Biocultural vulnerability exposes threats of culturally important species

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Abstract

There are growing calls for conservation frameworks that, rather than breaking the relations between people and other parts of nature, capture place-based relationships that have supported social-ecological systems over the long term. Biocultural approaches propose actions based on conservation priorities and cultural values aligned with local priorities, but mechanisms that allow their global uptake are missing. We propose a framework to globally assess the biocultural status of specific components of nature that matter to people and apply it to culturally important species (CIS). Drawing on a literature review and a survey, we identified 385 wild species, mostly plants, which are culturally important. CIS predominate among Indigenous Peoples (57%) and ethnically defined groups (21%). CIS have a larger proportion of Data Deficient species (41%) than the full set of IUCN species (12%), underscoring the disregard of cultural considerations in biological research. Combining information on CIS biological conservation status (IUCN threatened status) and cultural status (language vitality), we found that more CIS are culturally vulnerable or endangered than biologically and that there is a higher share of bioculturally endangered or vulnerable CIS than of either biologically or culturally endangered CIS measured separately. Bioculturally endangered or vulnerable CIS are particularly predominant among Indigenous Peoples, arguably because of the high levels of cultural loss among them. The deliberate connection between biological and cultural values, as developed in our 'biocultural status' metric, provides an actionable way to guide decisions and operationalize global actions oriented to enhance place-based practices that have supported social-ecological systems over the long term.

Significance statement

Recognizing the connections between people and other parts of nature and incorporating them into decision making will enable to operationalize actions simultaneously based on conservation priorities and cultural values aligned with local priorities. Our framework and metric of 'biocultural status' shows that high levels of cultural loss, particularly among Indigenous peoples, swamp the influence of biological status on assessing biocultural status. To sustain culturally important species, we need to accelerate biological research on species that are culturally important and support the cultures that value them.

Biocultural vulnerability exposes threats of culturally important species

At a time of global decline in nature, there are growing efforts to conserve the world's biodiversity both for nature's sake and for its contributions to humankind (1). In these efforts, conservation policies based mostly on biological criteria miss the social, cultural, and livelihoods needs and aspirations held by local communities (2). They thus risk perpetuating existing inequalities in the distribution of social and ecological burdens and benefits of conservation (3, 4). For example, conservation proposals to safeguard 30% (5, 6) or 50% (7) of the planet face opposition on the grounds that they might increase the negative social impacts of conservation actions and pose immediate risks for people whose livelihoods directly depend on nature, in particular Indigenous Peoples and local communities (8, 9). To help address these potential conflicts, researchers and practitioners increasingly emphasize the need for different conservation frameworks that, rather than focusing on breaking the relations between people and other parts of nature, include a broader range of worldviews, knowledge, and values, and that capture place-based relationships that have supported social-ecological systems over the long term (10–13).

Biocultural approaches can widen existing conservation frameworks by recognizing and honoring the relationships between people and other parts of nature, proposing actions based on conservation priorities and cultural values aligned with local priorities (3, 14, 15). Examples of biocultural approaches to conservation include initiatives that recognize the spiritual significance of landscapes as manifested in sacred sites (16, 17), the importance of social norms, such as taboos or customary rules in wildlife management (18, 19), or the cultural significance of some species, including them in management strategies (20, 21) or in conservation planning in the face of climate change (22). Despite recent applications of biocultural approaches in specific case studies, we lack mechanisms that allow a global uptake of a biocultural framework (but see (23) for a proposal). This gap most likely exists because many of the interactions that mediate the relationships between people and non-human nature are context-specific and difficult to articulate to outsiders (11, 24) resulting in challenges for the transferability, integration, and scalability of local knowledge (25).

