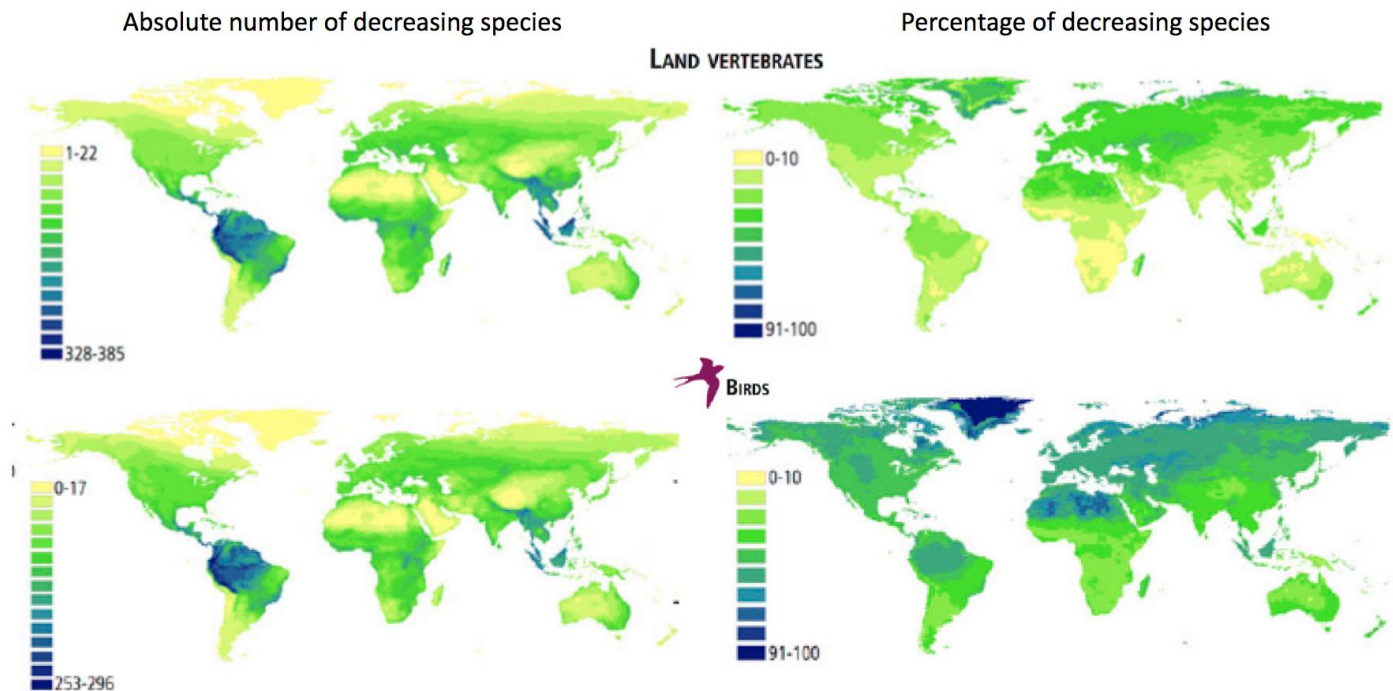




Vertebrate Declines and the Sixth Mass Extinction

HOW TO USE THIS RESOURCE

Show the figure below to your students along with the caption and background information either by printing the student handout or by projecting the image and reading the text aloud. The “Interpreting the Graph” and “Discussion Questions” sections provide additional information and suggested questions that you can use to guide a class discussion about the characteristics of the graph and what it shows.



Caption: Global distribution of species declines over the past 115 years (1900–2015). Declines are measured as the number and percentage of species that declined per 10,000 km² area. The left panels show the absolute number of species whose populations have declined in each region; the right panels show the percentage of species that declined in each region. The top panels include all land vertebrates (amphibians, birds, reptiles, and mammals), whereas the bottom panels represent only bird species.

