Prevalence of sustainable and unsustainable use of wild species inferred from the IUCN Red List

Sophie M.E. Marsh[1], Michael Hoffmann[2], Neil D. Burgess[3,4], Thomas M. Brooks[5,6,7], Daniel W.S. Challender[8], Patricia J. Cremona[9], Craig Hilton-Taylor[9], Flore Lafaye de Micheaux[5,10,11], Gabriela Lichtenstein[12], Dilys Roe[13], Monika Böhm[14]

Author information

1. Centre for Biodiversity and Environment Research, Department of Genetics, Evolution and Environment, University College London, Gower Street, London WC1E 6BT, UK. Sophie.marsh19@alumni.ucl.ac.uk
2. Conservation and Policy, Zoological Society of London, Regent's Park, London, NW1 4RY. Mike.hoffmann@zsl.org
3. UNEP-WCMC, 219 Huntington Road, CB3 0DL, Cambridge, UK
4. CMEC, GLOBE Institute, University of Copenhagen, Denmark
5. International Union for Conservation of Nature, Gland, Switzerland.
6. World Agroforestry Center (ICRAF), University of the Philippines, Los Baños, The Philippines.
7. Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia.
8. Department of Zoology, University of Oxford, Zoology Research and Administration Building, 11a Mansfield Road, Oxford, OX1 3SZ, United Kingdom
9. International Union for Conservation of Nature, Cambridge, UK
10. Institute of Geography and Sustainability, University of Lausanne, Switzerland
11. French Institute of Pondicherry, India
12. Instituto Nacional de Antropología y Pensamiento Latinoamericano (INAPL)/CONICET, Argentina
13. International Institute for Environment and Development (IIED) and IUCN Sustainable Use and Livelihoods Specialist Group (SULi), London UK
14. Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY.

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Running head

Use of wild species

Article impact statement

Use is likely unsustainable for 16%, likely sustainable for 36%, and undetermined for 48% of ~10,000 wild species analyzed on the Red List.

Abstract

Unsustainable exploitation of wild species represents a serious threat to biodiversity and to the livelihoods of local communities and indigenous peoples. However, managed, sustainable use has the potential to forestall extinctions, aid recovery, and meet human needs. Here, we infer current prevalence of unsustainable and sustainable biological resource use among species groups; research to date has focused on the former with little consideration of the latter. We analyzed species-level data for 30,923 species from 13 taxonomic groups comprehensively assessed on the IUCN Red List. Our results demonstrate the broad taxonomic prevalence of use, with 40% of species (10,098 of 25,009 from 10 taxonomic groups with adequate data) documented as being used. The main purposes of use are pets, display animals and horticulture, and human consumption. Use is often biologically unsustainable: intentional use is currently considered to be contributing to elevated extinction risk for more than one quarter of all threatened or Near Threatened (NT) species (2,752 – 2,848 of 9,753 species). Of the species used and traded, intentional use threatens 16% (1,597 – 1,631 of 10,098 species). However, 36% of species that are used (3,651 of 10,098 species) have either stable or improving population trends and do not have biological use documented as a threat, including 172 threatened or NT species. It is not yet inferable whether use of the remaining 48% of species is sustainable; we make suggestions for improving use-related Red List data to elucidate this. Around a third of species that have use documented as a threat are not currently receiving any species management actions that directly address this threat. Our findings on the prevalence of sustainable and unsustainable use, and variation across taxa, are important for informing international policymaking, including

IPBES, the Convention on Biological Diversity, and the Convention on International Trade in Endangered Species.

Introduction

It is critical to understand and manage the impacts of threats related to the use of wild species to ensure their survival while continuing to support global demand for biological resources. Over-exploitation is among the predominant threats to many species (Maxwell et al., 2016; di Minin et al. 2019), and the primary threat to aquatic species (IPBES 2019). Nonetheless, billions of people rely on wild species, including plants, animals and fungi, for their food, medicines, construction and other uses (e.g. Nasi et al. 2011; Thilsted et al. 2016). Indeed, the use of wild species underpins the livelihoods of millions of people and has cultural, religious and recreational value. These values in turn provide a local incentive for the conservation of species. The tension between over-exploitation as a major driver of biodiversity loss and humanity's reliance on wild species for many different needs creates a conundrum: how can use be managed in a sustainable way that helps meet human needs and incentivizes conservation, rather than further driving species to extinction?

The use of wild species can be sustainable given adequate management (e.g. Lichtenstein 2010; Austin & Corey 2012); indeed, the concept of sustainable use is embedded in many international and national regulatory and policy frameworks as a conservation management tool, to promote human development, and to ensure availability of natural resources for future generations. It is one of the three primary objectives of the Convention on Biological Diversity (CBD), and is explicit in the UN Sustainable Development Goals. Nonetheless, sustainable use as a practice remains a polarizing debate (Hutton & Leader-Williams 2003; Challender & MacMillan 2019), especially consumptive use of animals (i.e. involving the removal of either live or dead individuals), and one with limited consensus regarding the effectiveness of different approaches. This issue is exacerbated in equal parts by concerns that inaction or ineffective sustainable use policies could rapidly imperil many already threatened species (e.g. Auliya et al. 2016); conversely, actions to prevent or reduce use could have negative consequences (Cooney & Jepson 2006; Bonwitt et al. 2018), including for people who depend on their use and particularly those who are most vulnerable.

The discourse around sustainable use is hampered further by knowledge gaps. We have limited understanding of different patterns of use within species, the degree to which use might be sustainable or unsustainable (and which dimensions of sustainability are affected by use), and the degree to which species currently being impacted by over-exploitation are receiving appropriate conservation actions. The IUCN Red List of Threatened Species (henceforth 'Red List') provides data that can assist managers and policymakers in understanding and delivering targeted action to address threats to biodiversity. The role of the Red List in supporting and influencing global policy instruments is well established, from tracking progress against globally agreed targets such as the CBD Aichi Targets (SCBD 2014) – and new targets under discussion in the post-2020 Global Biodiversity Framework – and Sustainable Development Goals (Brooks et al. 2015), to providing key data and trends that inform processes such as those under the Convention on International Trade in Endangered Species of Fauna and Flora (CITES; e.g. Challender et al.

