



Methods and supplemental information for Defenders' report: Biodiversity in Crisis

Literature Search: Biodiversity and Threats

We conducted a search of primary literature from a major database (Scopus) to extract the number of published scientific articles that mention biodiversity from 1991 to 2022. We based our methods off of Legagneux et al. (2018). Like Legagneux et al., we compiled scientific manuscripts from studies worldwide published in English. We used Legagneux et al.'s search terms to identify biodiversity-related papers ("biodiversity," "ecosystem services," "endangered species," "IPBES") to represent the total number of studies discussing biodiversity over this time. We then identified which papers within this group specifically discussed each of the five drivers of global biodiversity loss ("climate change," "invas*", "pollut*," "overexploit*," "overharvest*," "overfish*," "degrad*," "habitat loss," "land-use change," "sea-use change") or extinction ("Anthropocene," "biodiversity loss," "extinct*," "imperiled"). We also identified the number of papers that included terms related to both threats and biodiversity loss/extinction. We used publication year to analyze temporal trends in the number of total papers related to biodiversity, the five threats or extinction (Figure 1).

Our searches encompassed almost 300,000 papers and are representative of the total numbers and proportions of literature in the aforementioned categories. While we strove to apply search terms that would be direct and relevant to the literature represented in our findings, there will inevitably be papers included that are from inapplicable fields or that do not apply. A different set of relevant search terms would yield slightly different results. Our findings are therefore meant to depict trends rather than precise counts. All final searches were conducted February 8, 2023.

Species' Threats Determination

We used multiple sources to determine which five drivers threaten each species listed under the U.S. Endangered Species Act (ESA; n=1,662) since their time of listing: Haines et al. (2021), Delach et al. (2019), Weber et al. (2023), Wroblewski et al. (2023), International Union for the Conservation of Nature's Red List of Threatened Species (IUCN 2023), NatureServe's Explorer (NatureServe 2023), and Species Status Assessments from U.S. Fish and Wildlife Service (USFWS).

Haines et al. identified which species were threatened by six factors at the time of listing under the ESA: "habitat modification", "overutilization", "pollution", "species-species interactions", "environmental stochasticity" and "demographic stochasticity". We considered "habitat modification", "overutilization", "pollution", and "environmental stochasticity" to relate directly to "land- and sea-use change", "overexploitation", "pollution", and "climate change", respectively. "Species-species interactions" were flagged as a broader category under which the "invasive species" threat would fall. To confirm that the "species-species interactions" referenced included a non-native species, we checked additional sources. More specifically, if IUCN did not identify invasive species as a threat for a given species for which Haines identified "species-species interactions" as a threat, we searched NatureServe threat descriptions for the

following terms: invas*, alien, feral, exotic, introduced, non-native, nonnative, zebra mussel, WNS (white-nose syndrome), cats. We considered invasive species a threat if any of these terms were present.

Ten species were listed under the ESA after the Haines data was published, for which we referenced the most recent USFWS assessment or listing proposal. For these species, threats were identified using the process outlined in Leu et al. (2019).

In addition to the Haines et al. analysis, we searched the IUCN threats description for each species. If the following terms were identified in the threats description and the threat was not already identified as part of the process above, we included the associated threat:

- Land and Sea-Use Change: "degrad*" "habitat loss" "land-use change" "sea-use change"
- Overexploitation: "overexploit*" "overharvest*" "overfish*"
- Invasive Species: "invas*"
- Climate Change: "climate change"
- Pollution: "pollut*"
- climate change: "climate change"

We then identified whether a threat was direct or indirect as well as hypothesized or current. Indirect threats are threats that result from one of the other threats as a primary driver (e.g., the primary driver of feral pigs causing habitat degradation is invasive species; land- and sea- use change is an indirect threat). A threat was considered hypothesized rather than current if “potential,” “may,” “could,” “expected,” and “likely” terminology was involved in the description. We incorporated all current direct threats into our analysis (Figures 5 and S1).

Lastly, if Delach et al. 2019, Weber et al. 2023 or Wroblewski et al. 2023 found a species sensitive to climate change, we included climate change as a threat.

Given this approach, threats for any species may have been added based on the literature and other published sources, but none have been removed from those identified at the time of listing. Further research may choose to adjust this more conservative approach, but will need to make explicit decisions about at what threshold a threat is no longer endangering a species. For example, some species were originally listed under the ESA due to overexploitation pressures that may have been alleviated to some extent by more recent harvest and trade regulations.

To explore the data and sources, visit our interactive dashboard: Indicator of Risks to Imperiled Species (IRIS) at <https://defenders-cci.org/publication/five-drivers/>.

Geospatial Data Collection and Analysis

We collected geospatial data that directly represent or serve as proxy for the five main drivers of global biodiversity loss: climate change, land-use change, invasive species, overexploitation, and pollution (see table below). All datasets were publicly and freely available, cover all the contiguous U.S. and were resampled to 1km resolution. In some cases, multiple datasets were combined to represent a single threat. Spatial correlation among datasets was tested prior to inclusion in the threat layer to avoid redundancy. To achieve this, first we log[X+1]-transformed each layer (Halpern *et al.* 2015; Di Minin *et al.* 2019) which reduced the effect of extreme outliers when rescaling the data. For integer data such as species richness and land-use change detection, pixels with true zeros were also excluded to avoid zero-inflation when rescaling. Each individual layer was rescaled between 0 and 1 and then combined by taking the mean value for each pixel (Halpern *et al.* 2015; Di Minin *et al.* 2019). For the resulting threat layer, a larger value represents higher

exposure to the potential impacts of that threat. The five resulting threat layers were combined in a similar manner to create a cumulative index of threat exposure (Figure 3). All data pre-processing and analyses were done in ArcGIS Pro 3.0.3 (ESRI 2022) in USA Contiguous Albers Equal Area Conic projection.

Climate Change: We used climatic dissimilarity (Belote *et al.* 2018) and climate velocity (AdaptWest Project 2015) to describe climate change (following Dreiss *et al.* 2022). Climate velocity describes the rate of climate change and was informed by an ensemble of seven general circulation models (GCMs), which greater values representing greater exposure to climate change. Climate dissimilarity describes differences between current and future climates based on 11 bioclimatic variables. Greater values represent higher differences between current and future climate. Both datasets used future climate projections to 2080s time period based on emission scenario representative concentration pathway (RCP) 4.5.

Land-use Change: We calculated potential threat to land conversion using land cover data for 2005 and projected land cover in 2075 (pathway scenario B1; Sohl *et al.* 2014). Ten land cover categories were used: water, developed, mechanically disturbed, barren, forest, grassland, shrubland, agriculture, wetland, and ice/snow. Then we identified land cover change between 2005 and 2075, resulting in a binary 0,1 dataset where 0 represents no change and 1 represents change in land cover category between the two time-periods. We calculated the proportion of area within each 1km grid cell projected to change land classes.

