# Use and Effectiveness of Fuel Treatments During the 2014 Funny River Fire, Alaska


Photo: USFWS

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# Executive Summary

The Funny River Fire (AK-KKS-403140) was ignited by humans on May 19, 2014, and burned almost 200,000 acres on the Kenai Peninsula, Alaska, by early June. Most of the fire was within the Kenai National Wildlife Refuge, but it threatened adjacent communities. Four recreational cabins and two outbuildings were burned, but many more structures would have been lost were it not for two fuelbreaks, one shaded and one masticated, located on what became the northern perimeter of the fire just south of the Funny River community. The purpose of this report is to document the effectiveness of the fuels treatments in the Funny River Fire and provide discussion and recommendations that could aid fire managers in future fuel treatment planning efforts.

The Funny River fuelbreaks highlight the need for fuel treatment planning to protect communities. This was the second time that the shaded fuelbreak was utilized; the first was as part of a contingency line for the Shanta Creek Fire in 2009. The fuelbreaks also provided an opportunity to evaluate fuel treatment effectiveness and inform the planning process for future treatments. Some key points derived from the Funny River Fire experience are:

- Both treatment types were effective in reducing fire behavior and providing an anchor point for suppression resources, primarily by enabling or improving capability to perform burn out operations. There would not have been enough time to construct the amount of line needed to perform these operations in the absence of pre-existing fuelbreaks.
- Both treatment types were breached by spotting and would not have prevented the fire from spreading to communities without the intervention of firefighters. Spotting distances of up to 0.5 miles were reported. Treatments that would reduce the occurrence of spotting prior to reaching the fuelbreak would be necessary to reduce the probability of spot fires challenging the fuelbreaks.
- Firefighter safety, cost, and other concerns such as viewshed or unwanted access may play a larger role in determining treatment design than effectiveness as both fuelbreak types served the desired purpose under the given conditions.
- Suppression personnel indicated that tree spacing in the shaded fuel break was sufficient to reduce fire behavior and provide safe working conditions.
- Monitoring of fuel treatments is needed to determine appropriate maintenance schedules. It is uncertain if retreatment on the shaded fuelbreak was conducted in the most cost effective time frame. Type and rate of vegetation regrowth in the masticated fuelbreak are uncertain as it was recently constructed.

# Introduction

The Funny River Fire was detected on the Kenai National Wildlife Refuge (NWR, Refuge), Alaska on May 19, 2014 and by June 7 the perimeter encompassed 196,610 acres (Figure 1). The fire was human-caused and occurred early in the year, when dry fuels were available pre-greenup. Lack of snow in late winter and only 0.39 inches of rain in the month preceding the fire resulted in an abundance of dry grass and other fine fuels that, coupled with strong winds when the fire started, led to rapid spread.

Four recreational cabins and two outbuildings were lost in the fire. According to numerous accounts from personnel involved in suppression activities, many more homes would have burned had it not been for the presence of two fuelbreaks: a 6.5 mile long shaded fuelbreak and a 4.5 mile long cleared fuelbreak (3.5 miles masticated, 1 mile hand-cleared), located on what became the northern perimeter of the fire. According to Oded Shalom, Chena Interagency Hotshot Crew (IHC) superintendent, “If we didn’t have those fuel treatments, I don’t think we could have done what we did. (They) pretty much saved the day.”

Fuel Treatment  Definitions

**Fuel Treatment:** Manipulation or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling, and burning.

**Fuelbreak:** A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled.

**Firebreak:** A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work.

Types of Fuelbreaks

**Shaded Fuelbreak:** Fuelbreaks built in timbered areas where the trees on the break are thinned and pruned to reduce the fire potential yet retain enough crown canopy to make a less favorable microclimate for surface fires. Cut vegetation is often piled and burned.

**Masticated Fuelbreak:** Fuelbreaks in which all vegetation is cut and reduced in size by mechanically grinding, shredding, chunking, or chopping. Masticated biomass typically left on the ground.