2019) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES; Brooks et al. 2016; IPBES 2019).

Individual Red List assessments are carried out by thousands of scientific experts in accordance with a system of objective, quantitative categories and criteria that rank a species' extinction risk from Least Concern (LC) to Extinct in the Wild (EW) or Extinct (EX). A species is considered threatened if it is assessed as Vulnerable (VU), Endangered (EN), or Critically Endangered (CR). Assessments follow well-defined guidelines with an independent process for review (Collen et al. 2016), and are underpinned by ancillary data on distribution, population size and trend, habitat preferences, threats and conservation actions in place or needed. Much of this information is coded in standardized classification schemes that enable comparative analyses across taxa.

Previous analyses of biological resource use using Red List data have focused on individual taxonomic groups (e.g. birds, Butchart 2008; cacti, Goettsch et al. 2015), or on particular dimensions of use (e.g. traded vertebrates, Scheffers et al. 2019; spatial concentrations of unsustainable use, di Minin et al. 2019). Here, we investigate patterns of biological resource use across a broad suite of species in comprehensively assessed taxa on the Red List to address: i) the main purposes of use of wild animal and plant species recorded in the Red List; ii) for which species are current levels of use having a negative impact on species populations, and hence likely biologically unsustainable; iii) for which species are current levels of use not having a negative impact on populations, and hence likely biologically sustainable; and iv) for which utilized species are conservation actions currently in place to directly target impacts from current levels of use. Our study substantially advances previous analyses of Red List data, provides a framework for replicating the results in the future (for example, to track trends over time), and yields concrete suggestions for improving the quality of use-related Red List data in future assessments.

Methods

Species data

We collated species-level data for 13 taxonomic groups that have been comprehensively assessed on the Red List (version 2020-1). The Red List defines comprehensively assessed groups as taxonomic groups that include at least 150 species, of which >80% have been assessed (IUCN 2020). Excluding non-comprehensively assessed groups, which may primarily focus on species that are likely threatened, or may have a regional focus, avoids introducing bias into our analysis, e.g. as threat processes affecting species are usually not evenly distributed across space (Miqueleiz et al. 2020).

We classed the 13 taxonomic groups into six primarily aquatic (freshwater and/or marine) and seven primarily terrestrial groups (including amphibians, among which ~30% are documented as terrestrial only, the remainder as both terrestrial and freshwater). We excluded all species listed as Extinct (EX) or Extinct in the Wild (EW), as neither can be currently used in the wild, or Data Deficient (DD), as the impact of any use on their extinction risk is unknown. This restricted our analyses to LC, Near Threatened (NT), and threatened species only (hereafter, extant, data sufficient species). This dataset comprises 30,923 species, made up of 6,603 primarily aquatic species and 24,320 primarily terrestrial species (Table 1; Supporting Information).

Red List data used

For each species, we downloaded the following coded data from the Red List: Red List category, current population trend, threats, use and trade, and conservation actions in place. Documenting current population trend is required information for all assessed species on the Red List and is presented as either stable, decreasing, increasing, or unknown. Use of species is captured on the Red List in two ways: as a threat under the Threats Classification Scheme (Class 5, Biological Resource Use; Salafsky et al. 2008; Supporting Information), and as a form of use or trade under the Use and Trade Classification Scheme, which explicitly does not associate the use with a threat (Supporting Information). While the coding of major threats impacting a species is required documentation for species listed as EX, EW, threatened, and NT (IUCN 2016), coding of use and trade is only recommended documentation and may thus not be consistently coded across all species on the Red List, including for comprehensively assessed groups. Conservation actions are coded as both actions in place and actions needed (Salafsky et al. 2008), but are recommended documentation only, and thus may not be consistently coded (Luther et al. 2016). For our analysis, we only considered conservation actions that were already in place.

Analyses

Main purposes of use of wild animal and plant species recorded on the Red List

We investigated the prevalence of different purposes of use based on the information coded in the Use and Trade Classification Scheme, excluding records for "establishing ex situ production" (use code 16), "other" (17), and "unknown" (18). For this analysis, we limited our dataset to 10 taxonomic groups that have adequate recording of use and trade, leading us to exclude cartilaginous fishes and cephalopods from the aquatic species group and mammals (a high-profile group when it comes to discussion of use) from the terrestrial group (Supporting Information). For each taxonomic group, we calculated the total number of species recorded as being used for at least one purpose in the Use and Trade Classification Scheme, and summarized the data as the percentage of extant, data sufficient species recorded for different types of use on the Red List (Supporting Information).

Identifying wild species for which intentional use is having a negative impact

For our analysis, we consider use to be biologically unsustainable when it is likely to be having an adverse impact on species extinction risk. To identify such cases, we analyzed the proportion of i) all species with at least one purpose of use coded (from among the 10 taxonomic groups with adequate data), and ii) all NT and threatened species (from among all 13 taxonomic groups comprehensively assessed), for which "biological resource use" is documented as a major threat, as recorded using the IUCN Threat Classification Scheme. Since not all types of biological resource use are directly targeted at the species in question, and hence intentional, we developed a decision-tree for removing those types of threats that are not relevant to an analysis of direct use of species (Supporting Information). In some cases, we were unable to determine whether the use was intentional. We present this uncertainty in our results as a range where the "minimum" proportion includes all species with threats that could be conclusively determined as intentional, and the "maximum" proportion additionally includes those species with motivation unknown or unrecorded that may represent further cases of intentional biological resource use. For groups where no species have such motivation unknown / unrecorded threats, we present only the minimum (Supporting Information).

We included biological resource use as a threat if it had a medium to high impact on species extinction risk. The Red List uses a scoring system to derive threat impact, based on timing, scope, and severity of the threat. This information is used to create an overall threat impact score. Threat timing is recommended information to be provided in the Red List assessment, while severity and scope are discretionary. As such, we amended the impact score categorization to help exclude threats that are not likely to be major (Supporting Information).

Identifying wild species for which intentional use is not having a negative impact

We considered use to be biologically sustainable when it is unlikely to have an adverse impact on species extinction risk. Due to data constraints, we could only derive a minimum estimate by determining the number of species recorded as being subject to some form of use or trade that: i) are also currently LC and not declining (i.e., have either stable or increasing current population trends); and ii) are threatened or NT and have stable or increasing population trends and are not documented as having intentional use as a major threat. We confined analyses to those 10 taxonomic groups for which use and trade information was adequate, as discussed above.