Invasive Species: We collected species range data for non-indigenous birds (Dyer *et al.* 2017) and mammals (Biancolini *et al.* 2021), as well as point occurrence data for non-indigenous reptile (Wiens *et al.* 2019) and non-indigenous aquatic species (USGS 2023). We also collected habitat suitability ensemble models for 220 invasive plant species (Jarnevich *et al.* 2023). We developed a species richness dataset for each taxonomic group, treating them as separate inputs to the cumulative invasive species threat dataset. For plants, individual ensemble models were reclassified to 0,1 based on a 70% model threshold and then summed together to create invasive plant species richness layer. We generated minimum convex hulls around occurrence data for individual invasive reptile species as a proxy for the species' invasive range. Given the widespread distribution of non-indigenous aquatic species and specificity to freshwater systems, we did not use convex hulls to determine range of these species. Instead, we used the actual occurrence points rasterized to 1km to determine range of each species. Range map data were rasterized to 1km resolution.

Overexploitation: We used datasets on recreational freshwater fishing and total harvestable species richness (EPA EnviroAtlas; Pickard *et al.* 2015). Big game recreational demand and migratory bird recreational demand were highly spatially correlated with freshwater fishing recreational demand and therefore were removed from the analysis. These datasets are summarized at a HUC-12 spatial scale. Recreational demand was estimated from USFWS Fishing, Hunting, and Wildlife-Association Recreation surveys to summarize annual day trips for each watershed. Total harvestable species richness refers to the number of species that may be hunted or trapped, including big and small game, waterfowl, and fur-bearer species. Species richness was calculated from habitat models, and total number refers to the highest species richness recorded for each watershed.

Pollution: We considered nine variables that were uncorrelated: Total annual sulfur deposition (kg/ha), Stream length impaired by pH, acidity, or caustic conditions (km), Stream length impaired by organic enrichment or oxygen depletion (km), Stream length impaired by nutrients (km), Stream length impaired by metals other than mercury (km), Stream length impaired by mercury (km), Surface runoff from agricultural land (mm) (EPA EnviroAtlas). These datasets are at a HUC-12 spatial scale.

DRIVER	METRIC	SOURCE
CLIMATE CHANGE	Climate Dissimilarity based on 11 biologically-relevant temperature and precipitation variables, RCP 4.5, 2080s. Climate velocity based on A2 emissions scenarios implemented by seven GCMs of the CMIP3 multimodel dataset, RCP 4.5, 2080s.	Belote et al, 2018 AdaptWest Project 2015
INVASIVE SPECIES	Global Avian Invasions Atlas -bird species range - shapefiles Distribution of Alien Mammals – mammal species range - shapefiles Reptiles – point occurrence Non-indigenous aquatic species – point occurrence INHABIT database – invasive plant species distribution models	Dyer et al, 2017 Biancoline et al, 2021 Wiens et al, 2019 NAS.USGS Jarnevič et al. 2023
LAND USE CHANGE	Predicted land-use change 2005-2075 using pathway scenario B1	USGS LULC, Sohl et al, 2014
OVER-EXPLOITATION	Freshwater fishing recreation demand (day trips per year), Total harvestable species richness – Maximum	EPA-enviroAtlas
POLLUTION	Total annual sulfur deposition (kg/ha), Stream length impaired by pH, acidity, or caustic conditions (km), Stream length impaired by organic enrichment or oxygen depletion (km), Stream length impaired by nutrients (km), Stream length impaired by metals other than mercury (km), Stream length impaired by mercury (km), Surface runoff from agricultural land (mm)	EPA-enviroAtlas

Threat Hotspots

Hotspots for each threat dataset were identified based on the 90th percentile: top 10% of the contiguous U.S. Hotspots for each separate threat were combined to determine areas of cumulative threat exposure.

Ecoregional deviations in threat values among imperiled biodiversity-rich areas were analyzed to understand variability in threat exposure across ecoregions in the contiguous U.S. (Figure S2; EPA level III ecoregions; EPA 2010). For this analysis, we only considered the threat values associated with areas of biodiversity importance for each ecoregion (90th percentile) to avoid zero-inflation from included non-biodiversity hotspot locations. We first measured overall mean for each driver across all ecoregions and then measured the deviation between all grid cells of each region to that overall mean so that values higher than 0 represented grid cells with values higher than the overall mean. Finally, we measured the mean deviation within each ecoregion.

Areas of Biodiversity Importance

Areas of biodiversity importance were based on range-size rarity data from the Map of Biodiversity Importance project (NatureServe Network 2021; Hamilton *et al.* 2022). This dataset is the summed range-size rarity of species in the lower 48 United States that are protected by the Endangered Species Act and/or considered to be in danger of extinction (NatureServe category G1 or G2). The dataset is based on habitat suitability models for 2,216 of the nation's most imperiled vertebrate, vascular plants, freshwater invertebrate and pollinator species. High values identify areas where species with very small ranges (and thus fewer places where they can be conserved) are likely to occur; the presence of multiple imperiled species contributes to higher scores. Areas of highest biodiversity importance were identified based on the 90th percentile: top 10% of the contiguous U.S. Only these locations were used in analyses.

Because potential impacts to specific species could not be distinguished from the pooled biodiversity data, we also analyzed individual species ranges for those listed as threatened or endangered under the Endangered

Species Act that are found in the continental U.S. (freshwater or terrestrial species or marine species with terrestrial habitat). Ranges for 958 listed species were gathered from U.S. Fish and Wildlife Service's Environmental Conservation Online System.

Overlaps (Important Biodiversity Areas at Higher Risk of Exposure)

We measured extent of overlap between threat hotspots (separate and cumulative) and areas of biodiversity importance for the four taxonomic groups (vertebrate, vascular plants, freshwater invertebrate, and pollinators) and combined (Figures 2, 4 & S3, Table S1). To assess spatial relationships between cumulative threat intensity and biodiversity importance, we measured terciles (i.e., 33% and 66% percentiles) for cumulative threat ranking and imperiled range-size rarity, in order to categorize pixels with low (pixels with values under 33% percentile), medium (values between 33% and 66% percentiles) and high threat ranking or biodiversity importance (values higher than 66%). We used this matrix to identify important biodiversity areas at risk of exposure to the five threats.

We quantified imperiled species range overlaps with the threats that were identified as contributing to their endangerment (Table S2; see *Species' Threats Determination*). Data were summarized by threat, taxonomic group and for small-range species. Small-range species were defined as those whose range sizes fell in the first quartile. T-tests were conducted to determine significant differences in the mean proportion of range overlapping each threat hotspot and multiple hotspots between small-range species and others.

Data Limitations

Spatial

There are some inherent limitations to the data used in this analysis. For example, in absence of spatial data explicitly developed to measure the extent of a particular threat, we used proxies (e.g., exploitation). For others, we only focused on a small subset of the threat: spatial data for soil and water pollutants and not light, air, or others. Additionally, spatial datasets on species diversity will always be biased toward the taxonomic groups for which spatial data is available and only give a partial picture of biodiversity. Species-specific overlaps with threat hotspots were based on range data, which provide valuable perspective on patterns at larger scales, but are less useful for identifying areas for local conservation action as they also include areas of unsuitable habitat. Additionally, species with larger ranges (i.e., birds, bats, non-volant migratory mammals, etc.) are less likely to have higher proportion of overlap with threat hotspots. Additional threat metrics should be considered to account for this. Most data represent the current state of threats and habitat suitability, much of which may shift with global climate change. Future local, regional, and continental scale analyses can help inform which areas need long-term protections.

