Innovations in Fuels Management: Demonstrating Success in Treating a Serious Threat of Wildfire in Northern Minnesota

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Abstract—*This case study illustrates the positive effects of strategic fuels treatments in continuous heavy fuels. In 1999, a severe windstorm blew down close to 1,000 square miles of forest land in northern Minnesota and Canada. As much as 400,000 acres of the blowdown occurred in the Boundary Waters Canoe Area Wilderness. Fire experts were invited to assess the hazardous fuels problem and to design and implement a treatment strategy that would effectively slow the spread of wildland fires and reduce the threat of a wildfire moving out of the Boundary Waters Canoe Area Wilderness (BWCAW) and into adjacent homes and businesses along a highly used area of the Superior National Forest. Treatment blocks were strategically placed in a brick/grid pattern across the blowdown landscape in order to slow a wildfire's progress while only treating 15 to 20 percent of the total area. Success of those treatments was demonstrated when a large fire threatened the area of businesses and homes along the Gunflint Trail in July 2006. While the brick/grid pattern treatments were not completely in place, the fuel treatments were effective in containing the 32,000 acre Cavity Lake Fire. The fire behavior dramatically dropped within the big treatment units, allowing firefighters to successfully implement control tactics and protect $31 million worth of structures in the direct path of the fire.*

Introduction

The setting for this case study is northeastern Minnesota, the home of the Superior National Forest (fig. 1). This part of the State is dominated by boreal forest, combining aspen, paper birch, balsam fir, white and black spruce, jack pine, red pine, and white pine. All of these species with the exception of red and white pine are short lived trees (60 to 100 years) and are adapted to large-scale disturbance, including wild fire. After heavy logging at the turn of the 19th century, the area was designated as a National Forest where reforestation

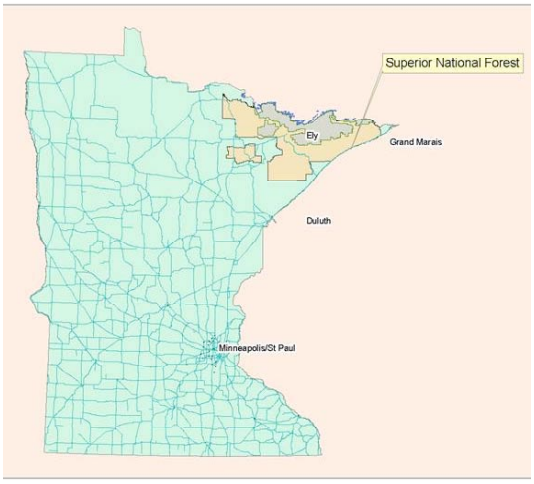

Figure 1—The Superior National Forest, in the northeastern part of Minnesota, borders Canada and shares a vast Wilderness resource with Canada, known as the Boundary Waters Canoe Area Wilderness.

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and protection became the primary objectives for decades. By the 1990s the Superior National Forest had abundant second growth forest. Although by this time forest management was common, a large part of the Forest had become mature to overmature and more than 1 million acres had been protected as the Boundary Waters Canoe Area Wilderness (BWCAW).

On July 4, 1999, a tremendous wind and rain storm caused substantial damage to the Superior and Chippewa National Forests as well as other public and private lands throughout northeastern Minnesota and Ontario, Canada. The storm, described as a Derecho, brought the jet stream to the surface of the forest, and winds of nearly 100 miles per hour flattened roughly 1,000 square miles of forest land. Approximately 477,000 acres of the Superior National Forest were damaged by the blowdown, concentrated in the BWCAW and in small, scattered areas on the remainder of the Forest. Fuel loadings in the damaged areas increased from an average of 10 tons per acre to more than110 tons per acre. A five county area in northeastern Minnesota was declared a Federal disaster by the President on July 28. The path of blowdown stretched over 125 miles and at times was 20 miles wide and as is typical for the Lake States lies in a direction from southwest to the northeast. Dozens of homes and businesses were damaged, hundreds of miles of roads were closed by tree fall, and more than 60 people camping in the BWCAW received injuries. The Superior National Forest recognized the immediate threats to life and property and initiated search and rescue efforts for those injured. Our second priority was to open roads and clean up property and businesses outside of the BWCAW.