Conservation actions in place or lacking for utilized wild species

To understand the current level of conservation actions in place to respond to over-exploitation, we extracted all NT and threatened species that are documented as receiving targeted species management actions, as coded via the Red List's Conservation Actions Classification Scheme. Specifically, we selected species for which there is a harvest management plan in place and species subject to any international management / trade controls (e.g., CITES or US Endangered Species Act listing, regional fisheries agreements). We then determined the number of species that are threatened by biological resource use, and: i) are coded as receiving either one or both of these actions, and ii) are not receiving either of these conservation management actions.

Results

How many wild species are used, and what are the main purposes of use?

Among the 10 taxonomic groups with adequate information, the proportion of extant, data sufficient species documented as having at least one purpose of use coded ranged from 15% (crustaceans) to nearly 100% of cone snails (544 of 545 species) among primarily aquatic groups, and 11% (amphibians) to 76% (conifers) among primarily terrestrial groups. Across the 25,009 species in these 10 groups, 10,098 (40%) had some purpose of use documented.

In the aquatic groups, the top purposes of use were for human food (bony fishes and crustaceans), specimen collection (cone snails), and pets and display animals (corals and bony fishes) (Supporting Information). Additional purposes of use were for handicrafts and jewelry (cone snails and corals) and medical purposes (cone snails). For terrestrial animal groups, the two most prevalent uses were for pets or display animals and for human consumption (Supporting Information). This was followed by sport hunting and specimen collecting for birds, medicinal purposes for amphibians and wearing apparel / accessories for reptiles. For plant taxonomic groups, the predominant uses were for structural and building materials (conifers) and horticulture (all three groups). Overall, plant groups were used for more purposes than animal groups, including for human and animal food, medicinal use, household goods and handicrafts / jewelry, fuels and chemicals.

How many and which species are negatively impacted by intentional use?

Considering all 10,098 species for which some purpose of use is documented, a sixth have intentional biological resource use documented as a threat (1,597 – 1,631 species or 16%). Moreover, more than a quarter of all NT and threatened species, across all 13 comprehensively assessed taxa, have intentional biological resource use documented as a threat (minimum = 2,752 species or 28%; maximum = 2,848 or 29%, out of 9,753 threatened and NT species overall).

Across NT and threatened species, a higher overall proportion of aquatic species than terrestrial species have intentional biological resource use coded as a threat (Fig. 2). Among aquatic groups, the taxa with highest prevalence are corals (100%; 388 species) and almost all cartilaginous fishes (99%; 314 out of 318 species), with fishing the predominant threat (Supporting Information); in the terrestrial groups, cycads appear most impacted (58 – 60%, 147 – 152 of 255 species), largely due to gathering (147 species).

How many and which species are not negatively impacted by intentional use?

Among the 10 taxonomic groups for which information was adequate, most species subjected to some form of use or trade were LC, with the exception of cycads and corals. The overall percentage of utilized species that were LC was 72%, ranging from 16% and 35% in cycads and corals, respectively, to 76% in crustaceans, 77% in birds, 88% in cone snails and 90% in bony fishes (Fig. 3). Among terrestrial groups, between 11% (cycads, 20 species) and 42% (birds and dicots, 2,120 and 462 species, respectively) of utilized species are LC with either stable or increasing population trends. For aquatic groups, proportions are lower, ranging from 1% (corals, 6 species) to 30% (bony fishes, 413 species). Across all 10 taxa for which data on purpose of use are adequate, 34% (3,469 of 10,098) of utilized species are LC and not declining. Furthermore, even among threatened and NT species we documented 172 species (2%) subject to some form of use that exhibit stable or increasing population trends and are not impacted by intentional biological resource use (Supplementary Information).

Conservation actions in place or lacking for utilized species

No information on species management actions relevant to use is recorded for NT or threatened corals, cone snails and cephalopods (Table 1), while only 1% of amphibians (26 species) and 8% of crustaceans (46 species) have available information on harvest management actions, and 3% of amphibians (82 species) and 1.1% of crustaceans (6 species) have recorded data on international trade controls (Supporting Information). On the other hand, over 80% of conifers, reptiles, and cycads and 100% of birds have at least one of these conservation actions coded. Among threatened and NT species impacted by intentional use and with at least one of these actions coded, cycads, reptiles, mammals and dicots all have >80% of species documented as being subject to some form of international trade control (Supporting Information). Species groups are more likely to receive international trade controls than harvest management actions, but conifers, bony fishes and cartilaginous fishes are all as likely to receive harvest management interventions as international trade control measures (Fig. 4).

In total, out of at least 2,752 threatened and NT species that have intentional biological resource use coded as a threat (1,599 of which have available documentation for one or both conservation actions), fewer than a thousand (985 – 989) are documented as benefitting from either international trade control or species harvest management interventions; at least 206 species are explicitly stated as lacking any such actions (Supporting Information). Compared with terrestrial groups, species in aquatic groups are more likely to be lacking any conservation management in response to biological resource use.

Discussion

While previous analyses of Red List data have mostly examined the degree to which biological resource use is a threatening process driving extinction risk (which we further expand on here), our study provides a first attempt to analyze Red List data to understand the extent to which use of wild species is *not* having a detrimental impact on species extinction risk and hence might currently be biologically sustainable. Although our analyses were hindered by data constraints, our findings that more than one-third each of birds, reptiles, conifers and dicots that are used are currently categorized as Least Concern and exhibit either stable or increasing population trends indicates that, at least at the time of assessment, use is not contributing to an increase in extinction risk. These proportions are substantially higher when accounting for all Least Concern species, whether their current population trend is increasing or declining. We also find evidence that some threatened and NT species that are used have stable or increasing population trends. Of course, the Red List assessment concerns the species across its range, and consequently it is possible that, despite overall population trends, some species could be undergoing localized declines due to the impacts of biological resource use or localized increases due to successful interventions.

