



GLOBAL WARMING: PLANTS AND ANIMALS ON THE MOVE

Kenneth J. Feeley^{1*} and Benjamin G. Freeman²

¹Department of Biology, University of Miami, Coral Gables, FL, United States

²School of Biological Sciences, Georgia Institute of Technology, Atlanta, GA, United States

YOUNG REVIEWERS:



BERNARDA

AGE: 8



BRYSON

AGE: 10

Global warming is forcing many species to change where they live. As temperatures rise, some places will become too hot for the plants and animals that live there now. Species will migrate out of these hot areas and into other areas that used to be too cold for them. In some cases, species will not be able to move fast enough to escape rising temperatures, or there will not be enough places with suitable climates left for them to live in—increasing the risk that these species will become extinct. As global warming forces many plant and animal species to move around, or causes them to become extinct from certain areas, the types of species that we find around us will change, which will affect our lives.

SOME LIKE IT HOT—AND SOME DO NOT

All organisms have a range of temperatures in which they are comfortable. Exactly which temperatures are comfortable differs between species—some species like it hot and other species like it

TROPICAL

Describes areas near the Earth's equator that are typically hot all year round.

TEMPERATE

Describes areas farther from the Earth's equator that are typically colder than tropical areas.

GLOBAL WARMING

The increase in Earth's temperature through time due to the greenhouse effect. Hotter temperatures can cause changes in rainfall and other aspects of climate.

Figure 1

The South American tapir likes the heat, so the only place you can find it is in the hot, lowland Amazon rainforests of South America. In contrast, the elusive and endangered mountain tapir likes colder temperatures, so it lives high up in the Andes Mountains of Colombia, Ecuador, and Peru (Drawings and graphics by G. Enriquez).

GREENHOUSE EFFECT

The trapping of heat in the Earth's atmosphere due to increasing concentrations of CO₂, methane, and other greenhouse gases, caused by the burning of fossil fuels and other human activities.

cold. As a result of these different temperature preferences, we can predictably find certain species in certain places. For example, the South American tapir (Figure 1) likes the heat, so the only place we can currently find it is in the hot, lowland Amazon rainforest. In contrast, the mountain tapir (Figure 1) likes colder temperatures, so it lives high up in the Andes mountains. This is not true only for animals—trees and other plants also have temperature preferences. For example, the mango tree grows in hot **tropical** forests and would quickly die in the cold, but the cherry tree grows far to the north in **temperate** forests, where temperatures regularly drop below freezing. Thanks to specific temperature preferences like these, forests look very different at the tops of mountains (where it is cold) vs. at the bottom (where it is warmer); and they also look different in hot, tropical places vs. colder, temperate locations. But **global warming** is starting to mix things up.



Figure 1

SPECIES ARE ON THE MOVE

The **greenhouse effect** is warming our planet and, as the climate continues to get hotter, temperatures are starting to get uncomfortable for many plant and animal species. Scientists think that, to avoid overheating, these species will have to change where they live and

move to areas that used to be too cold for them. This usually means that species will have to move farther away from the tropics or higher up into the mountains. To test this idea, scientists have been making maps of all the places where a species was found in the past and comparing those old maps with new maps showing where the species lives today.

By comparing maps, scientists found that their predictions were correct—as the planet heats up, most species are moving to colder places! For example, scientists compared maps of the locations of several bird species in the Andes mountains of southern Peru in 1985 with maps of the same bird species in 2017. The scientists found that most bird species had moved about 40 meters (131 feet) higher up on the mountains in the 32 years between maps [1]. Similar location changes have been found in lots of other animal and plant studies. For example moose, coffee plants, mangrove trees, and mosquitos have all been found to be moving away from the tropics or to higher elevations [2, 3].

HOW DO PLANTS AND ANIMALS CHANGE WHERE THEY LIVE?

MIGRATE

To change through time the location where a species lives.

DISPERSAL

The movement of offspring away from their parents. In the case of plants, dispersal refers to the spreading of seeds by wind, water, and animals.

RECRUITMENT

The birth or establishment of new individuals in a population.

