

How climate change drives the spread of invasive plants

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Buffelgrass has invaded southwestern desert ecosystems. Credit: [US Fish and Wildlife Service](#)

As the climate warms, the number of alien species on every continent is expected to increase [36% by 2050](#). Some alien species—that is, plants or animals that live outside their natural range—are invasive and can harm ecosystems and the areas they invade with serious impacts on the global food supply, medicines, water quality, biodiversity, and livelihoods.

Rising temperatures, increased CO₂, and [extreme weather](#) that alters landscapes favor the spread of invasive species, which also exacerbate climate impacts by making habitats, agriculture and cities less resilient. For example, when [invasive plants](#) overrun [native plants](#) and establish a monoculture, the area may be more susceptible to wildfires or pests. This phenomenon may intensify the effects of climate change on humans and our environment.

What are invasive plants?

Not all alien or non-native plant species are invasive. Invasive plants are defined as those that adapt easily to new environments, reproduce quickly, and damage the native species, ecosystems, property or economy of their new terrain. Many food crops, such as wheat, rice, tomatoes, and [garden plants](#) are non-native and are not considered invasive.

A recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [report](#) estimated that 6% of all alien plants are invasive. In 2019, invasive [alien species](#), both plants and animals, cost the world more than \$423 billion a year.

Alien species are not inherently invasive, but they become so when they move to a new place and cause harm. "There's no denying that some kinds of vegetation change have consequences. And those consequences

are sometimes negative," said Matt Palmer, a senior lecturer in the department of Ecology, Evolution and Environmental Biology at Columbia University. "But those consequences are situational. That plant in its home territory isn't considered an invasive plant."

Plants must go through [five stages](#) to be considered invasive:

1. Transport, when a species is moved outside of its natural range.
2. Introduction, when it is accidentally or intentionally released into nature in a new area.
3. Establishment, when its population becomes self-sustaining in the wild.
4. Spread, when the species increases its range.
5. Impact, when the species causes harm to its new environment or to human health.

At any stage, factors such as climate, resources, environmental conditions or other competitors could prevent an alien species from becoming invasive. Some will not be able to colonize. Some may colonize but not achieve establishment. Others may establish but not spread.

What makes invasive plants successful?

While there are certain traits associated with plants that spread successfully, in order for the plants to increase in abundance, those characteristics must be well suited to the particular environment.

Invasive plants are typically fast growing and produce many seeds or fruits that are easily dispersed by birds, bats, other animals or the wind. Their seeds often germinate earlier and tolerate [warmer temperatures](#) than those of native plants. If they previously flourished across a large geographic range with climate variation, they tend to adapt more easily

to new environments.

Invasive plants can also usually thrive in any soil, which allows them to establish themselves in areas where native plants may not survive. Any natural or human disturbance of an ecosystem, such as fragmentation of land, deforestation or construction, changes the availability of resources, displaces native plants, and leaves gaps in the vegetation, providing an opportunity for invasive plants to grow.

Some invasive plants have root systems that spread widely, hindering the growth of other plants. Others produce chemicals that prevent nearby plants from growing. Some invasive species can also change the soil chemistry or the availability of light in ways that favor their growth at the expense of native plants. They can bring new and diverse bacteria to an area, which can alter nutrient cycles, mineralization rates, and the amount of soil carbon and nitrogen present.

Moreover, when invasive plants enter a new ecosystem, they have no natural enemies or predators in the new terrain. The native species often lack defenses against invading species, which allows invasive plants to outcompete them.

Why should we worry about invasive plants?

In the next 50 years, 1 million species are [in danger of extinction globally](#). Invasive species are a major cause of biodiversity loss. They degrade wildlife habitats and water quality, disrupt ecosystems and alter food webs. In turn, the loss of biodiversity facilitates invasion by non-native species. "Diversity on its face has some advantages like resistance to change or resilience in the face of change," said Palmer.

Because they may outcompete native plants, invasive plants can turn diverse ecosystems into monocultures, which are susceptible to collapse

because they have a set of traits suited to a particular set of conditions. "If the conditions change, then you could suddenly lose them all," said Palmer. "For example, if you're a farmer that only grows one type of crop and a pathogen comes and wipes out your crop, you're out of luck. But if you grow 10 crops and a pathogen wipes out one, you've got the other nine to buffer some of that risk."