In general, our results reiterate the broad extent of use of wild species. Across the assessed groups, a predominant form of use is for pets, display and / or horticultural use, followed by hunting or collection for food. Among birds, the primary factor explaining the predominance of pets is the live cage-bird trade, which has emerged as a major driver of declines among passerines, particularly in Southeast Asia (e.g., Eaton et al. 2017). Meanwhile, cacti have long been sought after for the horticultural trade and by private collectors for their ornamental value and their perceived rarity, with both seeds and mature individuals collected (Goettsch et al. 2015). Since use and trade is not always consistently coded on the Red List, especially for non-threatened species, we cannot be conclusive about the full extent of use, or prevalence of different types of use, in all comprehensively assessed taxonomic groups. However, our initial results confirm some taxon-specific investigations into the use of wild species, such as trees where, besides timber, the use is often for horticultural purposes (e.g., Beech et al. 2017).

While our results indicate that more species are *not* being impacted detrimentally by use than are, we also show that intentional biological resource use is a major threat, contributing towards an increased risk of extinction for more than a quarter of NT and threatened species. The proportion of species threatened by biological resource use is generally higher in aquatic taxa than among terrestrial taxa. While the impact of fisheries is well established for bony and cartilaginous fishes (Dulvy et al. 2014; MacNeil et al. 2020), the high proportion of corals and cone snails threatened by biological resource use is generally explained by the increasing removal and harvest of corals for display in aquariums and for the curio-trade in the former (Bruckner 2000, Cannas et al. 2019), and by bioprospecting for conotoxin research and shell collecting in the latter (Peters et al. 2013).

Perhaps the starkest result of our analyses is that many species that are impacted by biological resource use are not currently documented as receiving any management actions that directly address this threat. The relatively high proportion of species subject to international trade controls can be explained by the fact that the most common management action that is documented is listing in a CITES Appendix. All cycads, for example, are included on CITES Appendix II through a higher-taxon listing (representing 229 out of the 255 threatened or NT cycad species in this analysis). Very few species have a national harvest management plan in place, although these appear to be more readily available for aquatic species, such as cartilaginous fishes, which have traditionally been under-represented in CITES. The high numbers of species threatened by use stresses the value of national management plans being in place. Of course, many species impacted by biological resource use benefit from conservation actions that we did not directly investigate, such as the establishment and management of protected areas, community-based resource management, and other site-based interventions, while some are subject to measures to reduce demand.

There are several important caveats to our analyses. First, our study focuses on intentional forms of biological resource use, but the impacts of use extend well beyond the direct impacts on the species being targeted. The most evident examples of this are deforestation (specifically logging) in the terrestrial realm and by-catch in the aquatic realm. While logging is clearly a major direct threat to timber species, it can also have severe repercussions on forest-dependent species. For example, some 55% of NT and threatened bird species are threatened by the unintentional effects of logging (IUCN 2020). Likewise, while commercial fishing is a direct threat to many target fisheries, by-catch is a major recognized threatening process in the sea (Komoroske & Lewison 2015). Our analysis only included by-catch for cartilaginous fishes where parts (e.g., fins, gills) of by-caught species frequently enter trade.

Second, we focused our analysis on 13 taxonomic groups that have been comprehensively assessed on the Red List, but our estimates of the extent of use of reptiles and dicotyledonous plants may be inflated because the families and orders included in our analysis are not necessarily representative of the broader diversity in the class (and are possibly more likely to be used). We also excluded DD and EX/EW species throughout our analyses. For DD species, assessors were not able to assign a category of extinction risk due to uncertainty in the assessment, including on the severity of threatening processes (Bland et al. 2017), such as over-exploitation; while many DD species may prove to be threatened, some have also been shown to be more widely distributed or common than previously understood (Butchart & Bird 2010). Unsustainable exploitation is already understood to have driven many species to extinction, such as the Dodo *Raphus cucullatus* and Steller's Sea Cow *Hydrodamalis gigas*. At least 12% (102) of species listed as recently (since 1500) Extinct on the Red List have intentional use indicated as a threat that led to the species' extinction (IUCN 2020).

Third, our study is dependent on the information captured under the IUCN classification schemes. Because some information is indicated as "required" while some is "recommended", our analyses are constrained by the degree to which this information has been coded up consistently. Even where the information has been coded, assessors may not always be aware of the full range of threats, uses or actions that apply. For example, in completing the "Use and Trade" module, full consideration may not always be given to traditional or indigenous uses; IUCN is currently preparing guidelines that would help assessors take such uses into account. The Red List assessment process has to delicately balance the time and resource constraints faced by individual assessors (Rondinini et al. 2013), with the need to ensure there is at least a minimum level of supporting documentation in place to underpin an assessment and inform conservation. Recognizing that the documentation requirements are the outcome of prolonged discussions that carefully weigh up these concerns, we cannot propose that these fields be made mandatory for assessors.

Considering the above, we propose a few recommendations (Table 2) that would help to reduce the proportion of used species – currently nearly half – for which we have no evidence as to whether use is sustainable or not. Recommendation one concerns coding of the threat category "motivation unknown". In the current Threats Classification Scheme, if the assessor does not know the scale of harvest (i.e., whether "subsistence/small scale" or "large scale"), their only option is to select the option for "motivation unknown / unrecorded" under the sections 5.3 (logging & wood harvesting) and 5.4. (fishing & harvesting aquatic resources), even though they are likely to know whether the use is intentional or unintentional. For instance, we found 1,519 amphibian species for which "logging and wood harvesting" was coded as a threat, of which 1,187 species threats were recorded under "motivation unknown", but the motivation must have been unintentional as these species are impacted through the loss of forest, not through direct exploitation. Although our methodology excludes these cases from our analyses, we propose a modification to the Threats Classification Scheme for assessors to indicate where the motivation is known, but the scale is not, to avoid these coding issues in the future (Supporting Information).

Recommendation two is that data on timing, scope and severity of threats should be better coded as it would allow us to tease out more effectively where threat impacts are medium to high and bring greater precision to our results. For corals and cone snails, the threat of biological resource use is likely to be small in comparison with the impacts of bleaching and disease for corals (Carpenter et al. 2008), and urban pollution, tourism and coastal development for cone snails (Peters et al. 2013). Further, it would be useful to better understand and quantify the degree to which species can be subject to some level of use without this resulting in them becoming threatened (i.e., impact is low, highly localized, negligible or no impact), but this requires that the effects of use are more consistently recorded for LC species (Recommendation three).

