensing. This includes threats such as hunting and infectious diseases, details of land use, and civil conflict. To allow for data comparison and integration with other platforms, we applied commonly-used classification systems, specifically the IUCN Red List of Threatened Species (IUCN, 2020) and the World Database of Protected Areas (UNEP-WCMC & IUCN, 2019). We always state the source of information (e.g., published study, report, or personal communication) and the method that was used to derive abundance estimates (e.g., line transect, model estimate, or informed guess) following Campbell et al. (2016). This enables users to consider the degree of uncertainty associated with estimates or other pieces of information.

The Wiki is open to anyone involved in ape conservation to contribute to an existing page or to start a page on a site not yet included in the Wiki. To ensure quality of the entries and transparency, we ask contributors to register an account using their real name, as is common practice in Science and in similar wiki projects (e.g., Coastal Wiki). A platform moderator oversees the process of ensuring quality of entries and that they are up-to-date.

3 | EXAMPLE

3.1 | Study area and species

While the aim of the A.P.E.S. Wiki is to compile information on all small and great ape sites and make it publicly accessible, we illustrate the process using the western chimpanzee, which occurs in eight West African countries (Figure 2). It is estimated that 52,811 (CI: 17,577–96,564) individuals remain in West Africa, with the largest populations in Guinea, Liberia and Sierra Leone (Heinicke et al., 2019). Western chimpanzees are listed as Critically Endangered by the IUCN Red List of Threatened Species (Humble et al., 2016), as the population declined by 80% and their geographic range contracted by 20% within 24 years (Kühl et al., 2017).

3.2 | Data analysis

For each site, we compiled data into a standardized format to ensure consistency across sites and to enable users to extract information from each of the tables using a web scraping approach. An example of the R code for web scraping the tables is available in the Supporting Information. To illustrate how data compiled in the A.P.E.S. Wiki can be used for applied analyses, we derived the proportion of chimpanzees that occurs at sites where a specific conservation activity is being implemented: environmental education. To this end, we overlaid the shapefiles of those sites for which environmental

TABLE 1 Information recorded on the A.P.E.S. Wiki

A.P.E.S. Wiki category	Information included	Details
Site characteristics	General site description	Including topography, surface area in km ² , human population, co-occurring species, historical background, if applicable
	Area	As stated in paper/report or in the World Database of Protected Areas (UNEP-WCMC & IUCN, 2019)
	Spatial coordinates	Midpoint (centroid) of site
	Protected area designation	According to World Database on Protected Areas (UNEP-WCMC & IUCN, 2019)
	Habitat types	Classified following IUCN habitat classification scheme (IUCN, 2012)
Ape status	Ape species present	
	Year of survey	
	Abundance estimate	
	Density estimate	
	Encounter rate	
	Area surveyed	
	Survey method	Classified following Campbell et al. (2016)
Threats	Threat category	Classified following IUCN–CMP Unified Classification of Direct Threats (Salafsky et al. 2008)
	Threat level	Classified as low, medium or high, if threat level unknown classified as present
	Quantified severity	For example, hunting signs per km
	Description of threat	
	Year of threat	If unknown or ongoing, year of most recent paper/report mentioning the threat is listed
Conservation activities	Specific activity	Classified following Junker et al. (2017)
	Description of conservation activity	Including which organizations are involved and type of management (e.g., management by governmental agency, an NGO with governmental agency or Public Private Partnership).
	Year of activity	If unknown or ongoing, year of most recent paper/report mentioning the activity is listed
Impediments	Type of impediment	
Research activities	Documented ape behavior	Classified following the PanAf programme (Kühl et al. 2019)

education activities were reported (one of the most frequently cited conservation interventions in the Wiki) with the modeled western chimpanzee density distribution from Heinicke et al. (2019). All analyses and figures were implemented in R version 3.4.1 (R Core Team, 2018).

3.3 | Results

We compiled information for 59 western chimpanzee sites in nine countries, including Burkina Faso where they are now thought to be extirpated (Ginn et al., 2013). These sites cover 26% (138,610 km²) of the subspecies' total geographic range (524,100 km²; Kühl et al., 2017). The Wiki also includes nationwide information for seven countries (Figure 2). Response rate by experts from sites was 25% within one month (17 of 69 people contacted) and we received feedback for 20 sites. According to the World Database of Protected Areas, 39 sites of the 59 sites had a protected area status: 17 sites were designated as National Park (one of those sites only partially designated as National Park), and six as Classified Forest.

Information on threats was recorded for 57 of the 59 sites. The most frequently cited threats were unsustainable levels of resource use (e.g., hunting and logging), agricultural activities, mining, and housing developments (Table 2). Uncontrolled fires, set for clearing land or for hunting, and allowed to burn into adjacent land, were reported frequently for sites described as savanna and dry forest habitats (13 of 18 sites). Climate change was cited three times as a local threat, specifically droughts and temperature extremes.

Conservation activities were reported for 46 of the 59 sites. The most frequently recorded conservation actions were designation of protected areas, followed by environmental education, antipoaching patrols, and provision of nonmonetary benefits to local communities (Table 3 and Figure 3). Impediments to conservation were reported for 25 sites, with a lack of funding and technical means (e.g., vehicles) being cited most frequently (Table 4).

