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# Supplemental Information Report

## Boundary Waters Canoe Area Wilderness Fuel Treatment Final Environmental Impact Statement

Superior National Forest  
St. Louis, Lake and Cook Counties, Minnesota



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## INTRODUCTION

As a result of the extensive blowdown within the Boundary Waters Canoe Wilderness Area (BWCAW) caused by a July 4, 1999 windstorm, a fuels treatment project was proposed. The purpose and need for the project was described as follows:

*"...to improve public safety by reducing the potential for high-intensity wildland fires to spread from the BWCAW into areas of intermingled ownership, which include areas containing homes, cabins, resorts, and other improvements and areas across the international border into Canada" (BWCAW Fuel Treatment Final Environmental Impact Statement, 2001).*

The Final Environmental Impact Statement (FEIS) for the Boundary Waters Canoe Area Wilderness Fuel Treatment was completed in May 2001 and the Record of Decision based on that analysis was signed in May 2001. The selected alternative allowed for the application of fire on 86,260 acres in 79 burn units within the BWCAW. The units were chosen in a manner that would slow wildfire spread and allow fire managers to use a variety of wildfire suppression methods. The long-term goal was to reduce the risk of fire exiting the BWCAW; with an added benefit of creating conditions where the Forest Service could allow fire to play a natural role in **the BWCAW**.

Implementation of the decision began in 2001. Throughout this timeframe, the Forest has continued assessment of fuel conditions resulting from the blowdown. Conditions today are a reflection of implementation of the decision, wildfire, natural decomposition of downed material and natural regeneration. A robust monitoring program has informed decision makers and fire managers of fuel conditions and continued hazardous fuel reduction needs. A large number of burn units have been completed (49,367 acres) and an additional 16,979 acres have been dropped from further consideration based on monitoring results, wildfires or other factors. There are still 19,917 acres that were identified in the 2001 decision as a substantial fuel threat to areas outside the **BWCAW** that remain in need of treatment.

Since the fall of 2010, no burning has been accomplished in the **BWCAW** due to the Pagami Fire in 2011, wet conditions, and/or active fire seasons which limited funds and resources in 2012-2015. Before conducting any additional burning in the **BWCAW**, the Forest Supervisor decided that due to the age of the original analysis, a review of the analysis and decision was necessary to determine whether further implementation is within the range and scope of the effects described in the FEIS and original decision or whether new information or changed conditions would warrant a new analysis. An interdisciplinary team reviewed new information and/or changed conditions that had not been previously considered to determine whether the new information could reasonably result in changes to the analysis or conclusion of impacts disclosed in the FEIS.

Status	Acres	Percent
Treatment Acres Completed	49,367	57
Treatment Acres Dropped	16,979	20
Treatment Acres Remaining	19,917	23
Total Project Acres	86,260	100

## BACKGROUND

A total of 79 units were approved for implementation of prescribed fire in the Record of Decision. These 79 units were combined into 42 bum projects totaling 86,260 acres. Of this total, the Forest has completed 49,367 acres (58 percent), dropped 16,979 acres (20 percent), leaving 19,917 acres (31 percent) remaining. The amount of acreage burned in past years varied with as little as 291 acres in 2001 to a high of 13,972 acres in 2005. No prescribed burning was conducted in 2007, 2008, 2011, 2012, 2013, or 2014 as conditions were either too dry or too wet to successfully bum within established prescriptions and meet bum objectives during some of those years. In addition, the relative intensity of national fire activity limited funding and resources for completing the bums. Of the 11 units dropped from treatment, six units were dropped because the fuel type was primarily hardwoods (which have less potential to ignite and bum with high intensity) and/or the fuel loading was low enough that a hazard was not deemed significant. The other five units that were dropped from treatment were because they were located directly adjacent to wildfires that had occurred, and the wildfires were large enough in size to produce the same results as burning the units would have. For additional information on the fuels hazards and values at risk for the units, see Attachment A-Fuels and Risk Assessment of BWCAW Units and Attachment B-Map of BWCAW Units.

From 2000-2014 there have been 231 fires within the BWCAW. Seventy-three of these fires were determined to be human caused, with the remaining 158 fires lightning caused. Since 2000, there have been six large fires that have had at least a portion of their fire perimeters bum within the blowdown that resulted from the 1999 storm. These fires were Alpine Lake (1,335 acres), Cavity Lake (31,830 acres), Famine Lake (4,104 acres), Redeye (1,792 acres), Ham Lake (75,484 acres), and Pagami Creek (92,193 acres). The areas where the fires burned in untreated blowdown burned with high intensity and rates of spread. The areas where the fires burned into blowdown that had been treated exhibited much lower fire behavior characteristics (see Fites et al., "Fire Behavior and Effects, Fire Suppression and Fuel Treatments on the Ham Lake and Cavity Lake Fires" 2007).

## REVIEW AND FINDINGS

This report documents the review of 2001 FEIS and was conducted consistent with guidance found in Forest Service Handbook 1909.15 Section 18.1 and 40 CFR 1502.9. Specifically, FSH 1909.15 provides the following guidance:

If new information or changed circumstances relating to the environmental impacts of a proposed action come to the attention of the responsible official after a decision has been made and prior to completion of the approved program or project, the responsible official must review the information carefully to determine its importance. Consideration should be given to whether or not the new information or changed circumstances are within the scope and range of effects considered in the original analysis.

If, after an interdisciplinary review and consideration of new information within the context of the overall program or project, the responsible official determines that a correction, supplement, or revision to an environmental document is not necessary, implementation should continue. Document the results of the interdisciplinary review in the appropriate program or project file.

The following is the documentation of that review.

## **INTERDISCIPLINARY TEAM**

An interdisciplinary team (IDT) was convened to evaluate: 1) would the Purpose and Need of the original FEIS still be met with the implementation of the project, and 2) have conditions changed that may require further analysis prior to continuing with the implementation of the project.

Members of the interdisciplinary team are:

Ann Schwaller, Forest Wilderness Specialist, Superior National Forest

Emily Creighton, Hydrologist, Kawishiwi Ranger District

Tara Anderson, Wildlife Biologist, LaCroix Ranger District

Trent Wickman, Regional Air Quality Specialist, Eastern Region

Lee Johnson, Archeologist, Superior National Forest

Brian Jenkins, Forest Fuels Specialist, Chippewa and Superior National Forests

Patty Johnson, Zone Fire Management Officer, Gunflint and Tofte Ranger Districts

The team reviewed the original FEIS, monitoring reports, current agency policies, and best available science to conduct the review per FSH 1909.15.18.1. Findings of the team are presented below by resource. New information and changed circumstances related to fire and fuels is presented first to inform findings on the purpose and need for the prescribed burns. New information and changed circumstances was also evaluated for other environmental and social resources, including: air quality, soils and water, wildlife, recreation, wilderness, scenery, and heritage resources.

## **WILDFIRE RISK AND PUBLIC SAFETY**

The 2001 FEIS considered the increased potential for wildfire within the BWCAW to spread to adjacent private, State, and federal lands or across the international border into Canada where there is substantial infrastructure and human occupancy. The impact of wildfire on public safety within and adjacent to the BWCAW was also a concern. To analyze the effects of potential wildfire impacts on public safety, three primary factors were considered:

- Risk of wildfire escaping the BWCAW and putting private property and public safety at risk.
- Resistance to control of wildfire by fire suppression forces and related firefighter safety risk.
- Ability to implement Wildland Fire Use in the future.

To assess issues related to wildfire risk reduction and public safety, an analysis of the potential for a fire to start and spread to an area where public safety could be threatened was conducted. This required a look at fire behavior, human safety and property concerns, fire protection capability, and wildland fire use. A summary of the fuel characterization and the risk for each remaining unit has been included in Appendix A.

## **FIRE BEHAVIOR**

The three factors that affect fire behavior are topography, weather, and fuels.

**Topography** has not changed since the FEIS was originally completed.

**Weather** is also considered to be fairly static when looking at the timeframe from 2001 until present. Whether climate change has occurred to the degree that fire behavior may be impacted is unknown. Of the large wildfires that have occurred since 2001, three have been larger than what was seen in the 50 years prior to that. However, these fires are well within what has been identified as the natural fire regime for the area (see Heinselman, 1995 for more information on natural fire regimes of northern Minnesota, located in project record).

The primary changes in climate being observed since 2001 are longer fire seasons and higher temperatures. Fire seasons have been observed to be two weeks earlier in the spring and two weeks later in the fall. The higher temperature profile has resulted in periodic drier periods than what was observed prior to 2001. The potential effect on fire behavior of these changes may have played a role in the Pagami Fire of 2012 where the fire burned 12 miles in one day during September when that type of fire growth was not typical based on past fire history. Climate change may have had an impact on the Ham Lake Fire where the fire made multiple runs in different directions. Typical fire history is a 1-2 day event driven by winds that produce an elongated fire perimeter in one direction. Effects of climate change are expected to impact the fire behavior of future wildfires in similar ways. The predicted effects of climate change on fire behavior may make managing hazardous fuels more important than ever.

**Fuels.** The FEIS stated that, "dead and down woody fuel on the forest floor would most likely not return to pre-blowdown conditions for 15 years or more in hardwood stands and 30 years in conifer stands under natural decay processes (based on research from Spaulding and Hansbrough, 1944). Therefore, the elevated risk of a wildfire escaping the BWCAW would likely remain for a number of years." (FEIS, p 2-63.) Units that are predominantly hardwood and not near values at risk were dropped from further consideration based on monitoring information, observed fire behavior on prescribed fires and wildfires, and research information. Units that had a high conifer component and were near values at risk were considered a high enough risk for further consideration. Therefore, the following information on fuel conditions relates to the units still under consideration for treatment.

