Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS

Blowdown near the Gunflint Trail Corridor. Credit: USDA Forest Service Fuel Treatment Final Environmental Impact Statement.

Forecast for the Southern Boreal Forest: An Increasing Incidence of Severe Disturbance

Summary

On Independence Day, 1999, a storm system that originated over the Gulf of Mexico and passed through North Dakota dealt a severe blow to nearly half a million acres of the Superior National Forest in northern Minnesota. The blowdown, or derecho, packed winds exceeding 90 miles per hour and left in its wake downed and damaged trees and a dangerously high fuel load. Nearly half a million acres of forest were affected, primarily in the Boundary Waters Canoe Area Wilderness (BWCAW) and the Gunflint Trail Corridor, a strip of land in public and private ownership that supports a thriving tourist trade in the world's premier canoe wilderness. Immediately after the blowdown, the Forest Service began to implement a strategy to reduce risks to life and property in the corridor. Within the BWCAW, some exceptions to the Wilderness Act regulating human activity in primitive areas were allowed in accordance with the Forest Service mandate to ensure wildfire does not exit the wilderness. Prescribed fire applied on strategic sites at the boundary of the wilderness area later proved successful at containing a wildfire in 2006, but a second, human-caused fire in 2007 caused significant damage to buildings in the corridor. A number of research projects comparing treatments allowed in the corridor, including salvage logging and prescribed fire, helped guide the long-term management plan for the area. Results are not always clear, however, and managers have to consider a number of tradeoffs, balancing the risks to life and property versus the overall health of an ecosystem and the flora and fauna that have evolved along with moderate to severe fire with a return interval of approximately 70 years. Moreover, as the climate warms, managers may confront more-frequent severe weather events that will challenge their ability to respond.

Key Findings

- Wildfire is the primary disturbance that has shaped the southern boreal forest.
- Historically, a return interval of 50–70 years for severe, canopy, or stand replacing fire is considered typical in southern boreal forests.
- The big blowdown of 1999 in the BWCAW left a dangerously high-fuel load of downed and dying trees. Such a large blowdown is a relatively rare event, with an approximate return interval of 1,000 years, though smaller blowdowns occur with greater frequency.
- Climate change appears to be occurring more rapidly in the boreal forest and further north to the tundra and Arctic Zone than further south, increasing the likelihood of such severe weather events as the blowdown of 1999.
- In two key areas of the BWCAW that burned 7 and 8 years after the blowdown, key species of southern boreal forests, such as jack pine, may have difficulty recovering because the seed in the canopy was already on the ground and was consumed by these stand-replacing fires.
- Research on the relative risks and benefits of various fire mitigation strategies that are acceptable outside the wilderness area is ongoing in the Gunflint Trail Corridor. Comparing these treatments, including salvage logging, mechanical piling and burning, and prescribed fire, helps managers choose among treatment options on the boundaries of the wilderness area.

The best-laid plans

In July 2006, lightning ignited wildfire in the BWCAW of Superior National Forest in northern Minnesota. The Cavity Lake fire, which started near Sea Gull Lake in the north central portion of BWCAW, burned more than 30,000 acres (12,140 hectares) of forest that carried an extraordinarily high level of fuel loads following a severe weather event, the big blowdown of 1999. High temperatures, prolonged drought, and the heavy fuel load conspired to produce a very high intensity fire. “The Cavity Lake fire burned the soil down to the bedrock in some areas, which are now pink granite,” says Lee Frelich, director of the Center for Hardwood Ecology at the University of Minnesota.

The Cavity Lake fire burned away organic soil, exposing pink granite. Note the extreme severity of fire during drought. Credit: Dave Hansen, University of Minnesota.

Despite the severity of the fire, the Cavity Lake fire was completely contained within the wilderness. This fortunate outcome was due in part to a long-term management plan of strategically sited prescribed fire, primarily on the boundary areas of the wilderness area, and a mix of fire and mechanical treatments in the Gunflint Trail Corridor, a swath of land about 60 miles long that cuts through the BWCAW. The corridor is in public and private ownership with houses, resorts, and campgrounds.