As an example of how data from the A.P.E.S. Wiki could be used for analyses, we estimated that at least 15% of western chimpanzees (over 8000 individuals) occur at sites with environmental education activities (Figure 4), based on the reported information from these 59 sites, and the modeled western chimpanzee density distribution by Heinicke et al. (2019).

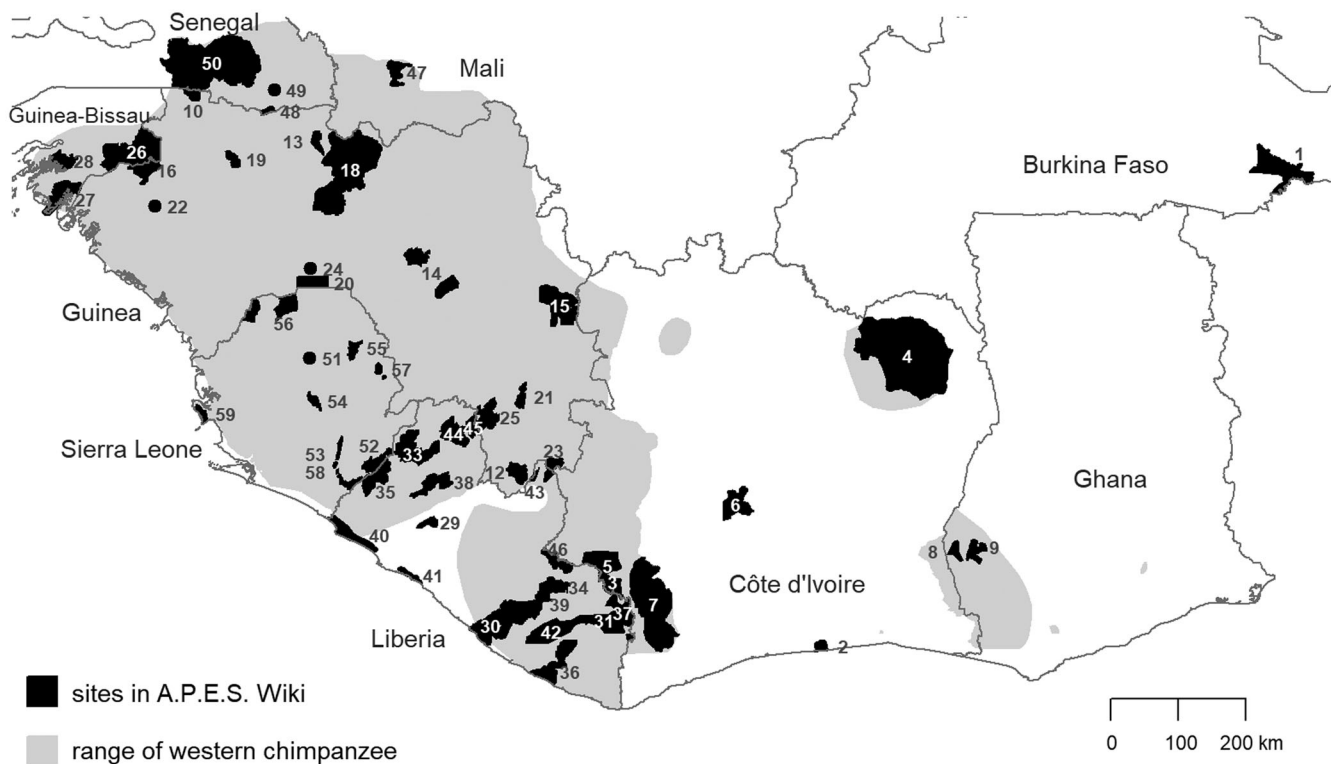


FIGURE 2 Sites included in the A.P.E.S. Wiki for western chimpanzees. Numbers correspond to site names listed in the Supporting Information

4 | COMPARISON AND CRITIQUE

The A.P.E.S. Wiki is the first data platform centralizing information and spatially-explicit data needed for evidence-based decision-making for ape conservation. It is a platform created by and for the ape conservation, research, donor, and funding communities. It can

TABLE 2 Frequency of the threats most often reported across all 59 sites

Threat	No. of sites for which the item was reported
Hunting & collecting terrestrial animals	50
Annual & perennial non-timber crops	47
Logging & wood harvesting	42
Mining & quarrying	36
Roads & railroads	35
Housing & urban areas	31
Fire & fire suppression	22
Livestock farming & ranching	15
Gathering terrestrial plants	11
Fishing & harvesting aquatic resources	8

Note: Naming and definition of threats follows Salafsky et al. (2008).

support collaboration among conservation practitioners, scientists, and other stakeholders involved or interested in ape conservation.

While original survey datasets are curated in the IUCN SSC A.P.E.S. database, the Wiki centralizes secondary information. This includes results from publications and reports, and locations where studies and conservation interventions have been or are being implemented, thereby complementing the IUCN SSC A.P.E.S. database. The Wiki is focused on individual sites and complements Primate Info Net, which compiles general information on primates at the species level.

4.1 | Applications

The aim of the Wiki is threefold: to provide access to data, to provide information on who has and is implementing research and conservation activities at which sites, and to act as a communication platform for the ape conservation community.