## Setting for the Funny River Fire

Kenai NWR, located on the Kenai Peninsula in southcentral Alaska, is 1.98 million acres in size, two-thirds of which is congressionally designated wilderness (Figure 1). The refuge is a microcosm of Alaska, with habitats ranging from alpine tundra, glaciers, and subalpine forest and shrublands to forested lowlands and coastal estuaries. It is one of two refuges in Alaska with portions that are accessible by road, making it a popular destination for recreational activities. Sections of its boundary are immediately adjacent to communities, and subdivisions and recreational cabins are scattered across the landscape. Numerous hiking trails, boating opportunities, and world-class fishing and hunting attract people from around the world each year. This close proximity of wildlands to communities results in a high incidence of human-caused fires compared to most of the state. The patchwork of land ownership complicates fire management, especially along portions of the Refuge's boundary where wilderness areas abut private or State property.

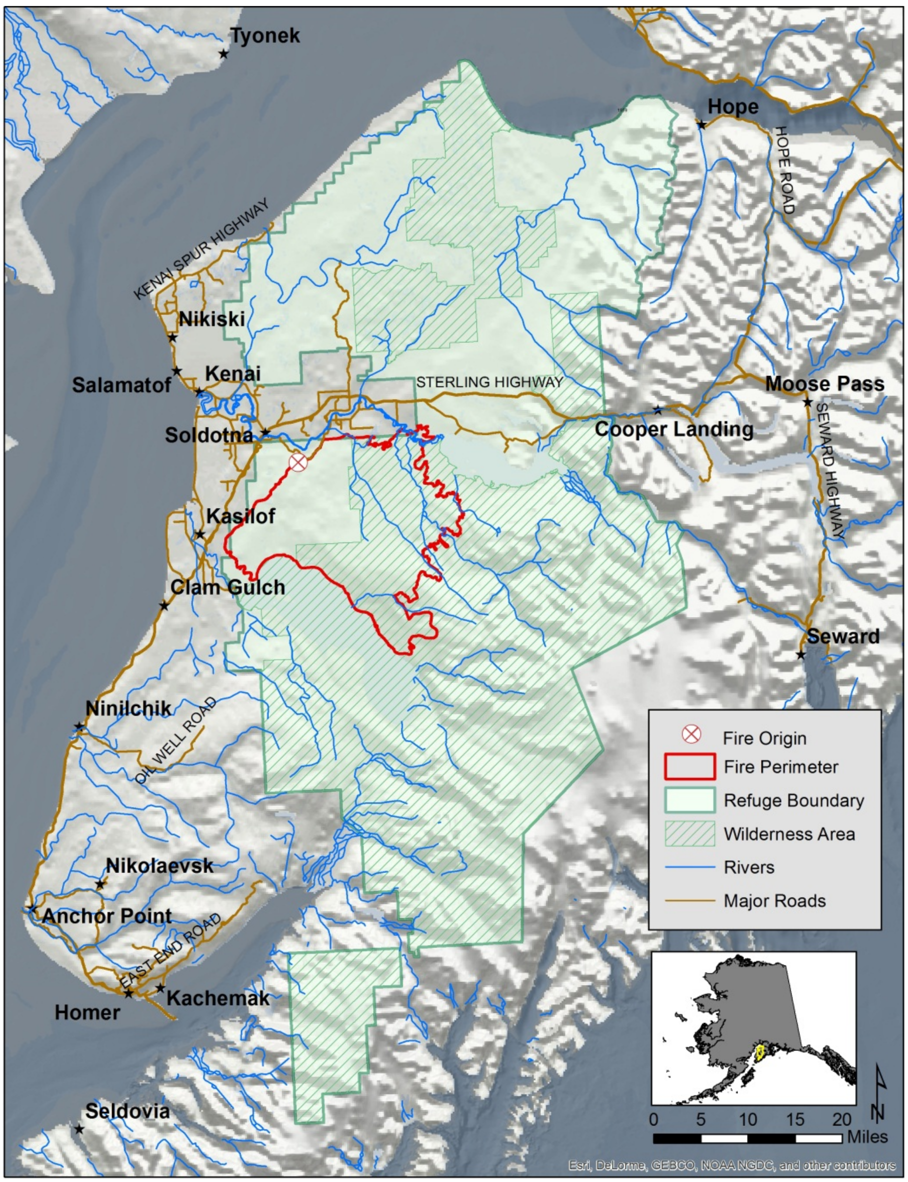



**Figure 1. Location of the Funny River Fire and Kenai NWR within the Kenai Peninsula, Alaska**

## *Fire Season and Fire Weather Characteristics*

Varied topographic features play a large role in fire behavior on the Refuge (USFWS 2013). Weather patterns include cold air drainage from glaciers