Focusing on values at the national scale means that entire ecosystems important to representing local species assemblages and key ecosystem services are not included on the map. While we took a stratified approach for assessing ecoregional deviations in threat exposure, other parts of our analysis can be modified to ensure that threats are assessed for all native ecosystems and their associated areas of biodiversity importance. We did not account for current land designations, management practices, or traditional ecological knowledge, all of which will be important to consider for assessments done at smaller scales.

Aspatial

To assess threats to species we took a conservative approach and used an amalgamation of threats listed from multiple different platforms. It is possible that some of these threats have changed since time of listing (e.g. if a species was listed on the ESA, overharvesting of that species may have decreased). While this data provides

important insight into trends for species at large as well as species groups, management plans for specific species should reassess threats periodically to ensure that management is focused on the most salient issues for a given species. We also only included species that have been listed under the ESA or IUCN Redlist in our analyses. The ESA does not include all imperiled species and the IUCN Redlist is an ongoing project to assess species. Invertebrates, among other groups, are likely disproportionately unaddressed.

Finally, we acknowledge the strong need for several additional considerations not accounted for in this work. In addition to the primary focus on biodiversity, developing a National Nature Assessment relevant to robust conservation policy and action will require addressing issues related to economic, political, and social constraints. Future work should also help to more explicitly identify opportunities for improving human health, well-being, and equitable access to nature. Goals to ensure a healthy environment for all communities have long been ignored or discounted in protected areas designations, in part because these topics are not well studied. Last, it is worth noting that variation in the ways that people value biodiversity and habitats varies, something that the leaders of the National Nature Assessment have sought to account for in their solicitation for public comment.

References

- AdaptWest Project. 2015. Gridded climatic velocity data for North America at 1km resolution.
- Belote RT, Carroll C, Martinuzzi S, *et al.* 2018. Assessing agreement among alternative climate change projections to inform conservation recommendations in the contiguous United States. *Sci Rep* **8**: 9441.
- Biancolini D, Vascellari V, Melone B, *et al.* 2021. DAMA: the global Distribution of Alien Mammals database. *Ecology* **102**.
- Delach A, Caldas A, Edson KM, *et al.* 2019. Agency plans are inadequate to conserve US endangered species under climate change. *Nat Clim Change* **9**: 999–1004.
- Di Minin E, Brooks TM, Toivonen T, *et al.* 2019. Identifying global centers of unsustainable commercial harvesting of species. *Sci Adv* **5**: eaau2879.
- Dreiss LM, Lacey LM, Weber TC, *et al.* 2022. Targeting current species ranges and carbon stocks fails to conserve biodiversity in a changing climate: opportunities to support climate adaptation under 30 × 30. *Environ Res Lett* **17**: 024033.
- Dyer EE, Redding DW, and Blackburn TM. 2017. The global avian invasions atlas, a database of alien bird distributions worldwide. *Sci Data* **4**: 170041.
- EPA. 2010. Level III ecoregions of the continental United States (revision of Omernik, 1987).
- Haines AM, Leu M, Costante DM, *et al.* 2021. Benchmark for the ESA: Having a Backbone Is Good for Recovery. *Front Conserv Sci* **2**: 630490.
- Halpern BS, Frazier M, Potapenko J, *et al.* 2015. Spatial and temporal changes in cumulative human impacts on the world's ocean. *Nat Commun* **6**: 7615.

- Hamilton H, Smyth RL, Young BE, *et al.* 2022. Increasing taxonomic diversity and spatial resolution clarifies opportunities for protecting US imperiled species. *Ecol Appl* **32**: e2534.
- IUCN. 2023. The IUCN Red List of Threatened Species.
- Jarnevich CS, LaRoe J, Engelstad P, *et al.* 2023. INHABIT species potential distribution across the contiguous United States.
- Legagneux P, Casajus N, Cazelles K, *et al.* 2018. Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. *Front Ecol Evol* **5**: 175.
- Leu M, Haines AM, Check CE, *et al.* 2019. Temporal analysis of threats causing species endangerment in the United States. *Conserv Sci Pract* **1**.
- NatureServe. 2023. NatureServe Explorer.
- NatureServe Network. 2021. The Map of Biodiversity Importance.
- Pickard BR, Daniel J, Mehaffey M, *et al.* 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosyst Serv* **14**: 45–55.
- Sohl TL, Sayler KL, Bouchard MA, *et al.* 2014. Spatially explicit modeling of 1992–2100 land cover and forest stand age for the conterminous United States. *Ecol Appl* **24**: 1015–36.
- U.S. Fish and Wildlife Service. ECOS: Environmental Conservation Online System.
- USGS. 2023. Nonindigenous Aquatic Species Database, Gainesville, FL.
- Weber T, Delach A, Albrecht R, and Niederman TE. 2023. Agency management plans also fail to address threatened species vulnerability to climate change in the US. *Biol Conserv* **284**: 110184.
- Wiens JJ, Litvinenko Y, Harris L, and Jezkova T. 2019. Rapid niche shifts in introduced species can be a million times faster than changes among native species and ten times faster than climate change. *J Biogeogr* **46**: 2115–25.
- Wrobleski A, Ernst S, Weber T, and Delach A. 2023. The impact of climate change on endangered plants and lichen. *PLOS Clim* **2**: e0000225.

Appendix I: Additional Figures and Tables

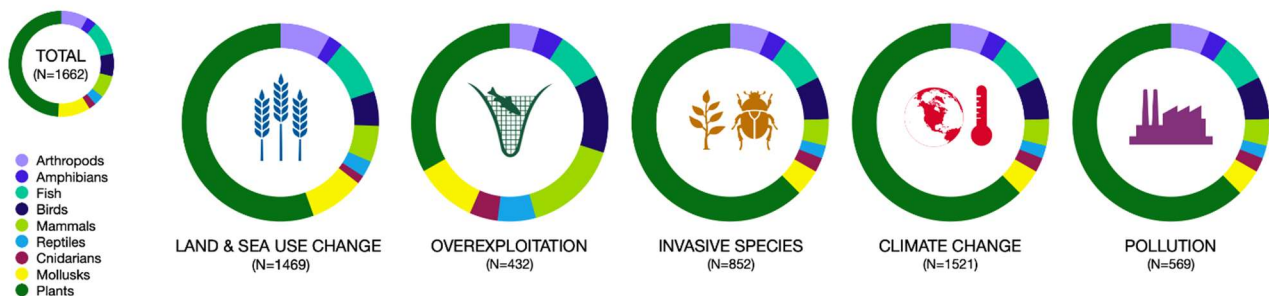


Figure S1: Taxonomic composition of species threatened by each of the five main drivers of global biodiversity loss.