4.1.1 | Data curation

The Wiki centralizes information on ape status, threats, implemented conservation activities, impediments to conservation, and ongoing research activities at the site-level. As spatially-explicit information on the conservation activities implemented is lacking so far (except for the existence of protected areas; Fishburn et al.,

TABLE 3 Frequency of the conservation activities most often reported across all 59 sites

Conservation activity	No. of sites for which the item was reported
Legally protect primate habitat	36
Educate local communities about primates and sustainable use	22
Conduct regular antipoaching patrols	15
Implement multimedia campaigns using theater, film, print media, discussions	13
Provide nonmonetary benefits to local communities for sustainably managing their forest and its wildlife	11
Farm more intensively and effectively in selected areas and spare more natural land	11
Involve local community in primate research and conservation management	10
Regularly play TV and radio announcements to raise primate conservation awareness	7
Provide monetary benefits to local communities for sustainably managing their forest and its wildlife	7
Implement monitoring surveillance strategies	7

Note: Naming and definition of conservation activities follows Junker et al. (2017).

2013; Geldmann et al., 2019), the Wiki compiles for the first time the types of conservation interventions being implemented for apes and their location(s). These data can, for instance, be used to account for conservation activities in species distribution models. For

example, for their study of extinction risk for African great apes, Tranquilli et al. (2012) compiled information on the presence/absence of specific conservation activities and modeled their influence on ape extinction in resource management areas. Similarly,

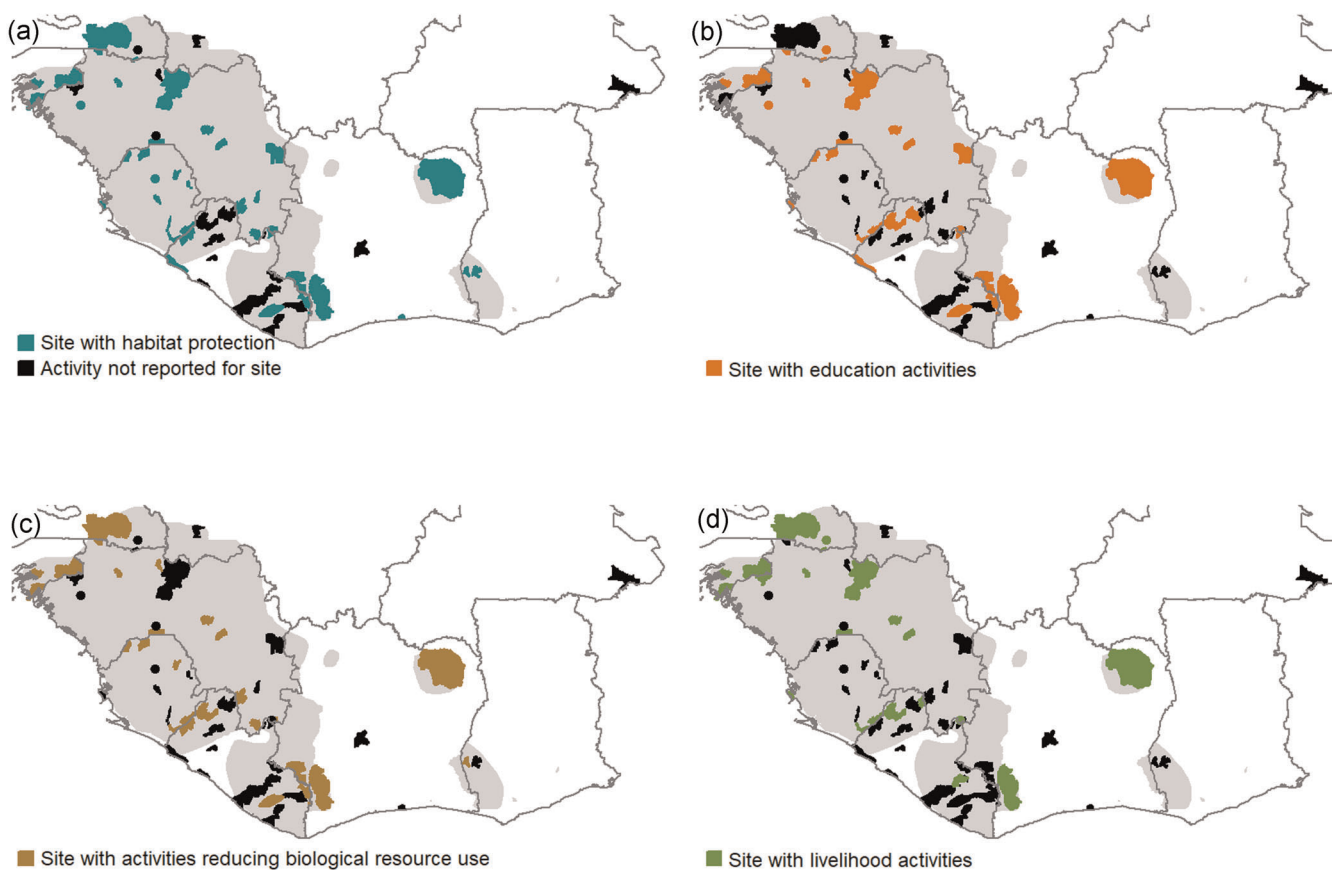


FIGURE 3 Sites in the A.P.E.S. Wiki where a conservation activity was reported for the categories (a) habitat protection, (b) education activity, (c) reducing biological resource use (e.g., antipoaching patrols), or (d) livelihood activity

TABLE 4 Frequency of the impediments to conservation most often reported across all 59 sites

Impediment	No. of sites for which the item was reported
Lack of funding	10
Lack of technical means (e.g., vehicles)	10
Lack of capacity/training	7
Lack of law enforcement	7
Civil unrest	4
Corruption	3

Strindberg et al. (2018) and Ordaz-Németh (in review) included binary site-level predictor variables in density distribution models. However, as data from the A.P.E.S. Wiki are at the scale of sites, they can only be used for studies at a spatial scale matching the input data.