Recommendation four is to encourage assessors to code up important conservation actions in place and needed. Our results based on analysis of data in the Conservation Actions Classification Schemes are particularly constrained because data are available for only a limited number of species. For example, while our results show that very few species have a harvest management plan in place, for only one taxonomic group (conifers) do more than half of NT and threatened species actually have this field coded as opposed to left blank (Supporting Information). Whether international trade control is in place is generally better documented than whether a harvest management plan is in place, likely because information on whether species are in a CITES Appendix or subject to some other policy controls is easier to obtain than whether a harvest management plan is in place. Finally, the addition of a simple check-box to indicate whether or not the classification schemes for a given species assessment have been filled in at the Recommended level, would be a powerful addition to the Red List documentation (Recommendation five).

As previous studies have shown, Red List data can play a key role in supporting major global assessment processes, and by extension broader international policy. Our study uses Red List data to quantify the degree to which the use of wild species either does or does not impact negatively on species extinction risk, and thus whether documented use may be biologically sustainable or unsustainable. Our ability to disentangle the nature and extent of this use could be considerably improved through some minor amendments to established Red List protocols and through greater efforts by assessors and Red List assessment initiatives to ensure, wherever possible, more consistent coding of the information and data underpinning Red List assessments. Nonetheless, our findings show that while over-exploitation is clearly a direct threat to many species, and indeed has already driven some to extinction, there are also many species for which use is clearly currently taking place at levels that are not likely to be contributing to an increase in their extinction risk. More effort needs to be invested in understanding the factors that determine whether use is sustainable, and the effectiveness of different mitigation actions.

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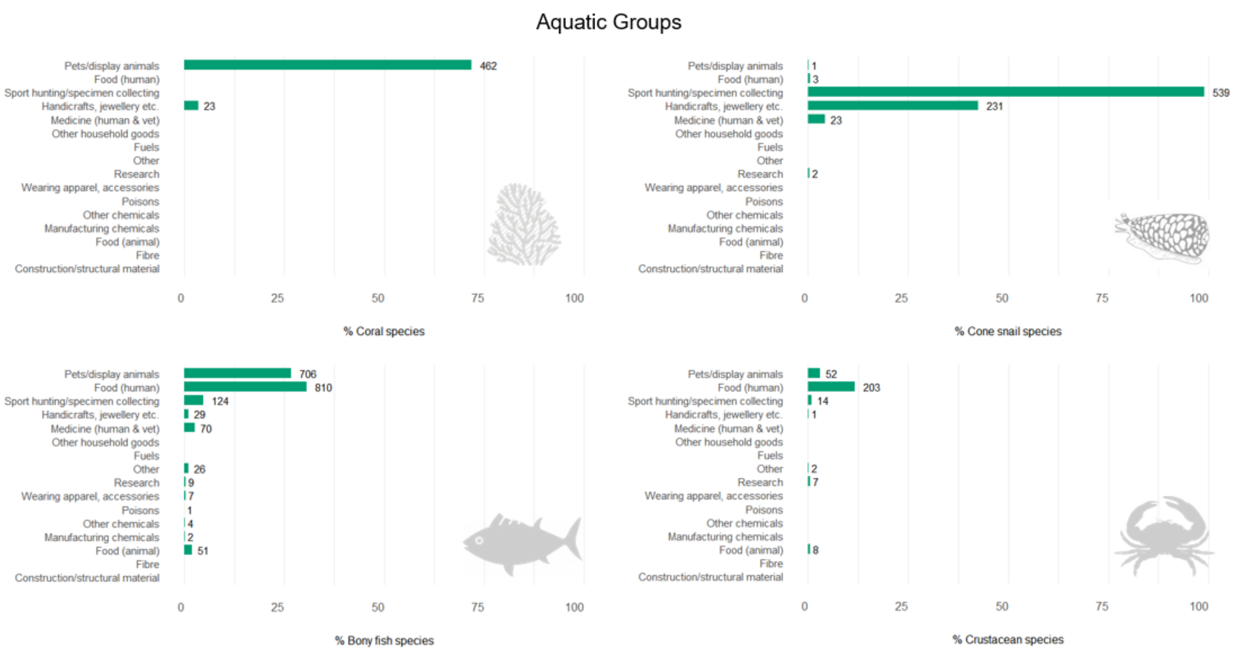
A