that can produce localized turbulence and downslope winds, turbulence and foehn winds along the west slope of the Kenai Mountains, and sea breezes from the southwest that potentially bring in moisture and trigger thunderstorms. North winds are less common, but these tend to be cool and dry and have been associated with severe fire danger in the past. The mountains also create rain shadows, causing annual precipitation to range from 17" – 25" along the length of the Kenai Peninsula, most of it falling between early August and November (USFWS 2013).

Fire season on the Kenai NWR typically runs from May – August, with most of the fires occurring in June (Figure 2). A majority of the fires are human-ignited and account for most of the acreage burned since 1940. Lightning fires primarily occur in June and July and account for a relatively small amount of the total acres burned. The largest fires prior to the Funny River Fire were the Kenai Fire of 1947 (310,000 acres) and the Swanson Lake Fire of 1969 (86,000), both of which were human-caused, elevating the acreage of non-natural fires. Most human-caused fires tend to be small, partly due to active suppression efforts.

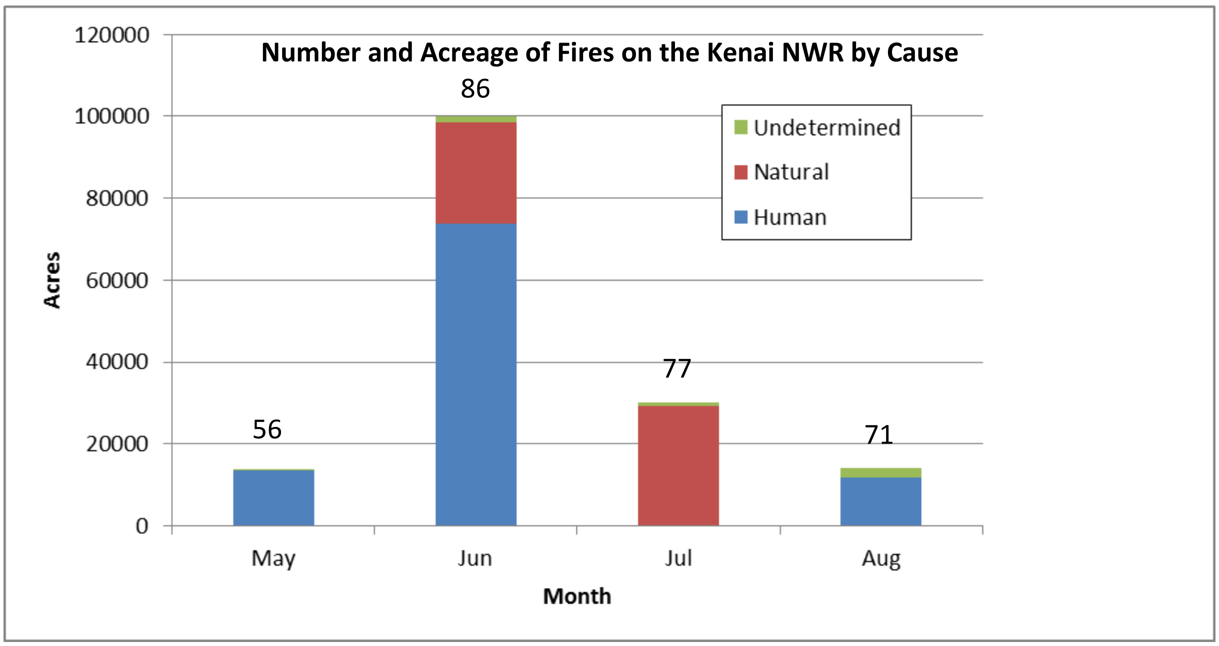



**Figure 2. Ignition month, ignition source, and acres burned on the Kenai NWR, May – August, 1981 – 2013. Number of fires above bars. Data source: FWS Fire Management Information System (FMIS).**