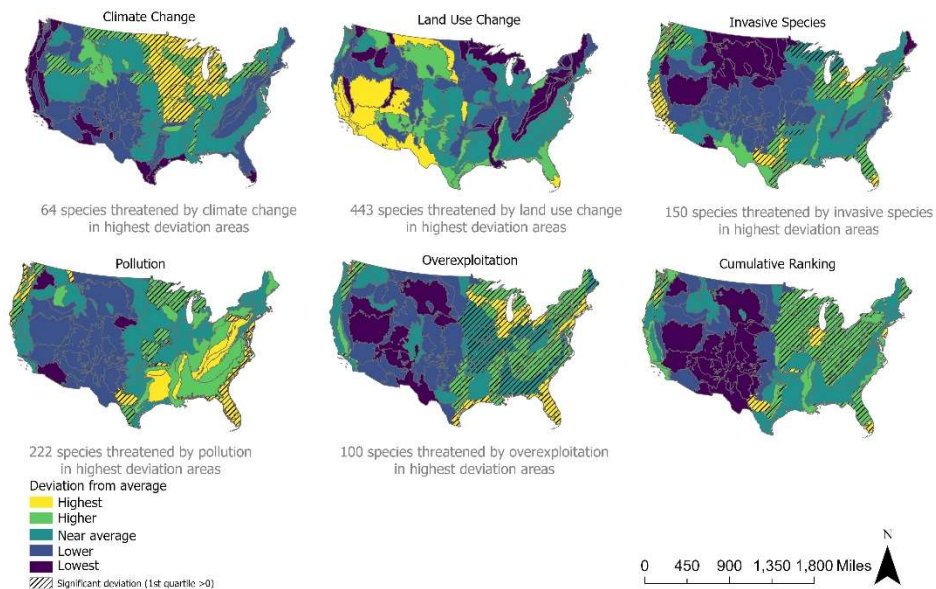


Figure S2: Ecoregional deviations from the overall mean (continental US) of each threat by ecoregion level 3. Values above the mean represent regional values higher than overall mean and values below the mean represent regional values lower than overall mean. Hatched regions show distributions where 1st quartile is higher than zero, meaning distribution of values in ecoregions is significantly higher than overall mean.

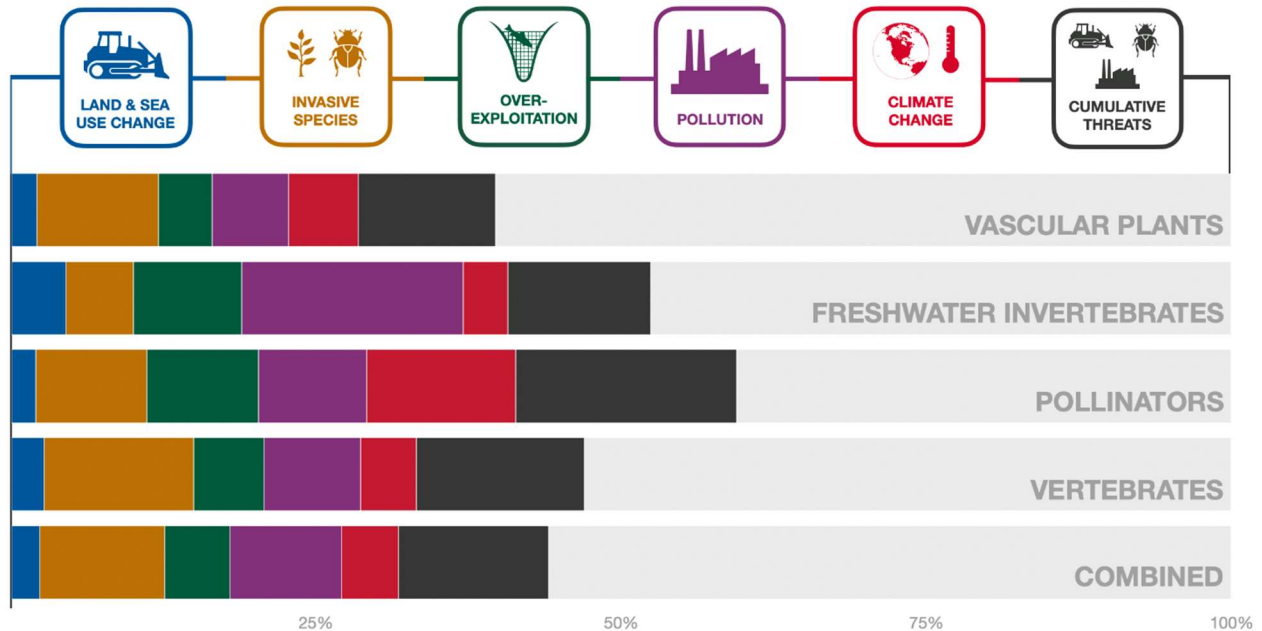


Figure S3: Areas with the highest values of biodiversity importance (top 10%, NatureServe's Map of Biodiversity Importance) for imperiled vascular plants, freshwater invertebrates, pollinators, vertebrates and all species combined were overlayed with areas of high exposure (top 10% of the contiguous U.S. for each threat) for each of the five underlying drivers of biodiversity loss: land- and sea-use change, invasive species, overexploitation, pollution and climate change. Bars indicate the percent of overlap. Colors and symbols correspond to the five main threats to global biodiversity loss, with black indicating more than one threat. Some of the most ubiquitous threats (e.g., land and sea use change and climate change may appear as smaller slices of the bar chart because of their overlap with other threats).

Table S1: Overlap between imperiled species hotspots and threat hotspots.

Taxonomic Group(s)	Pollution (%)	Overexploitation (%)	Invasive Species (%)	Land-Use Change (%)	Climate Change (%)	2+ (%)
Plant	6.26	4.39	9.97	2.14	5.70	11.26
Freshwater	18.14	8.89	5.51	4.52	3.63	11.74
Pollinators	8.87	9.10	9.11	2.05	12.21	18.09
Vertebrates	7.91	5.76	12.25	2.74	4.54	13.75
All	9.14	5.36	10.26	2.36	4.65	12.28

Table S2: Listed species with at least 90% of their range overlapping threat hotspots. For listing under the Endangered Species Act (ESA), T = Threatened and E = Endangered. Under threat columns, 1 indicates that the threat is contributing to species' endangerment. *For the California tiger salamander, both endangered distinct population segments are included.

