Which Wood You Choose?

Forest Landowners' Selection of Trees for Planting Forests Can Have Different Outcomes

USDA Forest Service photo.

Meet the Scientists

Courtesy photo from Yukiko Hashida.

◀ **Yukiko Hashida,** Environmental and Natural Resource Economist: My favorite science experience is converting my backyard to a butterfly and bird-friendly **sanctuary**. I am not a fan of the lawn as it doesn't support much biodiversity. I tend to go with native plants, which are diverse and drought resilient. The positive impact of my decisions is readily visible and supports **biodiversity** in my backyard.

Courtesy photo from John Withey.

◀ **John Withey,** Ornithologist and Landscape Ecologist: One of my favorite science experiences was going out in the Panamanian rainforest to find and study tropical songbirds. I lived close to Soberania National Park (next to the Panama Canal) with my family, and we would hear howler monkeys from our house. I caught birds of three different species, put small radio transmitters on them, and then would go back to find them and record their behavior. In my photo, I am studying birds in the Florida Everglades.

Courtesy photo from David Lewis.

◀ **David Lewis,** Environmental and Natural Resource Economist: My interests in forests and conservation go back to my long-term love of being outdoors, which started when I was a kid and continues to this day. My favorite science experience is when I discover something new. I love the idea that I can quantify a previously unknown link between humans and the environment which informs the management and conservation of natural resources.

Courtesy photo from Tara Newman.

◀ **Tara Newman,** Environmental Scientist: My favorite science experience was getting outside every day and exploring places that most people don't get to go to learn about and help protect wildlife. This has included wading through wetlands, kayaking on ponds and rivers, and hiking in the mountains in search of frogs and salamanders.

Courtesy photo from Jeff Kline.

◀ **Jeff Kline,** Environmental Economist: My favorite experiences over the course of my career as a scientist have involved working with scientists from other disciplines. Since I was a kid playing in the woods behind my house, I have always enjoyed observing nature—the plants and animals that live there, how they are influenced by and interact with each other, and how **topography** and the presence or lack of water help to determine what species thrive where. My career as a Forest Service scientist has enabled me to conduct research with other scientists who know things that I don't, giving me opportunities to learn about the science behind many of the things I observed as a kid in those woods behind my house.

What Kind of Scientist Did This Research?

Environmental Scientist: A scientist who studies the physical and biological aspects of the environment.

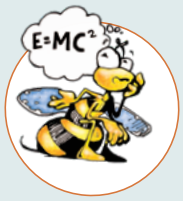
Environmental and Natural Resource Economist: A scientist who studies the way environmental goods, services, and wealth are measured, produced, distributed, and used.

Landscape Ecologist: A scientist who studies the relationships between ecological processes in the environment and particular ecosystems.

Ornithologist (ôr nə **thä** lə jist)**:** A scientist who studies birds.

Glossary words are bold and are defined on page 76.

Thinking About Science



Environmental and natural resource economists study human decisions—why, when, and how people make decisions and how these decisions affect the environment around us. For example, some people might decide to move out of a flooded area after a devastating hurricane. Other people might decide to rebuild in the same spot. These decisions affect how the natural system evolves. If a built-up area that experiences a flood is allowed to return to its natural condition, the larger community may be better protected from future floods. People make decisions all the time that affect the environment, and all decisions have consequences. Can you think of one decision that people make that affects the environment? What is that decision and how is the environment affected?

Forests, the subject of this research study, provide an example of an environment that can be affected by human decisions. To adapt to a changing climate, forest landowners may switch to planting more climate-**resilient** tree types. This may be a good thing for the forest landowners and the climate. However, some wildlife species that have adapted to today's forest types might not be able to survive in this new type of forest. In this study, the scientists were interested in how forest landowner decisions might affect wildlife habitat in the future.