Three Remote Automated Weather Stations (RAWS) are located in the vicinity of the fire. The Soldotna AKKKS RAWS (station ID 500927) is closest to the northwest flank of the fire and is the most influenced by coastal winds. This RAWS replaced a manual Soldotna RAWS (station ID 500925) in 2012 at the same location; the manual station continued to collect data into 2013. The Skilak Guard Station RAWS is closest to the northeast perimeter. It is influenced by winds coming off Skilak Lake, which is subject to downslope winds from the Skilak Glacier and by winds coming off the western foothills of the Kenai Mountains. It is located in deciduous forest, and is therefore not necessarily representative of the main fuel type of concern on the Refuge – spruce forest. The Kenai NWR RAWS is closest to the mountains and also farthest from the fire perimeter. Weather data referenced in this report will therefore be from the Soldotna and/or Soldotna AKKKS RAWs, depending on year.

Long-term (1971 – 2013) weather data indicate that average temperature peaks in mid-July and typically starts declining in August (Figure 3). Precipitation tends to be more variable, with peaks potentially occurring throughout the summer. Average wind speed is between 0 – 10 mph with occasional peaks exceeding 20 mph, usually in July and August.

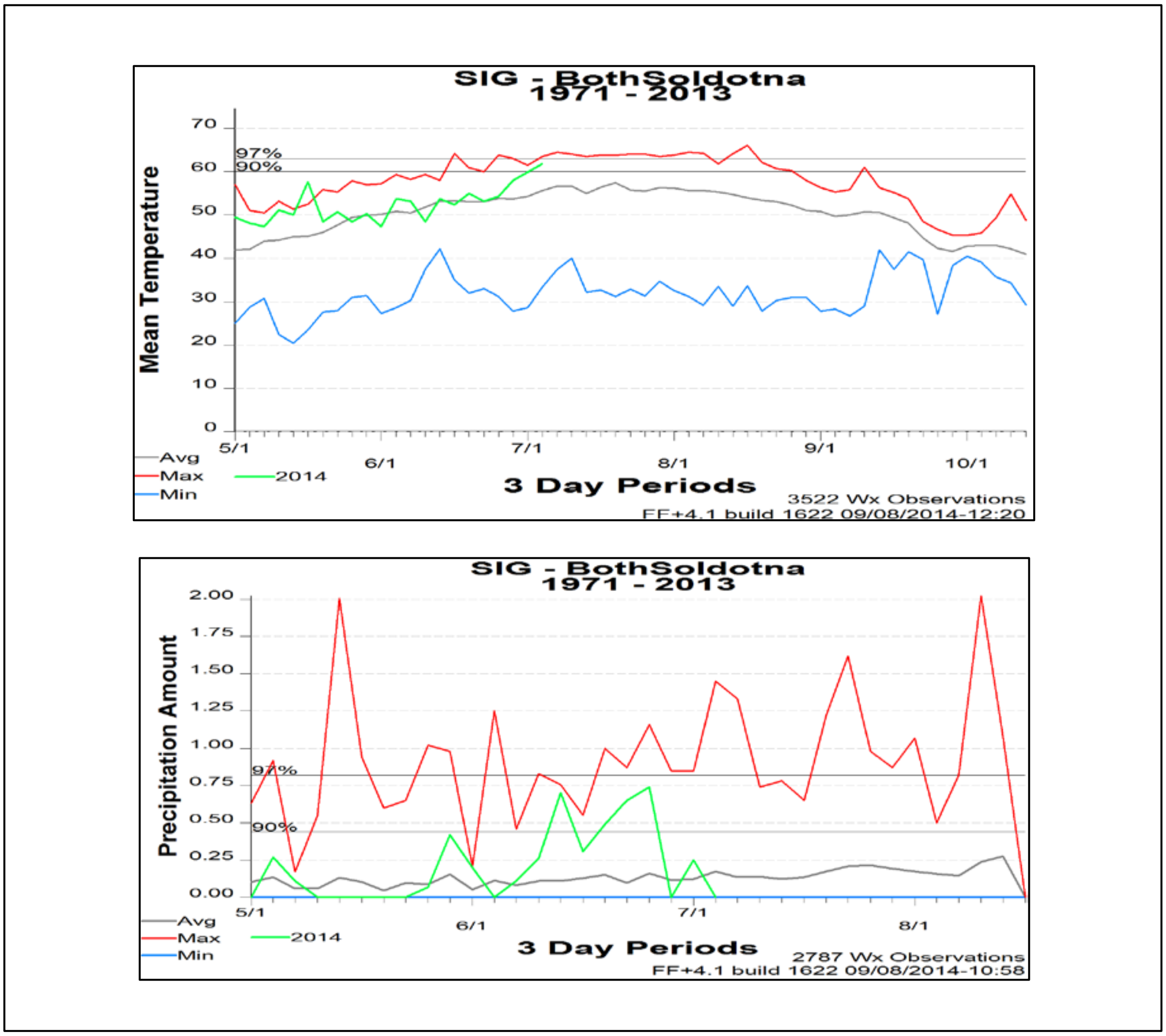
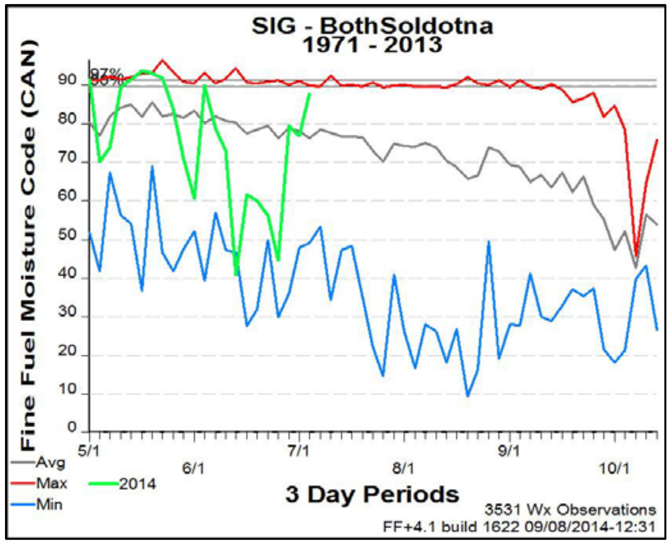
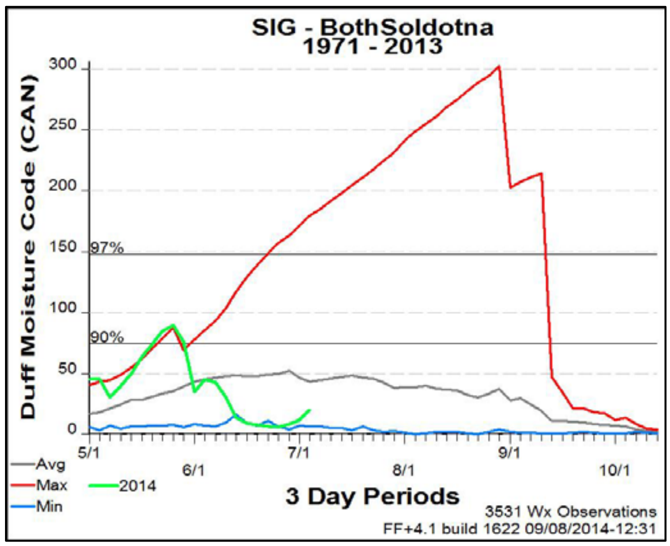