In February of 2000, the Fuels **Risk** Assessment of Blowdown in Boundary Waters Canoe Area Wilderness and Adjacent Lands (Leuschen et al. 2000) was completed to evaluate the situation and provide options for addressing the fire risk created by the blowdown. Based on that assessment, natural fuel loading within the **BWCAW** was estimated to be between 5 and 20 tons/acre prior to the blowdown event, depending on location. After the event, fuel loading was sampled at 50 to 100 tons/acre. Normal fuel loading in healthy forest stands is less than 10 tons/acre. Monitoring conducted since the analysis was originally completed shows that the fuel loading has decreased due to the decay of woody material and needles/leaves. Fuel loads in the blowdown areas have decreased by 30 percent on average over the areas monitored. This would suggest that fuel loadings in the blowdown fuels are currently 35 to 70 tons/acre.

It is important to remember that the decrease in fuel loading is predominately in small diameter material as the needles and smaller woody material decay; which are considered 1 hour (0 to 1A" diameter) and 10 hour (1/4 to 1" diameter) fuels. With this decay these smaller diameter fuels are closer to what we would see in a more natural fuel loading for these size classes. Little of the larger diameter (>1") have been reduced through decay, and fuel loadings in the 100 hour (1 to 3") and 1000 hour (>3") fuels are still higher than pre-blowdown conditions. The smaller diameter fuels contribute to the ignition and initial spread of a fire; while, larger diameter fuels add to the intensity of the fire and can cause fire to grow rapidly with high intensity.

The original analysis categorized the surface fuels into "fuel models." Fuel models assist in the description of different fuel profiles and are used in fire behavior prediction models. The Fire Behavior Predictions System (FBPS) (Andrews 1986, 1989) provides a basis for these fuel models (FEIS Section 3.2-10). In the original analysis, the blowdown fuels were considered as a Fuel Model 13 (heavy loading – moderate and heavy blowdown or timber slash) for modeling purposes to determine fire behavior outputs; this determination was based on the fuel loadings. Currently, based on the changes in previously described fuel loadings, the fuels are considered a Fuel Model 10 (natural timber fuel) during the time period the fire would be starting but would transition to a Fuel Model 13 once the fire is established. This means that a new fire start may take longer to get established within the blowdown areas due to the decreased 1 and 10 hour fuels similar to a natural fuel loading. Once established though, the fire would potentially increase in intensity as it starts to consume the larger blowdown fuels. This would result in increased flame lengths, higher rates of spread, increased spotting potential and larger fire sizes as modeled and described in the original FEIS.

These fuel loadings are only for down and dead fuels within the measurement areas and do not take into account any new growth that is now growing amongst these heavy fuel loads and may act as ladder fuels in the case of a fire. One change that has occurred to the fuel profile in the blowdown areas is the abundance of conifer that is now present. There was an abundant balsam fir component in the understory of the canopy that was released once the canopy was removed by the windstorm. Additionally, with the overstory hardwoods and pine removed, both balsam fir and spruce which were present in the understory were able to seed in. This has resulted in a young aged, high density, conifer understory. Under the right circumstances this new growth can transition a fire from being a low intensity surface fire to high intensity crown fire.

Therefore, even with the decrease in fuel loadings described above, existing fuel loading of the large diameter fuels and the new conifer growth will create fire environment conditions similar to those originally analyzed in the FEIS.

In August of 2013, a lightning fire occurred on Knife Lake in an area of heavy blowdown fuels. The fire behavior exhibited on that fire confirmed that the blowdown areas still had potential to burn with high intensity. The fire occurred during what is considered "moderate" fire conditions; it was an average fire season in terms of weather conditions and the days the fire burned were low wind conditions. The fire grew to 10 acres within one hour of detection. The fire was spreading at moderate rates with torching of single trees and short crown fire runs. The fire was actively suppressed at 130 acres. Under high wind, droughty conditions, it is estimated that the fire would have burned with high intensity and rates of spread and would have been difficult to suppress.

Based on the above discussion on changes in fuel loadings and observed fire behavior of recent wildfires, the predictions of fire behavior completed in the original FEIS are still valid at this time, with the exception of areas where prescribed burning or wildfire has already occurred.

Monitoring has shown that the treatment units have been successful in reducing the fire intensity from fast moving high intensity fires to slower moving low intensity fires. By reducing the fire's intensity, these units are increasing the chances that values at risk survive the fire, slowing the fire's rate of spread which may buy time for suppression activities and/or evacuations if needed, along with providing suppression resources with a safer opportunity to engage in suppression activities. This was evident during past wildland fires such as Cavity Lake and Ham Lake that

had completed treatment units within their burn perimeter. After the Ham Lake Fire in 2007, a report entitled *Fire Behavior and Effects, Suppression, and Fuel Treatments on the Ham Lake and Cavity Lake Fires* (Fites et al. 2007) was completed. This report presented findings derived from evaluating the use and effectiveness of fuel treatments and fire behavior inside treated and untreated areas on the Ham Lake and Cavity Lake Fires. During the Cavity Lake Fire, it was documented that the treatment areas had a significant impact on the suppression of the fire. These treatment units were areas that greatly modified the fire intensity and behavior to allow for the suppression resources to utilize direct attack tactics to suppress the fire. This resulted in stopping the fire's progression toward homes along the Gunflint Trail. During the Ham Lake Fire, these treatment areas again showed reduced fire intensity and also provided locations for suppression resources to successfully engage the fire safely and effectively perform direct attack suppression. The FEIS of 2001 describe the designed the fuel treatments in what is referred to as a "Finney-Brick Pattern." This type of strategy places fuel treatment areas across the landscape in a pattern which slows wildfire when it encounters the treatment areas because fire has to move around the treatment blocks. With the correct placement of the treatment blocks, fire is slowed in several places across the landscape. This allows fire managers time to use suppression tools to contain a fire. By not having all the proposed burn units completed, there are still large enough gaps on the landscape where fire can build intensity and impact values at risk outside the **BWCAW** boundary.

While the completed work has been shown to be effective in reducing human safety and property concerns, it is not as effective as it would be if the entire burn project was completed. There are still areas where treatments have not occurred that fire could escape the **BWCAW** and impact the public. By completing all the remaining proposed burn units, the Forest would have an extensive network of blocks strategically located throughout the **BWCAW** that would expand the opportunities of fire officials to manage fires within the **BWCAW** with reduced risks to human safety and property.

## **HUMAN SAFETY AND PROPERTY CONCERNS**

The presence of people and the location of properties have not changed since 2001. The **BWCAW** and surrounding area is still a high visitor use area, especially in the summer months when wildfires are most likely to occur. The amount of human development adjacent to the **BWCAW** is still similar to what it was in 2001. There are new developments in areas, but they do not warrant different actions than what was identified in the FEIS.

## **FIRE PROTECTION CAPABILITY**

The ability of fire suppression resources to be effective at managing wildfire to minimize impacts to values at risk is related to the fire behavior displayed by a wildfire. When a wildfire burns with low to moderate intensity levels, fire suppression resources can be effective at slowing and stopping wildfire. Fuel treatments were designed to reduce fire behavior in those areas to a level which fire suppression resources can be successful. Fuel treatments were designed to reduce flame lengths to less than four feet on 97 percent of fire season days. Ground-based firefighters are better able to safely work next to flame lengths less than four feet. Therefore, the fuel treatments would allow ground-based firefighters an improved margin of safety and to be more effective in suppression efforts.

As previously stated, current conditions in the untreated blowdown areas would allow for wildfires to burn with higher intensity and higher rates of spread, meaning suppression resources

would be less effective in those areas. Additionally, the type of fire behavior could potentially put firefighter safety at risk. Therefore, there is still a need to continue treatment in the identified high risk areas to increase the likelihood of success for suppression resources and reduce the exposure of unsafe conditions to firefighters.

### **WILDAND FIRE USE (MANAGING WILDFIRES WITH MULTIPLE OBJECTIVES)**

Wildland Fire Use in the BWCAW was implemented prior to the blowdown to allow for wildland fire to burn at natural fire regime levels (which would allow for the maintenance of naturally occurring fuel loadings and vegetation communities throughout the BWCAW). The term Wildland Fire Use is no longer used but is referred to as managing fire for multiple objectives of which one objective can be to allow fire to play its natural role. For fire to play its natural role in the BWCAW, the risk to adjacent values needs to be acceptable. With the additional fuel loadings created by the blowdown event, the risk in many areas was not acceptable. Where the probability of wildland fire reaching an area of concern exceeded the threshold values, the fire was not allowed to be a candidate for a resource benefit fire. The proposed fuel treatment areas would reduce that risk and create areas where the risk could be acceptable. In the untreated areas, the risk of unacceptable impacts is still present. Therefore, the ability to use fire for multiple objectives is still limited. Completing the identified high priority treatment areas would allow for fire to be managed for multiple objectives even in areas impacted by the 1999 blowdown. Essentially, these treatments are a trade-off of short duration prescribed burning for long term potential of allowing fires to play their natural role in the BWCAW ecosystems.

### **CONCLUSIONS**

The purpose and need of the fuel treatment identified in the FEIS was; "to improve public safety by reducing the potential for high-intensity wildland fires to spread from the BWCAW into areas of intermingled ownership, which include areas containing homes, cabins, resorts, and other improvements and areas across the international border into Canada."

The following is a summary of any changed conditions that would affect the ability to meet the purpose and need:

- The number of treatment units to be treated has been reduced due to wildfires burning through units or adjacent to units; thus, no longer needing treatment. The Finny Brick effect will still be achieved with current list of units identified as still needing treatment.
- There is little change in fire intensity and severity in untreated areas. The additional understory conifer component and heavy loading of dead and down could still produce a high intensity wildfire.
- Monitoring of completed burn units implemented in the BWCAW shows that prescribed burning has been effective.
- There is little change to the human safety concerns. There is still substantial infrastructure surrounding the BWCAW and high visitor use in the BWCAW.
- Current fire behavior in untreated areas could create situations where it may not be safe to commit firefighters for suppression purposes.

- Predicted fire behavior in the untreated areas adjacent to values at risk is generally unacceptable for allowing naturally ignited fire to be managed for multiple objectives or allowing fire to play its natural role in a wilderness area.