Scientific Name	Common Name	Taxon	ESA Status	Climate Change	Land-Use Change	Invasive Species	Overexploit	Pollution	Prop Range Threat
<i>Ambystoma californiense</i>	California tiger salamander	Amphibian	E*	1	1	1	0	1	1.00
<i>Thomomys mazama pugetensis</i>	Olympia pocket gopher	Mammal	T	1	1	1	1	0	1.00
<i>Penstemon penlandii</i>	Penland beardtongue	Plant	E	1	1	0	1	0	1.00
<i>Rhinichthys osculus thermalis</i>	Kendall Warm Springs dace	Fish	E	1	1	1	0	0	1.00
<i>Lirceus usdagalun</i>	Lee County cave isopod	Invertebrate	E	1	0	0	0	1	1.00
<i>Gila bicolor</i>	Hutton tui chub	Fish	T	1	1	0	0	1	1.00
<i>Eriogonum ovalifolium var. williamsiae</i>	Steamboat buckwheat	Plant	E	1	1	0	0	1	1.00
<i>Ambrysus amargosus</i>	Ash Meadows naucorid	Invertebrate	T	1	1	0	1	0	1.00
<i>Stephanomeria malheurensis</i>	Malheur wire-lettuce	Plant	E	1	0	1	0	0	1.00
<i>Thomomys mazama tumuli</i>	Tenino pocket gopher	Mammal	T	1	1	1	1	0	1.00
<i>Euphydryas anicia cloudcrofti</i>	Sacramento mountains checkerspot butterfly	Invertebrate	E	1	1	1	1	0	1.00
<i>Cirsium loncholepis</i>	La Graciosa thistle	Plant	E	1	1	1	0	0	1.00
<i>Dudleya stolonifera</i>	Laguna Beach liveforever	Plant	T	1	1	1	1	0	1.00
<i>Asimina tetramera</i>	Four-petal pawpaw	Plant	E	1	1	1	1	1	1.00
<i>Thomomys mazama glacialis</i>	Roy Prairie pocket gopher	Mammal	T	1	1	1	1	0	1.00
<i>Etheostoma nianguae</i>	Niangua darter	Fish	T	1	1	0	0	1	1.00
<i>Anaea troglodyta floridalis</i>	Florida leafwing butterfly	Invertebrate	E	1	1	1	1	1	0.99
<i>Cyprinodon nevadensis pectoralis</i>	Warm Springs pupfish	Fish	E	1	1	1	0	0	0.99
<i>Thomomys mazama yelmensis</i>	Yelm pocket gopher	Mammal	T	1	1	1	1	0	0.99
<i>Chasmistes liorus</i>	June sucker	Fish	T	1	1	1	1	1	0.98
<i>Sylvilagus bachmani riparius</i>	Riparian bush rabbit	Mammal	E	1	1	1	1	0	0.98
<i>Rorippa gambellii</i>	Gambel's watercress	Plant	E	1	1	1	1	0	0.98

<i>Consolea corallicola</i>	Florida semaphore cactus	Plant	E	1	1	1	1	1	0.98
<i>Fremontodendron mexicanum</i>	Mexican flannelbush	Plant	E	1	1	1	0	0	0.98
<i>Cambarus aculabrum</i>	Benton County cave crayfish	Invertebrate	E	1	1	0	1	1	0.96
<i>Dipodomys stephensi</i>	Stephen's kangaroo rat	Mammal	T	1	1	1	1	1	0.96
<i>Galium californicum</i> ssp. <i>sierrae</i>	El Dorado bedstraw	Plant	E	1	1	1	0	1	0.95
<i>Cicindela ohlone</i>	Ohlone tiger beetle	Invertebrate	E	1	1	1	1	0	0.95
<i>Lanius ludovicianus mearnsi</i>	San Clemente loggerhead shrike	Bird	E	1	1	1	1	1	0.95
<i>Astragalus osterhoutii</i>	Osterhout milkvetch	Plant	E	1	1	0	1	0	0.94
<i>Lampsilis strecheri</i>	Speckled pocketbook	Invertebrate	E	1	1	0	1	1	0.93
<i>Speyeria callippe callippe</i>	Callippe silverspot butterfly	Invertebrate	E	1	1	1	1	0	0.93
<i>Etheostoma moorei</i>	Yellowcheek darter	Fish	E	1	1	0	0	1	0.93
<i>Amblyopsis rosae</i>	Ozark cavefish	Fish	T	1	1	0	1	1	0.93
<i>Nitrophila mohavensis</i>	Amargosa niterwort	Plant	E	1	1	0	0	0	0.92
<i>Anaxyrus californicus</i>	Arroyo toad	Amphibian	E	1	1	1	1	1	0.92
<i>Menidia extensa</i>	Waccamaw silverside	Fish	T	1	0	0	0	1	0.90
<i>Cottus paulus</i>	Pygmy sculpin	Fish	T	1	1	0	0	1	0.90

Report Literature Cited

1. S. Sarkar, Origin of the Term *Biodiversity*. *BioScience*. **71**, 893–893 (2021).
2. P. Legagneux, N. Casajus, K. Cazelles, C. Chevallier, M. Chevrinai, L. Guéry, C. Jacquet, M. Jaffré, M.-J. Naud, F. Noisette, P. Ropars, S. Vissault, P. Archambault, J. Bêty, D. Berteaux, D. Gravel, Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. *Front. Ecol. Evol.* **5**, 175 (2018).
3. S. Díaz, N. Zafra-Calvo, A. Purvis, P. H. Verburg, D. Obura, P. Leadley, R. Chaplin-Kramer, L. De Meester, E. Dulloo, B. Martín-López, M. R. Shaw, P. Visconti, W. Broadgate, M. W. Bruford, N. D. Burgess, J. Cavender-Bares, F. DeClerck, J. M. Fernández-Palacios, L. A. Garibaldi, S. L. L. Hill, F. Isbell, C. K. Khoury, C. B. Krug, J. Liu, M. Maron, P. J. K. McGowan, H. M. Pereira, V. Reyes-García, J. Rocha, C. Rondinini, L. Shannon, Y.-J. Shin, P. V. R. Snelgrove, E. M. Spehn, B. Strassburg, S. M. Subramanian, J. J. Tewksbury, J. E. M. Watson, A. E. Zanne, Set ambitious goals for biodiversity and sustainability. *Science*. **370**, 411–413 (2020).
4. E. Dinerstein, C. Vynne, E. Sala, A. R. Joshi, S. Fernando, T. E. Lovejoy, J. Mayorga, D. Olson, G. P. Asner, J. E. M. Baillie, N. D. Burgess, K. Burkart, R. F. Noss, Y. P. Zhang, A. Baccini, T. Birch, N. Hahn, L. N. Joppa, E. Wikramanayake, A Global Deal for Nature: Guiding principles, milestones, and targets. *Sci. Adv.* **5**, eaaw2869 (2019).
5. IPBES, “Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services” (IPBES secretariat, Bonn, Germany, 2019), , doi:10.5281/ZENODO.3831673.
6. WWF, “Living Planet Report 2022- Building a nature positive society” (2022).
7. J. D. Bechtel, “Gender, Poverty and the Conservation of Biodiversity A Review of Issues and Opportunities,” *MacArthur Foundation Conservation White Paper Series* (MacArthur Foundation, 2010).
8. S. Díaz, J. Fargione, F. S. Chapin, D. Tilman, Biodiversity Loss Threatens Human Well-Being. *PLoS Biol.* **4**, e277 (2006).
9. L. Goldsmith, M. L. Bell, Queering Environmental Justice: Unequal Environmental Health Burden on the LGBTQ+ Community. *Am. J. Public Health.* **112**, 79–87 (2022).
10. A. D. Barnosky, N. Matzke, S. Tomiya, G. O. U. Wogan, B. Swartz, T. B. Quental, C. Marshall, J. L. McGuire, E. L. Lindsey, K. C. Maguire, B. Mersey, E. A. Ferrer, Has the Earth’s sixth mass extinction already arrived? *Nature*. **471**, 51–57 (2011).
11. G. Ceballos, P. R. Ehrlich, P. H. Raven, Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *Proc. Natl. Acad. Sci.* **117**, 13596–13602 (2020).
12. J. M. De Vos, L. N. Joppa, J. L. Gittleman, P. R. Stephens, S. L. Pimm, Estimating the normal background rate of species extinction: Background Rate of Extinction. *Conserv. Biol.* **29**, 452–462 (2015).