MORTALITY

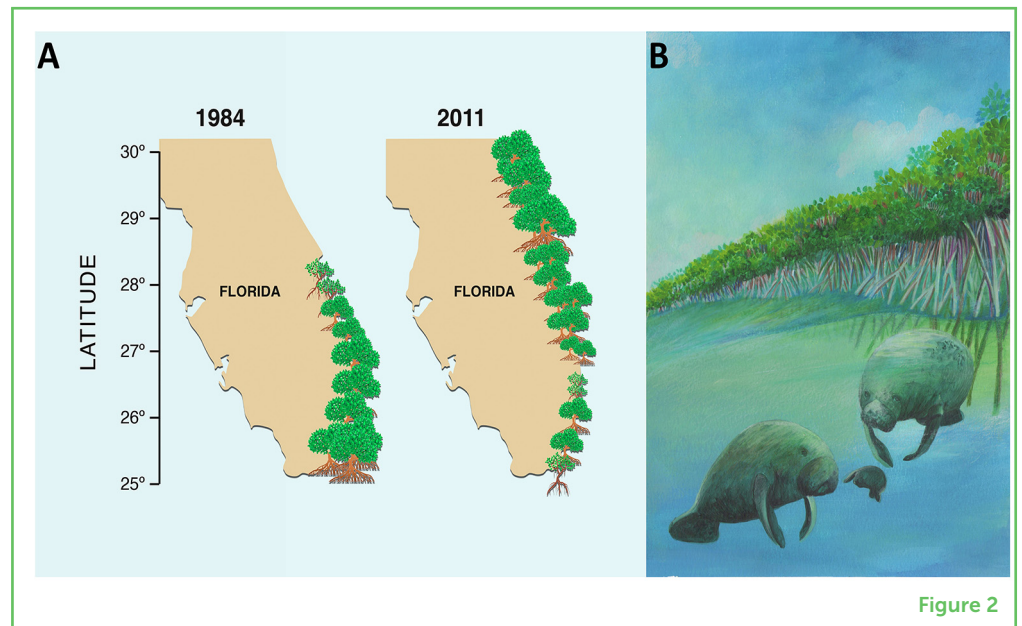
The death of individuals in a population.

You can probably imagine how animals can move, or **migrate**—but what about plants? Obviously, a tree cannot walk or fly away when it gets too hot, but plant species can still change where they grow. To reproduce, plants make lots of seeds. With the help of animals or the wind, the mother plants spread their seeds in every direction. Most seeds die, but some seeds survive and grow into new plants. Which seeds die and which seeds survive depends a lot on where they land. A seed that is dropped by a bird into the water or onto bare rocks will probably not survive, but a seed that is **dispersed** into a place that is too hot will not survive either. As the world gets hotter, only the seeds that land in cooler areas will survive to grow into plants and eventually produce more seeds. Given enough time, this uneven **recruitment** of individuals in hotter vs. colder places can cause plant species to change where they live.

In the same way, differences in the **mortality** of individuals in hotter vs. colder places can also change where plant species live. As the world warms up, the plants in hotter areas will die faster than plants of the same species in cooler areas. Over time, this will also change where plant species live. In other words, due to global warming, plants are dying faster in hotter areas and living longer and reproducing more in cooler areas—together, these differences in mortality and recruitment will cause trees and other plant species to migrate to higher elevations or to places farther away from the tropics (Figure 2).

Figure 2

(A) Many mangrove tree species are migrating north along the eastern coast of Florida, USA, increasing their numbers in higher-latitude (northern) areas that used to be too cold, and decreasing their numbers in lower-latitude (southern) areas that are becoming too hot [3]. (B) Coastal mangrove forests provide valuable habitats for many fish and other animals, including the Florida manatee (Drawings and graphics by G. Enriquez).

**Figure 2**

MIGRATING CAN BE DIFFICULT

While many species are moving away from hot places, often they are not migrating quickly enough to escape rising temperatures [4]. As we destroy the natural areas that species depend on, and build roads and cities that get in their way [5], we make it even harder for plants and animals to change where they live. This means that many species are now “stuck” in places that are too hot for them. As a result, some plants and animals are less healthy or are growing slower now than they did in the past, and there is even the risk that some species will become extinct.

Even if plants and animals *can* move fast enough to escape rising temperatures, they may still face the risk of extinction. Plants and animals depend on each other to survive. If some species migrate quickly but the other species that they depend on migrate slower or do not migrate at all, then they will have a difficult time surviving. Imagine a bird that likes to eat berries from just one type of tree. If that bird migrates to higher elevations but the tree does not, what will the bird eat? If the bird cannot find something new to eat, it could eventually become extinct. Additionally, as species migrate to the colder places higher up in the mountains, these areas will get crowded and the amount of available land will decrease. In the future, there may be no cool places left for species to move to [Figure 3](#).

