2025 NCF-Envirothon Alberta

Current Environmental Issue

ROOTS AND RESILIENCY: FOSTERING FOREST STEWARDSHIP IN A CANOPY OF CHANGE

ENVIROTHON

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STUDY RESOURCES

Part A

-Edited for the Louisiana Envirothon

2025 NCF-Envirothon Alberta Current Issue Study Resources Part A

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Roots and Resiliency: Fostering Forest Stewardship in a Canopy of Change

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Current Issue Part A Study Resources

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1. Describe the causes of climate change, including the greenhouse effect.

Study Resources

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Basics of Climate Change	*US Environmental Protection Agency, 2024*	Pages 4 - 6
Climate Change Indicators: Snow and Ice	*US Environmental Protection Agency, 2024*	Pages 7 - 8

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Basics of Climate Change

The earth's climate is changing. Multiple lines of evidence show changes in our weather, oceans, and ecosystems, such as:

- Changing temperature and precipitation patterns
- Increases in ocean temperatures, sea level, and acidity.
- Melting of glaciers and sea ice.[3]
- Changes in the frequency, intensity, and duration of extreme weather events.
- Shifts in ecosystem characteristics, like the length of the growing season, timing of flower blooms, and migration of birds.

These changes are due to a buildup of greenhouse gases in our atmosphere and the warming of the planet due to the greenhouse effect.

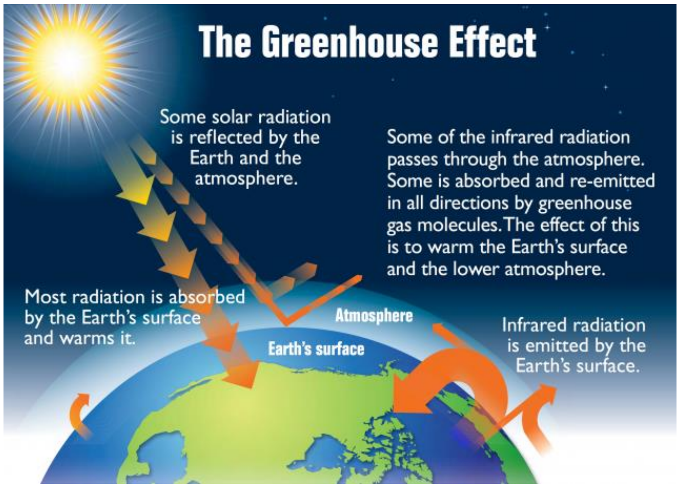

Figure 1) The greenhouse effect helps trap heat from the sun, which keeps

the amount of heat-trapping greenhouse gases in the atmosphere, causing the earth to warm up.

The earth's temperature depends on the balance between energy entering and leaving the planet's system. When sunlight reaches the earth's surface, it can either be reflected back into space or absorbed by the earth. Incoming energy that is absorbed by the earth warms the planet. Once absorbed, the planet releases some of the energy back into the atmosphere as heat (also called infrared radiation). Solar energy that is reflected back to space does not warm the earth.

Certain gases in the atmosphere absorb energy, slowing or preventing the loss of heat to space. Those gases are known as "greenhouse gases." They act like a blanket, making the earth warmer than it would otherwise be. This process, commonly known as the "greenhouse effect," is natural and necessary to support life. However, the recent buildup of greenhouse gases in the atmosphere from human activities has changed the earth's climate and resulted in dangerous effects to human health and welfare and to ecosystems.

Key Greenhouse Gases

Most of the warming since 1950 has been caused by human emissions of greenhouse gases.[4] Greenhouse gases come from a variety of human activities, including burning fossil fuels for heat and energy, clearing forests, fertilizing crops, storing waste in landfills, raising livestock, and producing some kinds of industrial products.

Carbon Dioxide

Carbon dioxide is the primary greenhouse gas contributing to recent climate change. Carbon dioxide enters the atmosphere through burning fossil fuels, solid waste, trees, and other biological materials, and as a result of certain chemical reactions, such as cement manufacturing. Carbon dioxide is absorbed and emitted naturally as part of the carbon cycle, through plant and animal respiration, volcanic eruptions, and ocean-atmosphere exchange.

The Carbon Cycle

The carbon cycle is the process by which carbon continually moves from the atmosphere to the earth and then back to the atmosphere. On the earth, carbon is stored in rocks, sediments, the ocean, and in living organisms. Carbon is released back into the atmosphere when plants and animals die, as well as when fires burn, volcanoes erupt, and fossil fuels (such as coal, natural gas, and oil) are combusted. The carbon cycle ensures there is a balanced concentration of carbon in the different reservoirs on the planet. But a change in the amount of carbon in one reservoir affects all the others. Today, people are disturbing the carbon cycle by burning fossil fuels, which release large amounts of carbon dioxide into the atmosphere, and through land use changes that remove plants, which absorb carbon from the atmosphere.

Methane

Both natural and human activities produce methane. For example, natural wetlands, agricultural activities, and fossil fuel extraction and transport all emit methane.

Nitrous Oxide

Nitrous oxide is produced mainly through agricultural activities and natural biological processes. Fossil fuel burning and industrial processes also create nitrous oxide.

F-Gases

Chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, together called F-gases, are often used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants.

Global Warming Potential

Different greenhouse gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. In addition, some gases are more effective than others at making the planet warmer. Learn more about Global Warming Potential (GWP), a measure of climate impacts based on how long each greenhouse gas remains in the atmosphere and how strongly it absorbs energy.

Other Greenhouse Gases

Ground-Level Ozone

Ground-level ozone is created by a chemical reaction between emissions of nitrogen oxides and volatile organic compounds from automobiles, power plants, and other industrial and commercial sources in the presence of sunlight. In addition to trapping heat, ground-level ozone is a pollutant that can cause respiratory health problems and damage crops and ecosystems.

Water Vapor

Water vapor is another greenhouse gas and plays a key role in climate feedbacks because of its heat-trapping ability. Warmer air holds more moisture than cooler air. Therefore, as greenhouse gas concentrations increase and global temperatures rise, the total amount of water vapor in the atmosphere also increases, further amplifying the warming effect.[5]

Aerosols

Aerosols in the atmosphere can affect climate. Aerosols are microscopic (solid or liquid) particles that are so small that instead of quickly falling to the surface like larger particles, they remain suspended in the air for days to weeks. Human activities, such as burning fossil fuels and biomass, contribute to emissions of these substances, although some aerosols also come from natural sources such as volcanoes and marine plankton.

Unlike greenhouse gases, the climate effects of aerosols vary depending on what they are made of and where they are emitted. Depending on their color and other factors, aerosols can either absorb or reflect sunlight. Aerosols that reflect sunlight, such as particles from volcanic eruptions or sulfur emissions from burning coal, have a cooling effect. Those that absorb sunlight, such as black carbon (a part of soot), have a warming effect.

Not only can black carbon directly absorb incoming and reflected sunlight, but it can also absorb infrared radiation.[6] Black carbon can also be deposited on snow and ice, darkening the surface and thereby increasing the snow's absorption of sunlight and accelerating melt.[7] While reductions in all aerosols can lead to more warming, targeted reductions in black carbon emissions can reduce global warming. Warming and cooling aerosols can also interact with clouds, changing their ability to form and dissipate, as well as their reflectivity and precipitation rates. Clouds can contribute both to cooling, by reflecting sunlight, and warming, by trapping outgoing heat.

Climate Feedbacks

Climate feedbacks are natural processes that respond to global warming by offsetting or further increasing change in the climate system. Feedbacks that offset the change in climate are called negative feedbacks. Feedbacks that amplify changes are called positive feedbacks.

Water vapor appears to cause the most important positive feedback. As the earth warms, the rate of evaporation and the amount of water vapor in the air both increase. Because water vapor is a greenhouse gas, this leads to further warming.

The melting of Arctic sea ice is another example of a positive climate feedback. As temperatures rise, sea ice retreats. The loss of ice exposes the underlying sea surface, which is darker and absorbs more sunlight than ice, increasing the total amount of warming. Less snow cover during warm winters has a similar effect.

Clouds can have both warming and cooling effects on climate. They cool the planet by reflecting sunlight during the day, and they warm the planet by slowing the escape of heat to space (this is most apparent at night, as cloudy nights are usually warmer than clear nights).

Climate change can lead to changes in the coverage, altitude, and reflectivity of clouds. These changes can then either amplify (positive feedback) or dampen (negative feedback) the original change. The net effect of these changes is likely an amplifying, or positive, feedback due mainly to increasing altitude of high clouds in the tropics, which makes them better able to trap heat, and reductions in coverage of lower-level clouds in the mid-latitudes, which reduces the amount of sunlight they reflect. The magnitude of this feedback is uncertain due to the complex nature of cloud/climate interaction.

Climate Change Indicators: Snow and Ice

The Earth’s surface contains many forms of snow and ice, including sea, lake, and river ice snow cover glaciers, ice caps, and ice sheets and frozen ground. Climate change can dramatically alter the Earth’s snow- and ice-covered areas because snow and ice can easily change between solid and liquid states in response to relatively minor changes in temperature. This chapter focuses on trends in snow, glaciers, and the freezing and thawing of oceans and lakes.

A Closer Look:

Rising global average temperature is associated with widespread changes in weather patterns. Scientific studies indicate that extreme weather events such as heat waves and large storms are likely to become more frequent or more intense with human-induced climate change. This chapter focuses on observed changes in temperature, precipitation, storms, floods, and droughts.

Why does it matter?

Long-term changes in climate can directly or indirectly affect many aspects of society in potentially disruptive ways. For example, warmer average temperatures could increase air conditioning costs and affect the spread of diseases like Lyme disease, but could also improve conditions for growing some crops. More extreme variations in weather are also a threat to society. More frequent and intense extreme heat events can increase illnesses and deaths, especially among vulnerable populations, and damage some crops. While increased precipitation can replenish water supplies and support agriculture, intense storms can damage property, cause loss of life and population displacement, and temporarily disrupt essential services such as transportation, telecommunications, energy, and water supplies.

Summary of Key Points

- U.S. and Global Temperature. Average temperatures have risen across the contiguous 48 states since 1901, with an increased rate of warming over the past 30 years. Nine of the top 10 warmest years on record have occurred since 1998. Average global temperatures show a similar trend, and all of the top 10 warmest years on record worldwide have occurred since 2005. Within the United States, temperatures in parts of the North, the West, and Alaska have increased the most.
- Seasonal Temperature. As the Earth warms overall, average temperatures increase throughout the year, but the increases may be larger in certain seasons than in others. Since 1896, average winter temperatures across the contiguous 48 states have increased by nearly 3°F. Spring temperatures have increased by about 2°F, while summer and fall temperatures have increased by about 1.5°F.
- High and Low Temperatures. Many extreme temperature conditions are becoming more common. Since the 1970s, unusually hot summer days (highs) have become more common over the last few decades in the United States. Unusually hot summer nights (lows) have become more common at an even faster rate. This trend indicates less “cooling off” at night. Although the United States has experienced many winters with unusually low temperatures, unusually cold winter temperatures have become less common—particularly very cold nights (lows). Record-setting daily high temperatures have become more common than record lows.
- Heat Waves. Heat waves are occurring more than they used to in major cities across the United States. Heat waves are occurring three times more often than they did in the 1960s—about six per year compared with two per year. The average heat wave season is 49 days longer, and individual heat waves are lasting longer and becoming more intense.
- U.S. and Global Precipitation. Total annual precipitation has increased over land areas in the United States and worldwide. Since 1901, precipitation has increased at an average rate of 0.2 inches per decade over the contiguous 48 states. However, shifting weather patterns have caused certain areas, such as the Southwest, to experience less precipitation than usual.