Thinking About the Environment

Wildlife and tree species thrive within a particular range of environmental conditions. Wildlife species are usually limited by the vegetation growing in an area, and the vegetation is usually limited by weather and climate conditions. These weather and climate conditions are the result of many factors, such as the coldest and hottest temperatures in the area, the duration of the temperatures, and the amount of rainfall and the season when it rains. Other conditions, such as the type of soil in an area, may also affect the range of a plant or wildlife species.

Forest ecosystems have evolved over time to support certain plant, tree, and wildlife species. As the climate changes, the type of forest ecosystem in an area may change. As the forest ecosystem changes, the wildlife living in that area may no longer be supported with suitable habitat.

In this study, the scientists were interested in learning about how forests might change as the climate changes and whether wildlife can live in the changing forests. The possible forest changes studied by the scientists, however, are not necessarily caused directly by climate change. Instead, these changes might happen because people are reacting to climate change. Climate change may cause people to make different decisions regarding the management of their forest land, and these different decisions may change the forest conditions and therefore the kind of wildlife habitat found there.

Introduction

Forest disturbance can happen by many means. Forest wildfires, destructive insects, and tree diseases, for example, may cause a lot of disturbance and change a forest ecosystem. You may have seen how wildfires have changed forests in California. Timber harvests, the result of human decisions, are also a type of forest disturbance. Climate change influences forest disturbance over time, as some species of trees may be more likely to die or are subject to more fires or insect outbreaks.

In the Pacific States of California, Oregon, and Washington (**figure 1**), private forest landowners are responsible for over 70 percent of forest change. This forest change is largely caused by landowner decisions to harvest timber. Landowners then manage the land through replanting trees or some other decision, and that land can continue to provide wildlife with habitat as the forest regrows. Timber harvests provide income for forest landowners and if they choose to replant trees, they will have income again in the future. Forest landowners, therefore, usually choose to plant trees that will be worth more when they are harvested.

As you know, climate change is creating many challenges for the future. You probably also know that trees hold carbon as they grow. Planting tree species that hold more carbon, therefore, offers one way to address climate change. To encourage forest landowners to plant tree species that hold more carbon, a **policy** known as carbon pricing has been developed. Under this policy, forest landowners are paid to increase the amount of carbon held in their forest trees. This encourages landowners to plant tree species that hold more carbon than other tree species. If the new tree species are different than the tree species being harvested, the forest ecosystem will change over time. If the forest ecosystem changes, the habitat for some wildlife species will also change.