MIGRATIONS CHANGE ECOSYSTEMS

As plants and animals move toward cooler places (or become extinct), forests and other natural areas change [6]. Imagine you could go back 50 years and walk through a forest or park near your house.

Figure 3

As temperatures increase, many animal species are moving to higher-elevation areas that used to be too cold for them. For example, a study in Peru's Andes mountains found that, in 2017, many species of birds like the chestnut-breasted wren and the yellow-throated tanager lived at higher elevations than they did just a few decades ago. Other bird species that used to only live on the mountaintops, like the variable antshrike, had nowhere higher to move to and, by 2017, had become extinct in that area [1] (Drawings and graphics by G. Enríquez).

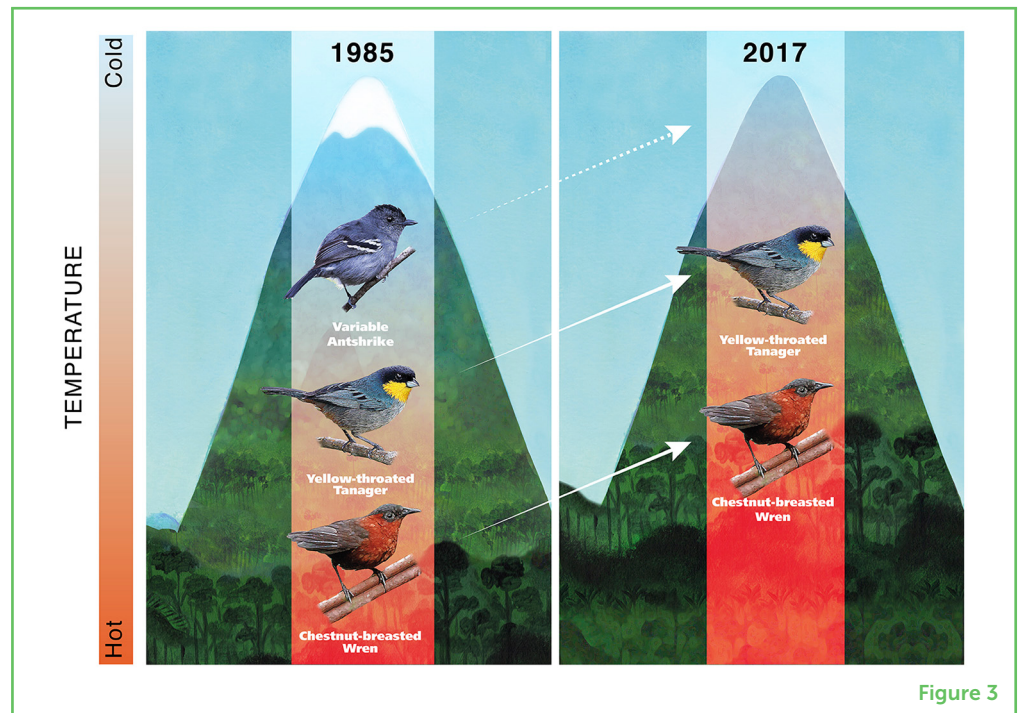


Figure 3

The forest would look very different than it does today, and the plant and animal species living there would also be different from what you are used to. If you could go 50 years into the future, it is likely that the area will also look very different than it does today—some of today's species will have become extinct or moved out, and other, new species will have moved in. In places that are already very hot, like the Amazon rainforest, temperatures may get so uncomfortable that no new species can move in—and we will be left with only a small group of species that really love the heat. This means that, in many places, the total number of plant and animal species will decrease over time—since many species will move away to cooler places, but fewer new species will move in [7].

CONSEQUENCES FOR YOU AND ME

The changes in where species live and the types of species found in a location can have important consequences for all of us. People all around the world depend on nature for food, building materials, medicines, and other **ecosystem services**. For example, forests produce timber and fruit, they filter water, and they help to regulate the climate. If nature changes, then the services that nature provides to us will also change [2]. In some cases, these changes could be good, but in most cases, they will be bad for us. For example, less food might be produced or there might be an increase in the number of diseases and pests. People simply may not be prepared for the changes, so they will not know how to use the new species that live around them. In other words, global warming is changing where many species live, and that is going to change how people live.