- Heavy Precipitation. In recent years, a higher percentage of precipitation in the United States has come in the form of intense single-day events. The prevalence of extreme single-day precipitation events remained fairly steady between 1910 and the 1980s but has risen substantially since then. Nationwide, nine of the top 10 years for extreme one-day precipitation events have occurred since 1996. The occurrence of abnormally high annual precipitation totals (as defined by the National Oceanic and Atmospheric Administration) has also increased.
- Tropical Cyclone Activity. Tropical storm activity in the Atlantic Ocean, the Caribbean, and the Gulf of Mexico has increased during the past 20 years. Storm intensity, a measure of strength, duration, and frequency, is closely related to variations in sea surface temperature in the tropical Atlantic and has risen noticeably during that time. However, changes in observation methods over time make it difficult to know for sure whether a longer-term increase in storm activity has occurred. Records collected since the late 1800s suggest that the actual number of hurricanes per year has not increased.
- River Flooding. Increases and decreases in the frequency and magnitude of river flood events vary by region. Floods have generally become larger across parts of the Northeast and Midwest and smaller in the West, southern Appalachia, and northern Michigan. Large floods have become more frequent across the Northeast, Pacific Northwest, and parts of the northern Great Plains, and less frequent in the Southwest and the Rockies.
- Drought. Average drought conditions across the nation have varied over time. The 1930s and 1950s saw the most widespread droughts, while the last 50 years have generally been wetter than average. Specific trends vary by region, as the West has generally experienced more drought while the Midwest and Northeast have become wetter. A more detailed index developed recently shows that over the period from 2000 through 2020, roughly 20 to 70 percent of the U.S. land area experienced conditions that were at least abnormally dry at any given time. However, this index has not been in use for long enough to compare with historical drought patterns.
- A Closer Look: Temperature and Drought in the Southwest. The southwestern United States is particularly sensitive to changes in temperature and thus vulnerable to drought, as even a small decrease in water availability in this already arid region can stress natural systems and further threaten water supplies. Several measures indicate persistent and more severe drought conditions in recent years.

Weather and Climate

Weather is the state of the atmosphere at any given time and place. Most of the weather that affects people, agriculture, and ecosystems takes place in the lower layer of the atmosphere. Familiar aspects of weather include temperature, precipitation, clouds, and wind that people experience throughout the course of a day. Severe weather conditions include hurricanes, tornadoes, blizzards, and droughts.

Climate is the long-term average of the weather in a given place. While the weather can change in minutes or hours, a change in climate is something that develops over longer periods of decades to centuries. Climate is defined not only by average temperature and precipitation but also by the type, frequency, duration, and intensity of weather events such as heat waves, cold spells, storms, floods, and droughts.

The concepts of climate and weather are often confused, so it may be helpful to think about the difference between weather and climate with an analogy: weather influences what clothes you wear on a given day, while the climate where you live influences the entire wardrobe you buy.

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Current Issue Part A Study Resources

Key Topic #2: Forest Health in a Changing Climate

5. Explain how globalization has enabled the spread of invasive insect species and impacted the world's forests.
6. Describe how wildfire impacts the hydrology, wildlife, and soils of forest communities.
7. Describe the conditions of drought as it relates to forest ecosystems, and identify how increasing drought severity and frequency impacts global forests.
8. Explain the biology and impacts of typical forest insect pests such as Mountain pine beetle, Spruce beetle, Spruce budworm, Forest tent caterpillar, Emerald ash borer, and Asian longhorn beetle.
9. Describe biology and impacts of typical forest diseases such as Western gall rust, Armillaria root rot, needle casts and needle rusts.
10. Describe how the prevalence and spread of forest pests and diseases are expected to shift with climate change.

Study Resources

Resource Title	Source
Forest health in a changing world: effects of globalization and climate change on forest insect and pathogen impacts	*Ramsfield et al. - Forestry: An International Journal of Forest Research, 2016*
How Does Wildfire Impact Wildlife and Forests	*Meghan Snow – US Fish and Wildlife Service, 2022*
Forest Pest Management	*Natural Resources Canada, 2015*
Biotic Pathogens	*Natural Resources Canada, 2015*
Forest Pests and Climate Change	*Climate Atlas of Canada, 2024*
Shape-shifting forests: A tale of climate, wildfires, and surprising outcomes	*Natural Resources Canada, 2024*
Drought	*Natural Resources Canada, 2024*

<u>Study Resources begin on the next page!</u> →

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Forest health in a changing world: effects of globalization and climate change on forest insect and pathogen impacts

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Forests and trees throughout the world are increasingly affected by factors related to global change. Expanding international trade has facilitated invasions of numerous insects and pathogens into new regions. Many of these invasions have caused substantial forest damage, economic impacts and losses of ecosystem goods and services provided by trees. Climate change is already affecting the geographic distribution of host trees and their associated insects and pathogens, with anticipated increases in pest impacts by both native and invasive pests. Although climate change will benefit many forest insects, changes in thermal conditions may disrupt evolved life history traits and cause phenological mismatches. Individually, the threats posed to forest ecosystems by invasive pests and climate change are serious. Although interactions between these two drivers and their outcomes are poorly understood and hence difficult to predict, it is clear that the cumulative impacts on forest ecosystems will be exacerbated.

Introduction

There is growing recognition among the scientific community and policy makers that sustainable forest management is affected by multiple factors associated with global change. Exponential population growth has resulted in the addition of 1 billion people between 1999 and 2012, leading to a global population of over 7 billion people that must be sustained by Earth's resources. Forests are of vital importance to humanity as they provide a wide range of essential ecosystem services (e.g. fuelwood, fibre, carbon sequestration etc., see Thompson et al., 2011) but the ongoing loss of forest cover means the increasing demand must be met from an ever shrinking resource (Brockerhoff et al., 2013). Concomitant with population growth has been the expansion of global trade networks and an increase in the volume of traded goods (e.g. Hulme, 2009). This has led to a considerable increase in the establishment of populations of non-native species in virtually all parts of the world (e.g. Roques et al., 2009; Aukema et al., 2010; Wingfield et al., 2015). While many of these species appear to be relatively benign, some have major deleterious impacts on trees in natural and managed ecosystems, as well as urban environments. For example, the invasive emerald ash borer has been devastating ash trees in North America (Poland and McCullough, 2006) and *Phytophthora ramorumis* causing dieback and mortality of a wide range of tree species in Europe and North America (Gru¨ nwald et al., 2012). Climate change can exacerbate invasions of forest pests as well as impacts of native pests. For example, climate change can facilitate the range expansion of both native and exotic pests (insects and pathogens), or affect tree resistance to pests (Jactel et al., 2012a), and there is increasing evidence that this is a widespread phenomenon (Battisti et al., 2005; Marini et al., 2012; Anderegg et al., 2015). Using the planetary boundaries approach of Steffen et al. (2015), Trumbore et al. (2015) identified that the main stressors of the world's forests today are invasive species and diseases as well as climate change, along with deforestation and the increasing demand for forest resources. An additional contributor to forest health problems is the ongoing intensification and mechanization of forest management which has increased the vulnerability of forests to disturbance from biological invasions, climate change and other stressors (Seidl et al., 2011). However, there is increasing recognition that forest management can be adapted to increase the resistance and resilience of forests to disturbance (Jactel et al., 2012b; DeRose and Long, 2014; Bahamondez and Thompson, 2016, this issue).

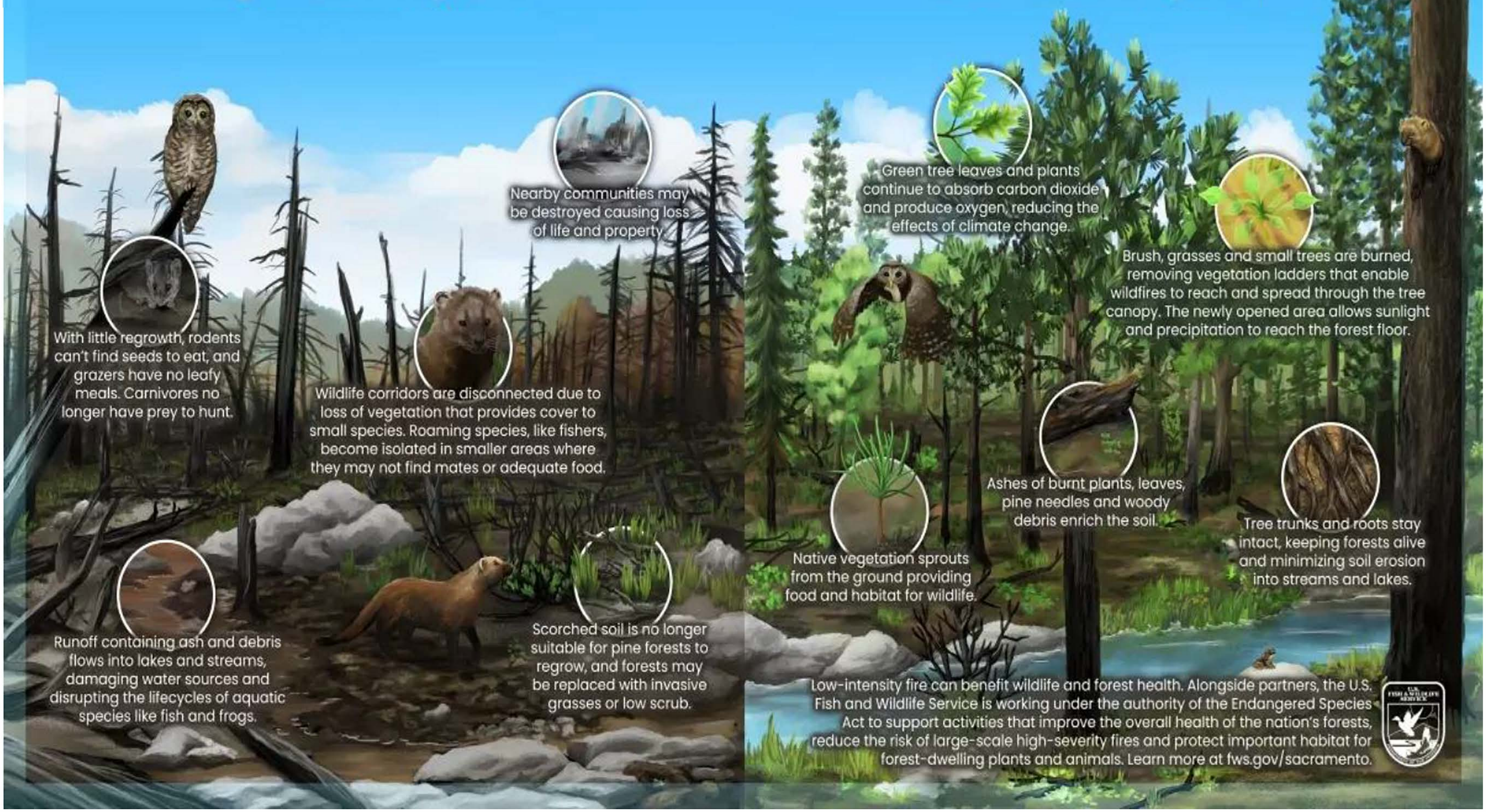
How does fire impact forests and wildlife?

Wildfires are inevitable, but not all fire is harmful to forests. Low-intensity fires can naturally "clean" and thin the forest by removing flammable and thick vegetation on the forest floor. The result is improved habitat for wildlife, healthier soil and new growth of native plants.

It also helps reduce the risk of large-scale high-severity fires that burn through the forest—from the floor to the canopy—with intense heat. High-severity fires across large landscapes can be devastating for wildlife, habitat and surrounding communities.

High-Severity Fire

Low-Intensity Fire



Government of Canada Gouvernement du Canada

Forest pest management

Native insects and diseases play an essential ecological role in Canada’s forests.

By consuming trees and other plant material, forest insects and micro-organisms contribute to healthy change and regeneration in forest ecosystems. They help renew forests by removing old or otherwise susceptible trees, recycling nutrients and providing new habitat and food for wildlife.

However, it’s not for their ecological benefits that forest insects and diseases sometimes make national news. When infestations are so severe they destroy or damage large areas of commercially valuable forest, or infest Canadian forest products bound for export, then insects and diseases—whether native or alien—become “pests.”

Mountain pine beetle, spruce budworm, and Dutch elm disease are all examples of well-known forest pests that have led to significant losses in value of Canadian forests.

What’s what: native, alien, invasive

Forest insects and diseases in Canada are typically classified into three broad categories:

- Native: Indigenous species that have existed in Canada for thousands of years. Outbreaks occur periodically. Examples are spruce budworms and mountain pine beetle.
- Alien: Species introduced into Canada’s forests within recent history. They are also referred to as “exotic,” “non-native” and “foreign.” Examples include emerald ash borer, brown spruce longhorn beetle and Dutch elm disease.
- Invasive: Insects and diseases that spread beyond their known usual range.