The following spring, in May 2007, another fire was ignited, this time from an escaped campfire inside the Gunflint Corridor. The results of that fire were not so serendipitous. The Ham Lake fire, though not as severe, moved fast and quickly made its way into standing timber. It burned 160 structures in the corridor, and crossed the international boundary into Canada. “When we were making plans to protect the Gunflint Corridor, we only planned for fires coming from inside the wilderness,” says Frelich, who has conducted intensive research on the response of boreal forests to the blowdown of 1999 and to subsequent prescribed fire and wildfire. “The Cavity Lake fire was stopped by prescribed burns, and then this fire comes along in the only spot where you could have started a fire.”

Jack pine forest burned by Ham Lake Fire, two months later, July 2007. Note the understory vegetation resprouting. Credit: Dave Hansen, University of Minnesota.

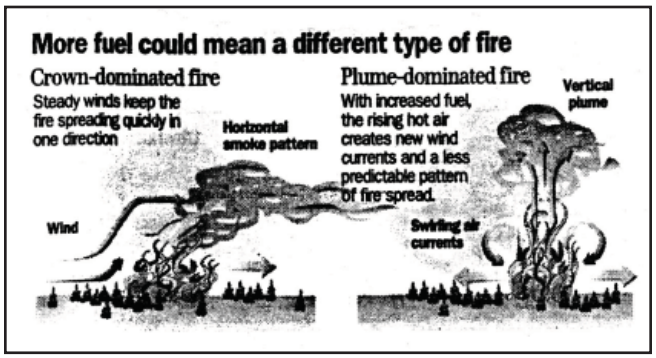
The coming fires

Severe wildfires compounded by the heavy fuel load were not only considered likely by the Forest Service and local residents in the Gunflint Trail Corridor, they were deemed inevitable. The big blowdown carried heavy rain

and straight-line winds, or downbursts, gauged at more than 90 miles per hour, leaving behind nearly half a million acres (200,000 hectares) of downed or damaged trees in a band 30 miles long and four to 12 miles wide. Fuel loads in the area increased from 5 to 20 tons per acre to 50 to 100 tons per acre.

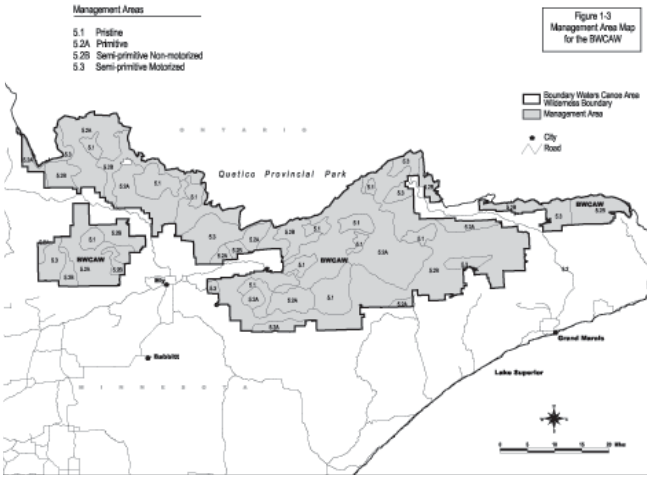
Close-up of a heavy blowdown area. Credit: Dave Hansen, University of Minnesota, 2000.

As emergency search and rescue operations wound down, rescue teams were relieved to discover that no lives were lost in the event. Resource managers and landowners then began to cast a wary eye at the unprecedented threat of wildfire in the area.



Credit: USDA Forest Service Fuel Treatment Final EIS.

Acting quickly and with careful consideration of the risks and benefits, the Forest Service immediately began to prepare an EIS to evaluate the threat of wildfire and to determine the best approach to reducing fuel loads working within the constraints imposed in wilderness areas. The Wilderness Plan for the BWCAW, adopted in 1993, dictates that the Forest Service must manage the area "in a manner that perpetuates and protects its unique natural ecosystems, provides an enduring wilderness resource for future generations, and provides opportunities for primitive and unconfined recreation." To meet that goal, mechanical treatments and salvage operations are not allowed within the wilderness. On the other hand, the Forest Service is responsible for wildfire that exits lands under its jurisdiction.



Management area map for the BWCAW. Credit: USDA Forest Service Fuel Treatment Final EIS.