**Figure 3. Temperature (°F) and precipitation (inches) data for the Soldotna RAWS station, 1971 – 2013.**

Fire danger indices also tend to start declining in late August and early September (Figure 4). Alaska uses the Canadian Forest Fire Danger Rating System in which fire danger indices largely represent dryness of forest floor components. The Fine Fuel Moisture Code (FFMC) is the moisture content of the litter and fine fuel layer, about 0.4 – 0.8 inches deep. Influenced by temperature, wind, rain, and relative humidity, it is estimated to have a time lag of 2/3 day and represents ease of ignition and flammability. The Duff Moisture Code (DMC) is based on moisture of loose organic matter, about 2 – 4 inches deep. Affected by temperature, rainfall, and relative humidity, it has a time lag of about 12 days and provides a measure of resistance to control. The Drought Code (DC) is represented by deep, compact organic matter about 4 – 8 inches deep. It indicates seasonal drought and ability of fires to smolder deep in the duff or in large logs. Sensitive to temperature and rainfall, the time lag is 52 days. Several remaining indices are developed by combining these codes. The Initial Spread Index (ISI) combines FFMC and wind to indicate fire spread immediately after ignition, without taking fuel type into consideration. It is highly variable, fluctuating with wind speed and time of day. The Build Up Index (BUI) combines DMC and DC to indicate total fuel available for combustion. It changes little on a daily basis. The Fire Weather Index (FWI) indicates the intensity of a spreading fire by combining ISI and BUI.