Both terms, “alien” and “invasive,” refer to shifts from one ecosystem to another, not to shifts across national borders. So, even organisms that move into new ecosystems within the same country can be considered alien and invasive if they extend beyond their usual geographic range. The spread of mountain pine beetle from British Columbia’s lodgepole pine forests to Alberta’s jack pine forests is an example of a native forest insect behaving invasively.

From friend to foe

Native forest insects and diseases are generally of little concern when they exist at non-damaging population levels.

It is when populations of these native species increase beyond an acceptable threshold, or when alien or native species behave invasively that concerns arise. If ecological or economic damage results in measurable impacts—such as a decline in ecosystem health or large reduction in the available wood fibre—then the insect or disease outbreak is seen as being a disturbance and active management intervention may be considered.

The challenge for forest resource managers is therefore two-fold. First is to assess the risks posed by potential and actual outbreaks and spread. Second is to apply risk-based decision-making to manage forest ecosystems in a way that minimizes the negative impacts of outbreaks and maximizes the positive impacts.

Mountain pine beetle

Dendroctonus ponderosae

Distribution
Saskatchewan, Alberta, British Columbia.

Present in most lodgepole pine forests of British Columbia, adjacent, central and northern Alberta, and in isolated locations in southwestern Saskatchewan. The geographic range has been expanding northward and eastward for the past decade.

Micro-habitat(s)
Trunk, Bark

Biology
The mountain pine beetle has a life cycle that normally lasts one year. In late summer, the adults emerge from the trees in which they feed and develop and fly off in search of new hosts, into which the females bore waiting for males to come to them. The females bore vertical galleries just under the bark, in which they lay their eggs. The larvae that emerge from the eggs spend the winter feeding under the bark. Adult emergence takes place between July and September.

A key stage in the life cycle occurs when the beetle transmits a blue stain fungus to the tree. Attacking beetles carry the spores of the fungus, which gain entry to the tree and eventually overcome its defense system and its ability to withstand beetle attack.

The mountain pine beetle and associated blue stain fungi (*Ascomycetes*) act together to kill trees. Adults transport spores of the blue stain fungi to new trees within a specialized sac (mycangium) on the maxillary cardine. These fungi are believed to stop water transport in the stem and thus kill infected trees.

Although the mountain pine beetle has many natural enemies including insect predators, parasitoids, and woodpeckers, these do not have sufficient impact on incipient and outbreak populations to exert effective control.

Damage
Infested trees can be detected through crown and external symptoms. The first signs are boring dust and resin on the bark associated with the attacking adults, but the mountain pine beetle can only be positively identified (and the success of an attack can only be positively determined) by looking under the bark.

At low (endemic) populations the mountain pine beetle survives in weakened or stressed trees. As populations increase or more trees become stressed because of drought or other causes, the population may quickly increase and spread. Healthy trees are then attacked and huge areas of mature pine stands may be threatened or killed. Warm summers and mild winters play a role in both insect survival and the continuation and intensification of an outbreak. Adverse weather conditions (winter low of -40°C or high winds during dispersal period) can reduce the beetle populations and slow the spread, but insect populations may recover (not the individual insects) and resume their attack on otherwise healthy forests.

Aerial detection of successfully attacked trees is possible as early as late spring (more typically mid-summer) in the year following attack. Detection of small groups of red-topped trees should be followed with ground inspection to verify cause.

The current outbreak in BC is starting to wane. MPB populations are likely to continue to spread eastward through jack pine and are unlikely to be stopped by an occasional cold winter. Over the last decade the insect's range in northern Alberta has expanded annually, despite several cold winters.

Symptoms
Accumulations of pitch or sawdust are conspicuous around entrance holes bored into the bark of trees by adult beetles from mid-July to early September. Sawdust is quickly blown or washed away, but abundant pitch tubes may remain for more than a year after attack. Pitch tubes may be much less evident on trees under severe drought stress prior to attack.

During the fall and winter after attack, woodpeckers feed on bark- and wood-boring insects on infested trees. Trunks of trees foraged on by woodpeckers are easily visible as much bark is stripped off and bark fragments accumulate in piles on the ground at the base of trees. Removal of bark from infested trees reveals adult egg galleries, larval feeding galleries, and one or more life stages (eggs, larvae, pupae, adults), depending on the time since attack. Egg galleries are 10–41 cm (average, 28 cm) long, oriented vertically on the stem, and have a short curved or diagonal section at the bottom.

Grayish blue staining of sapwood, caused by colonization of ray parenchyma cells by blue stain fungi transmitted by adult beetles, provides a conspicuous symptom shortly after successful attack. Various fungal fruiting structures (such as synnemata and perithecia) and mycelia of blue stain fungi and other fungi are often evident in beetle galleries and pupal chambers.

Tree foliage begins to dry out as soon as the conduction of water up the tree is interrupted. As a result, the colour of the foliage on infested trees gradually changes from bright to dull green. This early symptom in the lower crown will often become visible 2-3 months after attack. However, more distinct colour changes occur during the onset of the growing season the spring following attack when tree foliage turns brick red. The needles of infested trees first turn a faint yellow and then a reddish brown by late summer, which allows easy detection; however, by the time trees prominently display these symptoms, they are typically vacated by the mountain pine beetle, which has moved on to attack other trees. With time, retained foliage colour becomes more dull, and most of the foliage drops in 2-3 years; this will vary from species to species and with weather conditions. These rapid and distinct colour changes are used to schedule aerial mapping of recently attacked trees.

Diet and feeding behavior
Phloeophagous: Feeds on phloem.

Brown spruce longhorn beetle

Tetropium fuscum (Fabricius)

Distribution
Nova Scotia

Micro-habitat(s)
Bark

Biology & Damage
The adult has a flattened body, 1 to 1.5 cm long. The head and neck area are dark brown to black. The elytra (wing covers) can be tan, brown or reddish brown and have 2 to 3 longitudinal stripes. The antennae are red-brown and about half of the body length. The legs are dark brown. The egg measures one mm long, is oblong and white with a tinge of green. The larvae is yellow-white, about 14 to 28 mm long, and slightly flattened. The larva's head is reddish and about half of the body. The head is reddish brown and about 3 mm wide. The pupa is white and measures 10 to 17 mm long and 3.8 mm wide.

In the spring, female beetles lay eggs in the bark of standing or recently felled trees. Eggs are usually laid singly, but sometimes in clusters of up to ten eggs. Larvae hatch 10 to 14 days later, and bore into the phloem to feed, producing a network of irregular tunnels packed with sawdust-like frass (excrement).

Most *T. fuscum* overwinter as prepupal larvae either under the bark or in characteristic L-shaped pupal cells about 2-4 cm deep in the sapwood. Pupation occurs in spring and adults emerge about 14 days later, chewing a round or oval exit hole in the bark about 4-6 mm in diameter. The adults live approximately two weeks and can be found from June to August. Both males and females are strong flyers.

Over most of the range of spruce in Canada, the BSLB would likely have one generation per year.

In its native range BSLB is recognized mainly as a secondary forest insect, attacking trees that have already been subjected to other types of insect attack or environmental stresses. During a population outbreak, beetles can attack living, healthy trees. Outbreak levels have the potential to persist for a decade and continually cause damage over extensive tracts of vulnerable conifer forest. In Europe, *T. fuscum* often attacks stands of Norway spruce over 50 years of age. Tunnels in the wood as a result of larval feeding reduce timber quality.

Symptoms

- streams of resin scattered along the trunk
- holes in the bark about 4 mm across
- networks of feeding tunnels just under the bark, up to 6 mm across;
- tunnels in the wood about 4 cm deep and 6 mm wide. These tunnels appear L-shaped when the wood is cut longitudinally.
- Coarse sawdust may be found in and around tunnels or plugging the exit hole.

Other information
This insect is native to Europe, where it can be found from Scandinavia to Turkey. It is also known from Japan and western Siberia. The find in Nova Scotia is believed to be the first discovery in North America.

In March, 1999, the brown spruce longhorn beetle (BSLB), *Tetropium fuscum* was found in dying red spruce trees in Point Pleasant Park, Halifax, Nova Scotia. The following summer, the Canadian Forest Service (CFS) reared over 40 *T. fuscum* adults from red spruce bolts collected in the park. Subsequent investigations by the CFS concluded that *T. fuscum* was also attacking apparently healthy trees. Specimens collected in the park in 1990, originally identified as a related native species (*Tetropium cinnamopterum*) have also now been confirmed as *Tetropium fuscum*. Some fungi such as *O. tetropii* or *Pesotum fragrans*, have been isolated from brown spruce longhorn beetles or from boles infested by this insect. These fungi are not considered as being pathogenic.

Diet and feeding behaviour
Phloeophagous: Feeds on phloem.
Borer: Bores into and feeds on the woody and non-woody portions of plants.

Spruce budworm

Choristoneura fumiferana (Clemens)

Distribution
Canada

Micro-habitat(s)
Needle, Bud, Male flower, Cone

Damage, symptoms and biology
Spruce budworm damage appears in May. Evidence of a spruce budworm infestation includes the destruction of buds, abnormal spreading of new twigs, defoliation of current-year shoots and, if an affected branch is disturbed, the presence of large numbers of larvae suspended from strands of silk.

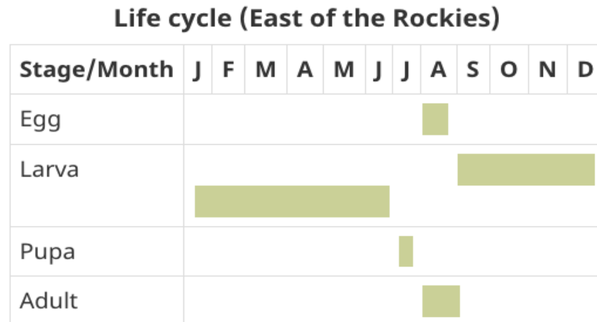
Defoliation begins at the top of the tree and quickly progresses to the periphery of the crown from the top downwards. Current-year needles are partially or completely consumed and, if large numbers of larvae are present, previous-year needles may also be affected. Spruce budworm larvae also feed on staminate (male) flowers and cones. During epidemics, the larvae may destroy all of the cones.

Severely affected stands turn a rust colour due to the presence of dried out needles held by strands of silk spun by the larvae. In the fall, most dead needles are dispersed by the wind and defoliated stands take on a greyish appearance.

A single year of defoliation generally has little impact on the tree. However, it does cause weakening of the tree, making it more susceptible to attacks by other insects. Defoliation over a few consecutive years causes tree growth loss. However, if defoliation of current- and previous-year shoots continues uninterrupted over several years, some trees will die, while others will continue to gradually decline for several years, even after the end of the infestation. This is the case with fir, the species most vulnerable to spruce budworm attacks, which dies after four consecutive years of severe defoliation.

In July and August, the female deposits her eggs in clusters of 10 to 30 under the needles of shoots, preferring those exposed to sunlight. The newly hatched larvae move towards the interior of the crown in search of a suitable overwintering site and construct a silken shelter, called a hibernaculum.

Life cycle (East of the Rockies)



Other information
A native species, the spruce budworm is considered the most serious pest of fir and spruce forests in North America. Its range coincides with that of fir, white spruce, and more and more with the range of the black spruce.

Radial growth analyses of trees have shown that cyclical invasions likely occurred between the 18th and 20th centuries. Spruce budworm populations are believed to have fluctuated during this period at intervals of 30 to 40 years. Since the beginning of the 20th century, three invasions have occurred in eastern North America.

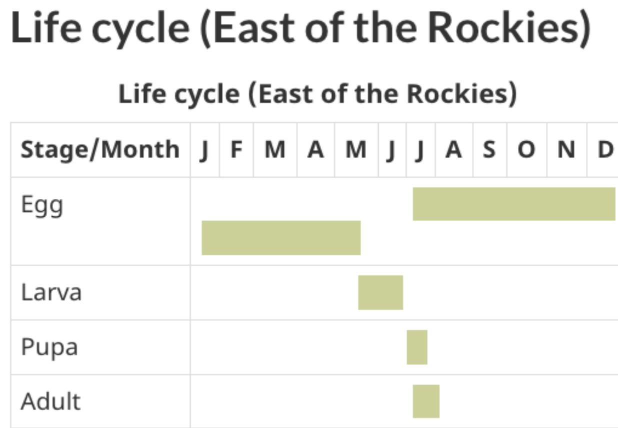
The spruce budworm is generally found in large fir stands. Much research has been conducted on this insect by the Canadian Forest Service and it is being monitored by the provincial forest departments. Most control methods mentioned in the recent literature involve the use of biological insecticides, primarily *Bacillus thuringiensis var. kurstaki* (B.t.k.).