Once the immediate health and safety of residents and visitors had been taken care of, the Forest set about to understand the long-term changes created by this new massive fuel bed. Obvious, at least to the Forest Service, was the increased risk of a major wildfire threatening everything in the path of the blowdown. Of particular concern were three narrow corridors of heavy private ownership that bisected the Wilderness; those corridors lie in the direct path of the blowdown. This case study involves one of those corridors, called the Gunflint Trail, basically a County Highway that bisected the BWCAW and dead ended near Canada. Directly in a downwind path was the urban interface of the upper Gunflint Trail where more than $31 million of homes and business exist. This area is also one of the most popular entry points for the Boundary Waters Canoe Area Wilderness (fig. 2).

Assessment

To fully understand the magnitude of the threat and to help develop alternative strategies, the Forest enlisted the help of a team of experts in fire behavior and fuels management analysis to provide an assessment of the Forest's situation. The team was lead by Dr. Mark Finney of the Rocky Mountain Research Station of the USDA Forest Service. Analysis was completed on several aspects of fire behavior to assist in planning necessary recovery measures. Modeling was done on fuel to estimate the risk of a fire spreading into the areas of homes and businesses within the Wilderness (fig. 3). This information was used to determine the breadth of fuels treatments necessary within the Wilderness in order to reduce the probability of a fire exiting the Wilderness. Other modeling was done to determine the intensity of behavior expected from a blowdown fire to allow us to determine appropriate suppression strategies and tools.

Figure 2—The nearly complete blowdown near the Seagull Lake area at the end of Gunflint Trail. Seagull Lake is a highly popular recreation site.

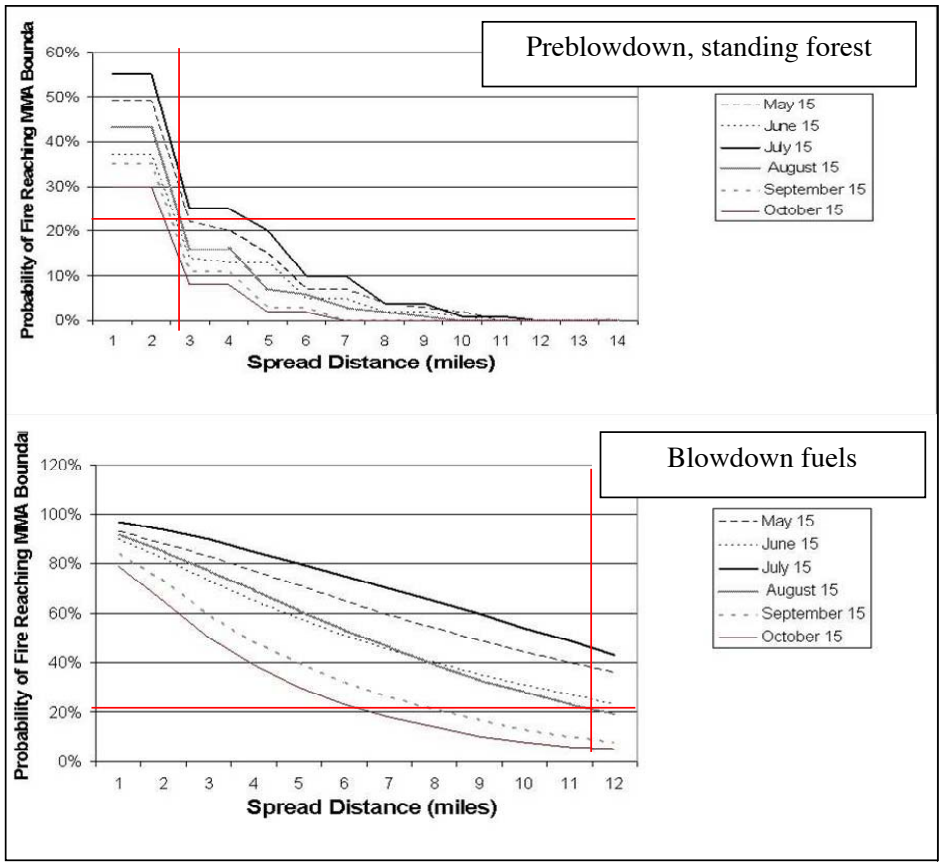

Figure 3—Comparison of probabilities that a wildfire might exit the BWCAW boundary and enter the urban interface. Top chart demonstrates that farther than 3 miles from the boundary, the probability drops well below 20 percent. Bottom chart demonstrates that even at 11 miles from the boundary, the probability is still greater than 20 percent.