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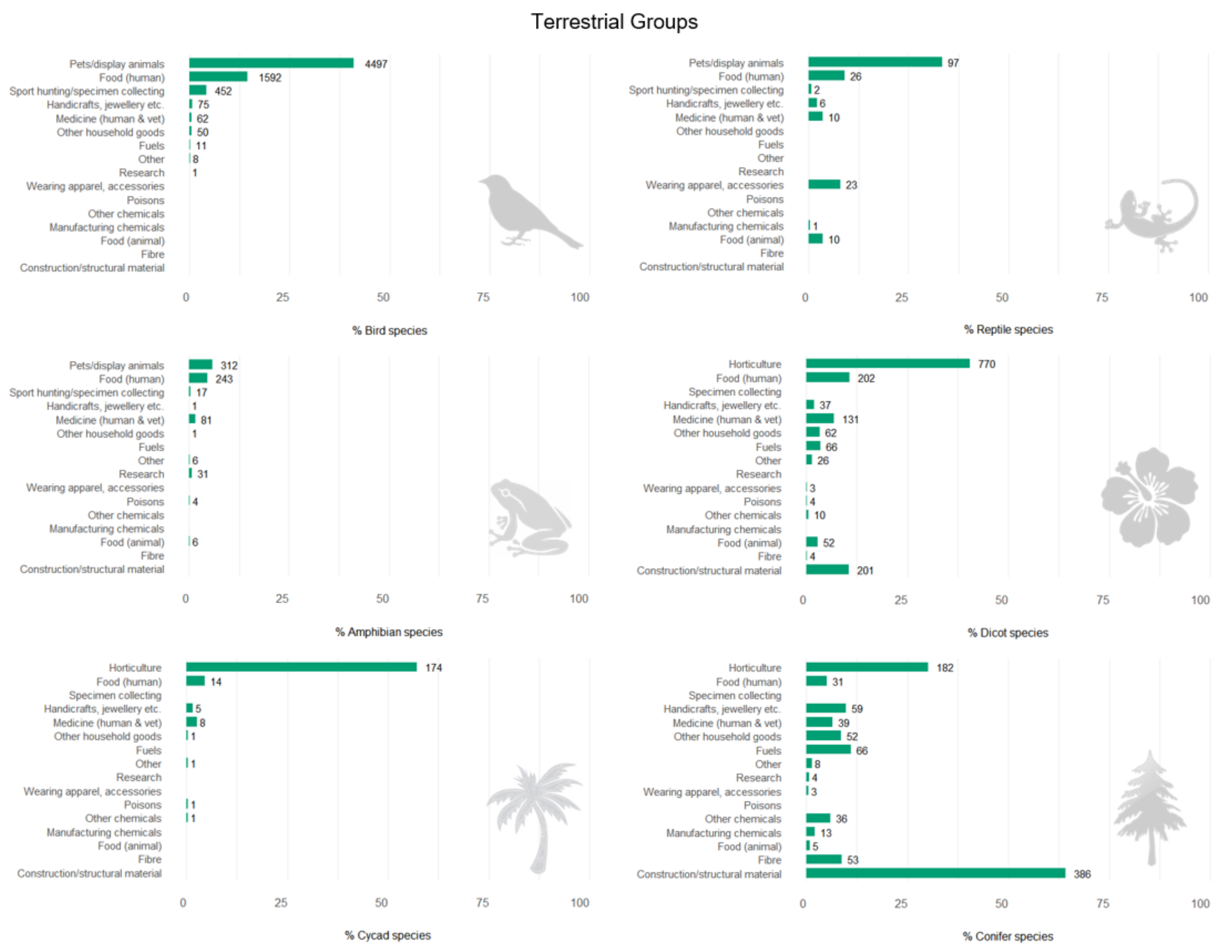

Figure 1. Percentage of extant, data sufficient species in A) aquatic and B) terrestrial taxonomic groups, recorded for different types of use on the Red List. Percentages out of total extant, data sufficient species (see Table 1). Data labels show the total number of species recorded for each purpose of use. Note that most species are subject to more than one type of use.

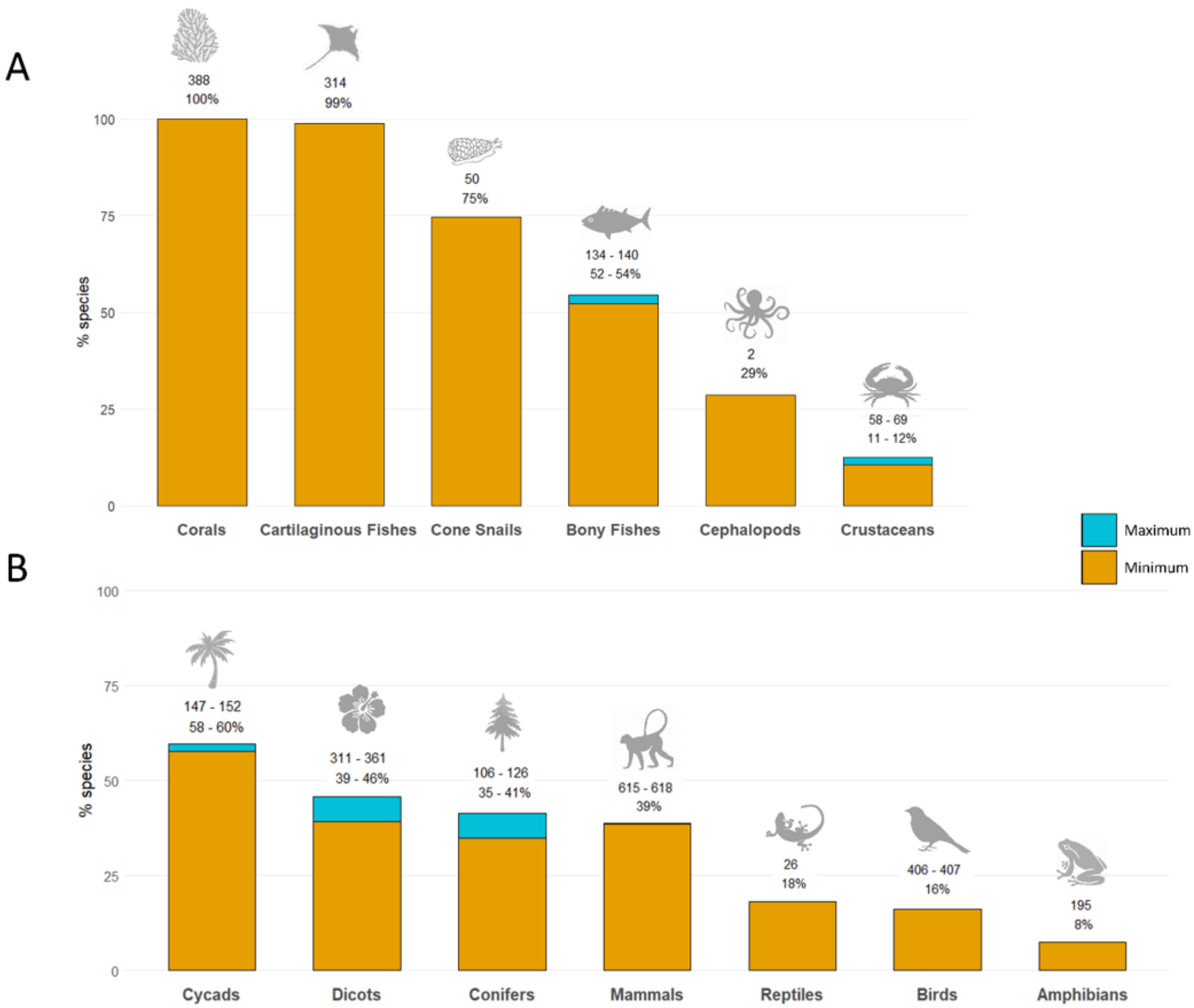

Figure 2. Percentage of NT and threatened species in A) aquatic and B) terrestrial groups with biological resource use documented as a threat on the Red List. Minimum (orange) bars are defined by the number of species in each taxonomic group that are affected by at least one type of intentional use; maximum (blue) bars are species that might be subject to intentional use, including where species are coded as threatened by use under “motivation unknown”. Black labels denote the minimum number of species affected by biological resource use in each taxonomic group, and the percentage range from minimum to maximum (where relevant).