Through a combination of annual surveys, prediction models, targeted control strategies and proper forestry practices, it is now possible to reduce economic losses caused by spruce budworm outbreaks.

On isolated or ornamental trees, vigorously shaking the tree or spraying with a powerful water jet will cause the larvae to drop to the ground. On small trees, the larvae can be removed by hand.

Diet and feeding behaviour
Heteroconophagous: Feeds occasionally on seeds and cones, but usually lives and feeds on stems and needles.
Phyllophagous: Feeds on the leaves of plants.
Webworm: Spins a silk shelter in which to hide or feed.
Pollinivorous: Feeds on pollen.

Forest tent caterpillar
Malacosoma disstria Hubner



Distribution
Canada

Micro-habitat(s)
Leaf

Damage, symptoms and biology
Defoliation is caused by the caterpillar, which begin to feed on the new leaves as soon as they appear in May. Given this insect's voracious appetite and gregarious behaviour throughout most of its development, its presence can be quickly detected. Older larvae devour entire leaves and, when the tree is completely defoliated, migrate in search of other sources of food. Larvae can also be observed in colonies on tree trunks sheltered from the sun's rays.

During massive invasions, trees can be completely defoliated over large areas. Even when severely defoliated, trees withstand infestations relatively well. Infestations generally last no more than three consecutive years. However, on trembling aspen, radial growth loss and twig dieback occur. Denuded trees will produce another crop of leaves during the season.

In the fall, the presence of egg bands, which resemble spongy, brownish masses, can be easily detected on small branches and twigs. In late June, the female deposits between 150 and 350 eggs in masses that encircle the twigs. The embryo develops over the course of the season and overwintering takes place as a fully developed embryo within the eggshell.

Other information
A species native to North America, the forest tent caterpillar is the most widespread defoliator of deciduous trees. Its range extends from coast to coast.

The insect has been known for many years and the first outbreak was recorded in 1791. Since then, the forest tent caterpillar has been reported at regular intervals in Canada.

Infestations are generally short and parasitoids are very important in the natural control of populations. The most important parasitoid is the large flesh fly, Sarcophaga aldrichi Parker, which acts quickly after the start of an infestation, and can destroy up to 80% of the pupal population.

In recreational parks or on ornamental trees, it is recommended that egg bands be removed in the fall. At that time of year, they are more visible because the leaves have dropped. In the spring, colonies of young larvae at rest can be removed by hand. On small trees, a water jet can be used to dislodge larvae from the foliage.

Diet and feeding behaviour
Phyllophagous : Feeds on the leaves of plants.
Free-living defoliator: Feeds on and moves about freely on foliage.

Emerald ash borer
Agrilus planipennis

Distribution
Quebec, Ontario

Micro-habitat(s)
Leaf, Branch, Trunk

Damage, symptoms and biology
Tree decline, including:

- yellowing of the foliage
- thinning crown
- evidence of adult beetle feeding on leaves
- long shoots growing from the trunk or roots
- vertical cracks in the trunk
- deformed bark (3-4 mm)
- small D-shaped emergence holes
- S-shaped larval tunnels under the bark filled with fine sawdust
- presence of woodpeckers in winter and woodpecker holes

The EAB has killed millions of ash trees in Southwestern Ontario, Michigan and surrounding states, and poses a major economic and environmental threat to urban and forested areas in both countries. The EAB attacks and kills all species of ash (except Mountain ash which is not a true ash).

The emerald ash borer has only one generation per year in the south of its distribution area in Michigan. Adult emergence starts with the month of June and ends with the end of July. A few days after mating, female lay eggs, one at the time, in bark crevices. One female lays between 60 and 90 eggs during its lifespan. Larvae dig S shaped galleries in the phloem in order to feed themselves. They hibernate in the bark and pupate in April or May. The lifecycle of the emerald ash borer, north of its distribution area, is not known for the moment, but it could last two years.

Other information
Native to eastern Asia, this pest was first discovered in Canada and the U.S. in 2002.

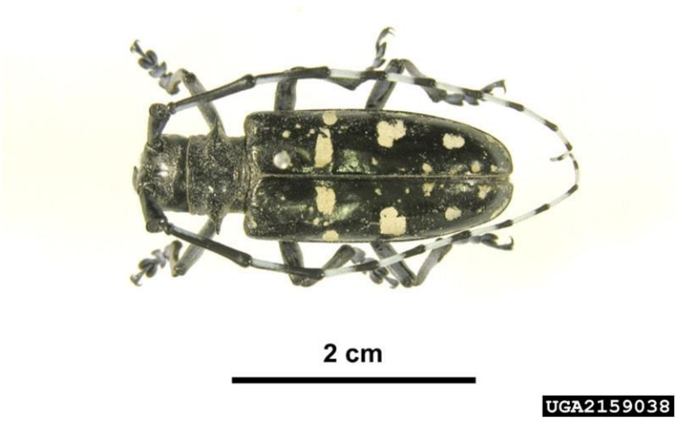
While the EAB can fly up to several kilometres, another significant factor contributing to its spread is the movement of firewood, nursery stock, trees, logs, lumber, wood with bark attached and wood or bark chips.

Regulated materials can be freely moved within a regulated area, but cannot be moved outside of a regulated area without prior written permission from the CFIA. Anyone violating this requirement may be subject to a fine and/or be liable for prosecution.

Regulated materials for EAB include nursery stock, trees, logs, wood, rough lumber including pallets and other wood packaging materials, bark, wood chips or bark chips from ash (Fraxinus species), and firewood of all tree species.

Diet and feeding behaviour
Phyllophagous : Feeds on the leaves of plants.
Xylophagous : Feeds on woody tissues (wood).

Asian longhorned beetle
Anoplophora glabripennis



Distribution
Ontario, United States

Micro-habitat(s)
Twig, Bark

Damage, symptoms and biology
In China, this species may have a one or two year life cycle, depending on the geographical region. The egg, larva, or pupa can overwinter. Young adults emerge from infested trees in May and may fly several hundred meters to search for a host. However, they tend to attack the same tree from which they emerged. Adults are active from early-summer to mid-fall. They feed on the bark of twigs periodically throughout the mating and egg-laying period. On sunny days the adult beetles are most active from mid-morning to early-afternoon. They usually rest in the canopy on cloudy days.

In preparation for egg-laying, females chew oval grooves in the bark in which they lay one egg about 5-7 mm in length. On average, each female will live 40 days and during that period will lay about 25-40 eggs. The wounds may occur anywhere on the tree, including branches, trunk, and exposed roots. Eggs hatch in one to two weeks. Young larvae begin feeding in the phloem tissue and as they mature they migrate into the wood, creating tunnels as they feed. These galleries cause tree dieback and death. Larvae become pupae, then adults, in the tunnels in summer. The new adults exit the tree through large round holes about 10-15 mm in diameter created by the newly emerging adults. Dripping sap is often seen to be flowing from the egg-laying wounds.

Piles of coarse sawdust around the base of the tree and in branch axils can be seen as well. The adults are large bluish-black beetles (2.5 to 3.5 cm in length) with white spots and very long antennae. The larvae and pupae are normally inside the tree within the larval tunnels. Full grown larvae can reach 50 mm in length.

Other information
In China, *Anoplophora glabripennis* is known as the "starry sky beetle" and is considered a major pest of hardwood trees in many parts of the country. Based on the Chinese distribution and the current infestations in the United States and Canada, it has been shown that the beetle can survive well in the hardwood forests of southern Canada.

The first report of this beetle being established outside of its native range was from the cities of Brooklyn and Amityville, New York in 1996. Many trees were found to be heavily attacked, particularly maples. Quarantine and eradication procedures were quickly implemented to prevent further spread and to eliminate the population. In July-August, 1998, three separate infestations were discovered around Chicago, Illinois. In October 2002 an infestation was discovered in Jersey City, New Jersey. In September 2003 an infestation was discovered in an industrial park located on the boundary line between the Cities of Vaughan and Toronto in the province of Ontario. All of these infestations are under strict quarantine control and are undergoing eradication.

Diet and feeding behaviour
Phloeophagous : Feeds on phloem.
Borer: Bores into and feeds on the woody and non-woody portions of plants.

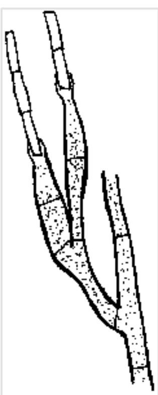
Biotic Pathogens

Bacteria are single-celled organisms that lack a true cell nucleus and have a single chromosome instead. There are only a few pathogenic bacteria that attack trees.

The majority of **forest pathogens are fungi,** which generally belong to one of the following divisions: *Basidiomycotina*, *Ascomycotina* or *Deuteromycotina*.

Deuteromycotina reproduce asexually by producing conidia on conidiophores (**Figure 1**) or within special structures, such as pycnidia. *Ascomycotina* reproduce sexually by producing 4, 8, 16 or 32 ascospores inside sacs, or asci (**Figure 2**), within structures called ascomata. These ascomata may be cup-shaped (apothecia), bottle-shaped (perithecia), or balloon-shaped (cleistothecia).

Basidiomycotina reproduce sexually by forming basidia, which produce four basidiospores (**Figure 3**) on a structure called ascoma. The basidia develop in gills, pores, teeth or other structures. Rusts (Uredinales) are *Basidiomycotina* that function as obligate parasites and have a complex life cycle that generally requires an alternate host.



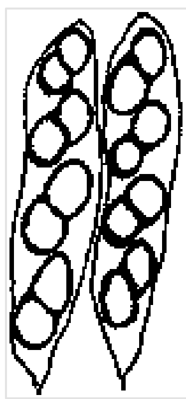
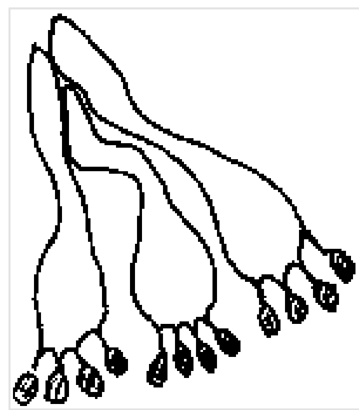


Figure 1 *Conidiophores and conidia*

Figure 2 *Asci and ascospores*

Figure 3 *Basidia and basidiospores*



Western gall rust

Endocronartium harknessii (J.P. Moore) Y. Hiratsuka

Micro-habitat(s)
Twig, Branch

Distribution
Canada

Damage, symptoms and biology
The fungus causes a gall that encircles the stem or bole of infected trees. White blisters develop at the site of the gall, just beneath the bark. In spring, the blisters burst and orange spores are released which end up infecting other pines. Rupturing of the blisters results in desiccation of the underlying living bark, killing the bark area around the gall. Following the death of the water-conducting tissues, some needles will die in the lower part of the branch, near the distal portion of the gall.

Damage is not significant on mature trees where most infections occur on branches. Branch galls do not result in serious growth losses. However, infections on young trees more often result in main stem galls that can cause stem malformations and predispose the tree to breakage in high winds or under heavy snow loads (Figs e, f).

A large number of galls reduces the aesthetic appearance and value of ornamentals and Christmas trees.

Other information
Unlike the other important stem rusts, *E. harknessii* does not require an alternate host to complete its life cycle. Infection occurs directly from pine-to-pine. This allows rapid intensification of the disease when conditions optimal for infection occur. However, such conditions only occur every several years, resulting in "wave years" of infection and gall formation.
Pruning the infected branches prior to spore production is a good means of control. Rodents feed on the galls in winter, and this may result in a high level of mortality some years.

Needle cast

Isthmiella faullii

Micro-habitat(s)
Needle

Distribution
Eastern Canada

Damage, symptoms and biology
This disease is the most common and most destructive needle cast in fir. It severely defoliates seedlings and young trees, reduces their growth, and may sometimes kill them. In larger trees, however, the damage does not cause any serious problems. The current year's needles are infected first, but they do not show any damage. The following spring, brown spots appear and spread, eventually covering the entire surface of the needles by mid-summer. The first fruiting bodies form on the upper surface of the needles and discharge spores in late summer or early fall. It is unclear just what role these spores play, but they may give rise to the second type of spores. Ascospores form in mid-summer on the needles infected two years earlier. Hysterothecia, the fruiting bodies bearing these spores, create a black line on the underside of the needles. This line is actually the ascus, which will release ascospores able to infect new shoots the following spring.