Thus, the purpose and need would still be met by implementing the remaining prescribed burn units in the BWCAW.

## AIR QUALITY

Three air quality related measures were used in FEIS Section 3.3.3.5: particulate matter (both PM<sub>10</sub> and PM<sub>2.5</sub>) emissions, PM<sub>10</sub> and PM<sub>2.5</sub> concentrations, and regional haze impacts. These three measures were projected over three future time periods: 10, 50, and 100 years. Similar calculations were made for every decade back in time to 1720 using Heinselman's stand origin maps for the BWCAW. This allowed comparisons to be made to pre-European settlement conditions.

To make the necessary calculations, the following models were used:

**FETM (fire effects tradeoff model):** generated acres burned, fuel consumption, and emissions were generated by this model. FETM is a stochastic model that predicts long-term fire effects on a regional basis. It was used to simulate the tradeoff between prescribed fire and wildfire. Fuel models were input to the model based on field measurements made in the BWCAW after the blowdown event. FETM was used to estimate the 95 percentile (upper end) wildfire-day which varied by alternative between about 3,500 and 6,000 acres. For historic wildfires the maximum fire growth day was assumed to be around 13,000 acres.

**Box model:** a simple representation of the atmosphere was used to generate far-field concentration estimates. This model used estimates of the footprint of the BWCAW, and morning and afternoon non-precipitation day mixing heights and wind speeds from International Falls along with the daily emission rates from FETM as inputs.

**The Koshmeider equation** was used to compute visibility impacts from the 24-hour PM<sub>2.5</sub> concentration.

**FOFEM and an EPA Gaussian plume model** were used for near-field model runs at two sensitive receptors in the Upper Gunflint Trail area.

A long list of mitigations were also included (FEIS Section 2.5, pp. 2-36 through 2-37; ROD App B), many of which are now standard due to other considerations that have come into play over the years, such as Agency burn plan requirements to incorporate the State Smoke Management Plan. There are some requirements that are unique to the FEIS such as when a sensitive receptor is located within three miles downwind of a burn. In this situation the FEIS prescribes that a smoke monitor be located at the receptor and that the minimum dispersion category necessary to burn is "good." New Forest air quality monitoring requirements were added for these burns (ROD; App C).

The major conclusions of the FEIS were that the modeled PM concentrations (17 to 58 microgram per cubic meter - ug PM<sub>2.5</sub>/m<sup>3</sup>) and visibility impacts were within the historical range of variability for the BWCAW. These concentrations were also below the EPA National

Ambient Air Quality Standards (NAAQS) of 150 ug PM10/m<sup>3</sup> and 65 ug PM2.5/m<sup>3</sup> that were applicable at that time.

### **IS THE ANALYSIS RELEVANT AND APPLICABLE**

Although some of the underlying models have been updated or changed since the publication of the FEIS, the analysis approach taken is still applicable today as long as the underlying data is still applicable. The primary concern would be the fuels data. If the fuels data was updated, an assumption is that the fuel load may have decreased over the years as the available fuel decays and is not as available to burn. This would reduce the fuel consumed and the emissions, making the previous analysis estimate higher values than we are likely to get. As discussed in the fire and fuels section of the SIR, the larger fuels have mostly not decayed while fine fuels have decayed. Some additional fuel has been created through regrowth. Overall, the previous analysis is considered similar or overestimates the current fuel situation making any newly predicted effects well within the analysis in the FEIS.

### **CHANGES NOTED SINCE THE ANALYSIS**

The main change that has taken place is that the 24-hour PM2.5 NAAQS was lowered in 2006 by the EPA from 65 to 35 ug PM2.5/m<sup>3</sup>. This would mean that some of the within-plume model runs would now be over the PM2.5 NAAQS. All of the air shed-average runs would still be below the standard because the smoke is mixed over the entire airshed. We use the NAAQS number as a benchmark to define an area where we need to focus our mitigation measures. The way we model smoke is different from industrial air emission modeling because we have less extensive source information. A fire is more complicated to model than an industrial stack and therefore the model results cannot be directly compared to the NAAQS.

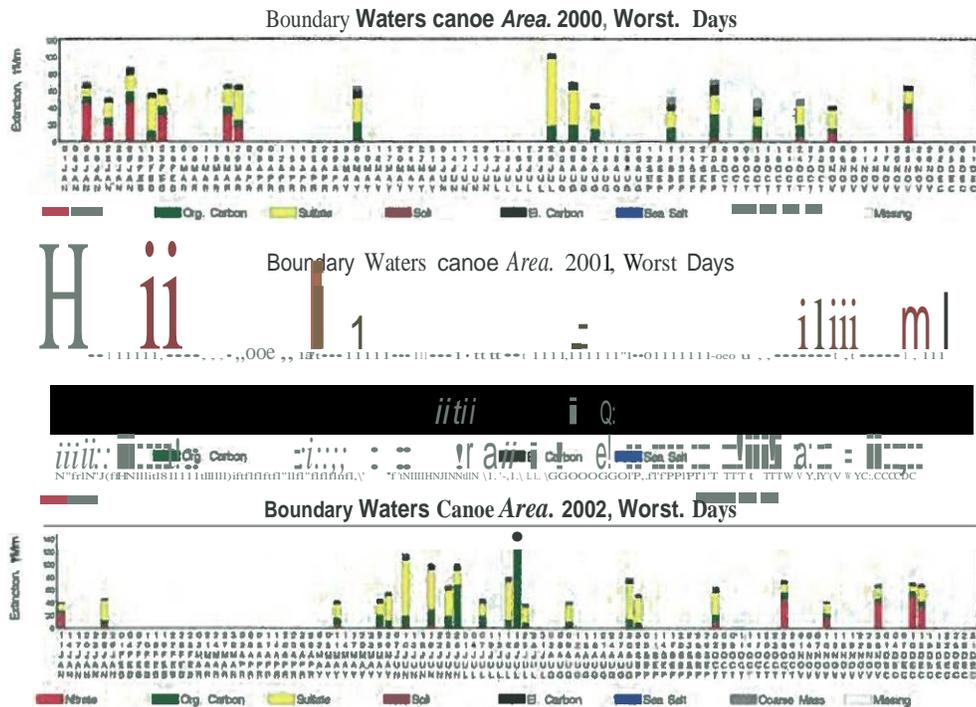
In spite of the discussion above, it is likely we will still be focusing our smoke mitigation activities in the same areas as before because the smoke sensitive locations have not changed. Also our experience in conducting the **BWCAW** burns over the years has given us on-the-ground knowledge of smoke impacts we did not have before, enhancing any model output.

At the time the FEIS was written, there was also a concern that prescribed fire could affect the baseline measurements for the regional haze rule for the BWCAW that would take place from 2000 to 2004. We can now examine the data from the site to see if this happened. Fine particulate is measured at this site and chemically speciated. The worst case days are shown in the following figure (Figure 1). These are the only days shown here because those are the days tracked by the Regional Haze rule. Days with a high percentage of organic carbon could be fire days. This is likely the case where a large portion of a bar is green.

Some organic carbon is always present in the atmosphere due to natural emissions from trees. Some work has been done in the area of the country since the FEIS to understand the proportion of organic carbon due to vegetation burning and natural tree emissions.

A study at a nearby Class I area (Seney Wilderness in Michigan) (Regional Haze in the Upper Midwest: Summary of Technical Information, version 2.2, February 22, 2008, LADCO, <http://www.ladco.org/reports/rpo/consultation/index.php>) found that on an annual basis less than one percent of the organic carbon concentration was from vegetation burning.

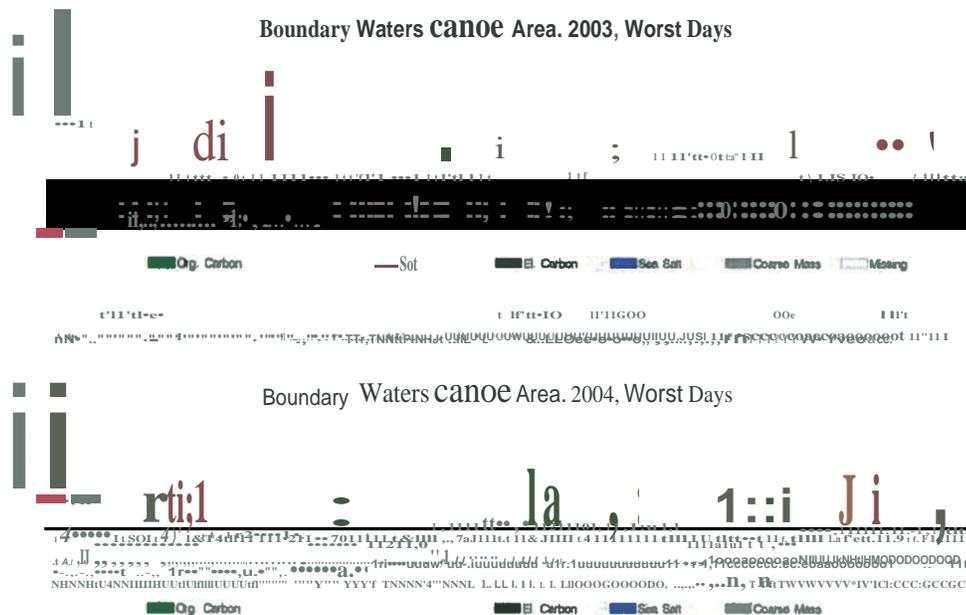
**Figure 1: Fine Particulate Measurements for Worst Days in the Boundary Waters Canoe Area Wilderness from 2000-2002**



Another study (summarized in the same reference above) expanded the above study to all four Class I areas in Michigan and Minnesota and found that on those few days where vegetation burning was likely impacting the Class I areas in Michigan and Minnesota, meteorological modeling showed the likely sources were primarily Canadian wildfires. Even if the impacts of the Canadian wildfires were removed from the baseline regional haze calculation, the impact was negligible. They concluded "...fire activity, although significant on a few days, is on average a relatively small contributor."