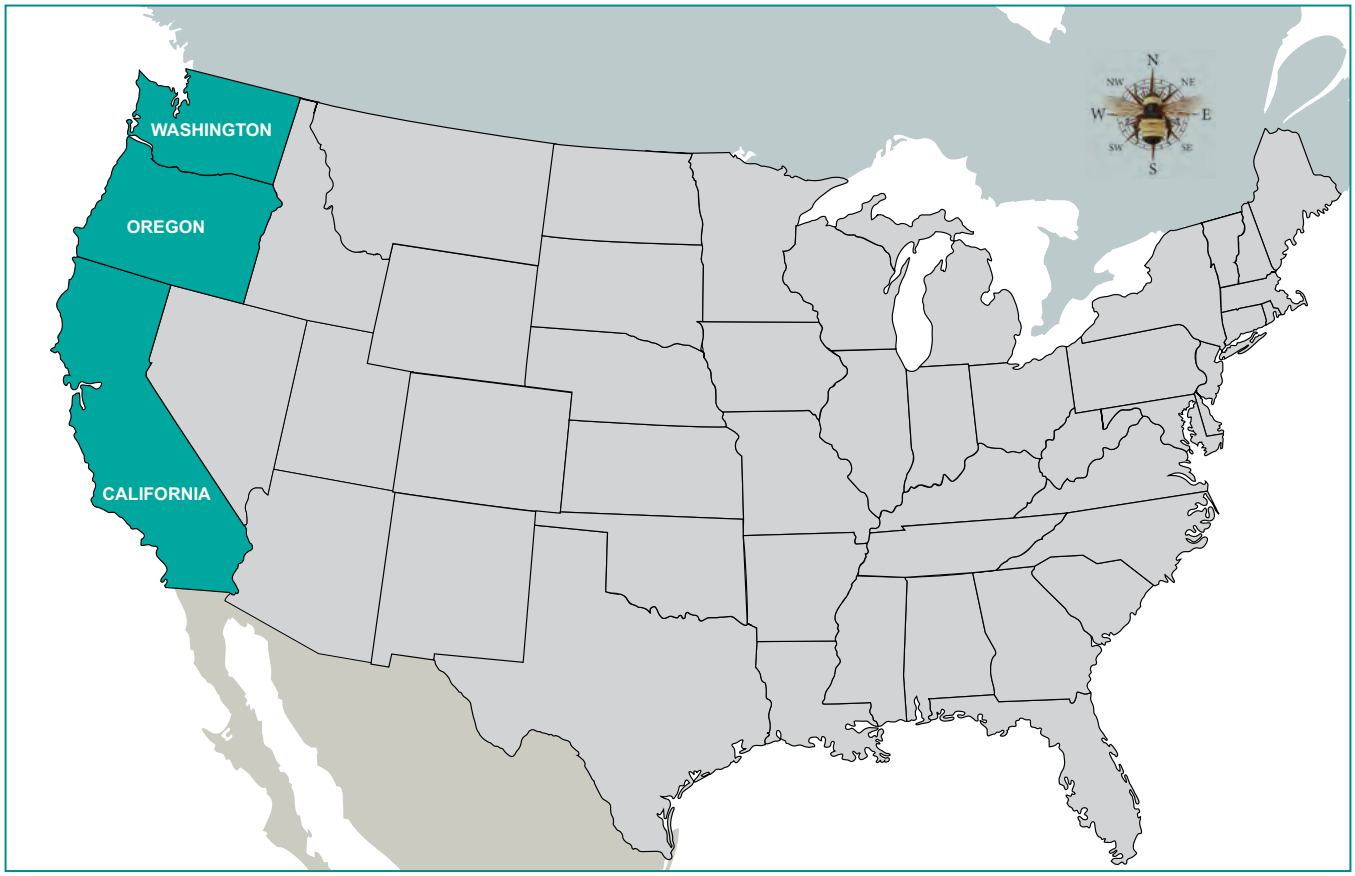


Figure 1. The Pacific Coast States are Washington, Oregon, and California. FIND Outdoors map by Leslie Shaw Design.

What Is the Difference Between Private and Public Forests?

In this study, the scientists were interested in decisions that might be made by private forest landowners. These private landowners are either citizens, organizations, companies, or large corporations who own and manage their own forests. Public forests, on the other hand, are forests managed on behalf of all citizens by a government. Public forests can be managed at the local, State, or Federal level. Public forests are managed in such a way as to balance a wide variety of benefits for citizens. Public forest examples include State forests and national forests.

If private landowners owning forests in Washington, Oregon, or California decide to replace the current tree species with a different species after harvesting, their private forests will change over time. As the forests change, the ecosystems will change. This change may have **implications** for the wildlife currently living in private Pacific forests. They may not thrive in the new ecosystems.

The scientists in this study were interested in exploring how the environmental conditions for wildlife species might change as landowners make decisions about replanting trees after harvesting.

Based on earlier science, the scientists knew that people tend to make decisions that maximize their profits. If landowners are paid to replant their land in something other than the current species, then the current habitat for wildlife may change. The scientists asked these questions:

(1) How might carbon pricing policy affect future privately owned forests of the three Pacific States?

(2) How might carbon pricing affect the **breeding habitat** of some wildlife species in those States?

Reflection Section

- In your own words, explain carbon pricing. How might carbon pricing be applied in another circumstance?
- In the Pacific States, landowners may be given an opportunity to address climate change and earn more income at the same time. On the other hand, those decisions to address climate change and earn more money may also have a negative consequence. What might be that negative consequence? Do you think the consequence is important? Why or why not?

