

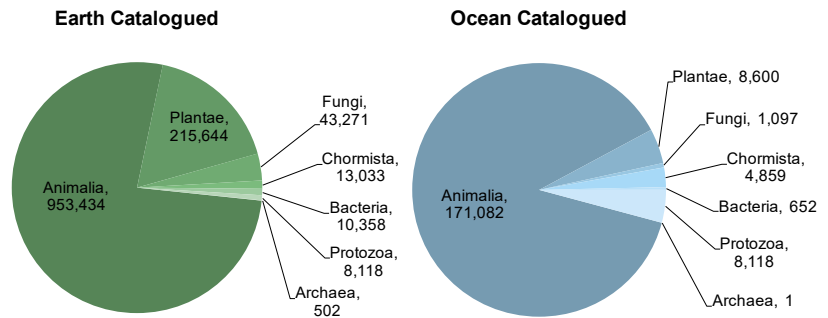
Biodiversity

Biodiversity, or biological diversity, is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part.¹ Biodiversity shapes the ecosystem services that contribute to human well-being—material welfare, security, social relations, and health.² Biodiversity is considered on three levels: species diversity, genetic diversity, and ecosystem diversity.³

Species Diversity

- Species diversity can be measured in several ways, including diversity indices (species richness and evenness), rank abundance diagrams, and similarity indices.⁴
- Of the estimated 8.7 million eukaryotic species (complex cells) on Earth, 86% of land species and 91% of ocean species have not yet been described.⁵
- 1.2 million species have been described globally.⁵
- 55,023 plant and animal species are listed in the U.S.; top-ranking states for species diversity are CA, TX, AZ, NM, and AL, respectively.^{6,7}
- Freshwater habitats account for only 0.01% of the world's water and make up less than 1% of the planet's surface, but they support one-third of all described vertebrates and nearly 10% of all known animal species.⁸
- One study suggests that while tropical reefs have more diverse fish communities, it is polar waters that are hotspots of fish speciation (formation of distinct new species) — contrary to much of the previous thinking about evolution.⁹

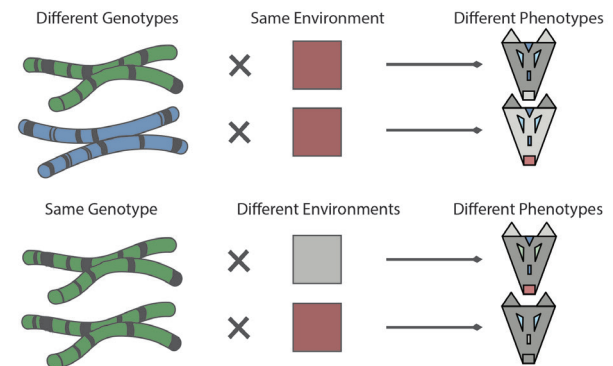
Catalogued Earth and Ocean Species⁵



Genetic Diversity

- Genetic diversity refers to the genetic variation within species (for both the same population and populations living in different geographical areas).³
- Individuals within a species have slightly different forms of genes through mutations, where each form (an allele) can code for different proteins and ultimately affect species physiology.³
- Genetic variations lead to differences in both genotype and phenotype, which are necessary for species to maintain reproductive vitality, resistance to disease, and the ability to adapt to changing conditions.³

Genotype vs. Phenotype³



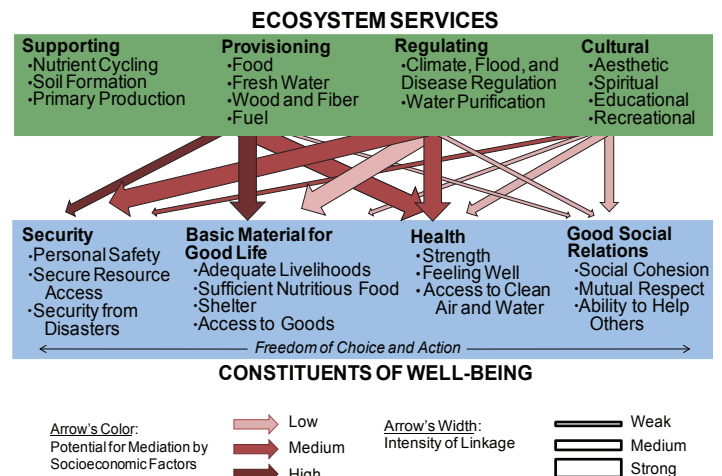
Community/Ecosystem Diversity

- Ecosystem diversity describes the variety of biological communities and their associations with the ecosystem of which they are part.³
- Within ecosystems, species play different roles and have different requirements for survival (i.e., food, temperature, water, etc.). If any of these requirements become a limiting resource for a species, its population size becomes restricted.³

Goods & Services

- Ecosystem services are the conditions and processes that enable natural ecosystems to sustain human life.¹⁰
- Ecosystem services include: air and water purification; mitigation of floods and droughts; detoxification and decomposition of wastes; generation and renewal of soil and soil fertility; pollination of crops and natural vegetation; dispersal of seeds and translocation of nutrients; protection from the sun's harmful ultraviolet rays; partial stabilization of climate; and moderation of temperature extremes and the force of winds and waves.¹⁰
- Biodiversity improves several ecosystem services, including crop yields, stability of fishery yields, wood production, fodder yield, resistance to plant invasion, carbon sequestration, soil nutrient mineralization, and soil organic matter.¹¹
- These services provide us with food, natural fibers, timber, biomass fuels, crop pollination, medicines, psychological health, and more.¹²