BWCAW burns took place every year between 2001 and 2004, as early as September 8, and as late as October 11th. It can be seen below that there are about a half dozen days over those five years (about five percent) dominated (over half the bar) by green. None of those days were within the fall time period of the BWCAW burns. As stated above the impact was likely from Canadian wildfires.

**Figure 2: Fine Particulate Measurements for Worst Days in the Boundary Waters Canoe Area Wilderness during 2003-2004**



## CONCLUSIONS

An extensive amount of smoke monitoring has been done since 2002 as the burns have been implemented (see previous Forest monitoring reports for the years 2002 through 2011). The results of the monitoring have agreed with the predictions of the models as far as the level of impacts. In addition, the FEIS compared wildfire versus prescribed fire impacts and indicated the wildfire smoke should travel farther downwind due to higher fuel consumption. This was seen in 2011 with the Pagami wildfire which sent smoke to Wisconsin, Illinois, and points further east. The impacts were so severe that the State of Wisconsin filed an exceptional event request to the EPA to help avoid a nonattainment designation due to the smoke. Pagami had three fire growth days over 13,000 acres which is over the value assumed in the historical wildfire calculations in the FEIS. Bumping up this value and recalculating historical emissions would just lead to a greater difference between wildfire and prescribed fire than was shown in the FEIS. Impacts similar to Pagami have not been seen by any of the prescribed fires to date.

The conclusions of the EIS hold as much today as they did then. Due to their size and fuel loads, these burn units can generate a lot of smoke. As indicated previously in the FEIS, if this level of smoke is not properly managed it could cause health and safety issues. Nevertheless these impacts are within the historical range of variability of smoke for the BWCAW.

## SOILS AND WATER QUALITY

In the 2001 FEIS, a variety of indicators were used to assess the likelihood of negative impact on soil and water resources. The indicator analyses were reviewed to assess whether the original methods and conclusions remain valid in light of the fuel loading changes. The discussion below focuses on differences between the No-action Alternative (wildfire-only management) and the Modified Alternative B (see 2001 FEIS; wildfire and prescribed burn management).

## **SOILS**

Three soil-related indicators were analyzed in the FEIS:

Indicator 1: Potential to limit extent of severe wildland fire

Indicator 2: Length of control line

Indicator 3: Number of helispots

To describe the potential to limit the extent of wildland fire the Fire Effects Tradeoff Model (FETM) was used. The FETM is a stochastic model that predicts long-term fire effects on a regional basis. It is used to simulate differences between prescribed fire and wildfire. Amount of control line and number of helispots were estimated based on modeled total area burned.

The 2001 FEIS soil analysis concluded:

Indicator 1: Potentially similar amounts of severe wildfire under both scenarios, although likely less under the scenario including prescribed burning. The FETM model estimated 68,000 to 185,300 acres burned by wildfire if prescribed burning was not implemented over the next 10 years, compared with a maximum of 108,000 acres with prescribed burning.

Indicator 2: Construction of approximately 91 miles of control line within the BWCAW, exposing 22 acres of mineral soil, was expected with full implementation of the selected prescribed burn plan; an unknown amount of control line would be created under a wildfire-only scenario, but line placement would be less likely to consider soil erosion concerns (e.g., slope).

Indicator 3: Development of 10-15 temporary helispots within the BWCAW was expected under the selected prescribed burning plan.

The analysis suggested a lack of prescribed burn management may result in more acres of severe-intensity burn.

## **IS THE ANALYSIS RELEVANT AND APPLICABLE**

Yes, the analysis methods are still applicable and relevant. As noted in the Wildfire Risk and Public Safety section, the strategic and controlled nature of prescribed burns already has been shown to reduce fire intensity and extent in wildfires across the blowdown area. Monitoring data (e.g., SNF Monitoring Report, 2008-available on the SNF webpage) collected pre- and post-prescribed and wildfire burn, as well as experience of Kawishiwi Ranger District soil scientist Jim Barott, indicate soils are at greater risk of substantial impact (e.g., reduced O-horizon and increased hydrophobicity) when exposed to wildfire as opposed to prescribed burn. In addition, a prescribed burn allows for thoughtful placement of control line and helispots; during wildfire, the urgency of firefighting operations may take priority over resource considerations when lives or private property are at risk.

## **WETLANDS AND RIPARIAN AREAS**

Geographic information systems (GIS) analysis indicated forested wetlands sustained the greatest impact from the blowdown of all wetland types; approximately 11 percent of rich swamp forests and nine percent of lowland conifer forests were blown down. Of the total riparian area, approximately eight percent were affected to some degree by blowdown.

Three wetland- and riparian-related parameters were used as indicators in the original EIS:

Indicator 1: Overall amount of burned area

Indicator 2: Amount of area burned by each type of fire (prescribed and wild)

Indicator 3: Length of control line constructed in wetland

To describe the amount of burned area in total and by type, the FETM was used. Amount of control line constructed in wetland was estimated using previous fire experience.

The major conclusions of the wetland and riparian resources section included:

Indicators 1 & 2: Wildfire-only management yielded the highest potential for wildland fires that could burn large areas under intense conditions with potentially large adverse effects on riparian areas (FEIS p. 3.5-12). The total amount of burned area under wildfire-only management was modeled to be less than under any of the other alternatives during the first 10 years of the project, due to prescribed burning occurring in addition to wildfire under the action alternatives. FETM model results over 10 years indicated wildfire plus prescribed burn management reduced the potential of a high-intensity wildland fire within the BWCAW that could result in greater reduction in jack pine, white pine, and red pine in riparian areas and increases in aspen and birch than a wildfire-only management scheme.

Indicator 3: The selected prescribed burn management included construction of approximately 87 miles of control line in riparian zones within the **BWCAW**. Magnitude of control line under wildfire-only management was difficult to estimate; however, control lines in a wildfire situation are typically placed under emergency conditions, without regard for resource considerations. A high proportion of wildfire control line may be located in wetland, reflecting the magnitude of water resources on the Superior National Forest and in the BWCAW.

## **IS THE ANALYSIS RELEVANT AND APPLICABLE**

The analysis method remains relevant. It remains likely that a prescribed burn/wildfire management scenario will result in the greatest burn extent but that wildfire-only management will have greater negative impacts on long-lived conifer in riparian areas. Wetland resource damage due to substantial wildfire is very likely to have greater negative impact than a prescribed burn and wildfire management scenario which utilized natural control lines when possible.

## **ACQUATIC RESOURCES**

Fire impacts aquatic resources based on the extent and severity of the fire. Aquatic resources analysis in the FEIS included an evaluation of possible effects of the alternatives on the physical, chemical, and biological components of the resource- i.e., hydrology, water quality, and aquatic species. Indicators for each resource element were identified as follows:

Indicator 1 (Physical): 60% young and open analysis; water yield, flood discharge, and bankfull discharge in fifth and sixth order watersheds.

Indicator 2 (Chemical): Turbidity, nutrients/eutrophication, mercury, and use of chemical fire retardant.

Indicator 3 (Biological): Management indicator species (**MIS**) - (brook trout, lake trout, walleye, northern leopard frog); Regional Forester Sensitive Species (**RFSS**; lake sturgeon, shortjaw cisco, northern brook lamprey, creek heelsplitter, black sandshell, four-toed salamander); aquatic habitat.

The analyst qualitatively evaluated worst-case impacts (e.g., long-term drought conditions) that would result in fires of high severity with extensive use of emergency control line construction and liquid fire retardants.

Indicator 1: Several watersheds were identified as likely having greater than 60% young and open under both prescribed burn and wildfire management; where young (<16 years old) and open area accounted for greater than 60% of the land surface. Based on research by S. E. Verry, these watersheds were at greater risk for erosion and water quality degradation than watersheds with less young and open area. Under both prescribed burn and wildfire scenarios, the analyst suggested water yield, flood discharge, and bankfull discharge would all increase, potentially resulting in increased erosion and sedimentation in streams.

Indicator 2: Water quality was expected to be impacted more for a wildfire-only scenario than a wildfire and prescribed burn scenario, reflecting the typically increased intensity of wildfire.

Indicator 3: High intensity wildland fire is expected to have a greater impact on MIS and RFSS than prescribed burns, due to increased water temperature, destruction of riparian habitat, and exposure of aquatic life to fire retardants.

### **IS THE ANALYSIS RELEVANT AND APPLICABLE**

Yes, the analysis method remains relevant. Similar responses to wildfire as described in the analysis would be expected. Severe fire typical of wildfire is likely to result in greater habitat degradation, water temperature increases, and increased potential for erosion and greater potential release of contaminants (e.g., sediment, nutrient) to water.

### **CONCLUSIONS**

Concern over the extent of fire severity is a common thread linking each of these resources. Increased fire severity is correlated with reduced nutrient content of soil, degraded habitat quality in the riparian zone, and increased likelihood of sedimentation or nutrient loading in streams among a variety of other responses.

Overall, the soil and water analysis methods were sound and came to reasonable conclusions that remain applicable, if conservative, today. Monitoring results as described in the soils analysis section, for example, support this conclusion. In general, minimizing the extent and severity of wildfire in the **BWCAW** through use of prescribed burning is beneficial to both soil and water resources. As outlined in the FEIS, severe wildfire may occur within the blowdown areas. The remaining proposed prescribed burns are placed to create fuel breaks for wildfire; thereby minimizing the potential for larger wildfires and potential burn severity. This would potentially reduce the total burned area (including riparian areas) and intensity of burn, which would likely reduce bare soil creation, erosion/transportation of sediment into water resources, and negative impacts to water quality.

### **WILDLIFE**

The FEIS analyzed potential impacts to species listed as threatened, endangered, and sensitive (TES species) in 2001. Since then, species on the TES lists have changed. For example, the bald eagle has been delisted by the U.S. Fish and Wildlife Service (USFWS) and is now considered a Regional Forester sensitive species (RFSS), while the northern long-eared bat is now federally

listed as threatened. Other changes include the addition and removal of several species to the RFSS list, the designation of critical habitat for lynx, and modifications to the use of Indicator species. This review considers these changes with respect to future fuel treatments in the BWCAW.