The Final EIS for the BWCAW, approved in 2000 by the Council on Environmental Quality, recommended prescribed fire treatments—including broadcast burns, understory burns and patch burns—on 79 high priority sites strictly for the purpose of reducing risk to people, land, and property outside the wilderness boundary. In more remote areas where the risk to life and property is low, wildfire is allowed to burn as part of a broader policy, Wildland Fire Use for Resource Benefits. Basically BWCAW now has designated zones where the risk of wildfire exiting the area is considered low.

The plan proposed to treat between 47,000 and 81,000 acres (19,020–32,780 hectares) over a 5- to 7-year time frame, but that schedule is dependent on appropriate weather conditions. "Years 2002 to 2004 were not good years for prescribed burns," Frelich says. "It rained much of the time." The three prescribed burn treatments include broadcast burns, patch burns, and combination patch and understory burns. In a broadcast burn, fire is ignited and allowed to burn large units between 200 and 3,500 acres (81,000–1,416 hectares). Fuel intensity ranges from low to high. Fine fuels are consumed by fire, but snags and downed trees remain. In a patch burn, isolated fuel patches located strategically near the boundaries are burned to decrease the likelihood of fire escaping the wilderness. In a combination patch and understory burn, an understory burn removes small fuels, shrubs, and young trees. It is used primarily in red and white pine forests that are adapted to low to moderate severity fire. Understory burns destroy the fuel ladder and maintain the canopy. Combination treatments are applied to stands of between 80 and 3,000 acres (32–1,214 hectares).

Three Mile Island: Pick-up sticks

Seagull Lake is at the wilderness/tourism interface at the end of the Gunflint Trail Corridor. It's the last lake in the area that can be accessed via motorboat. Though about half the lodges and houses were removed when the 1964 Wilderness Act created the BWCAW, lodges, cabins,

campgrounds, and private homes still remain on private land in the area.

Off shore is a 1,000-acre (404-hectare) island, Three Mile Island, which is close enough to land that wildfire there could jump across the water and threaten life and property. The island was included in the management plan to use prescribed fire to reduce the risk of wildfire exiting the BWCAW.

In September 2002, the Forest Service conducted a prescribed burn. "This was a very severe prescribed fire," says Roy L. Rich, who was at the time a Ph.D. candidate in Forestry at the Department of Forest Resources, University of Minnesota. Before the fire was set, Rich conducted an experiment to assess how prescribed fire severity relates to blowdown fuels.

Crew at work in the Three Mile Island prescribed burn, July 2007. Note the prolific paper birch regeneration. Credit: Dave Hansen, University of Minnesota.

The forest includes four types typical of southern boreal mixed species: red pine and white pine dominant, jack pine dominant, aspen dominant and birch-fir-spruce dominant. The experimental plots were all on south facing slopes to eliminate variations in soil moisture. Rich measured a number of variables before and after the prescribed fire, including duff thickness, moss and lichen cover, and fuels. Fuel measurements were made using the standard line intersect method, counting sticks and measuring their size, calculating volume and how it is distributed from fine fuels, less than 2.75 inches (7 centimeters) in diameter, to large woody debris. Rich found that in all forest types where the blowdown severity was high, prescribed fire reduced fine fuel loads by about 90 percent. "Prescribed fire did a good job of burning the fine and smaller dynamic fuels," he says, though the effects will not last over the long term. "Prescribed fire is successful in controlling fine fuels for a short period of time," he says.

"Prescribed fire is successful in controlling fine fuels for a short period of time"

Though the prescribed fires were eventually considered successful in keeping the Cavity Lake wildfire of 2006 from exiting the Wilderness Area, they cannot reverse the damage from the big blowdown. At Three Mile Island, as in much of the BWCAW, the jack pine that dominates much of the

For the birds

In 1976, an associate professor of botany at the University of Illinois, Urbana, embarked on what was to be a three-year study of the vegetation and bird population of the Devils Walk Bay area of the BWCAW. Setting out in spring, Alan Haney, an Ecosystem Restoration Expert who is today a Professor Emeritus of Forestry at University of Wisconsin-Stevens Point, College of Natural Resources, began gathering data on a 22-acre (9-hectare) plot of mature jack pine and black spruce forest, documenting the vegetation and recording the territories of nesting birds. The experimental site was in a mature forest that had burned in a stand-replacing fire in 1903.

By chance, in fall 1976, lightning ignited a 3,380-acre (1,368-hectare), wildfire in the forest, including the experimental site. This fire was not only stand replacing, it was also career altering. The three-year study turned into more than 30 years of data collection at the site. "The fire opened up the opportunity to look at effects of fire over the long term," Haney says.