Here, we propose a framework and implement a metric to assess the biocultural status of specific components of nature that matter to local communities. The proposed metric, 'biocultural status', allows the combination of information on biological and cultural conservation status of different components of nature and is based on the logic that the disappearance of a culture entails the disappearance of relations between human and non-human components of nature (2, 26, 27). Drawing on research on cultural keystone species (e.g., 21, 28), we apply this framework to assess the biocultural status of 'culturally important species' (CIS), here defined as species that have a recognized role in supporting cultural identity, as they are generally the basis for religious, spiritual, and social cohesion and provide a common sense of place, purpose, belonging, or rootedness associated with the living world (see Methods).

Culturally Important Species Characterization

Combining information from previous compilations of CIS and an online survey (see Methods), we identified 385 wild species that are culturally important for at least one socio-cultural group. We differentiated between CIS that are important for Indigenous Peoples, ethnic groups, local communities, and other socio-cultural groups (see Methods for definitions). We acknowledge that ours is not a comprehensive list of the total (currently unknown) number of CIS on Earth and that the inclusion of species in the list is probably biased by researchers' interpretation of which species are culturally important, as the compilation was not fully informed through diverse knowledge systems. However, the list represents the largest global compilation of wild species identified as culturally important to date. Our list includes many taxa, but is largely dominated by plants (n=242; 63%) (Fig. 1a). CIS were reported on every continent, with more reports in North America (23%) than elsewhere (Fig. 1b). Only four species (all sea turtles, i.e., *Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, and *Eretmochelys imbricate*) were reported as culturally important by groups in more than one continent. Other reports were continent-specific.

INSERT FIGURE 1

Species in our list are culturally important for a variety of socio-cultural groups, but mainly for Indigenous Peoples (57%) and ethnically defined groups (21%). Particularly, CIS are documented among Indigenous Peoples in the Americas, Oceania, and Asia and among ethnically defined groups in Africa (Fig. 1b). Some CIS are also documented among local communities (mainly in South America) and for other types of socio-cultural groups in Europe (e.g., citizens of a region, religious minorities).

Biological and cultural status

We assessed the biological conservation status of CIS (hereafter ‘biological status’) using the IUCN Red List of Threatened Species (29) and the ‘cultural status’ of the group(s) for which the species is culturally important using language vitality, following Ethnologue (30). We used language vitality as a proxy for a group’s cultural status because language is the primary means of cultural transmission (31, 32). We assigned a cultural status value to each CIS, combining information from the cultural status of all the groups for which the species is documented as culturally important (see Methods).

The distribution of IUCN categories within our list of CIS generally aligns well with the general distribution of IUCN Red List species [χ^2(df = 4, N = 32,713) = 3.23, p = .520], except for Data Deficient species. Our list of CIS has a much higher proportion of Data Deficient species (41%) than the full set of IUCN species (12%). The high share of Data

Deficient species in our list might result in an underestimation of the biological threat of some CIS, as species categorized as Data Deficient by IUCN seem to be more threatened than data-sufficient species (33). The disproportionally high amount of missing data on the biological status of CIS also aligns with reports of mismatches in metrics externally defined and those locally considered important (e.g., 34). Importantly, the data gap underscores that cultural considerations remain disregarded in much current biological research (3, 4).

CIS in our list are homogeneously distributed across the selected cultural status categories, with roughly one third of the species falling in the Not Threatened (36%), Vulnerable (28%), and Endangered (34%) categories. Only six CIS have a Data Deficient cultural status.

Biocultural status

We combined information on the CIS's biological and cultural status to create categories for a new metric of 'biocultural status' (Fig. 2). We acknowledge that there are biases in the datasets used to infer CIS biological (35) and cultural status (36), which precludes the precise assessment of 'biocultural status'. However, using a Pearson's chi-square test of independence we found that biological and cultural status of CIS in our sample are independent of one another (χ^2(df = 15, N = 382) = 14.95, p = .455). Overall, 163 (42%) of the CIS in our list are not of biological concern and a similar number (n=139, 36%) are not of cultural concern. A much lower share of CIS are not of biocultural concern (n=62; 16%), with 110 (29%) and 152 CIS (39%) having a Vulnerable and Endangered cultural status, respectively. Overall, then, more CIS in our list are culturally Vulnerable or Endangered than they are biologically Vulnerable or Endangered. Bootstrapped 95% confidence intervals show that the proportion of bioculturally Endangered and Vulnerable CIS are significantly greater than the proportion of Not Threatened and Data Deficient CIS.