## **THREATENED AND ENDANGERED SPECIES**

The BWCAW has not been thoroughly surveyed for threatened, endangered, and sensitive (TES) species due to its relative inaccessibility and because surveys are usually required for ground-disturbing activities. The lack of occurrence data does not indicate that these species do not occur in the BWCAW. Pre-treatment survey protocols and mitigations will continue to be followed to meet current standards and guidelines for wildlife resources.

**Gray Wolf:** The analysis of gray wolf continues to be valid. Direct and indirect effects as well as mitigations in the event of species or habitat occurrence have not changed since the original analysis and therefore remain valid. The determination for this project remains that it may affect but is not likely to adversely affect the gray wolf and its associated critical habitat. No further mitigations are needed for this species.

**Canada Lynx:** The determination for Canada lynx also remains valid. The determination for this project remains that it may affect but is not likely to adversely affect Canada lynx. Potential effects to critical habitat for Canada lynx were not evaluated in the FEIS. Forest-wide implementation of fuel treatments was addressed programmatically as a part of the 2011 Biological Assessment (BA) for the continued implementation of the revised Forest Plan. It was determined that prescribed burning in response to natural disturbance processes may affect but is not likely to adversely affect Canada lynx and its associated critical habitat and that any potential effects from these activities would be discountable or insignificant (USDA 2011). Project-specific consultation that addresses potential effects to lynx critical habitat resulting from implementing the remaining fuel treatments across 25,986 acres tiers to the 2011 Programmatic BA.

The BA pertaining to the FEIS concluded that the amount of suitable denning and foraging habitat for Canada lynx within and adjacent to the BWCAW was likely high at the time of the 1999 windstorm. The FEIS identified key habitat for Canada lynx as seedling and sapling lowland conifer forest, which occupied approximately 18,462 acres of the BWCAW prior to the blowdown event. Following the storm, the FEIS determined that the net amount of key habitat in the BWCAW increased by approximately 16 percent to 21,372 acres. The FEIS predicted that key habitat would decrease by approximately 2,670 acres from the existing condition under all alternatives within ten years, returning the suitability of key habitat for lynx to pre-blowdown levels.

The FEIS measured conditions in lowland conifer seedling and sapling forest as the indicator of impacts to lynx since these areas were assumed to produce suitable habitat with the highest densities of snowshoe hares as well as serve as refugia during low points in the hare population cycle. However, more recent assessments of habitat for lynx (USDA 2004, 2011) have utilized both upland and lowland forest in sapling and older stands (greater than three years) as indicators of snowshoe hare habitat, as opposed to early regenerating stands. Although the FEIS did not specifically measure unsuitable habitat, approximately 165,000 acres (22 percent of the

BWCAW) of blowdown would have been considered unsuitable using the habitat model parameters outlined in the Forest Plan (USDA 2004, 2011.)

An important difference from current conditions is that suitable hare habitat has increased from FEIS projections in the 16 years since the windstorm. In addition to the blowdown acres, six large wildfires (Alpine Lake, Cavity Lake, Famine Lake, Redeye, Ham Lake, and Pagami Creek) totaling over 200,000 acres have occurred within and adjacent to the blowdown area from 2000 to 2011. The new vegetative growth in these areas has likely attracted snowshoe hare and created additional foraging habitat for lynx.

Implementing the remaining fuel reduction treatments on 25,986 acres would reduce the existing amount of suitable foraging habitat for lynx in the short term (three to five years), but the acreage of suitable foraging habitat in the BWCAW would remain high. The FEIS addressed potential short-term effects to key habitat for lynx resulting from prescribed burning; noting that within five to ten years, vigorous regeneration of shrubs and seedling and sapling trees within these areas would likely enhance their value as snowshoe hare habitat. In addition, the FEIS concluded that prescribed burning would minimize the potential for negative effects associated with wildland fires, which typically take longer to recover as compared to areas that are burned with prescribed fire. The anticipated short- and long-term trends for lynx habitat suitability in the BWCAW with continued implementation of the FEIS therefore remain unchanged. Fuel treatment units are expected to temporarily decrease the acreage of suitable foraging habitat for lynx but would enhance lynx foraging habitat in five or more years. The determination for this project remains that it may affect but is not likely to adversely affect the Canada lynx.

**Northern Long-Eared Bat:** Potential effects to the northern long-eared bat were not evaluated in the FEIS. However, an analysis of potential effects to this species resulting from the implementation of on-going timber harvest, other broad-scale tree removal, and prescribed fire projects on the Superior National Forest was conducted during March 2015. The determination for these projects is that they may affect and may be likely to adversely affect individual northern long-eared bats and summer roosting habitat but are not likely to result in jeopardy to the species (USDA 2015).

Adverse effects are expected to result from activities that occur during the time when bats are present in their summer habitat (April 1 to September 30). Activities that occur during the winter (October 1 to March 31) are not likely to adversely affect individuals. Conservation measures specified in the BA and corresponding Biological Opinion (BO) will be followed during implementation of the remaining fuel treatments to minimize potential impacts to summer roosting habitat for bats. Critical habitat has not been proposed for this species.

## **REGIONAL FORESTER SENSITIVE SPECIES**

Between 2001 when the FEIS was published and 2015, the RFSS list has been modified to reflect 26 species additions, 21 species removals, and four changes to species' common names. Species not considered in the FEIS are addressed below.

**Additional RFSS – Wildlife Species:** little brown myotis, wood turtle, Nipigon cisco, black sandshell, headwaters chilostigman caddisfly, Quebec emerald dragonfly, and the ebony boghaunter.

The little brown myotis has habitat needs that are similar to the tri-colored bat (also known as the eastern pipistrelle), a species that was addressed in the FEIS. However, the analysis of potential

impacts to the tri-colored bat focused on winter habitats, which are not likely to be affected by fuel treatments due to the location and season of burning activities. Summer habitat associations and roost site characteristics of these bats have since been identified and could be affected by prescribed burning occurring from April 1 to September 30. Conservation measures developed to minimize impacts to the northern long-eared bat would minimize impacts to both the little brown myotis and tri-colored bat. Therefore, additional mitigations are not needed for these species.

While habitat for wood turtles could potentially be found within the BWCAW, this species is only known to occur on the Laurentian Ranger District of the Superior National Forest and is therefore unlikely to be affected by this project. Further analysis is not needed for the Nipigon cisco and black sandshell, as similar species (shortjaw cisco and creek heelsplitter) and their associated key habitats were analyzed in the FEIS. Effects to these habitats remain unchanged.

The three additional insect species (headwaters chlostigman caddisfly, Quebec emerald dragonfly, and ebony boghaunter) are found within lentic environments such as bogs, fens, and heaths. Within these environments, microhabitats include water-suspended or water-saturated sphagnum, often associated with open water and emergent grasses. Key habitat for these species was analyzed in the FEIS and effects to these habitats remain unchanged.

**Additional RFSS – Plant Species:** moschatel, long-leaved amica, maidenhair spleenwort, pointed moonwort, New England sedge, Ross' sedge, rough-fruited mandarin, linear leaved sundew, Canada ricegrass, sticky locoweed, livelong saxifrage, false-asphodel, smooth woodsia, and several species of lichen (*Arctoparmelia centrifuga*, *Arctoparmelia subcentrifuga*, *Frullania selwyniana*, *Huperzia appalachiana*).

Of the additional plant species, only three are associated with key habitats that were not analyzed in the FEIS (moschatel, long-leaved amica, and maidenhair spleenwort). These perennial herbs are found primarily on cool, damp cliffs and crevices. Potential effects to these species would be similar to those expected for other ledge and rock outcrop species considered in the FEIS (large-leaved sandwort and nodding saxifrage.) Rocky substrates where these species occur provide a moderate level of protection from fire and are unlikely to be disturbed during control line construction. No further mitigations are needed.

## **MANAGEMENT INDICATOR SPECIES AND HABITATS**

The FEIS utilized Viability Indicator Species (VIS) and Management Indicator Species (MIS) to assess potential effects of the proposed project alternatives to wildlife resources. Since the Forest Plan revision in 2004, these lists have been updated to include only four MIS (gray wolf, bald eagle, northern goshawk, and white pine). Goals and objectives (desired conditions) for each MIS are specified in the Forest Plan, including factors considered essential for their viability.

Direct and indirect effects, as well as mitigations in the event of species or habitat occurrence, for the gray wolf, bald eagle, and northern goshawk were specified in the FEIS and remain valid given current conditions. Further analysis and mitigations are not needed for these species. White pine was not explicitly considered as a MIS in the FEIS; however, potential effects to this species were considered in the analysis of forest vegetation (white and red pine communities and populations) and remain valid.

The FEIS specifically addressed potential effects to white pine resulting from prescribed burning, noting that implementation would likely result in mortality of regenerating white pine within the treatment units. Such mortality could result in the loss of local populations of white pine if remnant mature pines were also lacking, effectively reducing genetic diversity at the landscape scale within the BWCAW. However, the FEIS concluded that implementing low-intensity prescribed fires would minimize the likelihood of wildfire across the landscape. Compared to prescribed fire, wildfire would be more likely to kill the remaining overstory pines in addition to the regenerating understory trees; thereby, opening up the forest for invasion by paper birch and aspen. Significantly more acreage would also be expected to burn in a wildfire.

Fire effects monitoring conducted from 2001 to 2012 generally supported the FEIS predictions for white pine under various fire scenarios (prescribed fire versus wildfire). Specifically, white pine retained its presence (nine percent cover) within low- to moderate-severity prescribed burns but generally decreased in cover and/or failed to re-populate sites following high-severity wildfires. Most notably, white pine remained stable or slightly increased in the understory three to five years following low-severity burns in mesic upland communities. This species also remained a dominant overstory species within drier mixed communities following similar treatments. Mitigation practices to protect shoreline and interior old forest were generally found to be effective during prescribed burn operations. Approximately two-thirds of shoreline trees or stands monitored survived prescribed burning four years following fire (USDA 2012).