Other information
No measures are implemented to control this disease in the forest. With high-value trees, however, pruning of affected branches represents a good means of suppression. The disease causes considerable damage in Christmas tree plantations. Fungicide spraying may also be effective, but it must be done at the right time, that is, when the spores are released.

Armillaria root rot

Armillaria mellea

Micro-habitat(s)

Base of tree

Distribution

Eastern Canada

Damage, symptoms and biology

This is the most destructive and widespread disease involving pathogens that attack the roots and base of trees. In forest stands the disease will often kill trees either singly or in patches known as disease centers. These disease centers will continue to grow in size as the disease spreads outward over time.

Trees with armillaria root disease might or might not show external symptoms. The first symptoms of the disease are a decline in tree vigour, foliage yellowing followed by gradual browning, and a considerable flow of resin in conifers. Needles on dying pine trees first turn yellow-green and then red before falling off. Spruce needles often become a dull green (but not red) before they fall off. The infection begins when the fungus, living in the ground, sends out filaments that invade healthy roots. It then moves to the root collar, and spreads to the tree trunk. The spread of infection induces sapwood decay in the affected parts, and eventually kills the tree. Trees with root decay die as a result of sap flow being cut off or following wind throw. The infected areas have cream-coloured plates along with black mycelial cords resembling shoe strings. The rotting wood beneath the bark has a water-soaked appearance and is pale brown. Over time, the wood yellows, then whitens and becomes soft, spongy and stringy. In the fall, golden yellow fruiting bodies can be seen near infected trees or at their base. The fruiting bodies have darkish scales on the cap and fairly close yellowish white gills. The long, fibrous stem is encircled by a thin membranous ring. The fruiting bodies produce spores that are dispersed by the wind and end up creating new pockets of infection.

Other information

Armillaria root disease is caused by several closely related species of Armillaria. *Armillaria ostoyae* is the most prevalent and destructive of the Armillaria spp..

The causal fungus of Armillaria root rot can remain alive for many years in rotting wood on the ground. Some root disease centers have been estimated to be more than 400 years in age. Although the fungus usually lives on dead organic matter, it can attack healthy trees and cause major damage. The fruiting body is edible but opinion is divided regarding its flavour. It is best to consume only young specimens. Be sure to carefully identify them first. Trees whose foliage appears healthy but have rotten roots can be hazardous in campgrounds, or around buildings because they are susceptible to wind-throw.

Needle rust of pine

Coleosporium asterum (Diet.) Syd.

Distribution

Common throughout the range of host trees in Canada.

Damage, symptoms and biology

The pine-aster rust causes minor needle cast and discoloration of needles of pine and, in cases of severe infection, some reduction in terminal growth, but only rarely does it kill trees. Generally, only relatively small trees, less than 8 to 10 feet in height, are affected, and only heavily infected older needles are cast prematurely, resulting in lowered food production, consequent growth reduction, and reduced value for Christmas trees. However, death of seedlings could result from a combination of rust attack and insect attack fatal to the new shoots.

Coleosporium asterum is a macrocylic rust, producing five spore stages. In the early spring the pycnial stage appears as orange droplets on lesions on pine needles that were infected the previous fall. A white, columnar blister, the aecial stage, then forms on the needles in late spring or early summer, ruptures and releases orange-coloured aeciospores that are dispersed by the wind and infect the alternate hosts, aster, *Aster sp.*, and goldenrod, Solidago sp. Throughout the summer, on the underside of the leaves of the alternate host, the uredial stage develops and produces orange, cushion-like masses, which produce uredialspores that re-infect and spread the disease to other aster and goldenrod plants. Several generations of this stage may be produced during the summer months. In late summer, the telial stage develops on the underside of the alternate host leaves, germinates and produces the basidial stage, which releases basidiospores that are dispersed by the wind and re-infect the needles of the primary pine host, where the fungus then overwinters.

The current year's foliage that is infected late in the fall usually dies and falls from the tree the following summer. In some cases the infected needles will persist on the tree for 3 to 5 years. Infections that result in whole tree mortality are rare because the current year's needles are not affected until late in the fall, after the growing season is completed. Consecutive years of infection, accompanied by an additional stress, such as drought, could result in loss of vigour, growth loss, and whole tree mortality. Less vigorous trees are more susceptible to attack by other insects and diseases, such as bark beetles, Ips sp., and Armillaria root rot, Armillaria ostoyae (Romagn.) Herink.

The result of several consecutive years of defoliation can reduce the merchantability of trees in the Christmas tree and ornamental tree industry. In these cases, an application of a fungicide registered for control of this pine needle rust is recommended. The removal of any alternate host plants, aster, *Aster sp.,* and goldenrod, *Solidago sp*., from within 300 m of pine plantings should also provide some level of control.

Forest Pests and Climate Change

Many of Canada's most notorious forest pests and diseases have become household names in recent years:

- The mountain pine beetle killed off a large portion of British Columbia's Lodgepole Pine trees from the late 1990s through the 2010s and has also spread east, threatening forests in Alberta;
- The emerald ash borer has aggressively attacked eastern Canada's Green Ash trees, killing 99% of Toronto's 850,000+ Ash trees, and is now spreading west to the prairies; and
- Dutch elm disease is slowly but surely stripping cities and towns across eastern and central Canada of their majestic American Elms.

Under normal conditions, forest pests and tree diseases can be natural agents of disturbance that promote forest health and diversity. Unfortunately, our warming climate is tipping the ecological balance and turning them into a worsening threat.

Terry Teegee knows the forests of the west coast intimately, and has seen the astonishing results of insect damage first hand. He is Regional Chief of the British Columbia Assembly of First Nations, Tribal Chief of the Carrier Sekani Tribal Council, and a registered professional forester. Teegee and his community have witnessed sporadic pine beetle outbreaks going back many generations: "our elders talked about it: we'd hear stories about the forest being blood red." Recently however, pine beetle infestations have become massive in scale and in consequences.

The numbers are astounding. During the early 1990s, the beetle destroyed an average of about 45,400 hectares of forest per year; between 2004-2014 the beetle was a hundred times more destructive, killing over 6.4 million hectares per year. Teegee watched this devastation unfold. "We've seen a vast area being infested faster and faster," he says. "The reason for that is climate change."

> "We've seen a vast area being infested faster and faster. The reason for that is climate change."

Teegee says that climate change is leading to warmer winters and summers, and that both of these seasonal changes are contributing to the beetle's massive impact. In the past, he says, "we'd get an early freeze of the land and of the trees in October, and that kept the mountain pine beetle in check. That hasn't occurred often enough since the 80s." Teegee also observes that "with climate change we've seen a lot longer summers, meaning that there are two flights of mountain pine beetle. And that's unprecedented, but has happened more and more in the past twenty years."

The latest pine beetle infestations in BC have largely run their course, primarily because they've killed off most of their preferred tree species. But that doesn't mean the threat is over. Teegee says that "2008 was basically where mountain pine beetle exhausted its use of the pine tree because there were none left, and now it's carrying on into the boreal forest." The beetles have begun to attack jack pine, and forestry researchers have identified climate change as a major risk factor in the likelihood of this destructive species spreading to the vast pine forests of eastern Canada.

Teegee's experience of warming winters and summers leading to a sudden explosion of insect damage is a pattern that has also been seen with other pests across the country. In Toronto, for example, hotter summers allowed ash borer populations to undergo two reproductive cycles rather than just one, doubling their normal rate of infestation. Research has also shown that deep winter cold spells are needed to limit outbreaks of many pests, including ash borers and tent caterpillars. The warming climate thus weakens natural controls on insect pest populations at the same time as it accelerates their rates of growth and reproduction. This combination allows pests to spread much farther and faster than before.

> Deep winter cold spells are needed to limit outbreaks of many pests, including ash borers and tent caterpillars.

Pests attacking new species and making their way into new ecosystems are especially concerning consequences of climate change. Insects can now be found in unexpected places, such as near the tops of mountains or far north, near the tree line. These shifts in habitat and species can happen rapidly and can have devastating consequences when infestations reach forests that haven't evolved to resist these invasive threats.

Trees, of course, have natural defenses that allow them to repel and recover from many kinds of pests and diseases. Unfortunately the same changes in climate that promote the aggressive spread of insects also impact trees' capacities to defend against them. During warmer and drier conditions associated with periods of drought, trees are less resilient to the effect of insects and disease. And when faced with multiple sources of stress – such as an onslaught of insects during a drought – trees are much more likely to die.

Mitigation and Adaptation

Urban and wild forest management strategies can play an important role in reducing the impact of forest pests in the face of climate change.

The city of Winnipeg and the province of Manitoba, for instance, have implemented strategies to reduce the spread of Dutch elm disease, including practices around firewood storage, tree pruning, early detection, and the rapid removal of infected trees. Alberta and Saskatchewan have implemented a variety of strategies targeting the mountain pine beetle, in the hopes of slowing its spread, though they understand it may be difficult to stop it altogether.

Climate projections such as those presented in the Climate Atlas are essential to inform management strategies in both urban and wild settings. Projections show shifts in temperature, which could have implications about where pests might be found in the future, as well as what conditions trees will face as climate change alters the seasonal distribution of warmth, cold, and precipitation.

A key message arising from forestry research is that climate change will likely bring on sudden and unpredictable disturbances. Forest managers will have to cultivate diverse and resilient tree populations and management practices, because climate change means having to be ready for the unexpected.

Ultimately, the most direct way to preserve our forests in the face of these threats is to take prompt and effective action to prevent climate change from accelerating. The less warming that comes to pass, the less stress will be placed on the natural world, and the less our practices will have to adapt to more serious risks.

Teegee says "I think we're in dire straits with the reality of climate change," but notes that "the good thing about human beings is that we're resilient. We'll make a change." For Teegee, responding to climate change means recognizing that "we've lost that real connection with the land" and that fundamentally "we've really got to think about what's important in our lives" in order to live in balance with nature.

Shape-shifting forests: a tale of climate, wildfires and surprising outcomes

The story of North American forests is one of resilience, adaptation, renewal and hope. **January 2024**

If you hike or stroll through one of Canada's northern forests, you might experience a world of towering trees, cool shade filled with the scent of pines and spruces — home to many different plants and animals of all shapes and sizes. But Ellen Whitman, a wildfire research scientist at the Canadian Forest Service, sees things through a different lens. What she notices is a landscape quietly and gradually transforming.

A very different place

Ellen sheds some light on this phenomenon. "Globally, we're noticing a change in forest biomes as they shift away from mature forests toward shrub and herb-dominated ecosystems," she notes. "Head up to the Northwest Territories and you'll find parts of forests that have been utterly transformed. The towering jack pines have surrendered their reign to grasses and stunted aspens, armed with light seeds that can be carried on the wind," she says. The small, forested area that caught her eye back then is "a very different place now."

She first became interested in Wood Buffalo National Park and the southern Northwest Territories in 2014, after a major wildfire season. She worked with two other NRCan scientists, Marc-André Parisien and Dan Thompson, along with wildfire expert Mike Flannigan of Thompson Rivers University. The goal? To compare several paired forested areas with similar climate, pre-fire vegetation and soil conditions. One of each pair had experienced two fires in a short time, also known as short interval reburns. The other had a longer period of regrowth between fires. The differences were significant. The scientists published their findings in the international science journal *Nature*, noting that, in places with short interval reburns, open stands of aspens dominated in place of dense conifer forests, and the understorey vegetation beneath the trees consisted of sparse shrubs and grasses.

More recently, Ellen and a team of researchers studied wildfire and climate trends in northwestern boreal forests. Looking mainly at Alberta, using historical data from 1970 to 2019 their research findings were notable: the annual number of large wildfires and the number of extreme short interval reburns both increased as the climate grew warmer and drier. This research supports the growing body of evidence that increasing fire activity affects not just the local environment, but the overall ability of the forest to regenerate.

This transformation is most evident in western and northern parts of Canada and in the southwestern United States. In some reburned areas, you can still spot trees, but they're less dominant than in neighboring forests, creating a more open, almost savanna-like appearance. Savannas, which are common in Africa and Australia, have a drier climate characterized by rolling grasslands scattered with shrubs, trees and occasional patches of forest.