Another advantage is that data can be updated continuously and can easily be collated from the Wiki, as the tables have a standard format following well-established classification schemes, and we provide the R code for compiling these data. The two most frequently reported threats in the Wiki, hunting and agricultural activities, were also listed as the two highest-ranking threats in the

conservation action plan for western chimpanzees (IUCN SSC Primate Specialist Group, 2020). Although the groups of people contributing to both partially overlapped, the concordance between these two forms of data synthesis demonstrates that a data-based approach from a much larger group of contributors reached similar conclusions. At the same time, data retrieval from the Wiki requires less effort than expert consultation and is, therefore, more efficient. As data from the Wiki can be constantly updated and are collated in the same place, future iterations of action plans, Red List Assessments, or CITES and other reports will be easier to produce. As subsequent updates of species assessments and conservation action plans are usually planned at 10-year intervals, the Wiki can provide a more timely picture of the situation at conservation sites and could facilitate progress monitoring on the implementation of action plans.

Data standardization and centralization across the entire range of a taxon can also be used to identify remaining information gaps. For example, this study revealed that climate change was reported as a threat at only three sites, all of them in dry savanna-dominated areas. As primates are likely to face increasing direct and indirect threats linked to climate change, analyses across sites should expose research gaps (Carvalho et al., 2019). Identifying gaps can inform the design of future studies, support researchers and conservation practitioners in arguing their case when applying for funding, and guide prioritization of resource allocation by funding agencies.

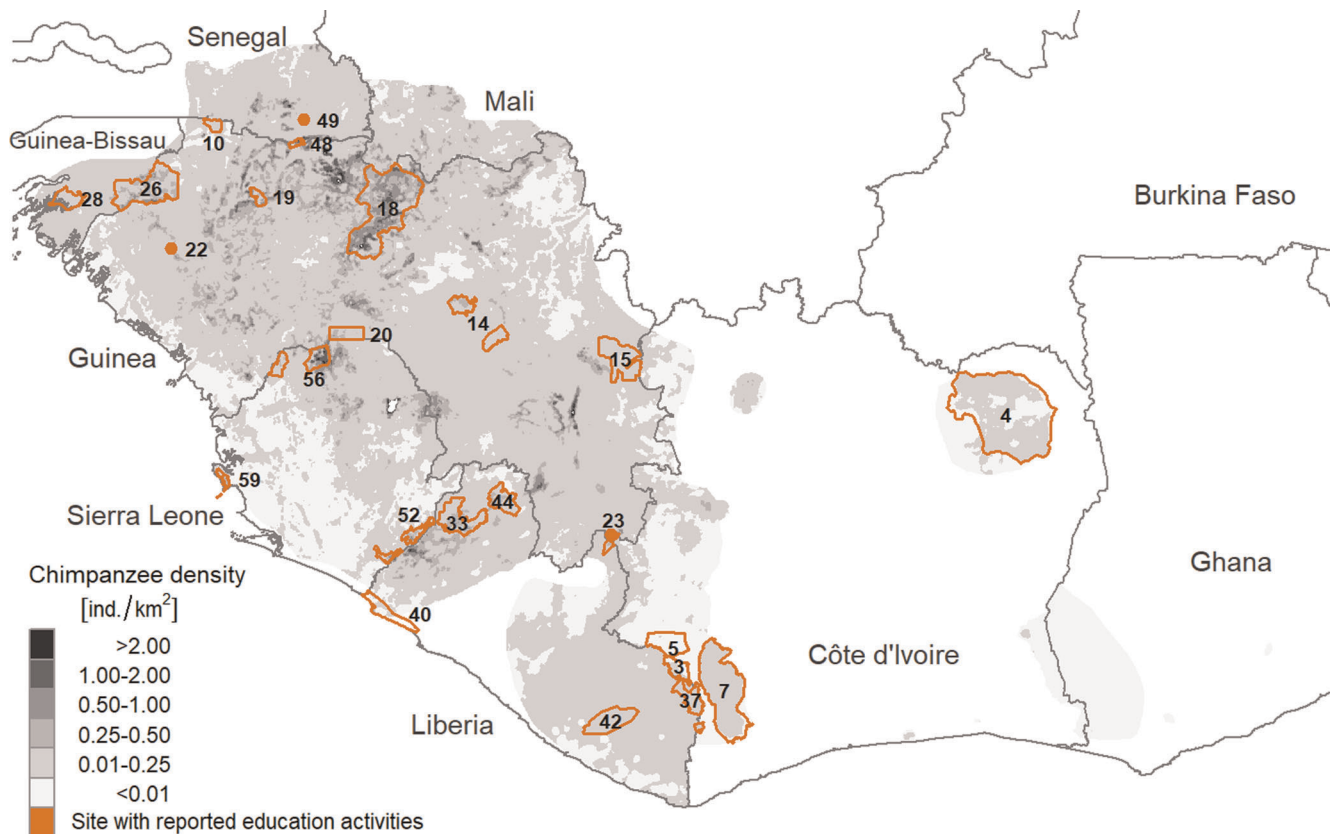


FIGURE 4 Results for an example analysis of how data from the A.P.E.S. Wiki could be used. Here, sites with reported environmental education activities were overlaid with the modeled western chimpanzee density distribution from Heinicke et al. (2019)