INSERT FIG. 2

Many CIS with a biological status other than Data Deficient are Least Concern or Near Threatened (n=163, 42%) but span the range of cultural status (Fig. 2). Over one third of the species in the Least Concern and Near Threatened categories (n=62; 16% of all CIS) are culturally Not Threatened. Examples of species in this category are *Ciconia ciconia* (white stork), considered a "national bird" by the Polish (37), *Macleania rupestris* (uva camarona), whose fruit is widely consumed by high mountain peasants in Colombia (38), and *Ptaeroxylon obliquum* (sneezewood tree), whose durable wood is used by the Xhosa in West Africa to construct ceremonial houses and represents allegiance to the ancestors (39).

A similar number of species (n=58; 15% of all CIS) are biologically Least Concern or Near Threatened but are important to culturally Endangered groups. Examples of species in this category include the venomous *Naja haje* (Egyptian cobra) of North Africa that is sacred to the Ikoma in Tanzania (40), or *Echyridella menziesii* (New Zealand freshwater mussel), a New Zealand endemic that is culturally keystone to the Maori (41).

Very few CIS are both biologically and culturally Endangered or Critically Endangered (n=13; 3% of all CIS; Fig. 2). Species in this category include the Endangered *Fraxinus nigra* (Black ash), which plays a central role in the spiritual and material culture (i.e., basketry) of different Native Americans and First Nations people in the Wabanaki Confederacy (42), the Critically Endangered crayfish *Cherax tenuimanus* in southwestern Australia, culturally important to the Endangered Indigenous Nations in the Murray-Darling River Basin (43), or the Endangered tree *Araucaria araucana* (pehuen), which plays a key role in the identity and concept of territoriality of the also Endangered Mapuche-Pehuenche people (44).

An analysis of the geographical distribution of biological, cultural, and biocultural status of CIS (Fig. 3a) shows that North America and Oceania have very high proportions of bioculturally endangered CIS (71% and 67% of CIS listed in these continents), which is driven almost entirely by Endangered cultural status. Conversely, most species listed in Europe (68%) are not bioculturally threatened. Most of the Data Deficient biocultural status is driven by lack of data on biological status, particularly prominent in Asia and South America (i.e., Data Deficient Red List assessments).

INSERT FIG. 3

Across socio-cultural group types, the share of bioculturally Endangered (57%) and Vulnerable (33%) CIS is highest among Indigenous People (Fig 3b). Conversely, the share of bioculturally Not Threatened CIS is highest among Other Socio-Cultural Groups (60%). Because Indigenous Peoples' lands show lower declines in nature than other lands (45), the high share of bioculturally Endangered and Vulnerable CIS among Indigenous Peoples probably derives from high levels of cultural endangerment of Indigenous Peoples (as measured by language endangerment). In fact, a recent global analysis of language endangerment shows that areas with the highest proportion of endangered languages include Australia, North China, Siberia, North Africa and Arabia, North America, and parts of South America (46), which also display high cultural diversity and presence of Indigenous populations (45). That is, the high extinction risk of Indigenous languages may swamp the influence of biological status on biocultural status.