BACKGROUND INFORMATION

Extinctions are a regular occurrence over the course of geologic time. But catastrophic events in which many species go extinct over brief periods of time are rare. When our planet loses more than 70% of its species within a relatively short geological time interval, scientists refer to these cataclysmic losses as mass extinctions. In the past 540 million years alone, scientists estimate that there have been at least five such mass extinction events. Many experts warn that a sixth mass extinction may be on our doorstep, triggered by human activities and a rapidly growing human population that has destroyed habitats and ecosystems around the world. Today, we are seeing massively accelerated extinction rates that exceed normal extinction rates by a factor of 12. Experts estimate that at the current rate, 75% of our species will disappear in less than 200 years. Species extinctions are nearly always preceded by high regional population declines. In this study, researchers measured species population declines on a global scale that may contribute to the sixth mass extinction. The figure shows the results of a study examining population trends for 27,600 land vertebrate species from 1900 to 2015. The researchers found that 32% of these species, many of which are mammals and birds, are currently in decline. The researchers argue that aggressive species and habitat conservation within the next couple of decades are the only ways to avoid a catastrophic sixth

mass extinction.

INTERPRETING THE GRAPH

The maps show that global species declines are not uniform. The total number of land vertebrate species in decline is greatest in the tropics, where species richness is naturally high, and lowest in desert regions and high latitudes, where species richness is low. In areas where richness is low, such as in Greenland, the loss of just a few species results in a high percentage of species in decline. This is why the heat maps for number of species in decline and for percentage of species in decline are different.

The map for absolute number of bird species closely mirrors the land vertebrate map. Decreasing species of birds occur over large regions across all continents. Together with mammals (not shown here), birds account for most of the overall pattern of decline seen in the land vertebrate maps. The authors argue that by losing populations (and ultimately species) of vertebrates and by limiting their range, we are losing diverse gene pools that would otherwise enable species to adapt to future changes in the environment.

Teacher Tip: Prompt your students to explain the parts of the figure:

- Figure Type: Global map
- Data Types: The map includes data from the International Union for Conservation of Nature (IUCN) on global population declines of 27,600 species from 1900 to 2015. The left panels display the absolute number of species in decline in a region, while the right panels display the percentage of a region's total species that are in decline.
- Color Patterns: Blue indicates the greatest degree of species decline in an area, green is moderate, and yellow indicates the lowest level of decline.

DISCUSSION QUESTIONS

- Which regions on Earth show the greatest number of species in decline?
- Compare the absolute number and percentage of species declines in the Amazon, Northern Africa, and Greenland. Why are the map colors not the same?
- Why do you think the researchers measured both the number and the percentage of species population declines across the globe?
- Compare the two maps showing bird declines with the two land vertebrate maps. What can you learn from data for just one group of land vertebrates (e.g., birds) that the compiled data for all vertebrates cannot show you?
- Use evidence from the map to support or refute the claim that bird species account for the pattern of vertebrate declines we see in the Amazon and in Southeast Asia.
- Look at the percentage of declining bird species. Where are the greatest declines? Why do you think the percentage is highest here?
- How might a shrinking population lead to a much less diverse (i.e., a more homogenous) gene pool over time? What would this mean for a species' ability to adapt to future environmental changes?
- How do you think large declines in a species' population and geographic range might affect ecosystems as a whole?
- How might species declines affect human populations?
- Species declines are often reported merely as the number of species lost over time. What's the benefit of visualizing species population declines across the globe using maps? What additional information can you gather from them? How might this information be used?

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- How might the information from these maps be used to prevent species extinctions?

KEY TERMS

human impacts, populations, scientific methodology, sixth mass extinction, statistics and math, vertebrate

SOURCE

Figure 2 from:

Ceballos, Gerardo, Paul Ehrlich, and Rodolfo Dirzo, "Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines," *PNAS* 114, no. 30 (2017): E6089-E6096.

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