



HOW DOES CULTURAL BURNING IMPACT BIODIVERSITY?

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YOUNG REVIEWERS:



KOHAKU

AGE: 11



RANJAI

AGE: 12



RANVIR

AGE: 11

Biodiversity is all the different types of life that are found in an area and it plays an important role in keeping ecosystems healthy. Unfortunately, biodiversity is decreasing around the world. Many species of plants and animals are rare and found only in certain ecosystems, which require disturbances, like fire, to stay healthy. Indigenous peoples have used fire as a tool to manage ecosystems for millions of years. This is called cultural burning. To understand how cultural burning impacts biodiversity, our research team conducted a review of over 1,000 scientific papers published globally from 1900 to 2020 (120 years). We assessed where, when, how, and why cultural burning was used to increase or decrease the numbers of certain animals, plants, insects, and even microbes! When cultural burning

is used regularly, and under the right conditions, it can support and increase biodiversity and ecosystem health worldwide.

BIOME

A large community of plants and animals living in a major habitat (such as a rainforest or tundra).

ECOSYSTEM

A community or group of living organisms that live in a specific environment and interact with each other.

BIODIVERSITY

The number of species in an ecosystem. Biodiversity can be used as a measure of an ecosystem's health.

INDIGENOUS PEOPLES

A group of people native to a specific region or cultural group that have always lived in a particular place. Also referred to as Tribal peoples, Aboriginal, First Nations, Native.

CULTURAL BURNING

Use of fire by Indigenous peoples to decrease the impacts of wildfires, respond to changing climate, and promote desired landscapes, habitats, and species. It also includes passing on fire knowledge, beliefs, and practices.

HABITAT

The natural home or environment of an animal, plant or organism.

DIFFERENT TYPES OF FIRE

Did you know that fire behaves differently depending on the climate (hot and dry vs. cool and wet), the features of the land (hilly or flat) and on what materials (trees, shrubs, or grasses) are available to burn? Fires can be sparked in two ways: from the energy produced by lightning contacting the earth or by people using ignition sources (such as matches or other types of fire starters like tree bark and dry grass). Both lightning and human-started fires occur regularly around the world and human-started fires can be started by accident or on purpose. Every land-based **biome** on Earth (rainforests, grasslands, and forests) has been shaped by long-standing relationships between humans and fire [1]. Many plants, animals, and insects depend on fire to grow and nourish themselves. For example, fire can encourage plant growth and plants are then available for animals to eat.

DANGEROUS WILDFIRES

When an **ecosystem** has not burned in a long time, it can have a lot of dry material available, and if a wildfire is sparked, that fire can become out of control. Some wildfires are frightening because they can destroy people's homes and threaten human health and safety. Sometimes wildfires are so hot that plants, animals, insects, and even microbes are unable to survive. These fires create ecosystems with fewer nutrients and less **biodiversity**. Sometimes it can take many years for a severely burned ecosystem to become healthy again. This is the type of fire that we often see or hear about on the news. Out of control wildfires are very different from the cultural fires that **Indigenous peoples** have used for millions of years to clear brush from forests, replenish nutrients in soils, and encourage species to grow and thrive. In fact, cultural fires are a very gentle type of fire. They are often called cool burns because they are less harmful to plants, and most animals and insects do not have to leave the area when **cultural burning** happens.

WHAT IS CULTURAL BURNING?

Cultural burning is when people use fire on purpose to manage the type and number of species in a **habitat** or ecosystem. Cultural burning is a community practice and is based on long-term knowledge about fire, beliefs, practices, and the effects of fire on ecosystems [2]. Children are often taught from an early age to respectfully use fire at times when the risk of a fire getting out of control is very low (Figure 1). Cultural burning takes many years of practice. Applying too much or too little fire can shift ecosystems and the species that depend on them out of balance.

Figure 1

Indigenous fire practitioner and co-author Amy Cardinal Christianson teaches her daughters how to conduct a safe cultural burn in the early spring. They are learning how to keep the flame moving to burn off the dead grass. Cultural burning is both a family and community practice in Treaty 6 Territory, northern Alberta, Canada (Photograph used with permission by Cardinal Christianson).