## **CONCLUSIONS**

This report documents the review of the BWCAW Fuel Treatment FEIS of May 2001. We evaluated new information and changed circumstances for wildlife resources to determine whether the scope and range of effects considered in the FEIS remain applicable 16 years after the 1999 blowdown event.

Determinations for wildlife resources disclosed in the FEIS remain biologically valid and may continue to be used to implement fuel treatments within the BWCAW. Potential effects to RFSS not explicitly addressed in the FEIS are covered in the analyses of key habitat associations and forest vegetation cover types and remain valid. Project-specific consultation that addresses potential effects to lynx critical habitat resulting from implementing the remaining fuel treatments across 25,986 acres ties to the 2011 Programmatic BA for the Superior National Forest.

## **HERITAGE RESOURCES**

Historic properties are discrete locations on the landscape which display evidence of past human activities. Traditional Cultural Properties (TCPs) are districts, sites, buildings, structures, or objects that are valued by a living community for the role they play in sustaining the community's cultural integrity. An example of a historic property would be an early 20th century logging camp and its associated artifacts and building remains. An example of a TCP would be a wild rice stand which has been annually harvested by a distinct, living community for the past 100 years. For the purposes of this review, the term heritage resources, or heritage resource site, will refer to both of these aforementioned property types.

Heritage resources are fragile and can be adversely affected by a variety of factors, including erosion, fire, and numerous human activities. Heritage resources are especially vulnerable to surface disturbances; however, disturbance from fire can vary greatly, depending on the nature of the resource, depth below surface, and the intensity and duration of burning.

### **IS THE ANALYSIS RELEVANT AND APPLICABLE**

The 2001 EIS used the heritage resource data available at the time to assess potential effects of the proposed project alternatives on heritage resources. Direct and indirect effects, mitigations, and standards are well reasoned and continue to be applicable for this project.

### **CHANGES NOTED SINCE THE ANALYSIS**

Heritage resource survey and site specific evaluations have continued to occur in the BWCAW subsequent to the publication of the original EIS in 2001. Heritage resource surveys completed from 2001-2015 have added about 3,500 acres of newly inventoried lands in the BWCAW, and led to the identification of an additional 278 sites. These surveys were completed in advance of ground disturbing projects such as shoreline erosion control, campsite rehabilitation, latrine excavation, and prescribed fire. With regards to heritage resource prescribed fire survey, Forest archaeologists have completed approximately 2,450 acres of survey within units proposed in the 2001 EIS. The Forest Service fully intends to avoid impacts to all heritage resources which are currently unevaluated or eligible to the National Register of Historic Places (NRHP). Towards that end, staff will continue to work with bum planners to ensure that data retrieved subsequent to publication of the 2001 EIS is fully incorporated into each bum plan. Unit specific heritage resource mitigations are presented in *Boundary Waters Canoe Area Wilderness Fuel Treatment FEIS, May 2001, Volume II, Appendix A-Treatment Unit Cards (pp.1-207)*. These mitigations will continue to apply where applicable; however, unit specific mitigations for heritage resources will be augmented, as necessary, to incorporate the results of heritage resource inventory conducted subsequent to the publication of the 2001 EIS.

### **CONCLUSIONS**

The Forest's direction for heritage resource management has not changed since the initial publication of the EIS. Standards and guidelines for heritage resource inventory, evaluation, consultation, and protection are listed in the Superior National Forest Land and Resource Management Plan (2004: p. 2-39), which tiers to the National Historic Preservation Act (as amended) and other federal regulations governing the management of heritage resources. Regarding compliance with the National Historic Preservation Act, the Forest will follow the procedures outlined in the *2015 Programmatic Agreement Regarding the Process for Compliance with Section 106 of the National Historic Preservation Act for Undertakings on the Superior National Forest of the U.S. Forest Service*.

## **RECREATION AND WILDERNESS VALUES**

The 2001 Final Environmental Impact Statement (FEIS) considered the effects of management ignited prescribed fire on what it called Primitive Recreation, Wilderness Values and Scenery in the BWCAW. These areas of consideration were defined as follows:

**Primitive Recreation** opportunities and potential effects are described in terms of campsites, portages, trails, and entry points. Effects are addressed in terms of the number of campsites, portage trails, and entry points that are closed for the prescribed burn operations and visitor safety purposes.

**Wilderness Values** is addressed from the aspect of the four Wilderness Attributes: Natural Integrity, Apparent Naturalness, Outstanding Opportunities for Solitude and Outstanding Opportunities for Primitive Recreation.

**Scenery** is addressed in terms of the Forest Service Visual Management System. The effects from the July 4th storm and existing visual condition are described. Environmental effects are described in terms of changes to variety classes in the **BWCAW**.

This analysis will consider whether the analysis in the FEIS is still relevant and applicable, any changes of note have occurred since the analysis and draw conclusions based on those considerations.

## **PRIMITIVE RECREATION**

The FEIS considered effects on campsites, portages, trails, and visitor use and distribution.

### **IS THE ANALYSIS RELEVANT AND APPLICABLE**

These factors are still very much relevant and applicable when evaluating the effects of management ignited fire on recreational use of the BWCAW. As described in the FEIS, levels of visitor use and its distribution throughout the BWCAW may be directly and indirectly affected by wildfire and prescribed fire.

### **CHANGES NOTED SINCE THE ANALYSIS**

Since the publication of the FEIS there have been no substantial changes in the number of campsites, portages, trails, or entry points. The volume of public use of this recreation infrastructure has not substantially changed. Implementation of burns authorized by the original decision and recent wildfires, such as the Pagami Creek fire, provide a valuable comparison to validate the determinations in the FEIS. Several camp sites and portions of trails have closed temporarily as the result of large wildfires, mainly Pagami. These facilities will remain closed until such time as they can be effectively restored. Use patterns also shifted away from large fire areas. By contrast campsites and use patterns have stayed largely the same after prescribed fires. Accurately, the FEIS estimated that wildfires in blowdown areas would likely have greater impacts on these resources than prescribed fires would have. Wildfires generally have burned in drier conditions than periods when burns were conducted, resulting in more widespread higher severity fire effects as well as greater short-term displacement and risk to wilderness visitors.

## **CONCLUSIONS**

Given the minor changes in recreation infrastructure and levels and patterns of public use since the publication of the FEIS, the original analysis is still relevant, applicable and valid. In the intervening years wildfires have affected trails, portages and campsites including the Pow Wow Trail. The cumulative and temporary effect of wildfires on these recreation resources does not rise to a level that warrants further or additional analysis.

## WILDERNESS VALUES

The FEIS utilizes a number of factors to consider the effect of prescribed fire on Wilderness Attributes. The Wilderness Attributes described in the FEIS are:

- **Natural Integrity:** The degree that an area's long-term ecological processes are intact and operating.
- **Apparent Naturalness:** The degree to which human impacts are apparent to most visitors.
- **Outstanding Opportunities for Solitude:** The opportunity to be isolated from the sights, sounds, and presence of others from the developments and evidence of humans.
- **Outstanding Opportunities for Primitive Recreation:** The opportunity for isolation from the evidence of humans, vastness of scale, feeling a part of the natural environment, having a high degree of challenge and risk, and using outdoor skills.

These factors are similar to qualities of wilderness used to define and measure Wilderness Character today. Wilderness Character and the quality measures detailed below are identified in the 2008 General Technical Report RMRS-GTR-212: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System. The Qualities are described as follows:

- **Untrammelled:** Wilderness is essentially unhindered and free from modern human control or manipulation.
- **Natural:** Wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped:** Wilderness is essentially without permanent improvement or modern human occupation such as structures, installations, habitations and the use of motor vehicles, motorized equipment, or mechanical transport.
- **Opportunities for Solitude and Primitive Unconfined Recreation:** Wilderness provides visitors with self-reliant, and challenging, experiences generally free from crowding and signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

To assess whether the Wilderness Values section of the FEIS is adequate or in need of supplemental analysis, consideration of the FEIS Wilderness Attribute measures and how they correlate to Wilderness Character Qualities follows. The Natural Integrity attribute considered in the FEIS is most closely correlated to the Natural Wilderness Character quality. The Apparent Naturalness attribute is most closely correlated to the Untrammelled and Undeveloped qualities. And, the attributes and qualities of Opportunities for Solitude and Primitive and Unconfined Recreation remain the same.

<b>Table 2: FEIS to Wilderness Character Measures Crosswalk</b>	
<b>Wilderness Attributes (FEIS)</b>	<b>Wilderness Character Measures (RMRS G1R*212)</b>
Natural Integrity	Natural
Apparent Naturalness	Untrampled/Undeveloped
Opportunities for Solitude and Primitive and Unconfined Recreation	Opportunities for Solitude and Primitive and Unconfined Recreation

**NATURAL INTEGRITY/NATURAL QUALITY**

The FEIS considered four factors for their effects on Natural Integrity: the preparation of treatment units, prescribed burning, long-term monitoring, and wildfires and wildland fire use.

**IS THE ANALYSIS RELEVANT AND APPLICABLE**

Naturally occurring fire has been a part of the BWCAWs ecosystem for thousands of years and the overall health of this complex system is largely dependent on the periodic occurrence of fire. Active fire suppression efforts in the modern era and since the designation of the BWCAW have contributed to a departure from the natural fire regime. For a discussion of current fuel and vegetation conditions see sections on fire behavior and fuel conditions. Although humans are manipulating the conditions in the BWCAW through the suppression of wildfire and the use of prescribed fire, the FEIS recognized this manipulation and considered it to be necessary to reduce the risk to human lives. Prescribed fire has the added benefit of allowing fire to return to the landscape and increasing the window of opportunities where naturally ignited fires may be allowed to burn improving natural integrity/natural qualities.