Methods

First the scientists created a list of **vertebrate** species considered to have conservation concern status in the States of California, Oregon, and Washington. The scientists identified probable forest habitat for the species based on the following **criteria**:

(1) The species must be associated with a forest habitat (not grasslands, open lands, or wetlands).

(2) The species cannot be associated with all forest habitats.

(3) The species cannot be extremely limited in its range.

(4) The species cannot be limited to old-growth forest.

After the scientists had considered all the species of conservation concern, they identified 35 species that may occupy the current private forest habitat. The list of wildlife species included 8 amphibian species, 12 bird species, and 15 mammal species (**figure 2**).

The scientists then determined which forest types were potential breeding habitats for each of the 35 species, and they created maps that showed the location of the breeding habitat for each species.

The scientists needed to determine how forest types might change under different climate change and carbon pricing **scenarios**. The scientists knew that earlier research has shown that the Western States will become warmer and drier as the climate changes. In a warmer and drier climate, hardwoods tend to be healthier over time than coniferous trees.

Figure 2. Some of the vertebrate species identified as species of conservation concern in Pacific State forests are **(A)** the Van Dyke's salamander, **(B)** the rufous hummingbird, and **(C)** the lodgepole chipmunk. Adobe Stock photos.

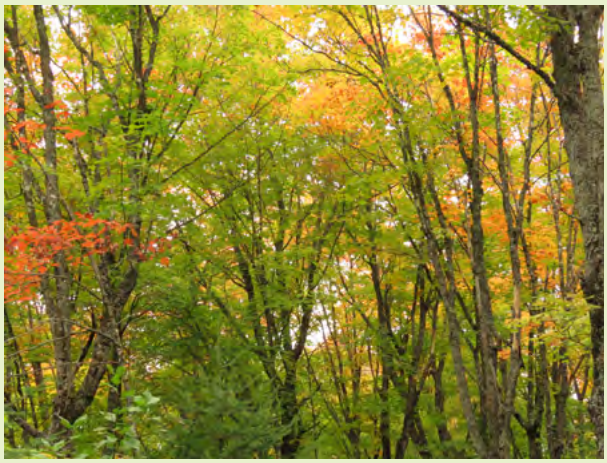
What Is a Species of Conservation Concern (SCC)?

A species of conservation concern (SCC) is a plant or animal for which the managing agency has concerns about its ability to remain on a particular landscape for a long time. An SCC is not a federally listed threatened, endangered, or candidate species under the Endangered Species Act. The SCC designation guides wildlife managers to pay close attention to the health and habitat of the species of concern. This attention is intended to prevent the SCC species from becoming federally listed as threatened or endangered. When a species becomes federally listed, it receives special protection based on United States laws.

What Is the Difference Between Hardwood and Coniferous Trees?

Hardwood trees are usually deciduous (di **si** jə wəs). Deciduous trees lose their leaves in the fall. Softwood trees are conifers (meaning that they have cones). Coniferous trees have needles rather than broad, flat leaves, and they keep their needles throughout the entire year. A common coniferous tree in the area studied by the scientists is the Douglas-fir.

HARDWOOD TREES AND LEAVES



SOFTWOOD TREES AND NEEDLES

USDA Forest Service photos, bottom right photo by Elisa Stamm.

The scientists also needed to include forest landowner decisions in their analysis. They used earlier research they had done that compared climate **variables**, carbon pricing, and landowner replanting choices. Their past research explored the decisions forest landowners make depending on carbon and harvest prices, tree growth, and climate.

If a forest landowner decided to harvest, the next choice was whether to replant in one of six primary forest types. The value of a forest landowners' land depends on what kind of trees are replanted. The scientists estimated how much money a forest landowner would receive under different tree planting options and three climate change and carbon pricing scenarios. They compared these options to a situation where the climate was not changing.

The scientists, therefore, considered how landowners would act in three possible situations:

(1) No climate change or carbon pricing

(2) Climate change only

(3) Climate change plus carbon pricing

The scientists considered two different options for climate change plus carbon pricing. The two options were paying a high price for carbon **sequestration** and a low price for sequestration. With carbon pricing, forest landowners would receive income twice: through carbon pricing and through timber sales when the timber is harvested.