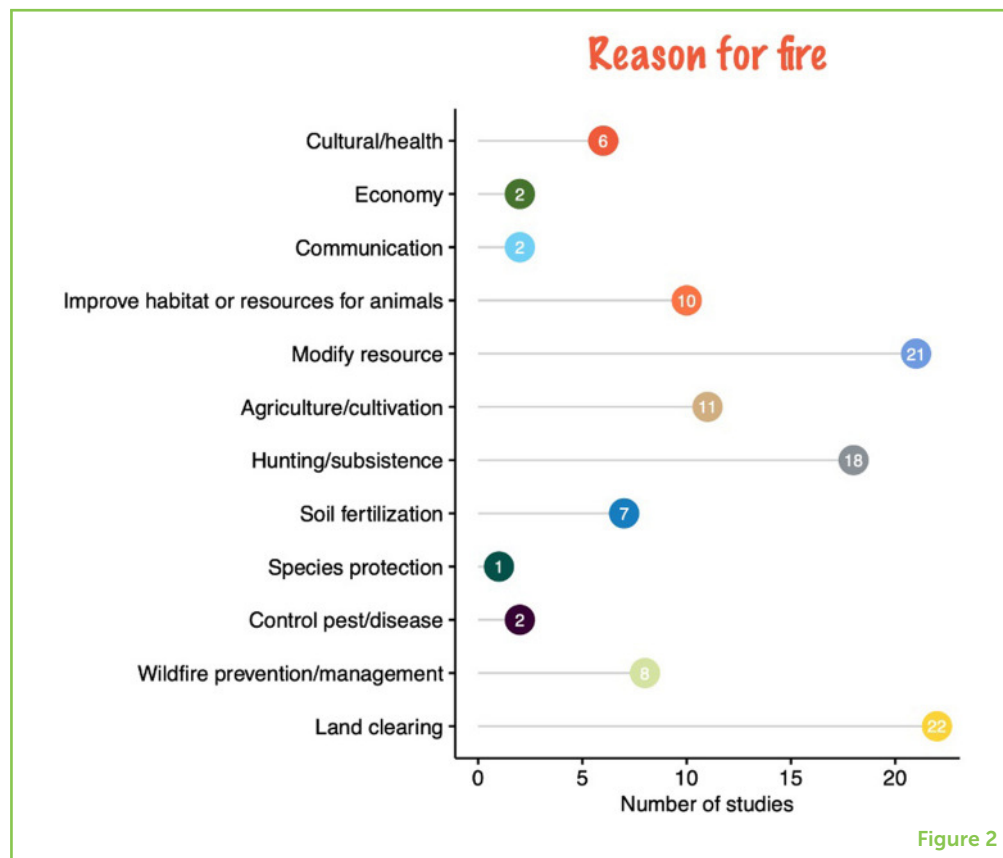
Figure 1

Cultural burning is an important activity for many Indigenous families. Many cultures have elders or knowledge holders (many who are grandparents or even great grandparents) who teach members of their communities how to carefully use fire. Elders supervise children who are learning to use burning sticks or bunches of grass to light fires to promote the growth of plants used for food and medicine. Cultural burning is done so carefully that it can be used right from people's doorsteps to get rid of dead plants, which can help protect homes and communities from out of control wildfires (Figure 2).

When fire is used at the right time, such as early spring or late fall, it can help certain food plants and medicine plants grow. For example, in northern British Columbia, Canada, early spring cultural burns can stimulate wild onions, hazelnuts, and berry bushes, while helping to protect ecosystems from lightning-ignited wildfires or accidental human ignitions during hotter and drier periods. Cultural burning is used around the world for similar reasons, but the details of when, where, and why cultural burning is used are specific to cultures, communities, and ecosystems [3].

Figure 2

Our review showed that cultural burning is most commonly used for clearing land, followed by modifying resources. Modifying resources can include enhancing or creating new habitats. Most studies reported that cultural burning was used for at least one, but often two or three objectives at the same time, such as reducing the risk of wildfires, creating new grass for mammals to feed on, and getting rid of unwanted pests.