The factors considered by the FEIS are still relevant and applicable. It remains true that the most notable effects on natural integrity/natural quality are likely to be from the preparation, implementation and monitoring of prescribed fire as well as wildfires. The effects of those activities are appropriately displayed in the FEIS.

**CHANGES NOTED SINCE THE ANALYSIS**

Both management and natural ignitions and fire management activities are known vectors for the spread of non-native invasive species (NNIS) which can have a detrimental effect on wilderness character. NNIS are an ecological threat to the natural quality of wilderness character nationwide, including in the BWCAW. The FEIS acknowledges that the fuel treatments will contribute to the overall level of disturbance in the BWCAW and are expected to increase the likelihood of noxious weeds entering the area. However, the analysis also states that the BWCAW is "relatively free of noxious weeds" and weeds are "not considered to be a major concern in the BWCAW." Since these statements in the 2001 FEIS, the Forest has completed a Forest-wide Weed Treatment EA (2006), SNF Monitoring Report on the BWCAW Fuel Treatments (2012), BWCAW weed treatment EIS and Minimum Requirements Analysis (2013), and the DRAFT Superior National Forest Non-Native Invasive Species (NNIS): A Guide for Firefighters.

The 2012 Monitoring Report revealed that the expected NNIS infestations of orange hawkweed, Canada thistle, common tansy and spotted knapweed, did occur following burning. NNIS not identified in the FEIS but that did occur, included yellow hawkweed and ox eye daisy. The 2012 Report said that although not conclusive, NNIS establishment appeared to be associated to fire management and recreation activities.

The FEIS predicted that the effects of wildfires in blowdown areas would be more severe than prescribed burning on the landscape. Wildfires would be severe enough to kill a greater percentage of plant life than low to moderate intensity prescribed fires. As a result, the amount of bare ground and open habitat that would potentially be available to invasive species would increase (p 3.7.-68). The FEIS also identified the potential of NNIS dispersal resulting from equipment and personnel involved in prescribed burning.

Forest monitoring did validate the FEIS assumption that high severity wildfires would create habitat more susceptible to NNIS establishment and spread compared to prescribed burns. Approximately 90 plots have been monitored since 1999 with 56 of the plots experiencing either wildfire or prescribed fire between 1999 and 2012. The remaining 34 plots have not experienced any fire. NNIS were documented on 25 percent of the plots. Of these occurrences, 86 percent were found in sites burned at least once by wildfires (Cavity and Ham Lake). Yellow and orange hawkweed and Canada thistle were the principal species encountered. NNIS plants were also observed within many burned areas outside of the burn plots.

<b>Table 3: High Severity Wildfire Effect on NNIS</b>	
<b>Disturbance</b>	<b>Percentage of plots with NNIS occurrence</b>
Ham Lake Fire	43
Cavity Lake Fire	43
Prescribed burn areas	7
Unburned areas	7

## **CONCLUSIONS**

While the concern for and detection of NNIS inside the BWCAW and throughout the Forest has increased since 2001, monitoring has validated that the predicted effects of wildfire and prescribed fire on the spread of NNIS displayed in the FEIS is still relevant and applicable.

## **APPARENT NATURALNESS/UNTRAMMELED/UNDEVELOPED QUALITY-**

The FEIS considered apparent naturalness as the degree to which human impacts are apparent to most visitors, and analyzed effects similar to other attributes considering the effects of burn preparations, implementation, and long-term monitoring. The wilderness character qualities of untrammeled and undeveloped were not directly addressed in the FEIS; however, they are very similar to Apparent Naturalness that was analyzed in the FEIS.

## **IS THE ANALYSIS STILL RELEVANT AND APPLICABLE?**

The analysis in the FEIS is still relevant and applicable. The effects of burn preparation; implementation and monitoring through implementation of the project, have been consistent with the effects described in the FEIS. In addition, the consideration of effects on the apparent naturalness from wildfire suppression activities is accurate. Since the FEIS did not include a

direct analysis for the Untrammeled and Undeveloped Qualities, further consideration of these two attributes is included here.

**Untrammeled** • Wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness, even though they may be taken to restore natural conditions for other purposes like safety. Implementing prescribed burns and associated actions in the wilderness can be seen as a manipulation of the wilderness and negatively impact wilderness character. The untrammeled quality monitors actions that intentionally manipulate, whereas the other qualities monitor the effects from these actions. An impact or degradation of the untrammeled quality of wilderness may result in a degradation of the natural or another quality, or conversely may benefit another quality. Wilderness character and the effects of actions on wilderness character cannot be considered individually, but must be considered holistically. In other words, while individual qualities of wilderness can be of high value in their own right and impacts or degradations to them troubling, one quality does not define the character of a wilderness. Wilderness character is the sum of the qualities.

In this case management ignition of prescribed fires, the direct and indirect effects of those actions disclosed in the FEIS do have a detrimental effect on the untrammeled quality of the BWCAW. To avoid this impact, the Forest would not ignite prescribed fires and seek to use natural ignitions to reduce hazardous fuels and allow fire to play its natural, unimpeded role in the BWCAW ecosystem. Unfortunately, as described in the FEIS and this document, opportunities to allow fire to play its natural role are limited and the risk to human lives and property from wildfires is exceptionally limited. In addition, wildfires and necessary suppression activities have unacceptable impacts on other wilderness qualities. The implementation of prescribed burns negatively impacts the untrammeled quality of wilderness but in doing so benefits the natural qualities as well as reduces risk to the undeveloped quality and opportunities for solitude and primitive and unconfined recreation. This trammeling may be beneficial to wilderness character in the long term.

**Undeveloped**- This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people's ability to occupy or modify the environment.

Continued implementation of prescribed burning can be seen as impacting the undeveloped quality of the wilderness character due to the administrative use of aircraft and other motorized equipment. However, prescribed burning has had and will continue to have a lesser impact on the undeveloped quality than the actions necessary to suppress a large wildfire that would require extensive wilderness intrusions over the course of its management. This is evidenced by the necessary response to fires like the Pagami, Cavity, and Ham Lake fires discussed elsewhere in this document. Given the ability to plan the time, manner, and location of ignition of prescribed burns, fire management personnel maximize the use of primitive tools and other efforts to minimize impacts to wilderness character as detailed in the Minimum Requirement and Minimum Tool Determination completed for the FEIS.

## **CHANGES NOTED SINCE THE ANALYSIS**

As, documented elsewhere in this analysis, the risk of wildfire still exists and there is still a need to use prescribed fire to reduce the risk to human lives and property. Monitoring and reporting

under the 10 Year Wilderness Stewardship Challenge program demonstrates that wilderness character and conditions in the BWCAW are improving since the FEIS was completed.

## **CONCLUSIONS**

The undeveloped quality of Wilderness will continue to be impacted by the implementation of prescribed burns; however, that impact will be short-lived and have less significance than effects from suppression of wildfires. Given the benefit of reducing hazardous fuels in the BWCAW, reducing the likelihood of large wildfires and the indirect benefit to restoring natural fire regimes, the impacts to the undeveloped quality are within the range described in the FEIS.

## **OPPORTUNITIES FOR SOLITUDE AND PRIMITIVE AND UNCONFINED RECREATION**

This quality is about the opportunity for people to experience wilderness. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior. The FEIS analyzed these two factors separately but used the same considerations for each: the effects of preparation and implementation of the prescribed burns and long-term monitoring of the burn units.

## **IS THE ANALYSIS STILL RELEVANT AND APPLICABLE**

The expected impacts disclosed in the FEIS and summarized here have proven to be accurate during the implementation of the completed burns. While the preparation and implementation of the burns can negatively impact some visitor's opportunities for solitude and primitive and unconfined recreation, the Forest has not received a large or notable number of complaints or concerns about the implemented burns. Motorized and mechanized equipment and other fire-related activities during preparation for the burns and during burning operations will cause human sights and sounds along visitor travel routes in the burn areas that could be perceived by visitors to reduce opportunities for solitude and impact wilderness character. As displayed in the FEIS, during burn implementation, management restrictions related to re-routing visitors, closing entry points or enhancing fire restrictions near the area, may reduce a visitor's opportunities for unconfined recreation. While the analysis is still relevant and applicable, some further consideration is warranted.

## **CHANGES NOTED SINCE THE ANALYSIS**

As part of the original analysis process a "Minimum Requirement and Minimum Tool Determination" was completed. The process used by the agency has been changed and is now called the Minimum Requirement Decision Process (MRDP). The original analysis was signed by the Forest Supervisor in June 2001 and documents the Forest's analysis of the appropriate approach needed to implement prescribed burning in the BWCAW. The goal remains the same today; simply use the approach that accomplishes the project in a manner that causes the least amount of impact to wilderness character while maintaining firefighter and public safety.

As stated in the Record of Decision (ROD), motorized tools and mechanized transportation will continue to be necessary to implement the Selected Alternative. Criteria in the Determination used to assess the impacts of each option included biophysical; social, recreational, and experiential effects; societal and political effects; effects of tool use; health and safety concerns; and economic and timing considerations. Also see specifics on page B-8 in the ROD, and FEIS pages 2-41 through 2-44 in the under mitigation for wilderness values. The effects of tool use

during the reconnaissance, preparation, lighting and holding, mop up, and rehabilitation phases of burning were also analyzed.

Each individual bum plan also has its own minimum tool analysis that tiers to the Minimum Tool Determination. The Forest has applied lessons learned through the prescribed burning implementation to date. Specific improvements to minimum tool techniques and Best Management Practices include using fewer motorized water pumps and motorboats, constructing fewer fire lines, and using better monitoring methods. Incoming and outgoing flights are fully utilized to reduce total flights. Training and better equipment minimizes impacts from crews camping in wilderness. Annually authorized motorized and mechanized activities are now documented and tracked, allowing a holistic understanding of their cumulative impacts on the Wilderness.

## **CONCLUSIONS**

The analysis of effects in the FEIS related to opportunities for solitude and primitive and unconfined recreation is adequate and relevant. Improved implementation procedures adopted since 2001 further mitigate effects beyond what is described in the FEIS.