13. NatureServe, NatureServe Explorer (2023), (available at <https://explorer.natureserve.org>).
14. J. Biden, *Strengthening the Nation's Forests, Communities and Local Economies. Executive Order 14072, 22 Apr 2022* (2022).
15. M. Cepic, U. Bechtold, H. Wilfing, Modelling human influences on biodiversity at a global scale—A human ecology perspective. *Ecol. Model.* **465**, 109854 (2022).
16. Y. M. Bar-On, R. Phillips, R. Milo, The biomass distribution on Earth. *Proc. Natl. Acad. Sci.* **115**, 6506–6511 (2018).
17. World Economic Forum, “The Global Risks Report 2020” (Insight Report 15th Edition, World Economic Forum, 2020), p. 94.
18. USGCRP, “Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II” (U.S. Global Change Research Program, 2018), , doi:10.7930/NCA4.2018.
19. K. Hayhoe, D. J. Wuebbles, D. R. Easterling, D. W. Fahey, S. Doherty, J. P. Kossin, W. V. Sweet, R. S. Vose, M. F. Wehner, “Chapter 2: Our Changing Climate. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II” (U.S. Global Change Research Program, 2018), , doi:10.7930/NCA4.2018.CH2.
20. Intergovernmental Panel On Climate Change, *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, ed. 1, 2023; <https://www.cambridge.org/core/product/identifier/9781009157896/type/book>).
21. “IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change” (Cambridge University Press).
22. J. J. Wiens, Climate-Related Local Extinctions Are Already Widespread among Plant and Animal Species. *PLOS Biol.* **14**, e2001104 (2016).
23. C. Román-Palacios, J. J. Wiens, Recent responses to climate change reveal the drivers of species extinction and survival. *Proc. Natl. Acad. Sci.* **117**, 4211–4217 (2020).
24. H. E. Roy, A. Pauchard, P. Stoett, T. Renard Truong, S. Bacher, B. S. Galil, P. E. Hulme, T. Ikeda, K. V. Sankaran, M. A. McGeoch, L. A. Meyerson, M. A. Nuñez, A. Ordonez, S. J. Rahlao, E. Schwindt, H. Seebens, A. W. Sheppard, V. Vandvik, “IPBES Invasive Alien Species Assessment: Summary for Policymakers” (Zenodo, 2023), , doi:10.5281/ZENODO.7430692.
25. D. Pimentel, R. Zuniga, D. Morrison, Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecol. Econ.* **52**, 273–288 (2005).

26. J. E. Fantle-Lepczyk, P. J. Haubrock, A. M. Kramer, R. N. Cuthbert, A. J. Turbelin, R. Crystal-Ornelas, C. Diagne, F. Courchamp, Economic costs of biological invasions in the United States. *Sci. Total Environ.* **806**, 151318 (2022).
27. H. Seebens, S. Bacher, T. M. Blackburn, C. Capinha, W. Dawson, S. Dullinger, P. Genovesi, P. E. Hulme, M. Kleunen, I. Kühn, J. M. Jeschke, B. Lenzner, A. M. Liebhold, Z. Pattison, J. Pergl, P. Pyšek, M. Winter, F. Essl, Projecting the continental accumulation of alien species through to 2050. *Glob. Change Biol.* **27**, 970–982 (2021).
28. M. C. Wilson, X.-Y. Chen, R. T. Corlett, R. K. Didham, P. Ding, R. D. Holt, M. Holyoak, G. Hu, A. C. Hughes, L. Jiang, W. F. Laurance, J. Liu, S. L. Pimm, S. K. Robinson, S. E. Russo, X. Si, D. S. Wilcove, J. Wu, M. Yu, Habitat fragmentation and biodiversity conservation: key findings and future challenges. *Landsc. Ecol.* **31**, 219–227 (2016).
29. B. Czech, P. R. Krausman, P. K. Devers, Economic Associations among Causes of Species Endangerment in the United States. *BioScience.* **50**, 593 (2000).
30. B. Czech, P. R. Krausman, Distribution and Causation of Species Endangerment in the United States. *Science.* **277**, 1116–1117 (1997).
31. A. Easter-Pilcher, Implementing the Endangered Species Act. *BioScience.* **46**, 355–363 (1996).
32. C. H. Flather, M. S. Knowles, I. A. Kendall, Threatened and Endangered Species Geography. *BioScience.* **48**, 365–376 (1998).
33. T. C. Foin, A. L. Pawley, D. R. Ayres, T. M. Carlsen, P. J. Hodum, P. V. Switzer, Improving Recovery Planning for Threatened and Endangered Species. *BioScience.* **48**, 177–184 (1998).
34. A. M. Haines, M. Leu, D. M. Costante, T. C. Treacle, C. Parenti, J. R. B. Miller, J. W. Malcom, Benchmark for the ESA: Having a Backbone Is Good for Recovery. *Front. Conserv. Sci.* **2**, 630490 (2021).
35. D. S. Wilcove, D. Rothstein, J. Dubow, A. Phillips, E. Losos, Quantifying Threats to Imperiled Species in the United States. *BioScience.* **48**, 607–615 (1998).
36. M. Lee-Ashley, J. Rowland-Shea, R. Richards, “The Green Squeeze: America’s Nature Crisis” (Center for American Progress, 2019), (available at <https://www.americanprogress.org/article/the-green-squeeze/>).
37. A. J. Eichenwald, M. J. Evans, J. W. Malcom, US imperiled species are most vulnerable to habitat loss on private lands. *Front. Ecol. Environ.* **18**, 439–446 (2020).
38. U.S Department of the Interior: Fish and Wildlife Service, Wetlands of the United States: Current Status and Recent Trends (1984), (available at https://www.nawm.org/wetlandsonestop/tiner_wetlands_of_us_report.pdf).
39. Global Footprint Network, Footprint Data (2023).