Figure 4 demonstrates the dramatic increase in fire intensity in the low to moderate fire danger conditions. The yellow arrows indicate when fires under each set of conditions will exhibit such intensity that direct suppression tactics will have little impact. The two blue lines display the narrow window estimated to be available to implement prescribed fires in blowdown fuels.

Conclusions regarding fire behavior were presented to the Forest upon completion of the Fuels Risk Assessment that lead to a new strategy for managing fuels on the Forest. Those conclusions were:

- Fire will impact the BWCAW; it is not "if" a fire will happen, but "when."
- Blowdown will burn more intensely under a wider range of burning conditions.
- Blowdown will result in more consistent fire growth (less sensitive to weather variations).
- Blowdown fires will demonstrate faster growth, but not faster than crown fire.
- Blowdown fires will resist control, particularly using standard tactics.
- Treatments will slow, but not stop, fire growth.

Fuels from similar blowdown events in Canada demonstrated the ability to contribute to extreme fire behavior to beyond 30 years after the event. Further, the Superior National Forest has a history of at least 1 year each decade where weather conditions contribute to large fire growth. Adding those two factors together, we understood that there will be a significant wildfire in the blowdown if not treated. Therefore, a strategy for addressing blowdown fuels was necessary even though much of the blowdown occurred within the Wilderness.

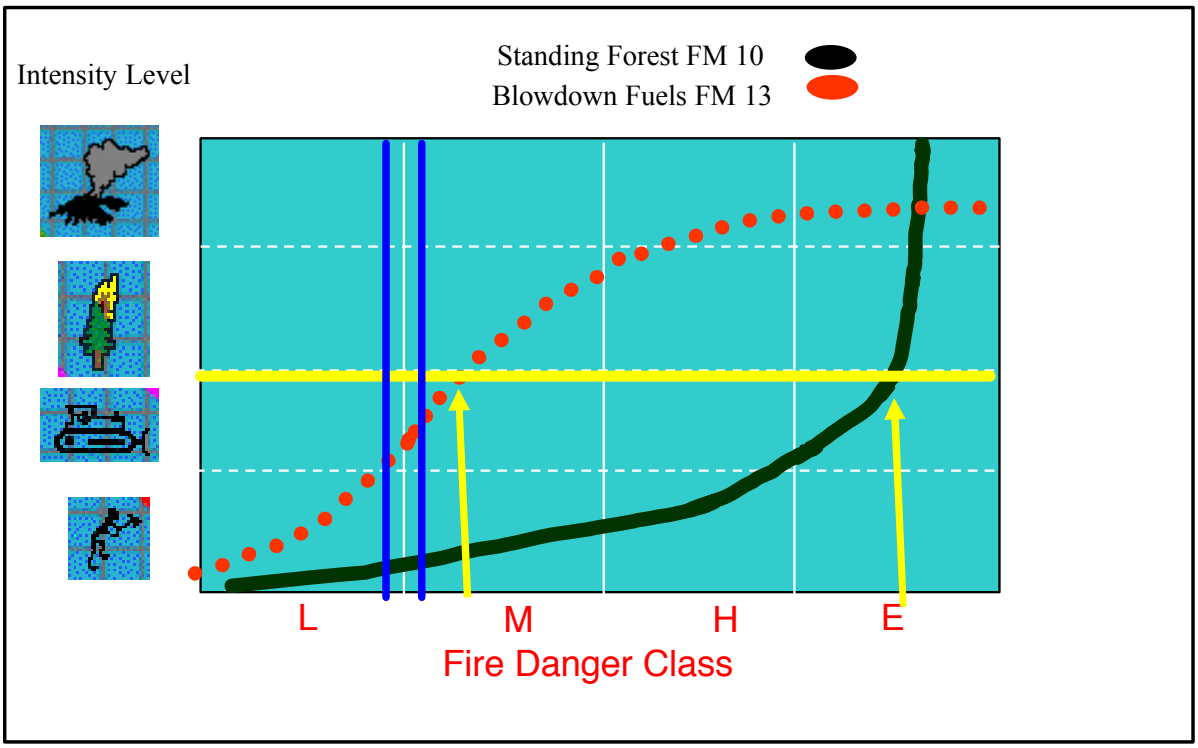

Figure 4—Hauling chart showing comparison of fuels related fire behavior.