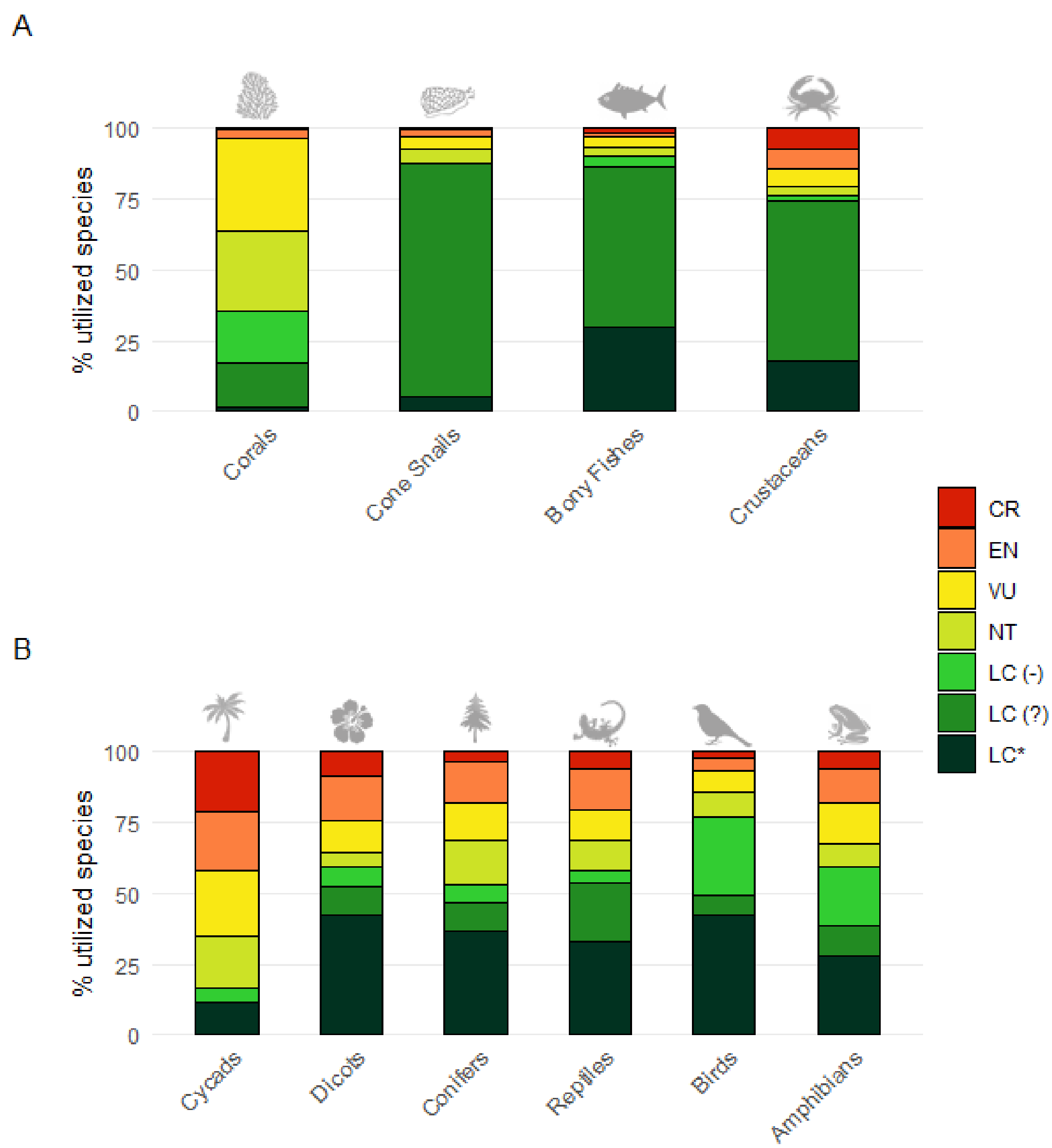

Figure 3. Percentage of extant, data sufficient species by Red List Category in A) aquatic and B) terrestrial groups that are subject to use and trade. LC(-) = Least Concern species with declining population trend; LC(?) = Least Concern species with unknown population trend; LC(*) = Least Concern species with stable or increasing population trend. Note that being LC and having a declining population trend, or being threatened and being subject to use and trade, does not imply that use is a major threat; we have no evidence as to whether use is sustainable or not for 48% of used species.