For all these different situations, the scientists predicted what decisions forest landowners might make regarding harvesting and replanting their forests.

Following this analysis, the scientists calculated the future forest areas that would be suitable habitat for each of the 35 species of conservation concern. They did this calculation for smaller areas, called ecoregions, within the larger forest areas. By calculating suitable habitat by ecoregion, the scientists predicted whether each future ecoregion was a suitable habitat for each species of conservation concern.

Reflection Section

- Environmental and natural resource economists study human decisions—why, when, and how people make decisions and how these decisions affect the environment around us. Explain in your own words what human decision the scientists in this study were interested in predicting.
- Forest landowners may receive more income by replanting their forest in another tree species. However, they may not think about the impact a new forest type might have on the wildlife currently living in their forest. This situation is an example of a tradeoff between private forest landowner profits and the public good that results from diverse and healthy wildlife populations. In your own words, describe this tradeoff between private and public benefit.

Findings

Forest landowners make decisions over decades, so any changes in the forest landscape will happen gradually. Currently, forest landowners living in warmer and drier western regions favor replanting other trees like hardwoods and ponderosa pine over Douglas-fir. With climate change, predicted warmer and drier conditions across the broader region will likely favor the decision to replant more forests in hardwoods over Douglas-fir trees and other coniferous trees (**figure 3**).

The scientists found that adding carbon pricing to the decision-making process **accelerated** the expansion of hardwood forests over Douglas-fir forests (**figure 4**). This expansion would likely be the result of landowner decisions based on lower **productivity** of Douglas-fir forests when compared with hardwood forests as the climate becomes warmer and drier.

If these predictions are accurate, forest landowner decisions to replant in hardwoods will result in many of the species of concern experiencing habitat reductions. When the scientists looked at the combination of species multiplied by each ecoregion under a changing