Developing a Plan

Four critical focal points were emphasized in the Forest's response to the increased threat of a wildfire in the blowdown:

1. Intensify fire prevention.
2. Change fire suppression tactics and increase suppression capabilities.
3. Intensify emergency action planning, including evacuation planning.
4. Initiate fuel treatment techniques

Prevention

History tells us that prior to the blowdown, nearly 90 percent of the fires outside the Wilderness and 50 percent of the fires inside the Wilderness were human caused. Because of the volatility of the fuel bed left from the storm, time was necessary in order to implement all four prongs of the response strategy. It was critical to delay the impending wildfire long enough to complete the planning phases for our suppression tactics and evacuation planning, as well as time to employ the appropriate level of fuels treatment. Using the information gained from the Fuels Risk Assessment allowed all the levels of government to develop key messages and strategies to implement a prevention program. In 2006, the Superior National Forest experienced 128 fire starts of which only 10 were human caused, and none developed into a significant fire.

Emergency Action and Suppression Capability

Within the first year, county, State, and Federal governments had developed evacuation plans for each of the areas of urban interface. Each level of government brought a new set of fire resources to northeastern Minnesota including hand and engine crews, helicopters, and air tankers. Adding to our complement of available tools were the air tankers made available from Canada through border mutual aid agreements.

Fuel Treatment Techniques

With the information at hand, an overall strategy for treating the blowdown fuels was crafted: "start in close and work our way out." Fuels in and around homes, businesses, and areas where people congregate would be treated first. A two-pronged approach was used. First, fuels were completely removed from homeowner sites using either machinery or hand tools and transported to disposal sites. Second, homeowners took it upon themselves to install sprinkler systems on and around their buildings. With the abundant water in the vicinity of the Gunflint Trail, and given enough time, homeowners could create a blanket of wet fuels surrounding their homes.

Next in our strategy, we would treat areas adjacent to the previous points using both machinery and prescribed fire, creating a fuels treatment buffer. The final step would be to use prescribed fire to create spatially located treatments within the BWCAW to slow the spread of a wildfire (see fig. 5). The formal decision to carry out that strategy was done through three Environmental Impact Statements, two Environmental Assessments, Alternative Arrangements coordinated through CEQ, and some small Categorical Exclusions.

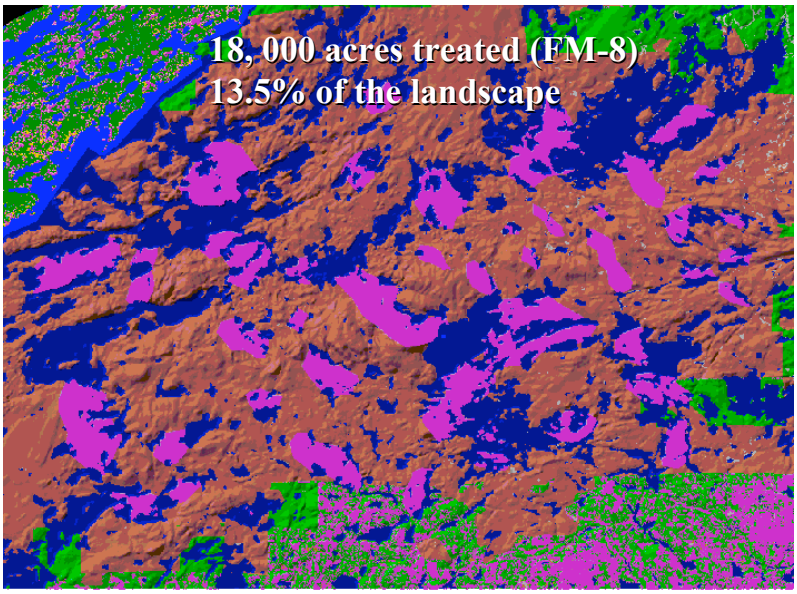

Figure 5—Strategic placement of treatments (SPOTS). Dr. Mark Finney (USDA Forest Service) developed a theory for treatment within the BWCAW where patches of prescribed fire land would connect to bodies of water. The concept is to interrupt the fuel bed to slow a fire and allow an opportunity for control measure to be used.

Implementing the Plan

Expediency was critical and the first two phases of the plan were completed by the end of 2001. To the greatest extent reasonable fuels treatments outside the BWCAW were completed using logging and other mechanical methods. However, Forest Service policy combined with limited, if any, access and steep, rugged terrain, precluded us from using mechanical tools to treat fuels inside the Wilderness. Prescribed fire with a heavy component of aerial resources was necessary to complete the fuels reduction within the BWCAW.