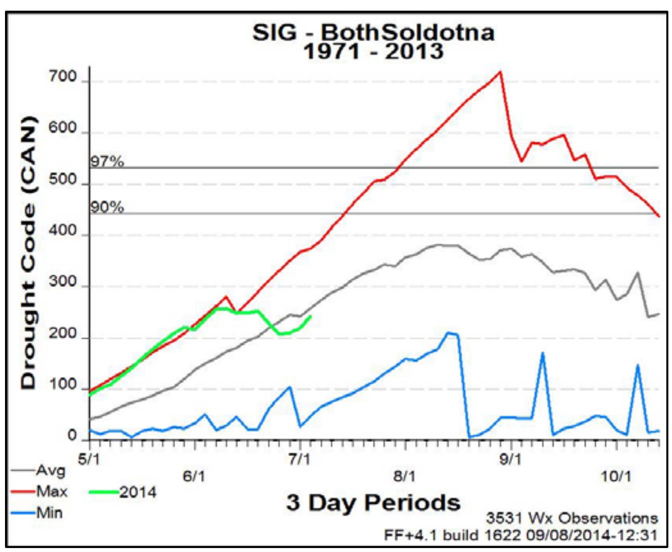




**Figure 4. Average, minimum, and maximum Canadian fire danger indices derived from the Soldotna RAWS station, 1971 - 2013**

## *Disturbance – Insects and Fire*

The Refuge's broad range of habitats and relatively easy access yields a complex disturbance history, including insect infestation, fire, and human development. The spruce bark beetle has been a major disturbance factor since the mid-1700s, with a recent outbreak starting in the mid-1990s that has infected over 1.06 million acres on the Kenai Peninsula with 80 - 90% mortality of mature white (*Picea glauca*) and Lutz spruce (*P.* x *lutzii*) trees (USFWS 2009, ALAH 2011). This outbreak opened the forest canopy, allowing proliferation and persistence of native grasses (primarily *Calamagrostis canadensis*) as pure stands or in the understory of remaining forests. This has resulted in altered fuel models and changes in fire behavior given the increased availability of fine fuels on the landscape. Dead trees that were not salvaged have long lost their fine fuels load and are in the gray stage or have fallen, adding to the surface fuel load. The lasting legacy of the infestation is a transition of large areas from a forested to a grass fuel model that allows easy ignition when cured and rapid spread of fire.

Fire is a predominant feature on the landscape, creating a mosaic of different aged habitats. There are two categories of fire return intervals on the Refuge. Lowland black spruce (*P. mariana*) forests typically have a mean fire return interval of 89 years with a range of 25 – 185 years (USFWS 2013). White and Lutz spruce forests have a much longer fire return interval, with an average fire return interval of 515 years, ranging from 105 – 1,642 years.

Fire perimeters are available for fires from 1940 – present from the Alaska Large Fire Database (http://fire.ak.blm.gov/predsvcs/maps.php), which provides perimeters for fires >1,000 acres prior to 1988 and fires >100 acres after 1988 (Figure 5). Like the Funny River Fire, the large 1969 Swanson River and 1947 Kenai fires burned near Soldotna and Sterling. Little information is available about the Kenai Fire, but Swanson River was a severe fire that exposed mineral soil, creating ideal conditions for establishment of deciduous trees, primarily birch. These fires resulted in reduced threat of wildfire to communities when spruce forest was converted to less flammable fuel models. Another benefit was an increase in the moose population, thanks to the post-fire production of deciduous browse. These post-fire benefits have waned in recent years as spruce has regenerated in the burns, increasing the threat of fire and reducing availability of moose forage. These changes, coupled with concerns about fast-moving grass fires in areas affected by the beetle infestation, have prompted agencies to consider actions on a landscape level that include a coordinated approach to fuels management by land managers.