WITH CLIMATE CHANGE

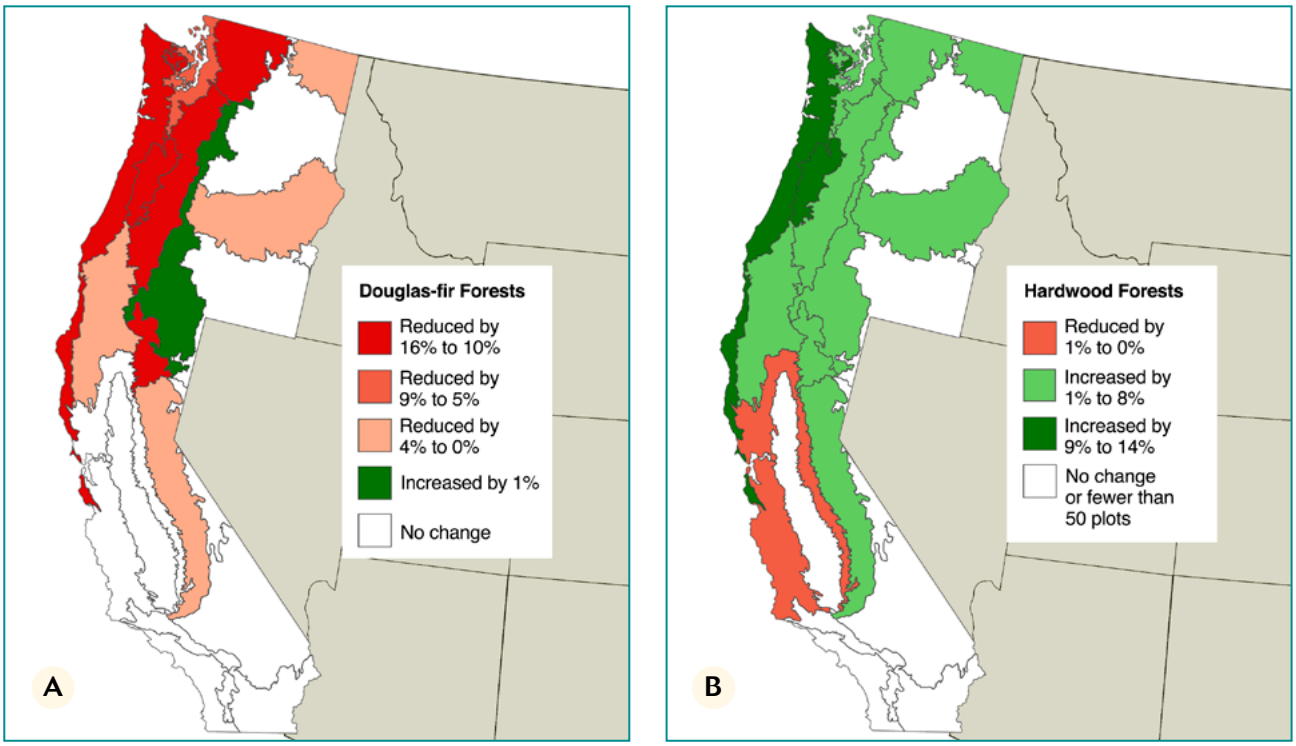


Figure 3. These maps show the predicted percentage change in area occupied by **(A)** Douglas-fir forests and **(B)** hardwood forests under a changing climate. These maps show that Douglas-fir forests may be reduced by up to 16 percent and that hardwood forests may increase by up to 14 percent. FIND Outdoors maps by Liz Sisk and Leslie Shaw Design.