Inside the BWCAW, roughly 32,000 acres of complex blowdown burning to create the spatially located treatment units had been completed by the end of 2005. This included treating a band of the heaviest blowdown surrounding the upper end of the Gunflint Trail. We started slowly with smaller units that included better opportunities for control. We chose conditions where fuel and soil moistures were high enough so that the fire only consumed fuels generally 3 inches in diameter and smaller. The concept was to treat only those fuels that would contribute to high fire intensity and spread rates.

Following each year of burning we would conduct a formal review of operations, organization, cooperation, planning, fire behavior, and fuels consumption. Each year the lessons learned were rolled into the next year's burn plans to improve our knowledge, skills, abilities, and success. From the first fires, it was evident that the fuels Risk Assessment contained credible information and projections. Our ignitions efforts demonstrated that on the same day, same location, and same conditions, fire in standing timber would barely creep while fire in immediately adjacent blowdown displayed 50 to 60 ft flame lengths. As our experience grew, so did our confidence in burning larger units at one time, and eventually we were burning 3,000 to 4,000 acres in one unit.

Monitor, Learn, Adapt, and Tell the Story

Conducting complex prescribed fire, using a myriad of aircraft, experiencing fairly intense fire behavior, and generating copious amounts of smoke in the backyards of homeowners does not necessarily lead to great public relations.

One point we implemented from the beginning was to bring information back to the public in an open forum where questions could be asked and our progress could be discussed. We took the lessons from our after action review and presented those each year, along with a discussion on the changes we made as a result of lessons learned. Five years of success with fire, talking to people regularly, providing information, and inviting the public to observe our actions brought the comfort of most of our public to an acceptable level. However, those at that comfort level were not necessarily the vocal ones. It seemed that we could not convince everyone of the benefits of our actions. However, the positive relations we held with the majority proved to be a great asset in our interactions with critics.

Testing the Plan with Our First Significant Wildfire

The year 2005 brought dry conditions and in August a lightning strike pushed by strong winds brought about our first project size fire. Although the Alpine Lake fire was in the general blowdown area, the fire spread for the first day was in standing conifer. An early break in the weather allowed us to control the fire spread right at the trigger point we had outlined for evacuation. We took the time to compare fire behavior and fire effects between this fire and the blowdown burns we have implemented. One notable point was that a crown fire stops its major movement when the wind stops blowing, whereas a blowdown fire continues to spread until it runs out of blowdown fuels.

We conducted a BARC (burn area reflectance correlation) analysis to look at the effects between the fires. Because we implemented our prescribed fires with soil moistures at higher levels, we noticed the consumption of organic soil layers was much less with prescribed fire than with wildfire.

However, the real unanswered question was: Would our prescribed fire treatments withstand the test of a major wildfire?

With 6 years of preparation under our belts, 2006 once again proved to be dryer than normal. On July 14, the lightning storm moved across northeastern Minnesota and Ontario, Canada, igniting about 40 fires across northern Minnesota and several hundred in Ontario. The Cavity Lake Fire was reported by a patrol aircraft at 1533 and air tankers were ordered at 1537. The fire was 6 miles inside the BWCAW but was also in some of the heaviest blowdown fuels and upwind of several homes, businesses, a heavily used campground, and a youth camp located within the Gunflint Trail corridor. Although we had not fully implemented our fuels reduction plan, we did have a buffer of prescribed fire between Cavity Lake Fire and the values at risk.

Heavy action by water scooping air tankers had little effect on the blowdown fire and it grew to over 100 acres within 4 hours. Flame lengths were estimated to be 100 to 200 ft in blowdown causing spotting of up to 1,000 ft. The fire grew steadily through the night and each of the next 2 days so that by late afternoon of July 16 it covered about 3,000 acres.

We had a fire in the same general area 2 weeks earlier called the Rog Lake Fire. Our airtankers proved successful at halting the forward spread of that fire and provided enough control to allow firefighters to cut a path through the blowdown to actively suppress the fire. This particular fire was only 150 yards from the shore of Seagull Lake, but it took a crew of six firefighters, using chainsaws, 9 hours to cut a path to get to the fire. Cavity Lake Fire's origin was nearly 1.5 miles from the closest point of entry for firefighters. There was no safe method to approach the fire from the ground because the entire distance to the fire was through some of our heaviest blowdown.