Invasive plants can reduce [water quality](#), as they may lessen water flows in streams that are already struggling with drought, or clog waterways. Purple loosestrife, formerly an ornamental plant with flowers, has overrun many wetlands in the Northeast, crowding out native plants that offered shelter and food to birds and other wildlife.

Islands are particularly vulnerable to invasive plants because the native species have evolved in isolation to survive in their unique environment. The IPBES [report](#) found that invasive plants now outnumber native plants on more than 25% of all islands.

How does climate change affect invasive plants?

"The new [environmental conditions](#) resulting from climate change define every species as a potential new colonizer or invader," [according to a U.S. Forest Service botanist](#).

"Anytime the environment changes, living things respond," said Palmer. "And when climate is changing rapidly, you end up with a mismatch between the environment the plants started in and the one they're experiencing at the present. Plants that are poorly suited to the new environment begin to decline and that opens up an opportunity for new plants that are better adapted to the changed conditions."

A warmer world is causing species to move northward and to higher elevations that were previously too cool for them. A U Mass [study](#) of

144 plants in the eastern U.S. found that with 2°C of warming, most of them will shift their ranges northeast by 213 kilometers, which could exacerbate the impacts of up to 40 invasive plants. In addition, some alien plants called "sleepers," which were previously limited by climate conditions, may "wake up" as the climate changes to better suit them, and become invasive.

Warming temperatures mean earlier springs. Some invasive plants produce sprouts and leaves sooner than native plants, allowing them to gain earlier access to soil, nutrients and sunlight, monopolizing the resources.

"Here in the forests of northeastern North America, many of the invasive shrubs leaf out earlier in the spring than the natives because they originated in a different climate where earlier leaf out is beneficial," Palmer said. "They [have] an advantage because if spring arrives earlier, some of the native shrubs are still responding to the day length, which isn't changing, as opposed to the temperature, which is. The earlier spring temperatures give the invasive plants a longer growing season so they can make more food over that year, grow faster, and ultimately start making more or earlier seeds."

Increased CO₂ in the atmosphere helps some plants grow faster, and certain invasive plants can use higher CO₂ levels even more efficiently than native plants.

Monocultures and trees stressed or damaged by invasive plants sequester less carbon. And areas that have succumbed to invasive plants may experience more wildfires that emit CO₂ into the atmosphere. For example, buffelgrass, a fast-growing grass, was brought to Arizona in the 1930s to control erosion. It has now invaded the Sonoran Desert in the Southwest and could turn this healthy ecosystem into a monoculture.

Because buffelgrass is extremely flammable, it exacerbates wildfires. In Florida, the invasive melaleuca has moved into the Everglades. These trees contain flammable volatile oils that can trigger high intensity fires, releasing CO₂, as well as seeds that will recolonize the area after the fire.

Land that is disturbed by extreme weathers provides opportunities for invasive plants to move in, since they can grow in almost any soil. Extreme weather events can also transport invasive plants to new environments.

Invasive species are being transported to new areas as the Arctic Sea ice melts and new pathways open up for shipping.

Methods of controlling invasive plants, such as herbicides and biological controls, may be less effective because of climate change impacts. For example, invasive plants absorb less herbicide when they are stressed by drought.

How do invasive plants get here?

Today's increasing levels of global trade or travel are accelerating the spread of invasive plants. They are often transported with freight shipped across the sea or as air cargo. Some hitch rides in transported soils or contaminated nursery materials.

In the past, many invasive plants were brought in for their use in forestry, agriculture, or landscaping. For example, the water hyacinth was introduced to Rwanda by Belgian colonial officers, who planted it as an ornamental flower in gardens. With its population doubling every 12 days, it spread down the Kagera river and covered 90% of Lake Victoria. Its dense growth blocked boat traffic, prevented plants and algae from growing, suffocated aquatic creatures, obstructed the hydroelectric dam intakes, bred mosquitoes, and damaged the fishing

industry.