Our approach allows exploration of the biocultural status of species across continents and socio-cultural groups, but it does not allow establishment of causal links between biological and cultural threats. One of the conservation approaches is based on the idea of the need to protect a pristine "wilderness", free from the damaging role of humans. It argues that breaking the relations between humans and other parts of nature (either because of the loss of cultural identity and traditional livelihoods, migration, or displacement) would lead to the recovery of wild species (47). Even if that is the case (48), breaking the relation between people and other components of nature might eventually lead to the decline of collective attention and memory to a species, or to the 'societal extinction of species', with potential implications for global conservation efforts (26). By contrast, the biocultural approach argues that the removal of the relations between humans and other parts of nature could lead to declines both on the status of nature and on people's quality of life, and ultimately to local extinction of species or habitat loss (2, 49). In part, this might occur because cultural decline entails a loss of culturally-unique knowledge and behavior, including forms of nature care and management, which might negatively affect non-human parts of nature (27). While further research is needed to understand the causal effects of changing the relations between humans and other parts of nature, particularly in areas where such relations have supported social-ecological systems over the long term, the deliberate connection between cultural and biological values, as developed in our 'biocultural status' metric for CIS, offers a tangible means to advance conservation that meets the needs of both people and nature. Importantly, while the focus of this work has been on CIS, the framework is transferable to species that are valued for their material contributions (e.g., food, regulation of freshwater) or even to other components of nature (e.g., domesticated species, ecosystems).

As the conservation community increasingly seeks to include diverse worldviews, knowledge, and values in nature management and restoration, the framework and metric proposed here offer a concrete mechanism that combines local perspectives on which species are culturally important with scientific assessments of the biological and cultural status of these species. Thus, the framework and metric provide an actionable way to guide decisions and operationalize global actions oriented to enhance place-based practices that have supported the conservation of social-ecological systems over the long term (e.g., Indigenous People practices). In that sense, our results for a subset of the global CIS identify how and where global and local conservation priorities intersect, and highlight the predominant biocultural vulnerability of CIS species from loss of culture. We derive two specific recommendations from these main results. First, there is a need for a larger focus to assess the biological status of CIS, as there is a disproportionately high number of CIS with Data Deficient biological status. Such focus would allow for the planning of actions simultaneously based on conservation priorities and cultural values aligned with local priorities. Second, as cultural endangerment drives the high levels of biocultural endangerment of CIS, there is a need to increase the support to maintaining thriving cultural diversity. In that sense, there are growing calls for the conservation community to actively engage with and support Indigenous rights to land, resources, diverse livelihoods, and lifeways, and particularly claims of Indigenous peoples and local communities for autonomous territorial management (13, 50, 51). By recognizing the connections between people and other parts of nature and directly incorporating them into decision making we hope our approach enables more effective action to reach the 2050 Convention of Biological Diversity goal of "Living in harmony with nature".

Methods

Defining and identifying CIS

To connect cultural perspectives with environmental conservation and restoration discourses, ethnobiologists have used the concept of "cultural keystone species" (e.g., 28, 42), proposing a set of criteria for identifying them (28). For the work presented here, we assembled information gathered by two previous compilations of cultural keystone species and an online survey. However, since we could not verify whether all the species in the list actually fit the criteria of 'cultural keystone species' (as defined in 28), here we use the more lax term “culturally important species” (CIS). The two compilations used include the list available in (21) and an unpublished list provided by Michael Coe, elaborated as part of his PhD dissertation and subsequent publications (52, 53). The analysis of the species appearing in the two compilations showed a geographical bias for North America and a likely taxonomic bias for plant species. To enlarge the list and potentially minimize the observed biases, we conducted an online survey (available in a dedicated webpage between January and June 2021) and distributed it around the world through social media and distribution lists of targeted networks (e.g., Indigenous and Communities Consortium, the list of the Anthropology & Environment Society of the American Anthropological Association). The survey, available in English, Spanish, French, Portuguese, Bahasa Indonesia, German, and Russian, asked for information (i.e., local name(s), scientific name, uses) about species considered culturally important for any socio-cultural group and requested details on the cultural identity of the group (i.e., group name, language, territory). The survey included 503 entries of CIS. Most respondents only entered information on one CIS/group, although some informants entered as much as 10 CIS/group (avg= 1.2). We eliminated incomplete records and records where the species could not be identified by the scientific name. We merged information from the literature and the survey to create our list of CIS (Suppl. Material). Because our focus is on wild biodiversity, we excluded 23 domesticated species (i.e., crops or pets) from the analysis.