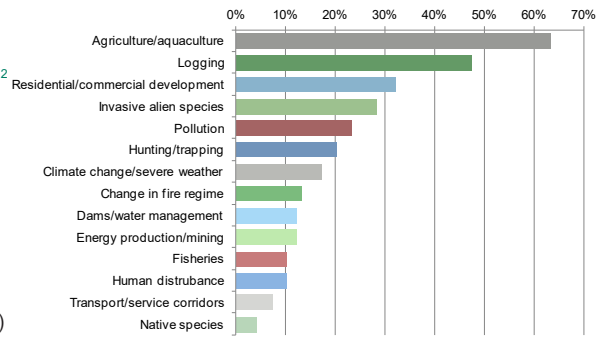
Biodiversity, Ecosystem Services, and Human Well-Being²



Loss of Biodiversity

- Since 1955, alteration of biodiversity related to human activities was greater than any time in human history, driven by habitat loss from agriculture and infrastructure, over-exploitation, pollution, invasive species, and climate change.^{2,12}
- Climate change is likely to become the largest threat to biodiversity, partially because it affects areas uninhabited by humans.¹² Higher temperatures could increase drying, resulting in dieback in the Amazon, which has the highest biodiversity of all forests.¹⁵
- In August 2019, 76,000 fires burned over 7,000 square miles of the Amazon, an 80% increase in fires from August 2018.¹⁶ The 2019-2020 Australian bushfires are estimated to have killed nearly 3 billion native vertebrates.¹⁷
- Habitat loss increases greenhouse gas emissions; 8% of global emissions (.8-.9 GtC) derive from tropical deforestation. Tropical forests sequester 1.2 - 1.8 GtC yearly.¹⁸
- Over-fishing and harvesting also contribute to a loss of genetic diversity and relative species abundance of individuals and groups.¹⁹

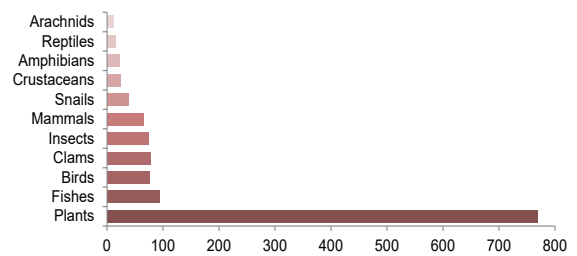
Major Threats to Critically Endangered Vertebrates¹³



Biodiversity Loss Due to Agriculture

- Of the 30 mammalian and bird species used extensively for agriculture, half account for over 90% of global livestock production.²⁰
- Genetic diversity within breeds is declining, and 2.4% of 8,803 livestock breeds identified are classified as at risk of disappearing.²¹
- Of 30,000 wild and 7,000 cultivated edible plants, 30 provide 95% of dietary energy. Wheat, rice, and maize provide >50% of plant-derived calories, globally.²²
- Between 1900 - 2000, ~75% of the genetic diversity of agricultural crops was lost.²³
- Productivity, stability, ecosystem services, and resilience are positively associated with species diversity in agricultural ecosystems.²⁴

Federally Listed Endangered Species by Taxonomic Group¹⁴



Extinction

- In Earth's history, there have been five mass extinctions, defined as time periods where extinction rates accelerate relative to origination rates such that over 75% of species disappear over an interval of 2 million years or less.²⁵
- Globally, 1% or less of the species within most assessed taxa are extinct. However, 20-43% of species in these taxa are labeled as threatened.²⁵
- As of 2022, 207 plant and animal species have gone extinct in the U.S. and 2,282 are threatened or endangered.^{6,26}
- Current extinction rates are higher than those leading to the five mass extinctions and could reach mass extinction magnitude in 300 years.²⁵
- Up to 1 million species may be threatened with extinction in coming decades.²⁷

Sustainable Actions

Policy

- Examples of treaties to protect species include: The Convention on Wetlands of International Importance (1971), The Convention of International Trade in Endangered Species (CITES) (1973), and the Convention on Biological Diversity (CBD) (1992).²⁸
- The Endangered Species Act (ESA) (1973), administered by the Interior Department's Fish and Wildlife Service and the Commerce Department's National Marine Fisheries Service, aims to protect and recover imperiled species and the ecosystems they depend on.²⁹
- As of 2022, 193 countries have National Biodiversity Strategic Action Plans for the conservation and sustainable use of biological diversity.³⁰
- Globally, over 238,000 protected areas (such as national parks and reserves) have been established, covering nearly 15% of the land and 7.3% of the sea. The size of the protected areas is now more than 18 times larger than it was in 1962.³¹

Global Initiatives

- The Strategic Plan for Biodiversity 2011-2020 is a framework of five strategic goals and twenty targets adopted by the Convention on Biological Diversity in 2010.³² If current trends continue or worsen, these goals will not be achieved and other goals set forth in the Paris Agreement and the 2050 Vision for Biodiversity will be undermined.²⁷
- The United Nations developed a list of Sustainable Development Goals (SDG's) in 2015 that commit to preserving biodiversity of aquatic and terrestrial organisms, among other things. Fulfilling the SDG's has the potential to greatly increase biodiversity and its associated benefits.³³

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