ECOSYSTEM SERVICES

All of the positive things that nature does for people, such as filtering our water, or providing us with oxygen to breathe and food to eat.

Climate change is creating lots of challenges for nature. In some cases, plant and animal species will need to migrate away from the places that get too hot and move into the places that used to be too cold for them—but are now just right. To make it easier for plants and animals, we need to try to slow climate change, so that species do not have to migrate as fast! We must also make sure to protect as many natural areas as possible, so that the plant and animal species have places to move to! With our help, many species can escape the heat and continue making our world a special place.

REFERENCES

1. Freeman B. G., and Class Freeman A. M. 2014. Rapid upslope shifts in New Guinean birds illustrate strong distributional responses of tropical montane species to global warming. *Proc. National Acad. Sci.* 111:4490–4. doi: 10.1073/pnas.1318190111
2. Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I. C., et al. 2017. Biodiversity redistribution under climate change: impacts on ecosystems and human wellbeing. *Science* 355:eaai9214. doi: 10.1126/science.aai9214
3. Cavanaugh, K. C., Kellner, J. R., Forde, A. J., Gruner, D. S., Parker, J. D., Rodriguez, W., et al. 2014. Poleward expansion of mangroves is a threshold response to decreased frequency of extreme cold events. *Proc. Natl. Acad. Sci. U.S.A.* 111:723–7. doi: 10.1073/pnas.1315800111
4. Freeman, B. G., Song, Y., Feeley, K. J., and Zhu, K. 2021. Montane species track rising temperatures better in the tropics than in the temperate zone. *Ecol. Lett.* 24:1697–708. doi: 10.1111/ele.13762
5. Feeley, K. J., and Rehm, E. M. 2012. Amazon's vulnerability to climate change heightened by deforestation and man-made dispersal barriers. *Glob. Change Biol. Bioenergy* 18:3606–14. doi: 10.1111/gcb.12012
6. Feeley, K.J., Bravo-Avila, C., Fadrique, B., Perez, T. M., and Zuleta, D. 2020. Climate-driven changes in the composition of New World plant communities. *Nat Clim Chang.* 10:965–70. doi: 10.1038/s41558-020-0873-2
7. Colwell, R. K., Brehm, G., Cardelus, C. L., Gilman, A. C., and Longino, J. T. 2008. Global warming, elevational range shifts, and lowland biotic attrition in the wet tropics. *Science* 322:258–61. doi: 10.1126/science.1162547

SUBMITTED: 20 July 2022; **ACCEPTED:** 11 August 2023;

PUBLISHED ONLINE: 28 August 2023.

EDITOR: John T. Van Stan, Cleveland State University, United States

SCIENCE MENTORS: Marijn Lijffijt and Maria Claudia Segovia-Salcedo

CITATION: Feeley KJ and Freeman BG (2023) Global Warming: Plants and Animals on the Move. *Front. Young Minds* 11:999231. doi: 10.3389/frym.2023.999231

CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

COPYRIGHT © 2023 Feeley and Freeman. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](#). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

YOUNG REVIEWERS

BERNARDA, AGE: 8

Hi, my name is Bernarda, I am 8 years old. I live in Quito, Ecuador. I love to ask questions about things that catch my attention. I like to read books and also I like to try experiments. I have a special notebook where I make drawings about my results. I also like a lot of animals, but my favorite have to be pandas. I want to become a vet, so I can go to China and take care of them.

BRYSON, AGE: 10

I love reading facts about animals. I am excited about school, especially art and math. I love my cats and chickens and love watching movies. I also speak two languages: English and Netherlands.

AUTHORS

KENNETH J. FEELEY

Dr. Kenneth Feeley is a professor of biology at the University of Miami and the director of the John C. Gifford Arboretum. He studies the ecology and conservation of forests with a focus on understanding how climate change is affecting tropical trees. In his free time, Ken enjoys woodworking, cooking, and playing board games. *kjfeeley@gmail.com

BENJAMIN G. FREEMAN

Dr. Benjamin Freeman is an assistant professor at the Georgia Institute of Technology. He is fascinated by why birds and other species live only in narrow slices of tropical mountainsides, and studies how climate change is impacting mountain species. Ben enjoys playing soccer, looking for birds, and hiking to the tops of mountains.