Key players: wildfires and climate

So, what exactly is happening? Ellen breaks it down: "Climate change and increasingly severe wildfires are key players in this transformation. While they might not be the sole driver, they're certainly capable of leading to this shift."

Climate stresses come in the form of droughts, floods and warmer than usual weather patterns. When it's drier than usual, wildfires tend to happen more often and become more severe.

What's more, areas recently burned by fires lack nearby sources of seeds for trees to regrow. Sometimes it's because the burned patch is so vast that the seeds would have a long way to travel. In other cases, it's because the seed bank, which refers to the dormant seeds that normally exist in the soil, was destroyed in the fire. And even if a tree seedling manages to take root, it might struggle with unusually hot and dry weather. Simply put, they may not survive in today's climate, which is different than it was when forests first took root decades and centuries ago.

Long term shifts

“There are ongoing long-term shifts away from old-growth tree species like spruce, toward shorter-lived ones like pine or aspen,” Ellen points out.

However, none of this is new, exactly. The balance of tree species in North American boreal forests have shifted many times since the last major ice age 11,700 years ago, as temperatures and wildfire patterns change. Wildfires are a natural phenomenon and can help forests thrive. “Fires can spark overdue regeneration, particularly where they’ve been artificially suppressed,” she points out. “Forests aren’t inherently superior to other ecosystems, and sometimes a bit of rebalancing is needed where they have invaded, such as in some former grasslands.”

Resilience: a race to keep up?

Forests and wildlife can be resilient. Trees have long been adapted to wildfires and changing conditions, while animals can find safer havens. Mature trees have great inertia, which means even if the climate changes fast, they will most likely persist. But Ellen notices a crucial shift. The speed of change is picking up and ecosystems have less time to recover between wildfires. She explains: “there’s some evidence they’re starting to lose the ‘safe operating space’ they need to be resilient to disturbances.”

The story gets more complex when the wider ecological impact is considered. Wildfires create a ripple effect. “In North America, the loss of large, old-growth trees could have consequences for creatures uniquely developed to thrive in mature forests,” notes Ellen. These include specialist species like martens and fishers, members of the weasel family that make their dens inside tree hollows, for example. Beyond that, wildfires impact human social and economic values by reducing carbon storage, altering water dynamics and even affecting how much sunlight the planet can absorb.

Hope, renewal, adaptation

The story of forests is not just a tale of loss, but one of renewal and adaptation. “We can expect most of our burned area to recover fine,” says Ellen. The reality is forests evolve. They may not always resemble the forests we’re used to seeing or respond how we expected. But different combinations of native and non-native plants are sure to fill the voids.

Ellen’s research serves as a reminder that our own actions have far-reaching impacts on the ecosystems we share. There are ways to adapt and mitigate these changes. Land managers can use strategies like fuel treatments and prescribed burning to lessen the severity and spread of wildfires. On a personal level, we can contribute by reducing energy use and cutting down on greenhouse gas emissions. The key is to find a balance that lets nature thrive, while providing the essential ecosystem services we rely on. There is still much work to do be done as Ellen and other wildfire scientists continue their quest to understand the drivers and consequences of changes unfolding in our forests.

Drought

Drought is expected to become more frequent and severe in parts of Canada.

Drought is defined as a shortage of precipitation over an extended period, usually a season or more, resulting in insufficient water availability that adversely impacts vegetation, animals and people.

Areas of western Canada are already experiencing frequent and severe droughts. Scientists expect new areas across the country to be affected and drought to become even more frequent and severe. The consequences could have far-reaching impacts on Canada's forests.

Why knowing about drought is important

Drought threatens Canada's forests by limiting the available water that trees need to survive. When water is limited, trees become weakened. Weakened trees cannot grow at a normal rate, may not be able to regenerate, or could die. It is also difficult for trees to defend themselves against insects and diseases as they become stressed. Similarly, during wildland fires, weakened trees are at higher risk. For the Canadian forest industry, these issues directly affect the available wood supply.

Canadian Forest Service researchers have developed a measure of drought called the Climate Moisture Index (CMI). CMI is calculated as the difference between the annual amount of precipitation and the expected amount of water that evaporates each year and can be used to indicate the amount of moisture available in a given year.

Tracking drought helps forest managers anticipate and manage for a changing climate. For example, the SeedWhere program can be used to predict where similar climates will be located under a range of future climate scenarios and timeframes. Forest managers can use this tool to select the planting stock (e.g., species and provenance) that is best adapted to predicted drought conditions.

What has changed

Several regions of Canada experienced substantial droughts between 1951 and 2010, but with significant variability between decades. However, during the first decade of the 21st century (2001–2010), exceptional droughts were observed across the country – for example, the 2001–2002 drought in the Prairies (Figures 1 and 2), caused abnormally high aspen mortality (see Tree mortality).

Similar trends have been reported in forests around the world. With droughts expected to become more frequent and severe in most of Canada's forests, there are growing concerns about the impact of drought on forest distribution, tree health and regeneration success.

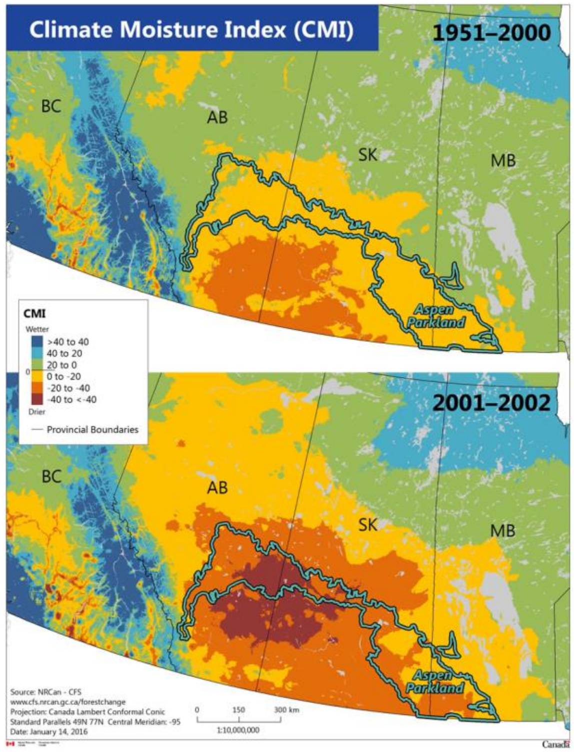


Figure 1 *– Mean Climate Moisture Index (CMI) for 1951–2000 and the 2001–2002 drought in the aspen parkland*

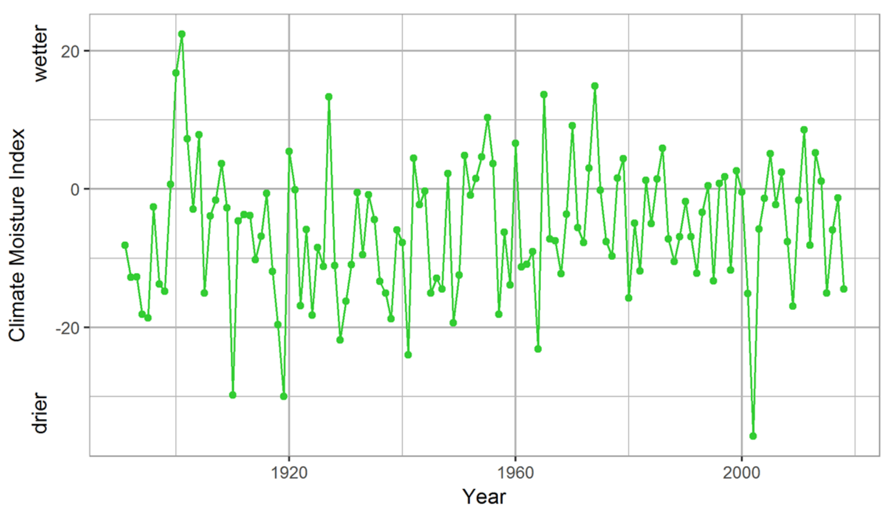


Figure 2 *– Long-term changes in the Climate Moisture Index (CMI) in the aspen parkland*

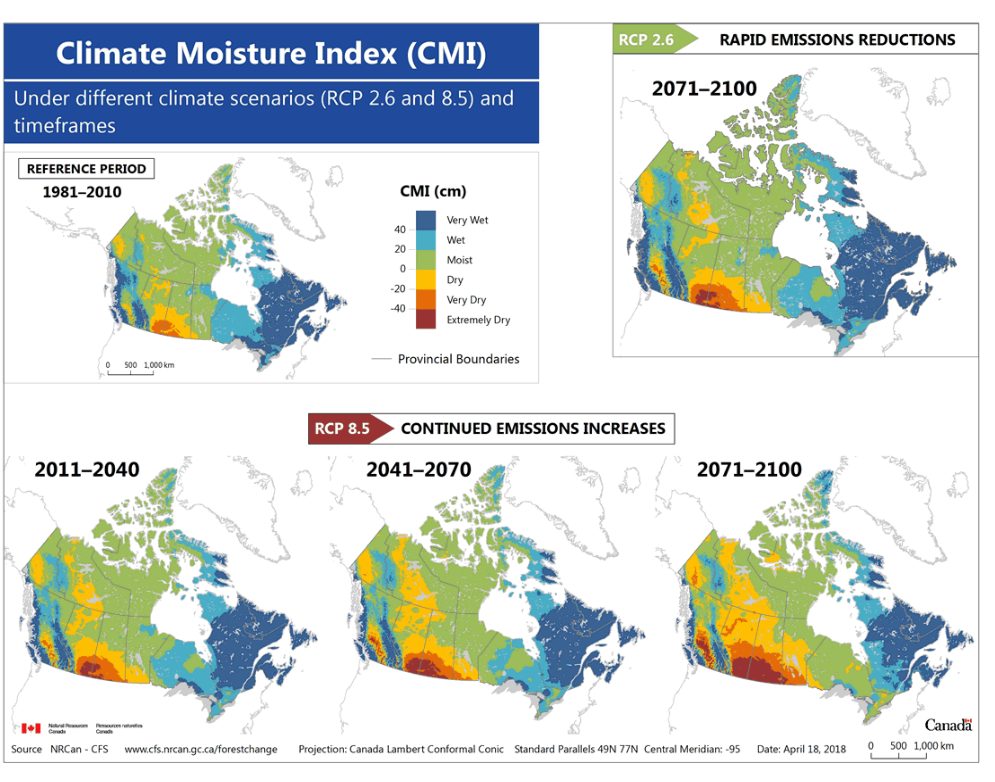


Figure 3 *– Reference period (1981–2010) and projected mean annual Climate Moisture Index (CMI) for the short- (2011–2040), medium- (2041–2070), and long-term (2071–2100) under the Representative Concentration Pathway (RCP)*

The outlook

Increases in drought could have far-reaching impacts on Canada's forests, both directly, through impacts on tree growth and survival, and indirectly, through drought-related increases in the frequency of disturbances such as fire and insect outbreaks.

Drought is expected to become more frequent in several areas that are already relatively dry, such as the southern interior of British Columbia and the Prairie provinces (Figure 3).

Some areas that have not previously experienced frequent drought are also expected to become drier in the future. The current prairie conditions are expected to spread northwards into areas of the southern boreal forest. Such a shift would lead to significant changes in forest ecosystems.

Moist regions, such as the Pacific and Atlantic coastal areas, are expected to be less affected, with limited changes in annual climate moisture index (CMI) values over the next 100 years. However, these moist areas could become more prone to the impacts of seasonal droughts even if the annual CMI indices remain positive.

The following section contains flyers related to the Current Issue topic specifically pertaining to Louisiana.