## **WILDERNESS POLICY**

Forest Service Manual 2324.2 Wilderness Management remains the same since the original analysis, but some fire management terminology has changed. Wilderness policy still allows for managers to utilize both wildfires and prescribed, management-ignited fires. Fire resulting from both human and natural ignition must have specific objectives, standards, and guidelines for its control, and must be approved and documented; as was done in the FEIS, through project-specific bum plans, as well as this analysis.

Agency policy granting authority to use prescribed fire has not changed. Prescribed fire may only be used in wilderness to reduce unnatural buildup of fuels and only if necessary to meet at least one of the wilderness fire management objectives set forth in FSM 2324.21 and if all of the following conditions are met:

- a. The use of prescribed fire or other fuel treatment measures outside of wilderness is not sufficient to achieve fire management objectives within wilderness.
  - Meets today's conditions. Fire Managers have treated many hundreds of acres adjacent to the BWCAW boundary, outside of wilderness, to protect life/property outside the wilderness. This work however, is not sufficient to prevent wildfires that originate or bum through blowdown affected areas.
- b. An interdisciplinary team of resource specialists has evaluated and recommended the proposed use of prescribed fire.
  - The FEIS met those conditions and an interdisciplinary team has evaluated any changed conditions and new information as documented here and through extensive monitoring.
- c. The interested public has been involved appropriately in the decision.
  - The public had opportunity to comment on the FEIS as described in Chapter 1 of the FEIS and participated in the post decision administrative process. Any additional burn units to be implemented will include a communication plan as

discussed above using the latest techniques including posting information on the National Recreation Reservation Service website and contacting visitors prior to arrival via text messaging, sound bites, email or phone calls for Forest-wide consistency.

- d. Lightning-caused fires cannot be allowed to burn because they will pose serious threats to life and/or property within wilderness or to life, property, or natural resources outside of wilderness.
  - Currently there is little use of fire managed for multiple benefits within the blowdown area due to the hazards and risks associated with it such as high fuel loads and potential for escape impacting safety. Thus, completing the burn units would help increase future wildfire benefits within the BWCAW and allow fire to play a greater natural role.

## SCENERY

The FEIS identified that according to the Forest Service's Visual Management System, the Visual Management Objective is "Preservation." This objective's intent is that natural processes, like ecological changes, wildfires and blowdown events be the agents of change to visual resources as opposed to the actions of man. Recognizing human-caused modifications are necessary for the protection of resources and public safety, the presence of established campsite infrastructure and administrative facilities are acceptable as is using prescribed fire.

The blowdown event resulted in significant change to visual resources that while natural has negatively impacted the perception of some visitors. The FEIS considered the effect of allowing these blowdown areas to remain untreated potentially resulting in larger, more intense wildfires further altering visual resources, as well as conducting prescribed fires to reduce fuel loading and allow fire to play its more natural role.

The analysis is still relevant and applicable. Both wildfires and prescribed fires that have occurred in the BWCAW since the FEIS was published have impacted visual resources in ways consistent with the predictions in the analysis. There have been no changes in scenery or visual resources of note since the FEIS was published that warrant further analysis.

## DETERMINATION

While the Record of Decision for this project is now nearly fifteen years old, assessment of conditions through robust implementation and effectiveness monitoring, research and professional observation have been nearly continuous throughout implementation. Managers have had real opportunities to evaluate effects of both wild fire and implementation of the prescribed burns to determine whether the effects predicted in the FEIS were accurate or not.

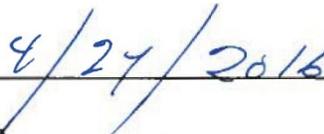
I find the effects disclosed with the new information are within the scope and range of effects that were disclosed in the BWCAW Fuels Treatment FEIS.

After considering the new information, I have determined that continued implementation of the BWCAW Fuels Treatment ROD complies with the Wilderness Act, the BWCAW Act and other applicable law, regulation and policy.

There is not a need to correct, supplement, or revise to the BWCAW Fuels Treatment FEIS.

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**W** Brenda Halter  
Superior National Forest Supervisor

  
Date

Appendix A: 2013 Fuels and Risk Assessment of Remaining BWCAW Units

Unit Name	Area (Acres)	Elevation (ft)	Slope (%)	Fuels Type			Blowdown	Fire History	Wilderness Boundary	Management	Risk	Notes			
				III?	III?	III?									
Duncan Lake	33 41 276 292 302	4,838	H	50	50	50	Several large patches	Spring Fall	Adjacent to the Canadian Border. 1/4-1 mile from values to the south (Menogyn YMCA camp, 2 businesses, 100 cabins/homes). Border Route Trail runs through unit.	Boundary directly adjacent to the north and south.	Caribou Rock bum (uncompleted) to the southwest.	Hardwoods to the north in Canada, WP/Hardwood mix to the south and west, heavy blowdown to the east in Canada.	H	Large overstory pine scatter throughout - may be able to get some pine regeneration.	Some cedar blowdown in patches on the northwest side of the unit - may not bum well. One large patch of birch on south shore of Rose Lake where there was a fire which is old enough to bum. A wide mix of forest types and blowdown.
Spider Three Eastle	310 316 320	9,580	H	90	10	90	Heavy Conifer blowdown	Fall	Middle of BW - Canada (Quetico) 1/2 to 2 miles to the north - Kek Cabin nearby.	2-3 miles to Wilderness boundary to the north and east.	Ham Lake Fire to the east.	Heavy, conifer blowdown, Confer mix.	M	Pine restoration.	
Prairie	324 342								Adjacent to Canadian	Within 1/2 mile of Wilderness		Heavy			Impact to Prairie Portage can be expected - lots of public safety

*Supplemental Information Report – Boundary Waters Canoe Area Wilderness Fuel Treatments*

<b>Trident</b>	346	3,987	<b>H</b>	50	50	75		Fall	Border and structures.	boundary .		blowdown .	<b>H</b>		sunnot.
<b>Crab</b>	54	2,401	<b>M</b>	50	50	15	Patchy	Fall	Burnside Lake with lots of development to the south/east within 1/2 mile.	1/2 mile to Wilderness boundary to the south and east.			<b>H</b>		Drop unit 3 of bum.

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<b>Border Units</b>	2 4 12 23 25	3,123	<b>M</b>	25	75	25	Patchy	Spring Fall	Adjacent to the Canadian Border. Border Route Trail runs through unit.	Boundary directly adjacent to the north.	Some harvesting on the north in Canada.	Mixed hardwoods, blowdown patches, JP plantation.	<b>M</b>	Large overstory pine scattered throughout - maybe able to get some pine regeneration	Units 2,4,25 are the priority. Units 2 and 4 both are over 50% blowdown near McFarland Lake properties. Unit 25 is adjacent to private property on Clearwater Lake.
<b>Bower Trout</b>	109 145	1,027	<b>M</b>	25	75	25	small patches	Spring Fall	2 miles to values at risk to the northeast (2 resorts).	Boundary directly adjacent to the east.	Swede Fire to the west.	Mixed Hardwoods	<b>L</b>	Large overstory pine scattered throughout. Moose habitat area around Bower Trout Lake.	
<b>Rum Sled</b>	102 103	298	<b>M</b>	25	75	25	small patches	Spring Fall	2 miles to values at risk to the northeast (2 resorts).	Boundary directly adjacent to the east.	Swede Fire to the west.	Mixed Hardwoods	<b>L</b>	Large overstory pine scattered throughout. Moose habitat area around Bower Trout Lake.	
<b>Morgan Lake</b>	202 203 204 207	1,149	<b>M</b>	25	75		small patches	Spring Fall	1 mile to values at risk to the northeast (2 resorts) and to the north (Poplar Lake, Ollalie Lake - 200 cabins/homes, 3 resorts, 3 businesses)		Redeye Fire 1 mile to west.	Mixed Hardwoods	<b>L</b>	Large overstory pine scattered throughout. Moose habitat area around Bower Trout Lake.	
<b>Crocodile Lake</b>	26	731	<b>D</b>	10	90	40	2 patches		1/4 mile to values at risk to the north (East Bearskin - 25 homes, 1 resort)	Boundary directly adjacent to the west and south.	Harvest treatment directly to the south. No other treatments to north or east.	Harvest to west and south, Hardwoods to the east, water to the north	<b>M</b>		Drop - blowdown is in 2 smaller patches and primarily a hardwood area.

*Supplemental Information Report – Boundary Waters Canoe Area Wilderness Fuel Treatments*

<b>Pine Lake</b>	16 17	3,366	D	15	85	25	Several small patches		1-2 miles to values at risk to the east (McFarland Lake - 50 cabins), to the west (Clearwater, Flour, W. . . Bearskin Lake - 250 cabins, 2 resorts) and to the Southwest (East Bearskin - 25 cabins, 1 resort)	Boundary directly adjacent to the north.	None in the area.	Mid-aged Hardwood.	M		Drop - blowdown is in small patches and primarily hardwoods, surrounded by hardwood veg types.
<b>Swamp Lake</b>	205	99	D	10	90	10	I small patch		1/4 mile to values at risk to the north (Poplar Lake, Ollalie Lake - 200 cabins/homes, 3 resorts, 3 businesses)	Boundary directly adjacent to the south.	,	Patchy blowdown/hardwoods	M		Drop - very small with hardwood blowdown .
<b>Brule Lake</b>	126 130	5,934	D	10	90	25	Scattered blowdown		2 miles to values at risk to the west (Sawhill Lake).	Boundary directly adjacent to the south.	South Temperance Fire to the west.	Burn area to the west, Hardwoods to the south and east, water to the north .	H		
<b>Hansen</b>	280 285 288		D	60	40	50					Ham Lake Fire directly to the east. Unit 280 half burnt.	Ham fire to the east - good fire break .	M		Burned as part of Cavity Fire.

Appendix 8: Treatment Unit Map