The BWCAW is the heaviest used Wilderness in the National Forest System with nearly 12,000 persons per night camping somewhere in the Wilderness during the summer, the heaviest use time of year. The primary concern of our ground forces was to interact with the Wilderness visitors to ensure they were safely moving out of harm's way.

As the end of the third day approached, Cavity Lake Fire had not reached the prescribed fires treatments; however, the evening of July 16 brought a different story. A thunderstorm with winds from 40 to 50 miles per hour created a fire storm of significant size. Our meteorologists gave enough advanced warning to ensure all aircraft and firefighters were out of harm's way. However, the storm began late in the evening and continued past dusk and provided us no opportunity to assess the extent of fire growth or location. Reports persisted through the night that fire had spread into the forest surrounding the homes and youth camp that our prescribed fires were supposed to protect.

Years earlier the public had been vocal about our prescribed fire treatments in and around Seagull Lake, a major attraction for the end of the Gunflint Trail. The view and water quality were vital to the success of several businesses and were important to residents of the lake. We did treat the one major island that was about 3 miles long (oddly called 3-Mile Island), but we did consent to leave some smaller islands untreated by our prescribed burns. The public insisted these islands would not be affected in a fire advance, but we had some doubt; nevertheless, the islands remained with untreated blowdown.

The thunderstorm of the evening of July 16 lasted 2 to 3 hours, but it brought no rain. Our patrols through the night indicated no structures lost, but it was not known exactly how close the fire had advanced. As daylight came, we were able to put aircraft up and assess the situation and were stunned at what we saw. During the hours of the thunderstorm, the fire tripled in size to roughly 12,000 acres. Those small islands that we had agreed to leave untreated had in fact become involved in the advance of the fire (fig. 6) as it apparently island-hopped across nearly 4 miles of water and ignited the mainland in the vicinity of the homes. What we also saw was that the fire had

Figure 6— One of the small islands in Seagull Lake that was not supposed to carry fire. Several smaller islands were not treated with prescribed fire, and looking back, "No Treatment" proved to be a valuable teachable moment. (Photo by Carol DeSain)

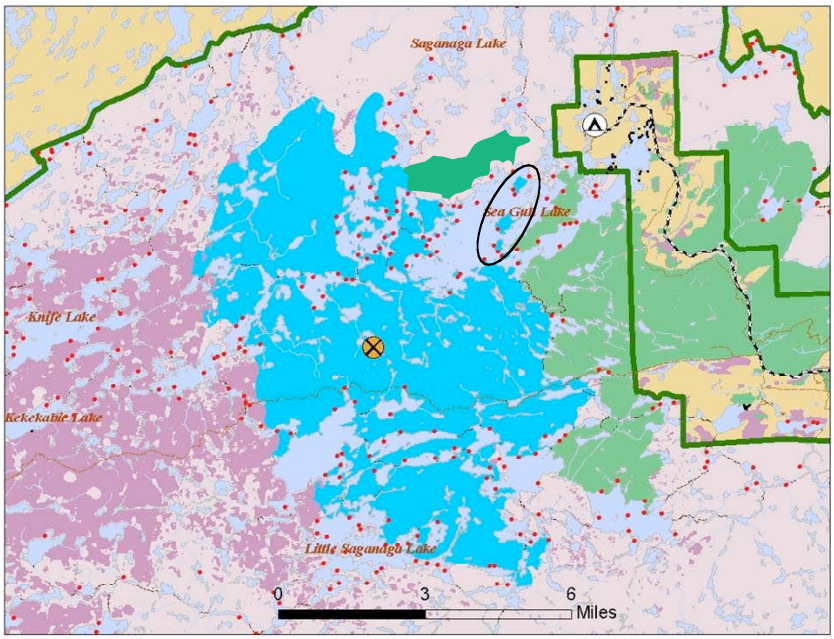

Figure 7—Final map of the Cavity Lake Fire. Origin of the fire is shown with the X while the blue shows the final extent of the fire. Prescribed fire treatments are shown in green on the eastern edge of the fire; further blowdown is shown in red to the west. Gunflint Trail corridor is shown within lines east of the fire. The area with many homes is near the symbol for the campground. The oval shows the islands that were not treated with prescribed fire but contributed to its spread.

spotted into the prescribed fires and was smoking at up to a half mile into the burns. However, the treatments had taken enough energy out of the fire to halt the spread toward the homes. A striking contrast existed between the black of the wildfire and the remaining green within the treated areas.