4.1.2 | Information on people and organizations active in ape research and conservation

The Wiki provides an easy and accessible overview of data collected on ape conservation, and which people and organizations have been or are active at a site. Centralizing information on past monitoring studies and other research activities may help avoid duplication of research efforts and the overlooking of existing information, for example, by consultants and researchers in the context of environmental impact assessments. In addition, the Wiki may be used by people seeking contact information for NGOs or researchers, including graduate students, journalists, and researchers seeking collaborators.

4.1.3 | Platform for the ape conservation community

The Wiki is a tool and a unique platform for information exchange among stakeholders involved in ape conservation. Specifically, it enables information exchange among people with experience at different sites, and fosters collaborations. With evidence of the effectiveness of conservation interventions for primates being scarce in academic publications (Junker et al., 2020), identifying which conservation interventions are being implemented elsewhere enables sharing the lessons learned by practitioners. For example, one of the most frequently cited conservation activities in the Wiki was environmental education to increase environmental knowledge and awareness. However, published evidence on its effectiveness is scarce (Junker et al., 2017). Identifying locations where conservation activities are implemented can inform the design of new studies and approaches to evaluating conservation effectiveness, for example, by combining it with population trend data. The Wiki also helps conservation practitioners to find specific information from sites with environmental characteristics and human dimensions similar to those in which they work, allowing for lessons learned to be more applicable to a stakeholder's context of interest. Such information allows the study of the social-ecological conditions that may influence the effectiveness of specific conservation interventions or barriers that may hamper their effectiveness under certain circumstances. Information from the Wiki could thus help in establishing a protocol to study the effectiveness of conservation interventions. Importantly, the Wiki can be used as a platform to document information on unsuccessful conservation interventions, and could in the future be expanded for sharing data collection protocols.

Calls for information sharing and collaboration in conservation are amplifying (Costello et al., 2015; Harvey et al., 2020), and platforms such as the A.P.E.S. Wiki can be an important step towards connecting scientists, conservation practitioners, and other stakeholders involved in ape conservation. Specifically, scientists can not only access up-to-date information for a given site in the Wiki but may also have the opportunity to showcase their work using this platform by, for example, providing information on the studies they have

conducted (wiki section on research activities). Conservation practitioners may benefit by sharing information about ongoing or previous work they have initiated. We hope that small and local NGOs, who otherwise lack resources to promote their work online, will also benefit from this platform. These resources are likely to also interest people who want to find out more about apes and their conservation, such as graduate students and journalists who may otherwise lack the contacts to obtain this information directly. Consultants and private sector organizations could use information from the Wiki as a starting point for identifying potential impacts of a planned project on ape populations. Importantly, with its simple and flexible design, the Wiki can be expanded and amended as determined by the ape conservation community, for example, by the addition of new sections to each wiki page or new pages on more general topics.

4.2 | Limitations and challenges

To date, experts on only 20 of the 59 sites currently in the Wiki have responded to our invitation to verify the information we compiled from papers and reports. Thus, the results we report are preliminary, particularly for conservation activities implemented and impediments to conservation. However, the advantage of this platform format is that wiki entries can be updated and verified continuously and instantaneously. As the Wiki is now actively supported by the SGA and SSA, and continues to cover an increasing number of sites and ape species, it is likely that more experts will become interested in contributing and evaluating the information for the sites.

The main challenges for a data platform are to provide up-to-date and correct information, and ensure the long-term sustainability of the platform. To promote the maintenance and use of the data, the support of a group of people that benefit by contributing, and institutional backing are required. As detailed above, there are multiple benefits for scientists and practitioners to contribute to the Wiki, and the support of the SGA and the SSA network is invaluable in promoting its use. Ensuring continued standardization and quality control of the data might require additional platform moderators, especially with the expansion of the Wiki to all ape taxa. Moderation responsibilities could be divided according to taxonomic groups (e.g., small apes), or regions (e.g., East Africa). Another challenge is securing sustained financial support for the data platform. However, data curation is likely to play a more prominent role in the future as conservation is increasingly relying on data-driven decision-making and might thus attract more funding (Juffe-Bignoli et al., 2016).

A further concern for a data platform is public access to sensitive information. All contributors to the Wiki were explicitly asked whether it would be inappropriate to make all information provided open-access. Contributors concluded that this was not the case, as the Wiki does not include specific locations of apes. However, we will be cautious with the expansion of the Wiki. The platform moderator can support contributors to assess how to handle potentially sensitive information, and it might be necessary to make specific entries not publicly accessible to ensure that information is not misused.

4.3 | Outlook

We aim to expand the Wiki to all 34 great and small ape taxa, meaning it will eventually house around 600 pages, each representing an individual site. With such an expansion, information for hundreds of sites would be available on a single platform, presenting a rich resource of centralized and standardized information for conservation decision-making. The SGA's and SSA's network of ape specialists is ideally positioned to support and guide the expansion of the Wiki. Managing a platform with centralized up-to-date information and integrating it into other SGA or SSA activities would lead to synergies and increased efficiencies, for example, for reporting and updating action plans.