Kudzu was [introduced](#) into the U.S. from Japan in 1883 as an ornamental plant, and used to shade porches in the Southeast. It also prevented erosion during the Dust Bowl; the Soil Conservation Service paid everyone who grew kudzu \$8 an acre. Today, kudzu, which can grow one foot a day, is everywhere, smothering other plants and even uprooting trees. It's estimated that kudzu is responsible for \$100–\$500 million each year due to lost forest productivity.

Many invasive plants are still sold and used as ornamental plants. The butterfly bush, often planted to attract butterflies and bees, is considered a weed in many places where it outcompetes native plants and spreads to unvegetated areas. Chinese or Japanese wisteria has beautiful purple flowers, but it spreads rapidly, and can wrap around trees in forests and starve them.

Japanese honeysuckle, the fifth most common invasive plant in the U.S., covers young trees in forests and prevents them from getting sun. The U Mass study found that U.S. nurseries currently still sell 89 invasive plant species. If they continue this practice, they could be responsible for the spread of 25 invasive species as temperatures warm and new areas become habitable for them.

Do invasive plants have any benefits?

In some contexts, invasive plants can be beneficial. They can beautify gardens. Sometimes they provide food for wildlife. In the short term, they may stabilize soils and provide erosion control in disturbed areas. And some create habitats for wildlife in landscapes that have been altered.

Invasive plants can also offer some benefits to urban areas. Amy

Karpati, an adjunct professor in the graduate Sustainability Management program at the Columbia Climate School, said, "It's very stressful in a highly urbanized environment. Often, the invasive species we find in cities are there because they are a good match for the new conditions we've created."

If you had to choose between having very low coverage of native plants in a vacant urban lot that is mostly debris and rubble where it's very dry and there's no shade, versus having high coverage of invasive plants, which are still sequestering carbon, reducing stormwater runoff, and providing some degree of habitat, wouldn't the latter be better even though they're not native to that area? Karpati asked.

"There are still arguments about this, however, because the best-case scenario is that you manage that space for native biodiversity," she said. "But when you consider all the money that would need to go into restoration and management and continued monitoring, is it worth it to have only native species rather than accept that these urban places are novel ecosystems where we have new assemblages of different species? Would those resources be better spent somewhere else, where the outcomes are expected to be better in terms of preserving biodiversity and native species?"

One risk with accepting invasive plants in cities, however, is that they might spread into the surrounding rural or suburban landscapes and wreak havoc there.

What can be done about invasive plants?

According to the IPBES report, controlling invasive plants is possible, but will require large investments and resources, as well as global cooperation. Preventing the introduction of invasive plants in the first place is the most critical and cost-effective way to manage them. This

will call for biosecurity laws, measures taken to prevent the introduction or escape of invasive plants, and their enforcement at international borders. But currently, over 80% of countries don't have laws to regulate invasive species.

Experts need to anticipate which species could spread, where and when they might invade, and understand how they would disrupt the invaded ecosystems.

When prevention fails, eradication may be effective, particularly in small or isolated areas. In small quantities, invasive plants can be pulled out or dug up by the roots. Over large areas, the use of an herbicide, such as glyphosate (the active ingredient in Roundup) is an effective way of controlling invasive plants; however, glyphosate kills everything it touches and can harm human health.

Biological control, the use of plant diseases or predatory insects from the invasive plant's home turf, can be used to control single species. For example, the Australian government employed cactus moth caterpillars, the natural predator of the prickly pear cactus from the Americas that was destroying the country's rangeland.

Gardeners can control the spread of invasive plants by becoming educated about which plants are invasive, not buying them, and identifying those already in the garden. They should be pulled out and disposed of away from natural areas. The area should then be mulched or replanted with native alternatives quickly so that invasive species don't move in again.

Is fighting invasive plants worth it?

The world is such a drastically altered place that some people feel it doesn't make sense to try to restore plants to the way they were 500 years

ago. "We're never going back to that past," said Palmer. A controversial theory of "[novel ecosystems](#)" suggests that we should be building natural communities to suit the present moment. This might involve some mix of species that are native to a region with those that are non-native.

"I sit somewhere in the middle," said Palmer. "I want to preserve as much biodiversity as possible, so that frequently means trying to manage invasive species. That's because I view diversity losses and extinction as existential problems. You can't come back from those things."

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