Plant taxonomic names were standardized using the Plants of the World Online (POWO; http://www.plantsoftheworldonline.org, accessed 1 January 2022) and animal names were standardized following the International Union for Conservation of Nature Red List of Threatened species (IUCN 2020). Names of cultural groups were recorded at the most specific level possible (e.g., Cree vs. First Nations), although in many cases sources provided only general names (e.g., Aboriginals, Indigenous communities). Groups with internal divisions (i.e., the Cree People are formed by numerous sub-groups, such as the Plains Cree, Woods Cree, or James Bay Cree) were aggregated in the denominator that best captures the identification used by the group.

Assessing species' biological, cultural, and biocultural status

We assessed the biological and the cultural status of all the wild species in our list. We equated biological status with species' conservation assessments from the IUCN Red List of species (2020), which includes categories of Least Concern, Near Threatened, Vulnerable, Endangered, and Critically Endangered. We generally defined a cultural group as a group of individuals who share a core set of beliefs, patterns of behavior, and values. We identified four types of socio-cultural groups: Indigenous Peoples (i.e., those who -belonging to specific nations or ethnic groups- self-identify as "Indigenous" and live in nation-states acknowledging Indigenous Peoples' rights), ethnic groups (i.e., ethnically distinctive groups who do not self-identify as Indigenous or who live in nation-states that do not acknowledge Indigenous Peoples' rights), local communities (e.g., *caboclo* or mestizo riverine dwellers, and forest extractive communities who have long term relations with the territory), and other socio-cultural groups (including citizens of a region who are identified by their ways of thinking and behaving, including religion). To assess the cultural status of the group reporting the species, we used language vitality as a proxy, as language is the primary means of cultural transmission (31, 32). Specifically, for each cultural group in our database, we collected information on language vitality (categories Institutional, Stable, Endangered, or Extinct) from Ethnologue (https://www.ethnologue.com/about), the most comprehensive and updated inventory of the status of languages in the world. When the categorization of the cultural group was too general to identify the language spoken by the group (e.g., "ethnic community"), we coded language vitality as "Data Deficient", except in cases for which we could assume the status. For example, of the more than 250 known Australian Indigenous languages, only about 145 are still spoken and of those 110 are critically endangered (46), so we assumed that the linguistic vitality of any Australian Indigenous language was Endangered.

As some species were reported as culturally important for more than one cultural group, we followed several steps to create a measure that captures a CIS cultural status. First, if the species was reported as culturally important for one group, or for groups with the same language vitality, we equated the species cultural status to language vitality using the following equivalence: Institutional language = Not Threatened; Stable language = Vulnerable; Endangered language = Endangered. Second, if a species was reported as culturally important for groups with different levels of language vitality, we considered the species cultural status to be i) Not Threatened if the species was reported only by groups with Institutional only or a combination of Institutional and Stable languages, ii) Vulnerable if the species was reported only by groups with Stable languages or by any combination of groups with Institutional/Stable languages and Endangered/Extinct languages, iii) Endangered if the species was reported only by groups with Extinct and/or Endangered languages. If the species was reported by several groups and one of the groups lacked information on language vitality, we classified its cultural status as "Data Deficient".

To assess CIS biocultural status, we combined information on the species' biological and cultural status to create categories of 'biocultural status' (Fig. 2). Specifically, we created the categories of Data Deficient, Not Threatened (which include CIS biologically Least Concern or Near Threatened and culturally Not Threatened), Vulnerable (which include CIS biologically Vulnerable and all categories of cultural status except Endangered), and Endangered (which includes CIS biologically Critically Endangered or Endangered CIS culturally Endangered).