This process of knowledge synthesis can be applied to other nonhuman primate taxa by employing a similar approach as that applied here. First, data compilation can be initiated for sites of a particular country or region, or where a specific taxon occurs. Sites for other regions or taxa can then be added incrementally. An approach of initiating a wiki with a core grouping of sites and subsequently expanding data curation to other regions or taxa has proven successful with the IUCN SSC A.P.E.S. database. In addition, involving a large community of researchers and practitioners, each contributing a component, can be an efficient way of centralizing information. The creation of a data platform can be headed by a group of specialists for a region or taxon to establish which data are needed, how data should be standardized, and to communicate with contributors. Furthermore, previous experience with the IUCN SSC A.P.E.S. database indicated that when data are used, additional data are compiled and fed back into the database, thus contributing to the growth of the database itself.

The A.P.E.S. Wiki has the potential to counteract the still prevalent silo structure that often hinders information exchange among stakeholders by facilitating a direct, centralized, and interactive way of sharing information. As it is an openly accessible platform, it provides a transparent resource for anyone interested in ape research and conservation. The Wiki can thereby enhance recognition of the huge efforts invested in surveying and protecting apes, and promoting access to the experience and knowledge gained through these actions.

ACKNOWLEDGMENTS

We thank Maria Voigt and Noémie Cappelle for helpful discussions on the content and layout of the A.P.E.S. Wiki, Andreas Walther for his support in the technical implementation and Franziska Honigschnabel for the design of the logo. We thank Elena Bersacola, Joana Bessa, and Marina Ramon for contributing up-to-date information for Cantanhez NP and Guinea-Bissau, and Laia Dotras and the rest of the team from the Jane Goodall Institute Spain for contributing information for Dindéfelo. We thank Marina Cords and two anonymous reviewers for helpful comments on earlier drafts of this manuscript. We also thank the Max Planck Society and the Robert Bosch Foundation for funding and support. The research adhered to German law and the ASP Principles for the Ethical Treatment of

Nonhuman Primates. Open access funding enabled and organized by Projekt DEAL.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the A.P.E.S. Wiki at <https://apeswiki.eva.mpg.de>.

ORCID

Stefanie Heinicke  <http://orcid.org/0000-0003-0222-5281>

Erin G. Wessling  <https://orcid.org/0000-0001-9661-4354>

Elizabeth A. Williamson  <https://orcid.org/0000-0001-6848-9154>

Hjalmar S. Kühl  <https://orcid.org/0000-0002-4440-9161>

REFERENCES

- Bingham, H. C., Juffe Bignoli, D., Lewis, E., MacSharry, B., Burgess, N. D., Visconti, P., Deguignet, M., Misrachi, M., Walpole, M., Stewart, J. L., Brooks, T. M., & Kingston, N. (2019). Sixty years of tracking conservation progress using the World Database on protected areas. *Nature Ecology & Evolution*, 3(5), 737–743. <https://doi.org/10.1038/s41559-019-0869-3>
- BirdLife International. (2019). *BirdLife Data Zone*. <http://datazone.birdlife.org/home>
- Boakes, E. H., McGowan, P. J. K., Fuller, R. A., Chang-qing, D., Clark, N. E., O'Connor, K., & Mace, G. M. (2010). Distorted views of biodiversity: Spatial and temporal bias in species occurrence data. *PLOS Biology*, 8(6), e1000385. <https://doi.org/10.1371/journal.pbio.1000385>
- Campbell, G., Head, J., Junker, J., & Nekaris, K. A. I. (2016). Primate abundance and distribution: Background concepts and methods. In S. Wich, & A. J. Marshall (Eds.), *An Introduction to Primate Conservation*. Oxford University Press.
- Carvalho, J. S., Graham, B., Rebelo, H., Bocksberger, G., Meyer, C. F. J., Wich, S., & Kühl, H. S. (2019). A global risk assessment of primates under climate and land use/cover scenarios. *Global Change Biology*, 25(9), 3163–3178. <https://doi.org/10.1111/gcb.14671>
- Corlett, R. T. (2011). Trouble with the gray literature. *Biotropica*, 43(1), 3–5. <https://doi.org/10.1111/j.1744-7429.2010.00714.x>
- Conservation Evidence. (2019). *Conservation evidence—Providing evidence to improve practice*. <https://www.conservationevidence.com/>
- Costello, M. J., Vanhoorne, B., & Appeltans, W. (2015). Conservation of biodiversity through taxonomy, data publication, and collaborative infrastructures. *Conservation Biology*, 29(4), 1094–1099. <https://doi.org/10.1111/cobi.12496>
- Dornelas, M., Antão, L. H., Moyes, F., Bates, A. E., Magurran, A. E., Adam, D., Akhmetzhanova, A. A., Appeltans, W., Arcos, J. M., Arnold, H., Ayyappan, N., Badihi, G., Baird, A. H., Barbosa, M., Barreto, T. E., Bässler, C., Bellgrove, A., Belmaker, J., Benedetti-Cecchi, L., ... Murphy, G. (2018). BioTIME: A database of biodiversity time series for the Anthropocene. *Global Ecology and Biogeography*, 27(7), 760–786. <https://doi.org/10.1111/geb.12729>
- Fishburn, I. S., Boyer, A. G., Kareiva, P., Gaston, K. J., & Armsworth, P. R. (2013). Changing spatial patterns of conservation investment by a major land trust. *Biological Conservation*, 161, 223–229. <https://doi.org/10.1016/j.biocon.2013.02.007>
- Flanders Marine Institute. (2020). *Coastal Wiki*. <http://www.coastalwiki.org>
- GBIF. (2020). *Global Biodiversity Information Facility*. <https://www.gbif.org/>
- Geldmann, J., Manica, A., Burgess, N. D., Coad, L., & Balmford, A. (2019). A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressures. *Proceedings of the National Academy of Sciences*, 116, 23209–23215. <https://doi.org/10.1073/pnas.1908221116>
- GFW. (2020). *Global Forest Watch*. <https://www.globalforestwatch.org/>