HOW DOES CULTURAL BURNING AFFECT BIODIVERSITY?

Cultural burning is used to support ecosystems that contain several types of insects, fungi, plants, and animals that are used for food and medicine. There are often many reasons to use cultural burning, but the most common reason we found in our study was to clear land (Figure 2). Using fire to clear land can generate heat to help plant seeds to **germinate** and can make space for plants to grow. Clearing brush with fire also removes areas where pests (such as ticks, rats, mice, and mosquitos) live.

Cultural burns are small compared to most wildfires, and they create a landscape that is made up of many patches of forest, shrubs, grasses, and other plants that have been burned at various times for different reasons (Figure 2). When cultural burning is used during the spring and fall or the wet season (when plants are not growing, or during cooler and wetter conditions when the fire risk is low) it can increase the abundance and productivity of certain species. This creates many types of habitats and allows more plants and animals to live together. The more species that live together in an ecosystem, the greater the biodiversity. When fire is kept out of these ecosystems, the biodiversity decreases. Many ecosystems require cultural burning to function in a healthy way. Our study found that cultural burning was most often used on woody plants, such as trees and shrubs, as well as non-woody

GERMINATE

A seed or spore from a plant or tree can grow up from the ground when the temperature and moisture conditions are favorable.

plants such as grasses. Many tree and shrub species need fire to re-sprout and germinate. We also found that cultural burning can be used to increase the number of mammals, birds, and reptiles that rely on the new growth of plants for food and shelter (Figure 3).

Figure 3

Woody plants such as trees and shrubs were the most common species associated with cultural burning, followed by non-woody plants including grasses and other food plants. Igniting a low-intensity cultural burn in a forest can promote the growth of mushrooms, make burrows in the forest floor that become homes for animals, and cycle nutrients into the forest floor, which benefits microbes.