We provide descriptive statistics of the biological, cultural, and biocultural status of the 385 species in our list. We compare the share of CIS (n=385) that fall into four main categories (i.e., Data Deficient, Not threatened, Vulnerable, and Endangered), according to their i) biological, ii) cultural, and iii) biocultural status, aggregated by continent (excluding four global species) (Fig. 3a) and socio-cultural group category (excluding 13 species with insufficient data on cultural group) (Fig. 3b). To calculate 95% confidence intervals around species' counts within each category, we resampled the dataset 1000 times with replacement, counted the number of species in each category, and identified the 2.5% and 97.5% quantiles as the confidence interval bounds. To test for independence of values given in the biological and cultural status datasets, we constructed a contingency table of species counts in each combination of biological status and cultural status, then performed a chi-squared test using the `chisq.test()` function in R. All analysis was performed in R version 4.2.1.

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References

1. S. Díaz, *et al.*, Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science (80-.).* **366**, eaax3100 (2019).
2. M. S. Fletcher, R. Hamilton, W. Dressler, L. Palmer, Indigenous knowledge and the shackles of wilderness. *Proc. Natl. Acad. Sci. U. S. A.* **118**, e2022218118 (2021).
3. P. Bridgewater, I. D. Rotherham, A critical perspective on the concept of biocultural

diversity and its emerging role in nature and heritage conservation. *People Nat.* **1**, 291–304 (2019).

4. D. Armitage, P. Mbatha, E.-K. Muhl, | Wayne Rice, M. Sowman, Governance principles for community-centered conservation in the post-2020 global biodiversity framework. *Conserv. Sci. Pract.* **2**, e160 (2020).

5. M. L. Noon, *et al.*, Mapping the irrecoverable carbon in Earth's ecosystems. *Nat. Sustain. 2021 51* **5**, 37–46 (2021).

6. E. Dinerstein, *et al.*, A Global Deal for Nature: Guiding principles, milestones, and targets. *Sci. Adv.* **5**, eaaw2869 (2019).

7. E. Wilson, Half-Earth: How to Save the Biosphere. *Half-Earth Our Planet's Fight Life*, 185–188 (2016).

8. J. E. Fa, *et al.*, Importance of Indigenous Peoples' lands for the conservation of Intact Forest Landscapes. *Front. Ecol. Environ.* **18**, 135–140 (2020).

9. R. C. Henry, *et al.*, Global and regional health and food security under strict conservation scenarios. *Nat. Sustain. 2022 54* **5**, 303–310 (2022).

10. M. Infield, A. Entwistle, H. Anthem, A. Mugisha, K. Phillips, Reflections on cultural values approaches to conservation: lessons from 20 years of implementation. *Oryx* **52**, 220–230 (2018).

11. E. J. Sterling, *et al.*, Biocultural approaches to well-being and sustainability indicators across scales. *Nat. Ecol. Evol.* **1**, 1798–1806 (2017).

12. R. Dacks, *et al.*, Developing biocultural indicators for resource management. *Conserv. Sci. Pract.* **1** (2019).

13. V. Reyes-García, *et al.*, Recognizing Indigenous peoples' and local communities'

rights and agency in the post-2020 Biodiversity Agenda. *Ambio* **51**, 84–92 (2022).

14. L. Maffi, E. Woodley, *Biocultural diversity conservation : a global sourcebook* (Earthscan, 2010) (April 11, 2022).

15. M. C. Gavin, *et al.*, Defining biocultural approaches to conservation. *Trends Ecol. Evol.* **30**, 140–145 (2015).

16. P. Dominguez, F. Zorondo-Rodríguez, V. Reyes-García, Relationships between religious beliefs and mountain pasture uses: A case study in the High Atlas mountains of Marrakech, Morocco. *Hum. Ecol.* **38** (2010).

17. L. R. Baker, A. A. Tanimola, O. S. Olubode, Complexities of local cultural protection in conservation: the case of an Endangered African primate and forest groves protected by social taboos. *Oryx* **52**, 262–270 (2018).

18. K. Metcalfe, R. Ffrench-Constant, I. Gordon, Sacred sites as hotspots for biodiversity: The Three Sisters Cave complex in coastal Kenya. *ORYX* **44**, 118–123 (2010).