What Climate Change Means for Louisiana:
https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-la.pdf

Wildlife Affected by Extended Heat Wave, Drought in Louisiana:
https://www.wlf.louisiana.gov/news/wildlife-affected-by-extended-heat-wave-drought-in-louisiana

Drought, excessive heat cause $1.69B in damage to Louisiana agriculture, forestry:
https://www.lsuagcenter.com/articles/page1701287247021

Assessing tree damage after an extended drought:
https://www.lsuagcenter.com/articles/page1698930888286

Dead pine trees create safety concerns for Louisiana officials: 'Never seen anything like this':
https://www.nola.com/news/louisiana-news-safety-concerns-officials-state-drought/article_e81697e2-3fc9-11ef-8ac9-2f4e95025cfa.html

August 2016
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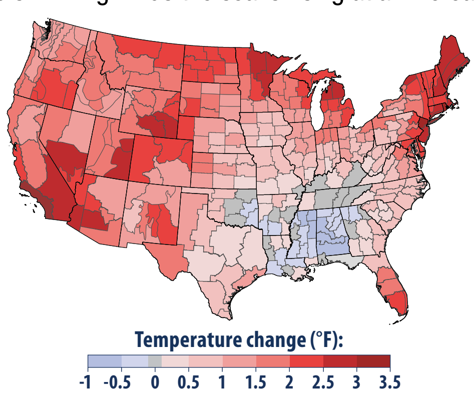
EPA United States Environmental Protection Agency

What Climate Change *Means for* Louisiana

In the coming decades, **Louisiana** will become warmer, and both floods and droughts may become more severe. Unlike most of the nation, Louisiana did not become warmer during the last century. But soils have become drier, annual rainfall has increased, more rain arrives in heavy downpours, and sea level is rising. Our changing climate is likely to increase damages from floods, reduce crop yields and harm fisheries, increase the number of unpleasantly hot days, and increase the risk of heat stroke and other heat-related illnesses.

The climate is changing because our planet is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of the earth about one degree (F) during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others. While most of the earth warmed, natural cycles and sulfates in the air cooled Louisiana. Sulfates are air pollutants that reflect sunlight back into space. Now sulfate emissions are declining, and the factors that once prevented the state from warming are unlikely to persist.

Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has warmed about one degree during the last 80 years. Warming is causing snow to melt earlier in spring, and mountain glaciers are retreating. Even the great ice sheets on Greenland and Antarctica are shrinking. Thus the sea is rising at an increasing rate.



Rising temperatures in the last century. Louisiana has warmed less than most of the United States, and part of the state has cooled. Source: EPA, Climate Change Indicators in the United States.

Rising Seas and Retreating Shores

Rising sea level is likely to accelerate coastal erosion caused today by sinking land and human activities. The sediment washing down the Mississippi River created the river delta that comprises most of coastal Louisiana. These sediments gradually compact, so the land sinks about one inch every three years. Historically, the river would occasionally overflow its banks and deposit enough new sediment to allow the land surface to keep pace with rising sea level and the delta's tendency to sink. But today, river levees, navigation channels, and other human activities thwart this natural land-building process, so coastal lands are being submerged. Louisiana has been losing about 25 square miles of land per year in recent decades.

If temperatures continue to warm, sea level is likely to rise one to three feet during the next century. Rising sea level has the same effect as sinking land, so changing climate is likely to accelerate coastal erosion and land loss. Federal, state, and local governments have ongoing projects to slow land loss in Louisiana, but if the sea rises more rapidly in the future, these efforts will become increasingly difficult.

Tropical Storms

Tropical storms and hurricanes have become more intense during the past 20 years. Although warming oceans provide these storms with more potential energy, scientists are not sure whether the recent intensification reflects a long-term trend. Nevertheless, hurricane wind speeds and rainfall rates are likely to increase as the climate continues to warm.

Most of New Orleans was flooded when rising water overtopped levees and floodwalls during Hurricane Katrina in 2005. Credit: LtCdr. Mark Moran, NOAA Corps

Increased Flooding

Whether or not tropical storms become more frequent, rising sea level makes low-lying areas more prone to flooding. Many coastal roads, railways, airports, and oil and gas facilities are vulnerable to the impacts of storms and sea level rise. Louisiana is especially vulnerable, because much of New Orleans and other populated areas are below sea level, protected by levees and pumping systems that remove rainwater, which cannot drain naturally. With a higher sea level, these levees may be over-topped more readily during storms. Severe flooding can disrupt the economy of a city by inducing people to move away, which occurred after Hurricane Katrina in New Orleans. The greater flood risk is also likely to increase flood insurance rates.

Changing climate is also likely to increase the risk of inland flooding. Since 1958, the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the Southeast, and the trend toward increasingly heavy rainstorms is likely to continue. Moreover, the amount of rainfall in the Midwest is also likely to increase, which could worsen flooding in Louisiana, because most of the Midwest drains into the Mississippi River.

The Port of New Orleans is vulnerable to river floods that shut down traffic on the Mississippi River, as well as coastal storms that can flood port facilities. In 2011, high water levels on the Mississippi River led the U.S. Army Corps of Engineers to divert water through the Morganza Spillway to the Atchafalaya River to prevent serious flooding of Baton Rouge and New Orleans. The resulting high water on the Atchafalaya flooded small towns and about 1,000 square miles of agricultural land, and required temporary levees to protect Morgan City. Although major flooding on the Mississippi River was avoided, high water levels still caused a barge collision that led the Corps to close the river near Baton Rouge for four days.

Heavy rains flooded Franklinton in March 2016. Credit: Sgt. Cody Westmoreland, Louisiana Army National Guard.

Agriculture, Forests, and Fisheries

Changing climate will have both harmful and beneficial effects on farming. Seventy years from now, Louisiana is likely to have 35 to 70 days with temperatures above 95°F, compared with about 15 days today. Even during the next few decades, hotter summers are likely to reduce yields of corn and rice. But higher concentrations of atmospheric carbon dioxide increase crop yields, and that fertilizing effect is likely to offset the harmful effects of heat on soybeans and cotton—if adequate water is available. On farms without irrigation, however, increasingly severe droughts could cause more crop failures. Higher temperatures are also likely to reduce livestock productivity, because heat stress disrupts the animals' metabolism.

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Louisiana, although the composition of trees in the forests may change. More droughts would reduce forest productivity, and climate change is also likely to increase the damage from insects and disease. But longer growing seasons and increased concentrations of carbon dioxide could more than offset the losses from those factors. Forests cover about half of the state, with loblolly-shortleaf pine forests most common outside of wetland areas. Changing climate may cause the loblolly and shortleaf pine trees to give way to oak-pine forests.

Rising sea level and higher temperatures threaten Louisiana's fisheries. Coastal wetlands account for most of the land that the state has been losing. Those wetlands support shrimp, oyster, crab, crawfish, menhaden, and other fisheries–about 75 percent of the state's total commercial fisheries. Rising temperatures may also harm fish by reducing levels of dissolved oxygen in the water, promoting harmful algal blooms, bacteria, and other factors that contribute to diseases in coastal waters.

Human Health

Hot days can be unhealthy, even dangerous. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. High air temperatures can cause heat stroke and dehydration and affect people's cardiovascular and nervous systems. Warmer air can also increase the formation of ground-level ozone, a key component of smog. Ozone has a variety of health effects, aggravates lung diseases such as asthma, and increases the risk of premature death from heart or lung disease. EPA and the Louisiana Department of Environmental Quality have been working to reduce ozone concentrations. As the climate changes, continued progress toward clean air will become more difficult.

Wildlife Affected by Extended Heat Wave, Drought in Louisiana

SEPTEMBER **11** 2023

CONSERVATION HUNTING PUBLIC AREA AND FACILITIES

Trey Iles • Baton Rouge

Like humans, wildlife in Louisiana is being impacted by the current drought and heat wave that has plagued the state this summer.

According to the NOAA National Integrated Drought Information System (Drought.gov) 90% of Louisiana is currently experiencing drought conditions with 77% of the state experiencing severe to exceptional drought conditions. July 2023 was the second hottest July on record (average temperature) since 1895 (National Centers for Environmental Education; ncei.noaa.gov).

Here is a summary of some of the repercussions experienced by wildlife:

Water birds

Reduced areas of water at a landscape level can result in concentrations of water birds wherever there is sufficient water, and the water that is present can become stagnant and have poor quality. Artificially high concentrations of ducks, or any species, increases the risk of widespread disease transmission and reduces the effort required by local predators. Excessive heat also increases physiological and behavioral thermoregulatory costs. Stressed plants (both natural and agricultural crops) which serve as the food source for waterfowl throughout the winter will be less productive. For locally breeding ducks, evaporation of isolated ponds or pools where non-volant broods (those incapable of flight) are growing significantly decreases survival, as they must travel overland to alternative ponds. Both predation and malnourishment during this travel may result in mortality.

Deer

Drought affects the growth of plants utilized by deer for food and cover. Actively growing plants are more nutritious and better withstand the effects of herbivory. This is important if deer are to reach their growth and reproductive potential. Drought timing and severity has also been linked to increased bluetongue virus (BT) and epizootic hemorrhagic disease (EHD) outbreaks. The environmental conditions caused by drought have been correlated with higher insect vector populations that transmit the disease. Overall, deer in Louisiana have coped well with past drought events based on physical data collected from hunter-harvested deer. However, the timing and duration of droughts can have impacts.

Turkey / Quail

Dry conditions (below average rainfall) are often desired during nesting and brood rearing periods for ground nesting birds across Louisiana and the southeast. Dry periods from April through June can often lead to above average reproduction for eastern wild turkeys by minimizing nest failures and poult mortality. The same is true for northern bobwhites during the months of June through August. However, excessive/extended drought conditions can have adverse effects to vegetation structure and insect populations that young turkeys and quail need to survive. Excessive drought conditions can also negatively impact seed and mast crops on which turkeys and other wildlife, including deer and squirrels, depend on throughout the remainder of the year. Lastly, drought conditions also limit water sources in some situations, thus concentrating wildlife and increasing the risk of predation and disease transmission.

Proper long-term habitat management practices and environmental stewardship will help to minimize the effects of drought and other weather extremes on wildlife populations. Maintaining diverse forested and grassland/forb habitats in various stages of succession, promoting native plants, and conservation of wetlands and broad functional riparian areas all help to minimize the impacts of environmental extremes on wildlife.

For assistance in developing a wildlife habitat management plan for your property contact an LDWF Private Lands Biologist. Private Lands Biologist contact information can be found at: https://www.wlf.louisiana.gov/page/private-land-management-assistance

Louisiana Department of Wildlife and Fisheries
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Administration

Commissions, Task Forces, & Councils

Resources

Drought, excessive heat cause $1.69B in damage to Louisiana agriculture, forestry

Olivia McClure (/profiles/omcclure)

(11/30/23) BATON ROUGE, La. — Louisiana agriculture and forestry suffered $1.69 billion in damage due to this summer's drought and excessive heat, according to preliminary estimates by LSU AgCenter experts.

Long stretches of record-high temperatures and little to no rain led to yield and quality losses and increased production costs for farmers of row crops as well as fruits, nuts and vegetables. Livestock producers dealt with animal health issues and struggled to grow adequate forage. Forest landowners faced wildfires while crawfish producers monitored the threat of saltwater intrusion .

In a recently released report, AgCenter economists Kurt Guidry, Jinggang Guo and Raghav Goyal and forester Robbie Hutchins detail the far-reaching effects of the challenging weather conditions on the state's agriculture and forestry — an industry with an annual value of about $11.4 billion.

"Unlike past natural disasters, which impacted only portions of the state for short periods of time, drought conditions coupled with record-high temperatures persisted statewide throughout most of the 2023 production season," the authors wrote.

They based their damage estimates on reports from AgCenter agents and specialists throughout Louisiana.

About half of the total damage, $836.5 million, occurred on farms where crops performed poorly or died. With the lack of usual summer rainfall, farmers also racked up expenses from having to irrigate more often. Soybeans and sugarcane took the hardest economic hit, with those industries losing a combined $595 million.

Livestock and hay producers sustained $389.2 million in losses stemming from animal deaths, forced liquidation, reduced sale weights, abortions and reduced milk production. Feed costs soared as the heat and drought hampered forage production and limited grazing capacity.

Wildfires burned more than 50,000 acres of forests, destroying $71.4 million of timber. Another $249.5 million in damage was caused by drought conditions that slowed tree growth and forced the replanting of failed seedlings.

The impact to the crawfish industry is estimated to be $139.8 million. The production and harvest season has just begun, however.

“Known issues with water availability and high salinity levels are expected to limit crawfish acres,” the report says. “In addition, research, along with historic experiences and knowledge, shows a high correlation between drought and extreme temperatures to reduced crawfish population.”

The full effects of this year’s extreme weather won’t immediately be known.

“There is potential for multi-year impacts to materialize that would increase the challenges faced by certain agricultural industries,” the report says.

The full report is available on the AgCenter website at https://tinyurl.com/msz9dhcb (https://tinyurl.com/msz9dhcb).