- Ginn, L. P., Robison, J., Redmond, I., & Nekaris, K. A. I. (2013). Strong evidence that the West African chimpanzee is extirpated from Burkina Faso. *Oryx*, 47(03), 325–326. <https://doi.org/10.1017/S0030605313000434>
- Harvey, J. A., Heinen, R., Armbrrecht, I., Basset, Y., Baxter-Gilbert, J. H., Bezemer, T. M., Böhm, M., Bommarco, R., Borges, P. A. V., Cardoso, P., Clausnitzer, V., Cornelisse, T., Crone, E. E., Dicke, M., Dijkstra, K.-D. B., Dyer, L., Ellers, J., Fartmann, T., Forister, M. L., & Kroon, H.de (2020). International scientists formulate a roadmap for insect conservation and recovery. *Nature Ecology & Evolution*, 4(2), 174–176. <https://doi.org/10.1038/s41559-019-1079-8>
- Heinicke, S., Mundry, R., Boesch, C., Amarasekaran, B., Barrie, A., Brncic, T., Brugièrè, D., Campbell, G., Carvalho, J., Danquah, E., Dowd, D., Eshuis, H., Fleury-Brugièrè, M.-C., Gamys, J., Ganas, J., Gatti, S., Ginn, L., Goedmakers, A., Granier, N., ... Kühl, H. S. (2019). Advancing conservation planning for western chimpanzees using IUCN SSC A.P.E.S.—The case of a taxon-specific database. *Environmental Research Letters*, 14, 064001. <https://doi.org/10.1088/1748-9326/ab1379>
- Humle, T., Boesch, C., Campbell, G., Junker, J., Koops, K., Kühl, H. S., & Sop, T. (2016). *Pan troglodytes ssp. verus*. *The IUCN Red List of Threatened Species 2016*. <http://www.iucnredlist.org>
- IUCN. (2012). *Habitats Classification Scheme (Version 3.1)*. IUCN Red List of Threatened Species. <https://www.iucnredlist.org/resources/habitat-classification-scheme>
- IUCN. (2020). *The IUCN Red List of Threatened Species. Version 2020-2*. The IUCN Red List of Threatened Species. <https://www.iucnredlist.org>
- IUCN SSC Primate Specialist Group. (2020). *Regional Action Plan for the Conservation of Western Chimpanzees (Pan troglodytes verus) 2020–2030*. IUCN. <https://doi.org/10.2305/IUCN.CH.2020.SSC-RAP.2.en>
- Jacobsen, L. (1994). Information programs for primatologists: Wisconsin Regional Primate Research Center. *American Journal of Primatology*, 34(1), 101–108. <https://doi.org/10.1002/ajp.1350340116>
- Juffe-Bignoli, D., Brooks, T. M., Butchart, S. H. M., Jenkins, R. B., Boe, K., Hoffmann, M., Angulo, A., Bachman, S., Böhm, M., Brummitt, N., Carpenter, K. E., Comer, P. J., Cox, N., Cuttelod, A., Darwall, W. R. T., Di Marco, M., Fishpool, L. D. C., Goettsch, B., Heath, M., ... Kingston, N. (2016). Assessing the Cost of Global Biodiversity and Conservation Knowledge. *PLOS One*, 11(8), e0160640. <https://doi.org/10.1371/journal.pone.0160640>
- Junker, J., Kühl, H. S., Orth, L., Smith, R. K., Petrovan, S. O., & Sutherland, W. J. (2017). *Primate conservation: Global evidence for the effects of interventions*. University of Cambridge.
- Junker, J., Petrovan, S. O., Arroyo-Rodríguez, V., Boonratana, R., Byler, D., Chapman, C. A., Chetry, D., Cheyne, S. M., Cornejo, F. M., Cortés-Ortiz, L., Cowlshaw, G., Christie, A. P., Crockford, C., Torre, S. D. L., De Melo, F. R., Fan, P., Grueter, C. C., Guzmán-Caro, D. C., Heymann, E. W., ... Kühl, H. S. (2020). A severe lack of evidence limits effective conservation of the world's primates. *BioScience*, 70, 794–803. <https://doi.org/10.1093/biosci/biaa082>
- Kühl, H. S., Williamson, L., Sanz, C., Morgan, D., & Boesch, C. (2007). A.P.E.S., IUCN SSC A.P.E.S. database. <http://apesportal.eva.mpg.de/>
- Kühl, H. S., Sop, T., Williamson, E. A., Mundry, R., Brugièrè, D., Campbell, G., Cohen, H., Danquah, E., Ginn, L., Herbinger, I., Jones, S., Junker, J., Kormos, R., Kouakou, C. Y., N'Goran, P. K., Normand, E., Shutt-Phillips, K., Tickle, A., Vendras, E., ... Boesch, C. (2017). The Critically Endangered western chimpanzee declines by 80%. *American Journal of Primatology*, 79(9), e22681.
- Kühl, H. S., Boesch, C., Kulik, L., Haas, F., Arandjelovic, M., Dieguez, P., Bocksberger, G., McElreath, M. B., Agbor, A., Angedakin, S., Ayimisin, E. A., Bailey, E., Barubiyo, D., Bessone, M., Brazzola, G., Chancellor, R., Cohen, H., Coupland, C., ... Kalan, A. K. (2019). Human impact erodes chimpanzee behavioral diversity. *Science*, 363(6434), 1453–1455. <https://doi.org/10.1126/science.aau4532>