Devil's Walk Bay north of Seagull Lake, first spring after fire of late summer 1976. Credit: Alan Haney.

Over the years Haney and colleagues were able to observe not just the natural succession of post-fire forest vegetation, but also the natural succession of birds. Before the blowdown, not surprisingly, Haney documented large populations of tree foliage birds, canopy-dependent species such as Blackburnian and Bay-breasted Warbler. Immediately after the fire, Haney observed an increase in the number of ground-brush foragers, which peaked at about 7 years after the fire while tree foliage searchers reached their lowest point. Woodpecker and secondary cavity nester populations also increased for 5 years as did transient species. A striking finding was the 4-fold increase in transient species 26 years after the fire. Even 30 years after the fire, the number of species in the forest was 70 percent higher than in the unburned, mature forest before the fire. "Recurring fires greatly contribute to the diversity of species that can occupy an ecosystem," Haney says.

southern boreal forest has been dealt a one-two punch from the blowdown of 1999 and subsequent fire. "Historically, jack pine regenerates after wildfire," Rich says, "but after the blowdown, most of the crowns were already on the ground and the seed source has been burned."

When is salvage logging acceptable?

Early studies following the big blowdown have established a baseline of knowledge on the effects of various fuel reduction treatments, including prescribed burning, salvage harvesting, and machine piling of down trees with or without burning. Daniel W. Gilmore, at the time a Professor with the Department of Forest Resources at the University of Minnesota, and colleague John C. Zasada, who was with the Northern Research Station in Grand Rapids, Minnesota, began immediate studies in the Gunflint Trail Corridor after the blowdown.

Their comparison of treatments showed that prescribed fire was effective at reducing fine fuel loads, while salvage logging reduced both fine and heavy fuel loads. This knowledge is critical to resource managers in the short term in situations where minimization of fire risk is paramount. For the long-term health of the forest, however, the picture is somewhat murkier. Increasingly, land managers concerned about overall ecosystem benefits are adopting the natural disturbance paradigm. Harvest can be used in this paradigm to break up the continuity of fuel loads stand by stand or in corridors. Elsewhere, wetlands or large bodies of water can prevent the spread of wildfire. In remote wilderness areas, wildfire can be allowed to return to the forest. And in some areas, coarse woody debris can be left untouched as it plays an important role in the life cycle of a number of species. "Wildlife species use coarse woody debris as part of their life cycle," says Gilmore, who is currently the Environmental Health Director for Oneida County, New York. Species such as salamanders, which are at the base of the food chain, thrive in decaying logs. This can affect species all the way up the food chain.

. . .salvage logging reduced both fine and heavy fuel loads.

In a study of avian and vegetation responses to the blowdown and salvage logging, the first of its kind in a southern boreal forest, Alan Haney and colleagues compared untreated and salvaged plots of mature black spruce/jack pine forest after the blowdown through 2005. The blowdown had destroyed more than 90 percent of the canopy in the study area. "Salvage logging absolutely reduced the breeding bird population," Haney says, with dramatic declines in diversity, population density, and abundance of non-territorial species compared to unsalvaged plots. "The whole trajectory of succession of salvage logging released aspen production, a deciduous tree," Haney says, so the subsequent forest will be typical of logged forests rather than wilderness.

Management Implications

- The rapid response of the Forest Service in the BWCAW to prepare the EIS and implement the recommendations can serve as a model for land managers facing similar severe weather events in other regions.
- In considering whether or not salvage operations are acceptable, managers have to balance risks and benefits not only for life and property but also for the ecological health of systems that support a wide variety wildlife, some of which are dependent on moderate to severe fire.
- Strategically sited prescribed fire is an important tool to minimize immediate risks to life and property after severe weather events.
- Prescribed fire is labor intensive, very expensive, and sometimes risky. In areas where salvage logging is allowed, mechanical harvesting may be used strategically with or without prescribed fire to create corridors in conjunction with natural barriers to wildfire such as wetlands or larger bodies of water.

Further Information: Publications and Web Resources

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Gunflint Corridor Fuel Reduction Final EIS: http://www.fs.fed.us/r9/forests/superior/storm_recovery/gunflint_corridor_final_eis.php

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