## *Fuels*

Prior to the Funny River Fire, forested land comprised 952,406 acres (50.3%) of Kenai NWR while shrublands and grasslands/tundra accounted for 191,185 and 188,835 acres, respectively (~10% each); the remainder is water, ice, and rock (USFWS 2009). About 89% of the acreage within the Funny River Fire perimeter was forested. Dominant forest types on the Refuge are black spruce and mixed conifer/deciduous forest consisting of black, white, or Lutz spruce along with paper birch (*Betula neoalaskana*), balsam poplar (*Populus balsamifera*), and quaking aspen (*P. tremuloides*). Mountain hemlock (*Tsuga mertensiana*) and pure hardwood stands are present in relatively small amounts.

Black spruce forests are generally considered the most problematic fuel type in the area. Flaky bark, dead lichen-covered branches that often extend from the base of the living canopy down to the ground, low live fuel moisture, and understories commonly consisting of quick-drying feathermoss and highly flammable shrubs and graminoids result in relatively high-intensity fires and torching of individual or small groups of trees. Wind-driven fires can move quickly through these forests with long spotting distances, as observed during the Funny River Fire.

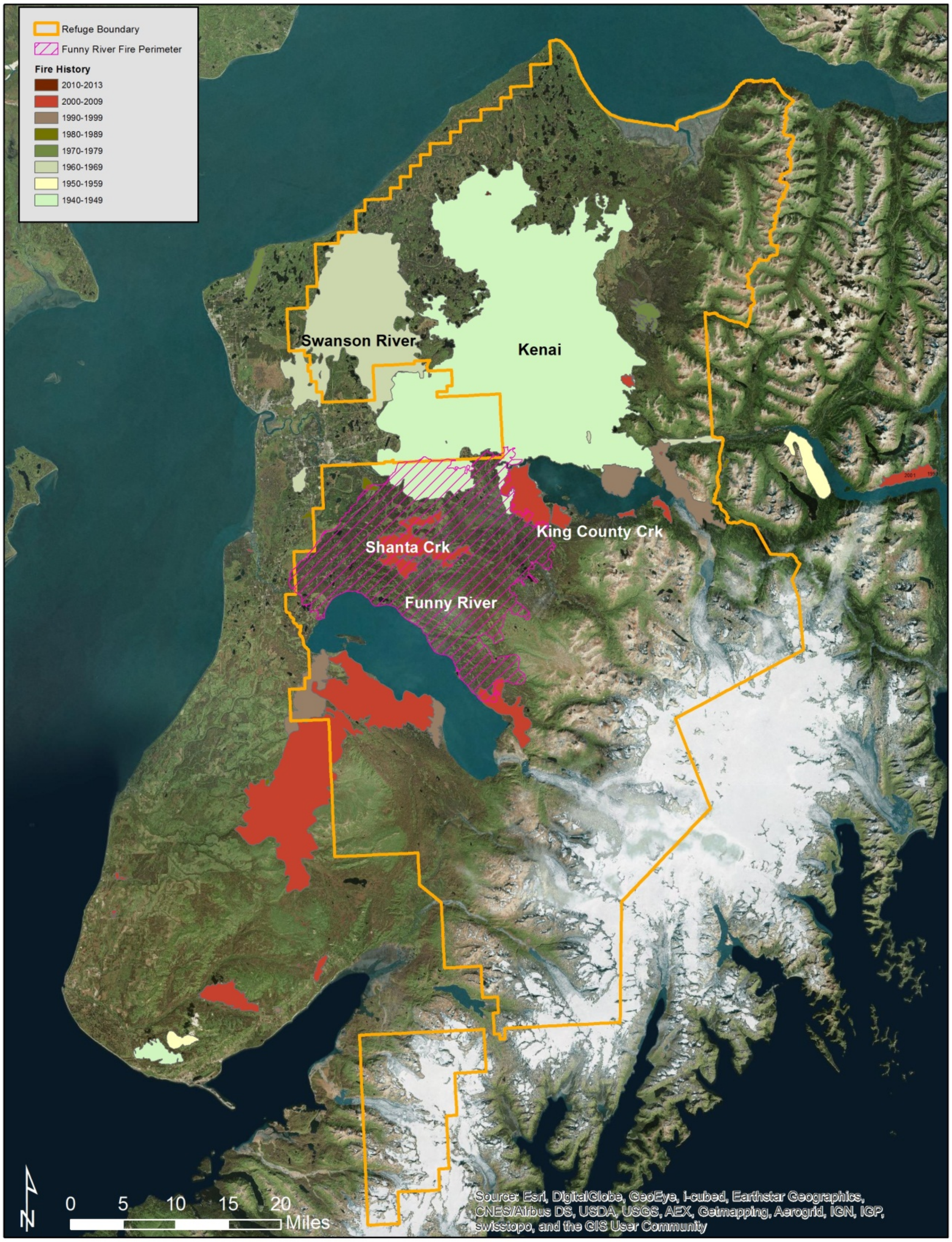



**Figure 5. Fire history on the Kenai Peninsula, Alaska, 1940–2013. Perimeters available for fires >100 acres. (Source: Alaska Interagency Coordination Center [AICC]). Fires discussed in the text are labeled.**

Fuels in Alaskan spruce forests are often represented by timber-understory (TU) fuel models in Scott and Burgan's (2005) 40-model system (FBFM40 fuel models) for fire behavior modeling. Black spruce has generally been classified as TU3 for closed forest and as TU4 for open forest and black spruce woodland with lichen and moss understories. However, under dry windy conditions it has been found that the shrub (SH) model SH5 better represents fire behavior observed in black spruce, with higher rates of spread (ROS) and flame lengths (Figure 6). White spruce is generally represented by TU1 for closed forest and TU5 for open forest and woodland (Cella et al. 2008).

Given these fuels characteristics, coupled with relatively common high winds on the Kenai Peninsula, fuels treatments are designed more to alter fire behavior enough to allow firefighters to safely work in an area than to completely stop a fire. These treatments provide increased flexibility, both strategically and tactically, allowing fire managers to consider a broader suite of suppression options. Wide, open treatments typically meet with public resistance due to aesthetic values and access issues, as openings tend to become