These sugarcane stalks in Chad Hanks' field in Lafayette Parish stood 3 feet tall in August, a time that they should have been 7 to 9 feet tall. Hanks was expecting at least a 40% reduction in his crop yields this year because of the extremely high temperatures and lack of rainfall. Photo by Craig Gautreaux/LSU AgCenter

Young pine trees sport dead, brown needles and charred bark in a forest along Lonzie Doyle Road near the Westport community in Rapides Parish on Sept. 5, 2023. This forest burned in the Highway 113 Fire, which damaged about 8,000 acres. Photo by Olivia McClure/LSU AgCenter

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Assessing tree damage after an extended drought

Heather Kirk-Ballard (/profiles/hkirkballard)

By Heather Kirk-Ballard (https://www.lsuagcenter.com/profiles/hkirkballard)

LSU AgCenter Horticulturist

Excessive drought conditions in Louisiana are quickly becoming a natural disaster that will have effects on gardens, landscape plants and natural areas all across the state for some time. We may not understand the full extent of the damage for years. The U.S. Drought Mitigation Center has categorized a substantial portion of Louisiana’s parishes as being in an “exceptional drought” state for an extended period.

Without supplemental irrigation, many lawns have gone dormant or have areas where the lawn will not recover. Many smaller bedding plants and shrubs have died. As we have experienced months of drought, we are really beginning to see the damage to trees. Shrubs such as azaleas, junipers, spireas, camellias, have been affected too.

You may have noticed that some trees are more susceptible than others. In my personal observations and in talking with people in the forestry, landscape and green industries, magnolia species and pines appear to be the most frequently affected. In research conducted in the southeastern United States, scientists found that pines and mesophytic species (those that thrive in moderate moisture conditions) are sensitive to drought while oaks are more drought tolerant.

Assessing damage after extended droughts is essential to determine the health and condition of your trees. Extended droughts can weaken trees and make them more susceptible to various issues.

Some signs that your tree is in distress: diminished leaf production, increased defoliation, interior thinning or dieback and smaller leaf size. If you want to assess the damage to our trees, start with a visual inspection of your trees to identify visible signs of damage.

Look for wilting or discolored leaves that are brown or yellow and prematurely dropping leaves, as they can be a sign of drought stress. Look for leaf scorch, where the edges of leaves turn brown, and check for cracks in the bark. Look for dying or dead branches. Many trees will sacrifice parts of the plant to survive. Check the overall canopy of the tree. Does it have a reduced canopy density or sparse foliage? This can be an indicator of drought damage.

You can check to see if a stem or branch is dead by gently pulling down on it to see how pliable it is. If it bounces back, it’s likely alive. If it snaps, it might be a goner. You can also scratch the bark of the stem. If you see green underneath, the plant is alive. If it is brown, it could be dead, depending on the species.

If you have real concerns that a tree is dead, another home assessment can be to check the condition of the tree’s root zone. Examine the roots for signs of damage such as root dieback or root rot. Gently dig around the base of the tree to inspect the roots without causing further harm. You can use a broom or large brush to gently sweep away soil.

It's often beneficial to consult a certified arborist or tree care professional for a more comprehensive evaluation. Arborists have the expertise to assess tree health and recommend appropriate treatments or interventions. A list of licensed arborists can be found on the website of the Louisiana Department of Agriculture and Forestry.

After assessing the damage, implement a supplemental watering and care plan to help the tree recover. Regularly monitor the tree's health and progress. Adequate watering, mulching and pruning may be necessary to aid recovery.

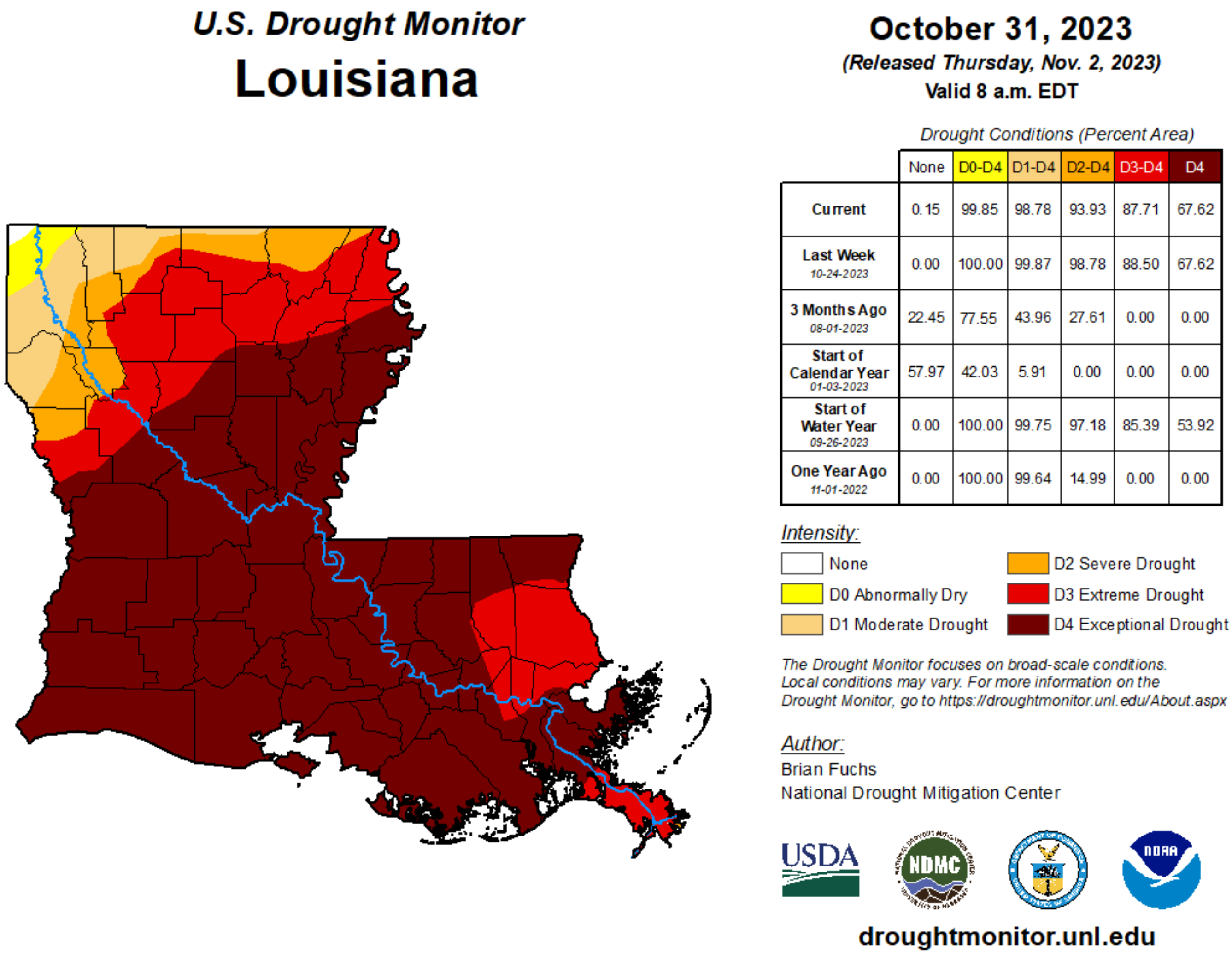
In severe cases, if a tree has sustained significant damage and poses a risk of falling or is unlikely to recover, it may need to be pruned or removed. A professional tree service can help with this decision and the necessary work.

Drought-stressed trees are more susceptible to pests and diseases. Keep an eye out for any signs of infestation or disease and address them promptly. Due to persistent drought conditions and multiple instances of freezing in recent years, the trees in our area have experienced higher levels of stress than usual, and this will make them more vulnerable to high winds, disease and pest pressures.

Remember that tree recovery from drought damage can be a slow process, and it may take several years for a tree to fully regain its health and vigor. Regular maintenance and care can help prevent future drought-related damage and promote tree resilience. Don’t give up on your trees immediately. You can take measures to help them survive as mentioned above.

Always consult with a local arborist or horticultural expert for guidance tailored to the specific conditions in your area and the tree species in question.

Trees will lose some branches in order to preserve the entire tree. Photo by Heather Kirk-Ballard/LSU AgCenter



U.S. drought monitor for Louisiana. Photo provided by the National Drought Mitigation Center

The drought has had a pronounced impact on pine trees. Photo by Heather Kirk-Ballard/LSU AgCenter

Azalea bushes have been impacted by drought in the landscape. Photo by Heather Kirk-Ballard/LSU AgCenter

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https://www.nola.com/news/louisiana-news-safety-concerns-officials-state-drought/article_e81697e2-3fc9-11ef-8ac9-2f4e95025cfa.html

Dead pine trees create safety concerns for Louisiana officials: 'Never seen anything like this'

Sara Cline | ASSOCIATED PRESS
Jul 11, 2024

This image provided by the USDA Forest Service shows a southern pine beetle completing metamorphosis into an adult at Kisatchie National Forest, in Pineville, La., Sept. 20, 2013. Louisiana officials say that dead pine trees, weakened by last summer’s drought and hungry beetles, are a major public safety concern and legislators on Louisiana's House Emergency Beetle Subcommittee gathered for their first meeting on Tuesday, July 9, 2024, to try to come up with solutions.
Erich Vallery/USDA Forest Service via AP, File

Dead pine trees, weakened by last summer's drought and hungry beetles, are a major public safety concern for Louisiana residents, with fears that fragile tree limbs may come crashing down on homes, roads, power lines and businesses without warning, officials say.

As more residents are reaching out to state and local officials asking for guidance and financial help to remove trees from their yards, legislators on Louisiana's House Emergency Beetle Subcommittee gathered for their first meeting on Tuesday to try to come up with solutions. From directing residents to charitable entities to asking the governor's help in seeking federal aid, officials say something must be done before there is widespread damage.

"You could be in your normal life and next thing you know you've got a tree over your bedroom, the kid's room, your car, or it hits a power line and causes a fire," said Republican state Rep. Michael Johnson. "In some sense, it's a silent danger that is ultimately going to happen."

Extreme drought struck last year in Louisiana, a state that typically is one of the wettest in the country. As millions of trees in the Bayou State struggled to survive, tiny bark beetles, namely the Ips Engraver, feasted on the pines. The pairing of weather and beetles caused more trees to die than some experts say they have ever witnessed before in central Louisiana.

Jim Meeker, a forest entomologist in Louisiana, said that when it comes to tree mortality in the area, he has "never seen anything like this."

"This is really a hazardous tree emergency," he said. "There are literally thousands and thousands of dead standing pine trees that are hazardous to health, property, travel corridors and right of ways."

Falling tree limbs are a constant concern in Louisiana, a state that frequently faces threats of tornados, severe weather and hurricanes. But with a large abundance of severely weak and dead trees, officials say outside forces like strong winds may not even be needed to knock the trees down.

"We have it bad enough when storms come through, much less with them (trees) falling with no warning," said Taylor Barras, the commissioner of the Louisiana Division of Administration.

Johnson said so far this year he knows of at least two cases in which weakened trees have fallen and killed people. In one case, a tree fell onto a woman's camper during a thunderstorm in Pineville. In another, a tree fell on a man in St. Landry Parish as he was standing in a parking lot.

State officials, including legislators and those in the Louisiana Department of Agriculture and Forestry, say they have been receiving numerous calls a day from residents worried about decaying trees in their yards and seeking resources to remove the pines. Tree removal can cost upwards of $1,000 and more than $3,000 for large trees close to the home.

The issue poses a hefty financial burden on residents, especially in a state that has the second-highest poverty rate in the country, according to data from the U.S. Census Bureau.

Johnson said he recently received a letter from an 87-year-old woman asking for help after being told it would cost her $6,000 to remove four trees.

"She has no money, but she's in danger of those trees falling on her home," Johnson said. "She's scared to death."

Additionally, if a dead tree is not removed and later falls on a neighbor's property, officials say many insurance policies likely do not cover the damage and the resident would be held liable.

On Tuesday, lawmakers discussed creating a list of volunteer groups who may help residents remove trees, in addition to possible emergency funding to aid homeowners.

They also looked to solutions outside of Louisiana — possibly in the form of congressional bills that could aid in federal resources. Gov. Jeff Landry could issue a state of emergency declaration, which could allow for the use of state resources. Landry could go a step further and ask President Joe Biden for federal money and aid.

Landry's office did not reply to an email seeking comment on the governor's possible plans.