19. G. Mikusiński, H. P. Possingham, M. Blicharska, Biodiversity priority areas and religions—a global analysis of spatial overlap. *Oryx* **48**, 17–22 (2014).

20. M. M. Tagliari, *et al.*, Collaborative management as a way to enhance Araucaria Forest resilience. *Perspect. Ecol. Conserv.* **19**, 131–142 (2021).

21. C. T. Freitas, *et al.*, Co-management of culturally important species: A tool to promote biodiversity conservation and human well-being. *People Nat.* **2**, 61–81 (2020).

22. R. Cámara-Leret, *et al.*, Climate change threatens New Guinea’s biocultural heritage. *Sci. Adv.* **5** (2019).

23. J. Loh, D. Harmon, A global index of biocultural diversity. *Ecol. Indic.* **5**, 231–241 (2005).

24. T. C. Daniel, *et al.*, Contributions of cultural services to the ecosystem services agenda. *Proc. Natl. Acad. Sci. U. S. A.* **109**, 8812–8819 (2012).

25. V. Reyes-García, *et al.*, A collaborative approach to bring insights from local observations of climate change impacts into global climate change research. *Curr. Opin. Environ. Sustain.* **39** (2019).

26. I. Jarić, *et al.*, Societal extinction of species. *Trends Ecol. Evol.* **37**, 411–419 (2022).

27. R. Cámara-Leret, J. Bascompte, Language extinction triggers the loss of unique medicinal knowledge. *Proc. Natl. Acad. Sci. U. S. A.* **118** (2021).

28. A. Garibaldi, N. J. Turner, Cultural keystone species: implications for ecological conservation and restoration. *Ecol. Soc.* **9**, 1 (2004).

29. IUCN, The IUCN Red List of Threatened Species. Version 2021-3 (2021) (November 22, 2021).

30. Ethnologue, Ethnologue: Languages of the World (2021) (July 12, 2022).

31. P. H. Raven, B. Berlin, D. E. Breedlove, The Origins of Taxonomy. *Science (80-.).* **174**, 1210–1213 (1971).

32. D. Nettle, S. Romaine, *Vanishing Voices: The Extinction of the World's Languages by Daniel Nettle | Goodreads* (Oxford University Press, 2000) (May 24, 2022).

33. J. Borgelt, M. Dorber, M. A. Høiberg, F. Verones, More than half of data deficient species predicted to be threatened by extinction. *Commun. Biol. 2022 51* **5**, 1–9 (2022).

34. T. A. Crane, *et al.*, Research Design and the Politics of Abstraction: Unpacking the Environmentality of Scientific Practice in Socioecological Assessments. *Hum. Ecol. 2016 446* **44**, 665–675 (2016).

35. S. N. Stuart, E. O. Wilson, J. A. McNeely, R. A. Mittermeier, J. P. Rodríguez, The

Barometer of Life. *Science (80-.)*. **328**, 177 (2010).

36. W. A. Foley, The Languages of New Guinea. *Annu. Rev. Anthropol.* **29**, 357–404 (2003).

37. J. Kronenberg, E. Andersson, P. Tryjanowski, Connecting the social and the ecological in the focal species concept: case study of White Stork. *Nat. Conserv. 22 79-105* **22**, 79–105 (2017).

38. S. Ortiz, C. Consuegra, M. C. van der Hammen, D. Perez, Perspectivas urbano-rurales sobre la circulación de dos frutos silvestres del Bosque Altoandino en sistemas agroalimentarios de Bogotá, Colombia. *Etnobiologia* **19** (2021).

39. T. Dold, M. L. Cocks, Voices from the forest: celebrating nature and culture in Xhosaland. 229 (2012).

40. J. R. Kideghesho, Co-existence between the traditional societies and wildlife in western Serengeti, Tanzania: its relevancy in contemporary wildlife conservation efforts. *Biodivers. Conserv. 2008 178* **17**, 1861–1881 (2008).