40. D. M. Costante, A. M. Haines, M. Leu, Threats to Neglected Biodiversity: Conservation Success Requires More Than Charisma. *Front. Conserv. Sci.* **2**, 727517 (2022).
41. NOAA, Status of Stocks 2021 (2022), (available at <https://www.fisheries.noaa.gov/national/sustainable-fisheries/status-stocks-2021#overview-of-phrases-to-know>).
42. EPA, National Lakes Assessment 2012: A Collaborative Survey of Lakes in the United States (2012), (available at https://www.epa.gov/sites/default/files/2016-12/documents/nla_report_dec_2016.pdf).
43. S. B. Borrelle, J. Ringma, K. L. Law, C. C. Monnahan, L. Lebreton, A. McGivern, E. Murphy, J. Jambeck, G. H. Leonard, M. A. Hilleary, M. Eriksen, H. P. Possingham, H. De Frond, L. R. Gerber, B. Polidoro, A. Tahir, M. Bernard, N. Mallos, M. Barnes, C. M. Rochman, Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science*. **369**, 1515–1518 (2020).
44. Y. Li, R. Miao, M. Khanna, Neonicotinoids and decline in bird biodiversity in the United States. *Nat. Sustain.* **3**, 1027–1035 (2020).
45. G. M. Lovett, T. H. Tear, D. C. Evers, S. E. G. Findlay, B. J. Cosby, J. K. Dunscomb, C. T. Driscoll, K. C. Weathers, Effects of Air Pollution on Ecosystems and Biological Diversity in the Eastern United States. *Ann. N. Y. Acad. Sci.* **1162**, 99–135 (2009).
46. D. M. Evans, J. P. Che-Castaldo, D. Crouse, F. W. Davies, R. Epanchin-Niell, C. H. Flather, R. K. Frohlich, D. D. Goble, Y. W. Li, T. D. Male, L. L. Master, M. P. Moskwik, M. C. Neel, B. R. Noon, C. Parmesan, M. W. Schwartz, J. M. Scott, B. K. Williams, Species recovery in the United States: Increasing the effectiveness of the endangered species act. *Issues Ecol.* **20** (2016) (available at <http://hdl.handle.net/10026.1/10108>).
47. M. Leu, A. M. Haines, C. E. Check, D. M. Costante, J. C. Evans, M. A. Hollingsworth, I. T. Ritrovato, A. M. Rydberg, A. M. Sandercock, K. L. Thomas, T. C. Treacle, Temporal analysis of threats causing species endangerment in the United States. *Conserv. Sci. Pract.* **1** (2019), doi:10.1111/csp2.78.
48. WRI, “Ecosystems and Human Well-being: Biodiversity,” *Millennium Ecosystem Assessment* (World Resources Institute, Washington DC, 2005).
49. T. Mazar, C. Doropoulos, F. Schwarzmüller, D. W. Gladish, N. Kumaran, K. Merkel, M. Di Marco, V. Gagic, Global mismatch of policy and research on drivers of biodiversity loss. *Nat. Ecol. Evol.* **2**, 1071–1074 (2018).
50. J. F. Brodie, M. Paxton, K. Nagulendran, G. Balamurugan, G. R. Clements, G. Reynolds, A. Jain, J. Hon, Connecting science, policy, and implementation for landscape-scale habitat connectivity: Corridor Science and Policy. *Conserv. Biol.* **30**, 950–961 (2016).
51. N. S. Sodhi, D. Bickford, A. C. Diesmos, T. M. Lee, L. P. Koh, B. W. Brook, C. H. Sekercioglu, C. J. A. Bradshaw, Measuring the Meltdown: Drivers of Global Amphibian Extinction and Decline. *PLoS ONE*. **3**, e1636 (2008).

52. S. N. Stuart, J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman, R. W. Waller, Status and Trends of Amphibian Declines and Extinctions Worldwide. *Science*. **306**, 1783–1786 (2004).
53. J. Schipper, J. S. Chanson, F. Chiozza, N. A. Cox, M. Hoffmann, V. Katariya, J. Lamoreux, A. S. L. Rodrigues, S. N. Stuart, H. J. Temple, J. Baillie, L. Boitani, T. E. Lacher, R. A. Mittermeier, A. T. Smith, D. Absolon, J. M. Aguiar, G. Amori, N. Bakkour, R. Baldi, R. J. Berridge, J. Bielby, P. A. Black, J. J. Blanc, T. M. Brooks, J. A. Burton, T. M. Butynski, G. Catullo, R. Chapman, Z. Cokeliss, B. Collen, J. Conroy, J. G. Cooke, G. A. B. Da Fonseca, A. E. Derocher, H. T. Dublin, J. W. Duckworth, L. Emmons, R. H. Emslie, M. Festa-Bianchet, M. Foster, S. Foster, D. L. Garshelis, C. Gates, M. Gimenez-Dixon, S. Gonzalez, J. F. Gonzalez-Maya, T. C. Good, G. Hammerson, P. S. Hammond, D. Happold, M. Happold, J. Hare, R. B. Harris, C. E. Hawkins, M. Haywood, L. R. Heaney, S. Hedges, K. M. Helgen, C. Hilton-Taylor, S. A. Hussain, N. Ishii, T. A. Jefferson, R. K. B. Jenkins, C. H. Johnston, M. Keith, J. Kingdon, D. H. Knox, K. M. Kovacs, P. Langhammer, K. Leus, R. Lewison, G. Lichtenstein, L. F. Lowry, Z. Macavoy, G. M. Mace, D. P. Mallon, M. Masi, M. W. McKnight, R. A. Medellin, P. Medici, G. Mills, P. D. Moehlman, S. Molur, A. Mora, K. Nowell, J. F. Oates, W. Olech, W. R. L. Oliver, M. Oprea, B. D. Patterson, W. F. Perrin, B. A. Polidoro, C. Pollock, A. Powel, Y. Protas, P. Racey, J. Ragle, P. Ramani, G. Rathbun, R. R. Reeves, S. B. Reilly, J. E. Reynolds, C. Rondinini, R. G. Rosell-Ambal, M. Rulli, A. B. Rylands, S. Savini, C. J. Schank, W. Sechrest, C. Self-Sullivan, A. Shoemaker, C. Sillero-Zubiri, N. De Silva, D. E. Smith, C. Srinivasulu, P. J. Stephenson, N. Van Strien, B. K. Talukdar, B. L. Taylor, R. Timmins, D. G. Tirira, M. F. Tognelli, K. Tsytulina, L. M. Veiga, J.-C. Vieilleduc, E. A. Williamson, S. A. Wyatt, Y. Xie, B. E. Young, The Status of the World's Land and Marine Mammals: Diversity, Threat, and Knowledge. *Science*. **322**, 225–230 (2008).
54. J. R. Allan, J. E. M. Watson, M. Di Marco, C. J. O'Bryan, H. P. Possingham, S. C. Atkinson, O. Venter, Hotspots of human impact on threatened terrestrial vertebrates. *PLOS Biol*. **17**, e3000158 (2019).
55. N. Cox, B. E. Young, P. Bowles, M. Fernandez, J. Marin, G. Rapacciuolo, M. Böhm, T. M. Brooks, S. B. Hedges, C. Hilton-Taylor, M. Hoffmann, R. K. B. Jenkins, M. F. Tognelli, G. J. Alexander, A. Allison, N. B. Ananjeva, M. Auliya, L. J. Avila, D. G. Chapple, D. F. Cisneros-Heredia, H. G. Cogger, G. R. Colli, A. De Silva, C. C. Eiseberg, J. Els, A. Fong G., T. D. Grant, R. A. Hitchmough, D. T. Iskandar, N. Kidera, M. Martins, S. Meiri, N. J. Mitchell, S. Molur, C. D. C. Nogueira, J. C. Ortiz, J. Penner, A. G. J. Rhodin, G. A. Rivas, M.-O. Rödel, U. Roll, K. L. Sanders, G. Santos-Barrera, G. M. Shea, S. Spawls, B. L. Stuart, K. A. Tolley, J.-F. Trape, M. A. Vidal, P. Wagner, B. P. Wallace, Y. Xie, A global reptile assessment highlights shared conservation needs of tetrapods. *Nature*. **605**, 285–290 (2022).
56. USGS, Why are amphibian populations declining?, (available at <https://www.usgs.gov/faqs/why-are-amphibian-populations-declining#:~:text=The%20average%20decline%20in%20overall,occupy%20in%20about%2020%20years>).
57. J. Alroy, Current extinction rates of reptiles and amphibians. *Proc. Natl. Acad. Sci*. **112**, 13003–13008 (2015).
58. D. M. Green, M. J. Lannoo, D. Lesbarrères, E. Muths, Amphibian Population Declines: 30 Years of Progress in Confronting a Complex Problem. *Herpetologica*. **76**, 97 (2020).