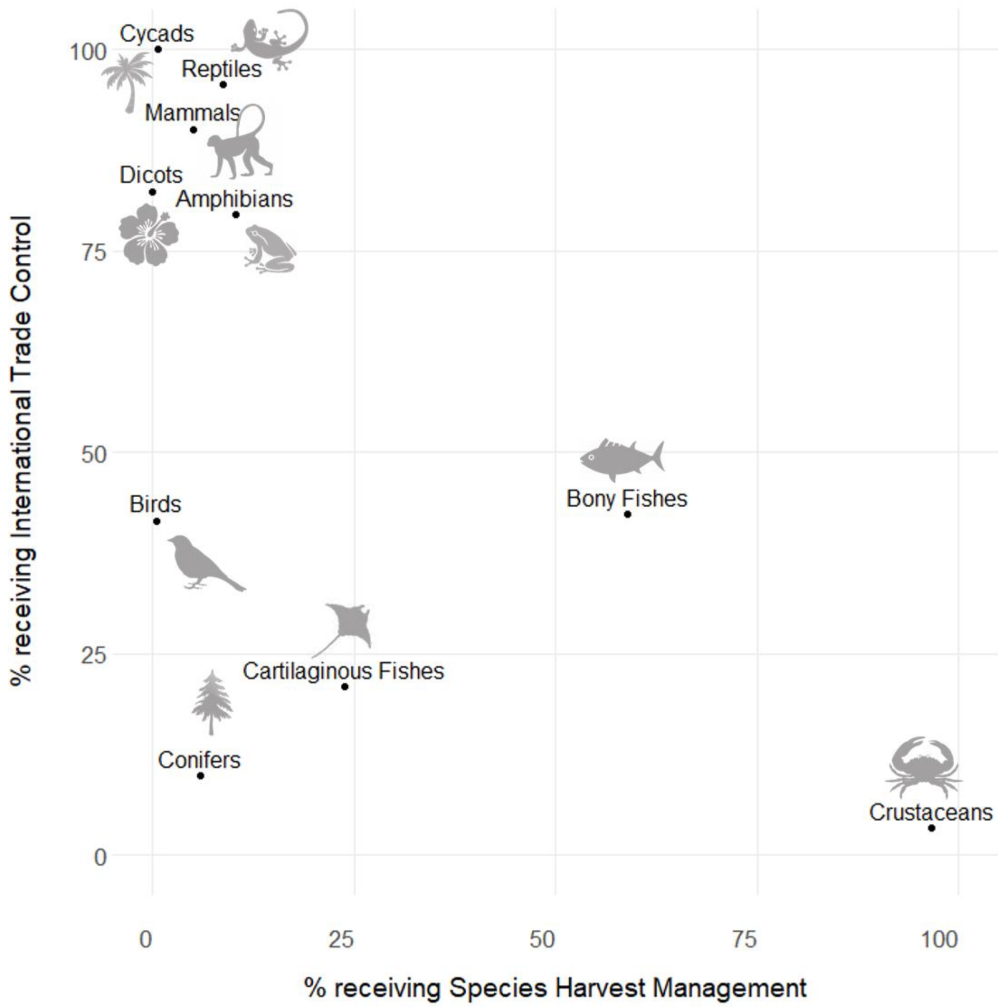

Figure 4. Relationship between the prevalence of international trade control and species harvest management across NT and threatened species threatened by intentional biological resource use (minimum estimate), based only on those species with available data on conservation actions (those where the field is coded as either "Unknown," "Yes," or "No", rather than left blank). No data are available for cephalopods, cone snails or corals (see Figure S3).

	Species data		*Documentation of use*		*Documentation of threats, including biological resource use (BRU)*				*Documentation of species management actions*		
							Intentional BRU			Intentional BRU	
Taxonomic group	n*	n**	Use*	Use**	Threats*	BRU*	Minimum **	Maximum **	Documented **	Minimum **	Targeted species management**
Aquatic	*6,603*	*1,589*	*2,674*	*577*	*3,187*	*2,047*	*946*	*963*	*277*	*236*	*158*
Bony fishes	2,649	257	1,386	137	984	542	134	140	95	78	74
Crustaceans	1,749	552	263	63	750	140	58	69	46	24	29
Cartilaginous fishes	686	318	N/A	N/A	582	571	314	314	136	134	55
Corals	643	388	481	311	643	643	388	388	0	0	0
Cone snails	545	67	544	66	129	102	50	50	0	0	0
Cephalopods	331	7	N/A	N/A	99	49	2	2	0	0	0
Terrestrial	*24,320*	*8,164*	*7,424*	*2,230*	*11,565*	*2,669*	*1,806*	*1,885*	*4,450*	*1,363*	*827 - 831*
Birds	10,930	2,503	4,988	1,136	2,745	445	406	407	2,491	406	171
Amphibians	5,406	2,577	576	235	4,281	373	195	195	91	39	35
Mammals	4,897	1,591	N/A	N/A	2,540	935	615	618	717	441	406 - 407
Dicots	1,898	791	1,094	441	1,228	511	311	361	552	231	196 - 199
Conifers	602	304	458	215	358	186	106	126	251	89	13
Cycads	300	255	177	148	219	168	147	152	229	134	138
Reptiles	287	143	131	55	194	51	26	26	119	23	22
Total	*30,923*	*9,753*	*10,098*	*2,807*	*14,752*	*4,716*	*2,752*	*2,848*	*4,727*	*1,599*	*985 - 989*

Table 1. Comprehensively assessed species groups included in the analyses and respective sample sizes.[1]

[1] Bony fishes, dicotyledons (dicots) and reptiles include selected higher-level taxa. Species data: number of species in the dataset; Documentation of use: number of species with data coded up in the Use and Trade Classification Scheme, excluding for purpose of ex situ propagation, 'other' or 'unknown' (cephalopods, cartilaginous fishes and mammals were excluded due to insufficient data); Documentation of threats, including biological resource use: number of species with any "Threats" coded in the Threats Classification Scheme, number of species with Biological Resource Use ("BRU"; Threats Classification Scheme 5) coded as a threat, number of species impacted by "Intentional BRU" ("Minimum" and "Maximum"; see Analyses); Documentation of species management actions: number of species with coding of either harvest management plan or international trade controls "Documented" (yes, no, unknown) in the Conservation Actions Classification Scheme ("Actions"), the "Minimum" number of these species impacted by intentional BRU, and the subset of these receiving "Targeted species management" actions for BRU (i.e., with either a harvest management plan or international trade controls in place: yes or unknown, shown as range); *number of extant, data sufficient species; **number of species assessed as NT or threatened

Recommendation	Proposal	IUCN protocol or system affected
1	Modify the Threats Classification Scheme for classes 5.3 and 5.4 for assessors to indicate where the motivation is known, but the scale is not	Threats Classification Scheme (Class 5)
2	Coding of scope and severity of threats becomes Recommended information for taxa listed as EX, EW, threatened or NT	Required and Recommended Supporting Information for IUCN Red List Assessments (annex 1 of Rules of Procedure for IUCN Red List Assessments)
3	Documentation of threats (with timing, scope and severity) becomes Recommended information for LC species	Required and Recommended Supporting Information for IUCN Red List Assessments (annex 1 of Rules of Procedure for IUCN Red List Assessments)
4	Assessments for taxa prioritized in the IUCN Red List Strategic Plan comply with the Recommended documentation requirements	No change (support for current protocol)
5	Addition of a check-box to the Species Information Service to indicate whether or not the classification schemes for a given species assessment have been filled in at the Recommended level	Species Information Service

Table 2. Recommendations for improving consistency and available information in use-related Red List data.