WITH CLIMATE CHANGE AND CARBON PRICING

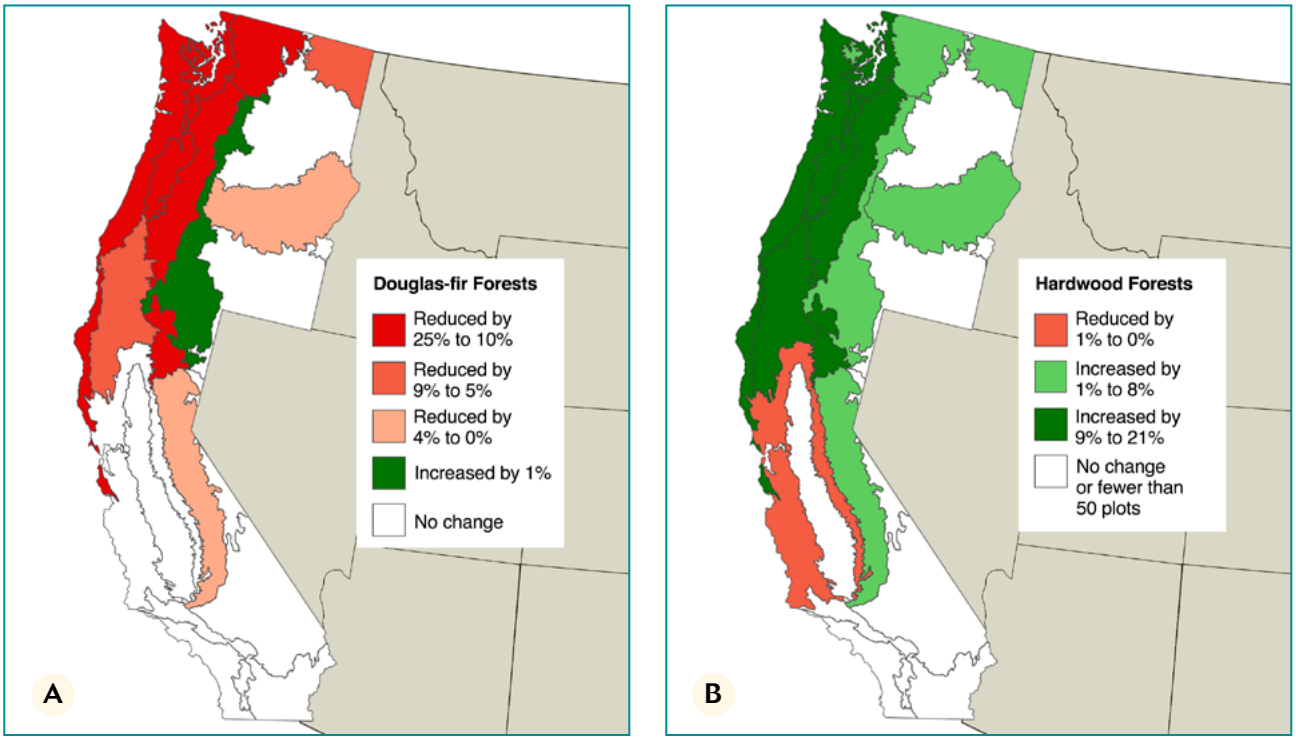


Figure 4. These maps show the predicted percentage change in the area occupied by **(A)** Douglas-fir forests and **(B)** hardwood forests under a changing climate and with carbon pricing options for forest landowners. These maps show that Douglas-fir forests may be reduced by up to 25 percent and that hardwood forests may increase by up to 21 percent. FIND Outdoors maps by Liz Sisk and Leslie Shaw Design.

climate, they projected a declining habitat for 171 combinations and an increasing habitat for 49 combinations. When the scientists added carbon pricing to the decision-making process, close to 180 combinations of species and ecoregions would experience declining habitat and about 40 combinations would experience an increase in habitat.

Species predicted to experience the greatest losses in habitat include four salamanders, three birds, three voles, and two mammals. None of these 12 species use hardwood forests as habitat. Included in this list is the Van Dyke's salamander and the rufous hummingbird (see **figure 2**, page 70).

The scientists predicted that as carbon pricing increases, changes in wildlife habitat will also increase. This prediction illustrates a connection between policies intended to increase the sequestration of carbon and forest characteristics that contribute to **biodiversity** on private forests.

Reflection Section

- When the scientists added carbon pricing to their analysis, their numbers changed. Why do you think carbon pricing plus climate change, as compared with climate change alone, changed the findings of this study?
- Reread the last sentence of the "Findings" section. Explain in your own words the connection between carbon pricing policies and forest biodiversity on private forests as described by the scientists in this study.

USDA Forest Service photo.

Discussion

Carbon pricing is widely used to encourage forest landowners to manage their forests for carbon sequestration. Carbon sequestration is an important process to help address climate change. This study shows that carbon pricing is also likely to have another impact on forest characteristics. If carbon pricing encourages landowners to replant their forests in a particular species, the new forests will favor wildlife who live in that forest habitat. Such replanting will not favor wildlife species who do not live in that forest habitat.

Carbon pricing can create a cost to society in the form of wildlife habitat loss. It can also, however, result in wildlife habitat gains. The findings of this research highlight the need to consider all consequences of forest policies, such as carbon pricing. The scientists recommend that the value of as many **ecosystem services** as possible be considered when implementing forest-related policies.

Reflection Section

- If the scientists' predictions are accurate, what do you think would happen to the habitat of wildlife species who live in hardwood forests? What might happen to their population size?
- In other studies, scientists have discovered that wildlife, and especially wildlife that may be threatened, possess many values for society. In short, people like to know that they share the planet with wildlife species. Do you think that these values should be considered when society makes decisions about forest management? Why or why not?
- Should private forest landowners consider the values of the larger society? Why or why not?

Adapted from Hashida, Y.; Withey, J.; Lewis, D.J.; Newman, T.; Kline, J.D. 2020. Anticipating changes in wildlife habitat induced by private forest owners' adaptation to climate change and carbon policy. PLOS ONE 15(4): e0230525. https://doi.org/10.1371/journal.pone.0230525.

What's in a Name?

Before you read this article, the article's title may have been a mystery to you. You might have thought the word "wood" was misused. You were correct! The word was misused. After you have read this article, however, you might have a better idea of why "would" was misused as "wood." In your own words, explain how the title relates to the article.