59. I. R. Staude, L. M. Navarro, H. M. Pereira, Range size predicts the risk of local extinction from habitat loss. *Glob. Ecol. Biogeogr.* **29**, 16–25 (2020).
60. R. G. Pearson, J. C. Stanton, K. T. Shoemaker, M. E. Aiello-Lammens, P. J. Ersts, N. Horning, D. A. Fordham, C. J. Raxworthy, H. Y. Ryu, J. McNees, H. R. Akçakaya, Life history and spatial traits predict extinction risk due to climate change. *Nat. Clim. Change.* **4**, 217–221 (2014).
61. A. Delach, A. Caldas, K. M. Edson, R. Krehbiel, S. Murray, K. A. Theoharides, L. J. Vorhees, J. W. Malcom, M. N. Salvo, J. R. B. Miller, Agency plans are inadequate to conserve US endangered species under climate change. *Nat. Clim. Change.* **9**, 999–1004 (2019).
62. T. Weber, A. Delach, R. Albrecht, T. E. Niederman, Agency management plans also fail to address threatened species vulnerability to climate change in the US. *Biol. Conserv.* **284**, 110184 (2023).
63. A. Wroblewski, S. Ernst, T. Weber, A. Delach, The impact of climate change on endangered plants and lichen. *PLOS Clim.* **2**, e0000225 (2023).
64. F. C. Bolam, L. Mair, M. Angelico, T. M. Brooks, M. Burgman, C. Hermes, M. Hoffmann, R. W. Martin, P. J. K. McGowan, A. S. L. Rodrigues, C. Rondinini, J. R. S. Westrip, H. Wheatley, Y. Bedolla-Guzmán, J. Calzada, M. F. Child, P. A. Cranswick, C. R. Dickman, B. Fessl, D. O. Fisher, S. T. Garnett, J. J. Groombridge, C. N. Johnson, R. J. Kennerley, S. R. B. King, J. F. Lamoreux, A. C. Lees, L. Lens, S. P. Mahood, D. P. Mallon, E. Meijaard, F. Méndez-Sánchez, A. R. Percequillo, T. J. Regan, L. M. Renjifo, M. C. Rivers, N. S. Roach, L. Roxburgh, R. J. Safford, P. Salaman, T. Squires, E. Vázquez-Domínguez, P. Visconti, J. C. Z. Woinarski, R. P. Young, S. H. M. Butchart, How many bird and mammal extinctions has recent conservation action prevented? *Conserv. Lett.* **14** (2021), doi:10.1111/conl.12762.
65. Y. Liang, I. Rudik, E. Y. Zou, A. Johnston, A. D. Rodewald, C. L. Kling, Conservation cobenefits from air pollution regulation: Evidence from birds. *Proc. Natl. Acad. Sci.* **117**, 30900–30906 (2020).
66. M. Evansen, H. Harl, A. Carter, J. Malcom, “Status of the recovery mandate under section 7(a)(1) of the U.S. Endangered Species Act” (preprint, Open Science Framework, 2021), , doi:10.31219/osf.io/hmab9.
67. D. Leclère, M. Obersteiner, M. Barrett, S. H. M. Butchart, A. Chaudhary, A. De Palma, F. A. J. DeClerck, M. Di Marco, J. C. Doelman, M. Dürauer, R. Freeman, M. Harfoot, T. Hasegawa, S. Hellweg, J. P. Hilbers, S. L. L. Hill, F. Humpenöder, N. Jennings, T. Krisztin, G. M. Mace, H. Ohashi, A. Popp, A. Purvis, A. M. Schipper, A. Tabeau, H. Valin, H. van Meijl, W.-J. van Zeist, P. Visconti, R. Alkemade, R. Almond, G. Bunting, N. D. Burgess, S. E. Cornell, F. Di Fulvio, S. Ferrier, S. Fritz, S. Fujimori, M. Grooten, T. Harwood, P. Havlík, M. Herrero, A. J. Hoskins, M. Jung, T. Kram, H. Lotze-Campen, T. Matsui, C. Meyer, D. Nel, T. Newbold, G. Schmidt-Traub, E. Stehfest, B. B. N. Strassburg, D. P. van Vuuren, C. Ware, J. E. M. Watson, W. Wu, L. Young, Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature.* **585**, 551–556 (2020).
68. E. Dinerstein, A. R. Joshi, C. Vynne, A. T. L. Lee, F. Pharand-Deschênes, M. França, S. Fernando, T. Birch, K. Burkart, G. P. Asner, D. Olson, A “Global Safety Net” to reverse biodiversity loss and stabilize Earth’s climate. *Sci. Adv.* **6**, eabb2824 (2020).

69. J. Geldmann, A. Manica, N. D. Burgess, L. Coad, A. Balmford, A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressures. *Proc. Natl. Acad. Sci.* **116**, 23209–23215 (2019).
70. A. Wolf, R. M. Mitchell, Leveraging Historic Cattle Enclosures to Detect Evidence of State Change in an Arid Rangeland. *Rangel. Ecol. Manag.* **78**, 26–35 (2021).
71. C. Carroll, J. C. Ray, *Glob. Change Biol.*, in press, doi:10.1111/gcb.15645.
72. P. Lehtikoinen, A. Santangeli, K. Jaatinen, A. Rajasärkkä, A. Lehtikoinen, Protected areas act as a buffer against detrimental effects of climate change—Evidence from large-scale, long-term abundance data. *Glob. Change Biol.* **25**, 304–313 (2019).
73. S. Hoffmann, C. Beierkuhnlein, Climate change exposure and vulnerability of the global protected area estate from an international perspective. *Divers. Distrib.* **26**, 1496–1509 (2020).
74. Mst. U. S. Nila, C. Beierkuhnlein, A. Jaeschke, S. Hoffmann, M. L. Hossain, Predicting the effectiveness of protected areas of Natura 2000 under climate change. *Ecol. Process.* **8**, 13 (2019).
75. S. Kodish, U. Reeves, N. Miller, A. Gonzales, J. Errick, K. Henderson, K. Albert, “Polluted Parks: How America is Failing to Protect Our National Parks, People and Planet from Air Pollution” (NPCA, 2019), (available at <https://www.npca.org/reports/air-climate-report>).
76. M. J. Hansen, N. A. Nate, Effects of Recruitment, Growth, and Exploitation on Walleye Population Size Structure in Northern Wisconsin Lakes. *J. Fish Wildl. Manag.* **5**, 99–108 (2014).
77. CRS, Federal Land Management: When “Multiple Use” and “Sustained Yield” Diverge (2023), (available at <https://crsreports.congress.gov/product/pdf/LSB/LSB10982>).
78. C. Langpap, Conservation of endangered species: Can incentives work for private landowners? *Ecol. Econ.* **57**, 558–572 (2006).
79. P. M. Morrisette, Conservation easements and the public good: preserving the environment on private lands. *Nat. Resour. J.* **41**, 373–426 (2001).
80. A. Fairbrother, Federal environmental legislation in the U.S. for protection of wildlife and regulation of environmental contaminants. *Ecotoxicology.* **18**, 784–790 (2009).