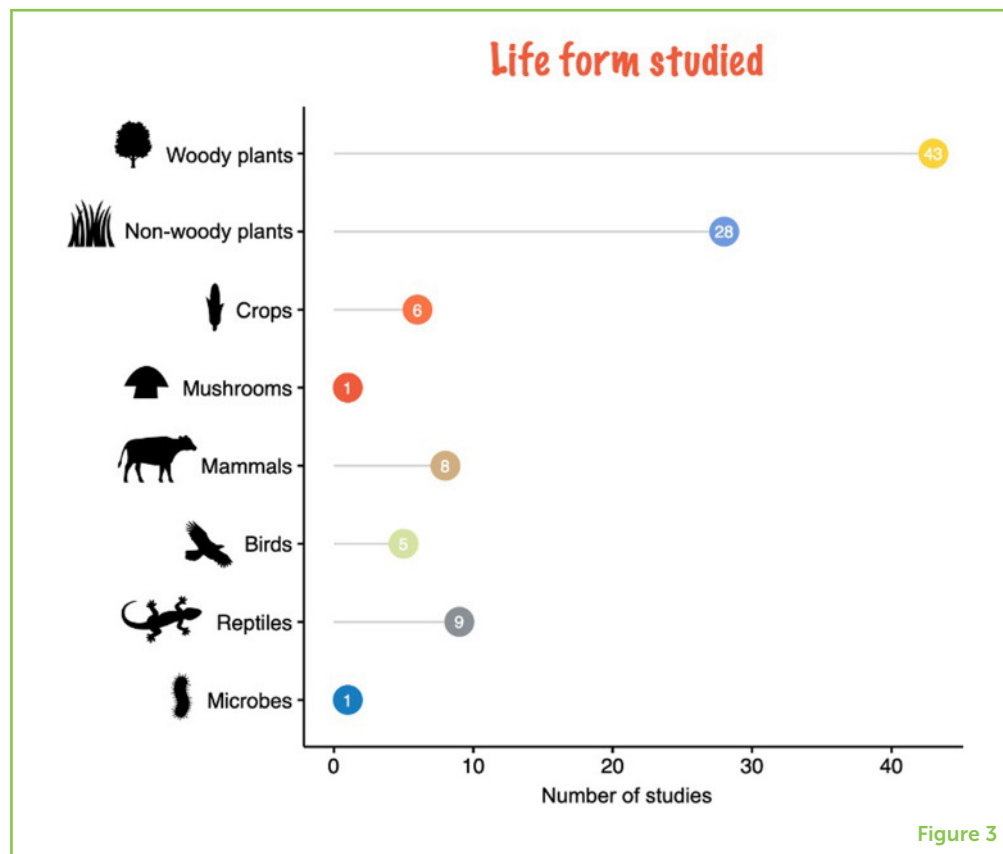


Figure 3

THE IMPORTANCE OF CULTURAL BURNING

For many decades, fires on the landscape were put out to protect people, communities, species, and ecosystems. Indigenous peoples were not allowed to light cultural fires because the positive impacts were not understood [4]. Putting out all fires has created problems, as many ecosystems depend on both cultural and lightning-ignited wildfires to be healthy (remember that not all wildfires get out of control) [5]. Fortunately, Indigenous peoples are demonstrating how important fire is for species and ecosystems and they are reviving cultural burning in their communities. Cultural burning increases the numbers and types of plants in an ecosystem and supports healthier and more biodiverse ecosystems while reducing the risk of out of control wildfires. Cultural burning is an important part of conserving Earth's remaining biodiversity.

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REFERENCES

1. Bowman, D. M., Balch, J. K., Artaxo, P., Bond, W. J., Carlson, J. M., Cochrane, M. A., et al. 2009. Fire in the earth system. *Science*. 324:481–4. doi: 10.1126/science.1163886
2. Lake, F. K., and Christianson, A. C. 2019. "Indigenous fire stewardship," in *Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires*. doi: 10.1007/978-3-319-51727-8_225-1
3. Lake, F. K., Wright, V., Morgan, P., McFadden, M., McWethy, D., and Stevens-Rumann, C. 2017. Returning fire to the land: celebrating traditional knowledge and fire. *J. For.* 115:343–53. doi: 10.5849/jof.2016-043R2
4. McWethy, D. B., Schoennagel, T., Higuera, P. E., Krawchuk, M., Harvey, B. J., Metcalf, E. C., et al. 2019. Rethinking resilience to wildfire. *Nat. Sustain.* 2:797–804. doi: 10.1038/s41893-019-0353-8
5. Bliege Bird, R., and Nimmo, D. 2018. Restore the lost ecological functions of people. *Nat. Ecol. Evol.* 2:1050–2. doi: 10.1038/s41559-018-0576-5

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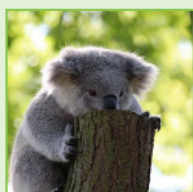
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YOUNG REVIEWERS



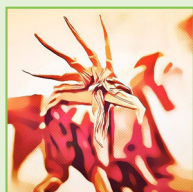
KOHAKU, AGE: 11

I like playing with lego and cooking. My favorite subject is Math. I like working in pairs or in a group. My favorite animal is a koala.



RANJAI, AGE: 12

I like space, fungi, rocks, chemistry, architecture, biology, physics, fortnite, NASA, space telescopes, Rockets, pizza, pasta, chicken (fried, smoked, etc), sea creatures, Dude perfect, Brave wilderness, history, geography, Rick Riordan books, weapons, archery, Cobra Kai, Beyblade burst, Jurassic park: Camp Cretaceous, Teen titans, Arrow, The Flash, DC, Marvel, Botany, MCU, Dinosaurs, Alan Walker songs, and debating.



RANVIR, AGE: 11

My name is Ranvir and I am in class 7. As hobby I catch snakes to learn about herpetology. I started doing that when I was 8. I used to catch skinks, but I got bored doing that, so I learned a few things about herpetology and went out with some of my friends. After some time, we found our first Microhylid frog. And after half a year we also found our first snake, a *Lycodon capucinus*! Besides herpetology, I also like doing origami. I also like reading Greek mythology.

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