41. K. Paul-Burke, J. Burke, C. Bluett, T. Senior, Using Māori knowledge to assist understandings and management of shellfish populations in Ōhiwa harbour, Aotearoa New Zealand. *New Zeal. J. Mar. Freshw. Res.* **52**, 542–556 (2018).

42. K. K. L. Costanza, *et al.*, The Precarious State of a Cultural Keystone Species: Tribal and Biological Assessments of the Role and Future of Black Ash (2017) https:/doi.org/10.5849/jof.2016-034R1 (April 5, 2022).

43. M. Noble, *et al.*, Culturally significant fisheries: keystones for management of freshwater social-ecological systems. *Ecol. Soc. Publ. online May 09, 2016 | doi10.5751/ES-08353-210222* **21** (2016).

44. M. Sedrez dos Reis, A. Ladio, N. Peroni, Landscapes with Araucaria in South

America: evidence for a cultural dimension. *Ecol. Soc. Publ. online Jun 03, 2014 | doi10.5751/ES-06163-190243* **19** (2014).

45. S. T. Garnett, *et al.*, A spatial overview of the global importance of Indigenous lands for conservation. *Nat. Sustain.* **1**, 369–374 (2018).

46. L. Bromham, *et al.*, Global predictors of language endangerment and the future of linguistic diversity. *Nat. Ecol. Evol. 2021 62* **6**, 163–173 (2021).

47. J. E. M. Watson, *et al.*, Protect the last of the wild. *Nat. 2021 5637729* **563**, 27–30 (2018).

48. A. Martínez-Abraín, *et al.*, Ecological consequences of human depopulation of rural areas on wildlife: A unifying perspective. *Biol. Conserv.* **252**, 108860 (2020).

49. M. S. Fletcher, T. Hall, A. N. Alexandra, The loss of an indigenous constructed landscape following British invasion of Australia: An insight into the deep human imprint on the Australian landscape. *Ambio 2020 501* **50**, 138–149 (2020).

50. S. Stevens, *Indigenous Peoples, National Parks, and Protected Areas: A New Paradigm Linking Conservation, Culture, and Rights* (University of Arizona Press, 2014).

51. Forest Peoples Programme, International Indigenous Forum on Biodiversity, Indigenous Women's Biodiversity Network Centres of Distinction on Indigenous and Local Knowledge, Secretariat of the Convention on Biological Diversity, *Local Biodiversity Outlooks 2: The contributions of indigenous peoples and local communities to the implementation of the Strategic Plan for Biodiversity 2011–2020 and to renewing nature and cultures. A complement to the fifth edition of Global Biodiversi* (Forest Peoples Programme, 2020).

52. M. A. Coe, O. G. Gaoue, Cultural keystone species revisited: are we asking the right

questions? *J. Ethnobiol. Ethnomed.* **16**, 1–11 (2020).

53. M. A. Coe, O. G. Gaoue, Most Cultural Importance Indices Do Not Predict Species' Cultural Keystone Status. *Hum. Ecol. 2020 486* **48**, 721–732 (2020).

Figures captions

Fig. 1. Taxonomic and geographical distribution of Culturally Important Species (n=385). a) Taxonomic distribution of CIS. b) Number of CIS documented, by continent and socio-cultural group type (i.e., Indigenous People, Ethnic group, Local community, Other socio-cultural group). Each square represents a CIS. In a) square color depicts taxonomic distribution and in b) it depicts the type of socio-cultural group who reported the CIS.

Fig. 2: Biological and cultural status of 385 Culturally Important Species, with representative examples. Biological status was assessed from the IUCN Red List of Threatened Species (28) and cultural status was derived from language vitality status from Ethnologue (29). Colors depict biocultural status and circle size indicates the number of CIS in each cell. See Supplementary Materials for full list.

Fig. 3: Biological, cultural, and biocultural status of 385 Culturally Important Species. a) Distribution across continents; b) Distribution across socio-cultural group type. Biological status was assessed from the IUCN Red List of Threatened Species (28) and cultural status was derived from language vitality status from Ethnologue (29). Colors depict status.