Over the next 2 weeks the fire continued to grow until it reached its final size of 32,400 acres (fig. 7). It challenged our suppression crews in other areas, but our fire specialists were able to use a combination of lakes and our prescribed fires to anchor control tactics that included burnout operations. Finally, 1.5 inches of rain stopped the spread and allowed more direct control measures, and though it smoldered into September, the fire made no further progress.

Results

During the course of the fire, we again brought fire behavior experts back to provide both a long-term assessment of fire growth potential and also to evaluate the Fuels Risk Assessment assumptions and our treatments as they related to Cavity Lake Fire (fig. 8). Our overhead team relied on the assessment to make decisions on control tactics including implementing the concepts of cost containment that are important to the Forest Service. Some of the major points from the evaluation:

- Fire in blown-down fuels behaved as predicted.
- The fuel treatment areas have functioned as designed.
- Prior analyses were based on “average” fire season climatology data.
- Probabilities for fires to exit the Wilderness as well as the projected fire sizes are greater than previously thought in a higher than normal fire danger year.
- It was a “Good Plan.”

Looking back at the untreated islands that contributed to the fire spread across Seagull Lake, I conclude that it was not necessarily a bad decision. Although the fire was carried across the lake, enough energy was removed from the fire that movement on the mainland was minimal, and we easily controlled it there. The event fully demonstrated to the public that the conclusions from the Fuels Risk Assessment were not overstated.

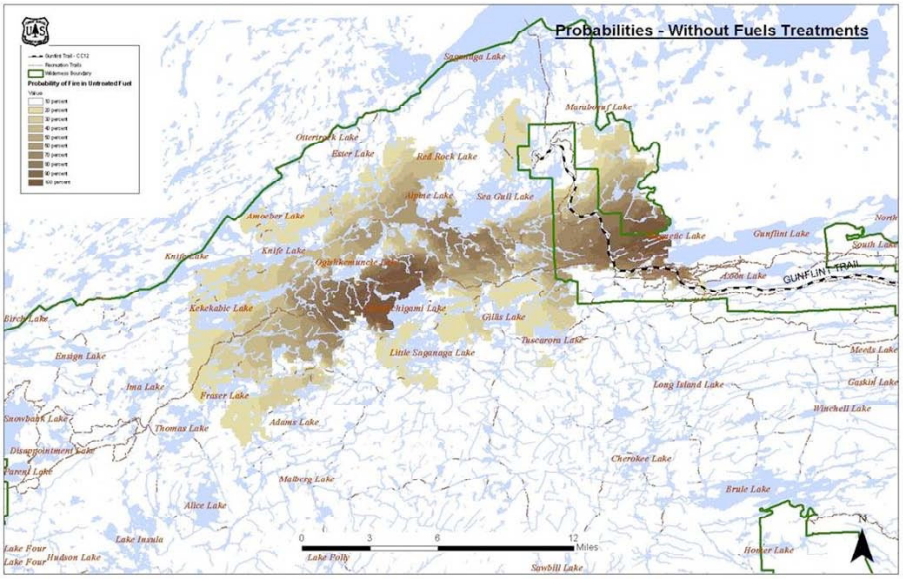

Figure 8—Fire behavior experts returned to help assess long-term fire behavior period, and to assess what the fire would have looked like without prior treatments. The darker the color equals higher probability of fire spread. The upper Gunflint Trail would have been inundated with fire.

Lessons Learned

As we do each year, we gathered in the fall and conducted a full after action review and looked for lessons learned. While there is always something to improve on, the positive factors and lessons learned from our review are as follows:

- Enlist outside expert analysis to aid your planning.
- Assess your fuels situation and develop strategies and tools to manage them.
- Fuels treatments are essential to reducing the threat of wildfire in an urban interface setting.
- Prescribed fire is effective as a method to take the energy out of a blowdown fire.
- You can never do too much public education or provide too much information on fires in the interface, and proper planning with practice pays off.
- Evacuation planning and practice (whether you use it or not) pays high dividends in terms of calming public response.
- The right decision is not always the popular decision.
- Using national resources to assist with long-term assessments provides critical information for decisionmaking on large events.
- Incident business advisors and buying teams help keep a District Ranger out of hot water during transition fires.