- Mace, G. M., Collar, N. J., Gaston, K. J., Hilton-Taylor, C., Akçakaya, H. R., Leader-Williams, N., Milner-Gulland, E. J., & Stuart, S. N. (2008). Quantification of extinction risk: IUCN's system for classifying threatened species. *Conservation Biology*, 22(6), 1424–1442. <https://doi.org/10.1111/j.1523-1739.2008.01044.x>
- Ordaz-Németh, I., Sop, T., Amarasekaran, B., Bachmann, M., Boesch, C., Brncic, T., Caillaud, D., & Kühl, H. S. (in review) Inferring range-wide African great ape density distribution from site-level abundances. *American Journal of Primatology*.
- Page, R. (2010). Wikipedia as an encyclopaedia of life. *Nature Precedings*, <https://doi.org/10.1038/npre.2010.4242.1>
- Peterson, A. T., & Soberón, J. (2018). Essential biodiversity variables are not global. *Biodiversity and Conservation*, 27(5), 1277–1288. <https://doi.org/10.1007/s10531-017-1479-5>
- R Core Team. (2018). *R: A language and environment for statistical computing*. R Core Team. <https://www.R-project.org/>
- Rodrigues, A. S. L., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M., & Brooks, T. M. (2006). The value of the IUCN Red List for conservation. *Trends in Ecology & Evolution*, 21(2), 71–76. <https://doi.org/10.1016/j.tree.2005.10.010>
- Salafsky, N., Salzer, D., Stattersfield, A. J., Hilton-Taylor, C., Neugarten, R., Butchart, S. H. M., Collen, B., Cox, N., Master, L. L., O'connor, S., & Wilkie, D. (2008). A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conservation Biology*, 22(4), 897–911. <https://doi.org/10.1111/j.1523-1739.2008.00937.x>
- Santini, L., Isaac, N. J. B., & Ficetola, G. F. (2018). TetraDENSITY: A database of population density estimates in terrestrial vertebrates. *Global Ecology and Biogeography*, 27(7), 787–791. <https://doi.org/10.1111/geb.12756>
- Strindberg, S., Maisels, F., Williamson, E. A., Blake, S., Stokes, E. J., Aba'a, R., Abitsi, G., Agbor, A., Ambahe, R. D., Bakabana, P. C., Bechem, M., Berlemont, A., Bokoto de Semboli, B., Boundja, P. R., Bout, N., Breuer, T., Campbell, G., De Wachter, P., Ella Akou, M., ... Wilkie, D. S. (2018). Guns, germs, and trees determine density and distribution of gorillas and chimpanzees in Western Equatorial Africa. *Science Advances*, 4(4), eaar2964. <https://doi.org/10.1126/sciadv.aar2964>
- Sunderland, T., Sunderland-Groves, J., Shanley, P., & Campbell, B. (2009). Bridging the gap: How can information access and exchange between conservation biologists and field practitioners be improved for better conservation outcomes? *Biotropica*, 41(5), 549–554. <https://doi.org/10.1111/j.1744-7429.2009.00557.x>
- Tranquilli, S., Abedi-Lartey, M., Amsini, F., Arranz, L., Asamoah, A., Babafemi, O., Barakabuye, N., Campbell, G., Chancellor, R., Dawnport, T. R. B., Dunn, A., Dupain, J., Ellis, C., Etoga, G., Furuichi, T., Gatti, S., Ghiurghi, A., Greengrass, E., Hashimoto, C., ... Kuehl, H. (2012). Lack of conservation effort rapidly increases African great ape extinction risk. *Conservation Letters*, 5(1), 48–55. <https://doi.org/10.1111/j.1755-263X.2011.00211.x>
- UNEP-WCMC, & IUCN. (2019). *Protected Planet: The World Database on Protected Areas (WDPA), Online April 2019*. UNEP-WCMC and IUCN. Protected Planet. <https://www.protectedplanet.net/>
- Wich, S. A., & Marshall, A. J. (2016). *An introduction to primate conservation*. Oxford University Press.
- Wickham, H. (2016). *rvest: Easily harvest (scrape) web pages*. R package version 0.3.2. <https://CRAN.R-project.org/package=rvest>

Wikispecies. (2020). *Wikispecies, free species directory*. https://species.wikimedia.org/wiki/Main_Page

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

How to cite this article: Heinicke S, Ordaz-Németh I, Junker J, et al. Open-access platform to synthesize knowledge of ape conservation across sites. *Am J Primatol*. 2021;83:e23213. <https://doi.org/10.1002/ajp.23213>