travel corridors for all-terrain vehicles. An alternative is to create shaded fuel treatments, which typically reduce canopy cover, raise canopy base height, and remove dead fuels from the understory. These treatments do not deteriorate aesthetic values as much as open breaks and do not provide easy access corridors. In addition, the shading can protect understory vegetation such as mosses and lichens from drying. Retention of native vegetation may reduce the likelihood of colonization by invasive plant species or other undesirable vegetation. However, they are more time consuming and expensive to construct compared to complete removal of vegetation. Both types of fuelbreaks require periodic maintenance, and maintenance costs will also vary with design. Any fuelbreak, shaded or open, is susceptible to breaching by spotting, especially long-linear breaks that are perpendicular to the primary direction of fire spread.

### *Values at Risk*

The Kenai Peninsula has a long history of human habitation, with 104 known prehistoric sites within the Kenai NWR (USFWS 2009). The first Europeans arrived on the Peninsula with Captain James Cook in 1778, followed by other English, Spanish, and Russian expeditions through the late 1790s. Trapping, gold mining, and fishing have been the primary economic ventures in the past. Commercial, sport, and subsistence fishing remain important components of the Peninsula's economy and culture to this day.

Portions of the Kenai Peninsula outside of Federal management are characterized by a patchwork of State, Borough, Native (Native corporations and allotments), and other private lands (Figure 7). The Refuge lies within the Kenai Peninsula Borough, which was estimated to have a population of 56,862 people in 2013 (State of Alaska Department of Labor and Workforce Development, http://laborstats.alaska.gov pop/popest.htm).

The 196,610 acre Funny River Fire burned mostly on the Refuge (195,172 acres), but it crossed on to non-Federal lands on its northern and western perimeters, close to the communities of Soldotna, Sterling, Funny River, and Kasilof. Population estimates in cities and Census Designated Places (CDPs) near the Funny River Fire for 2013 were as follows: 4,284 people in the city of Soldotna, 5,795 in the Sterling CDP, 884 in the Funny River CDP, and 589 in the Kasilof CDP (State of Alaska Department of Labor and Workforce Development). These three communities include 19.3% of the Borough's population and encompass numerous homes, businesses, and other infrastructure (Figure 8). Some structures are located in areas accessible only by boat or aircraft in summer. Many are in dense spruce forest, with limited road access (Figure 9).

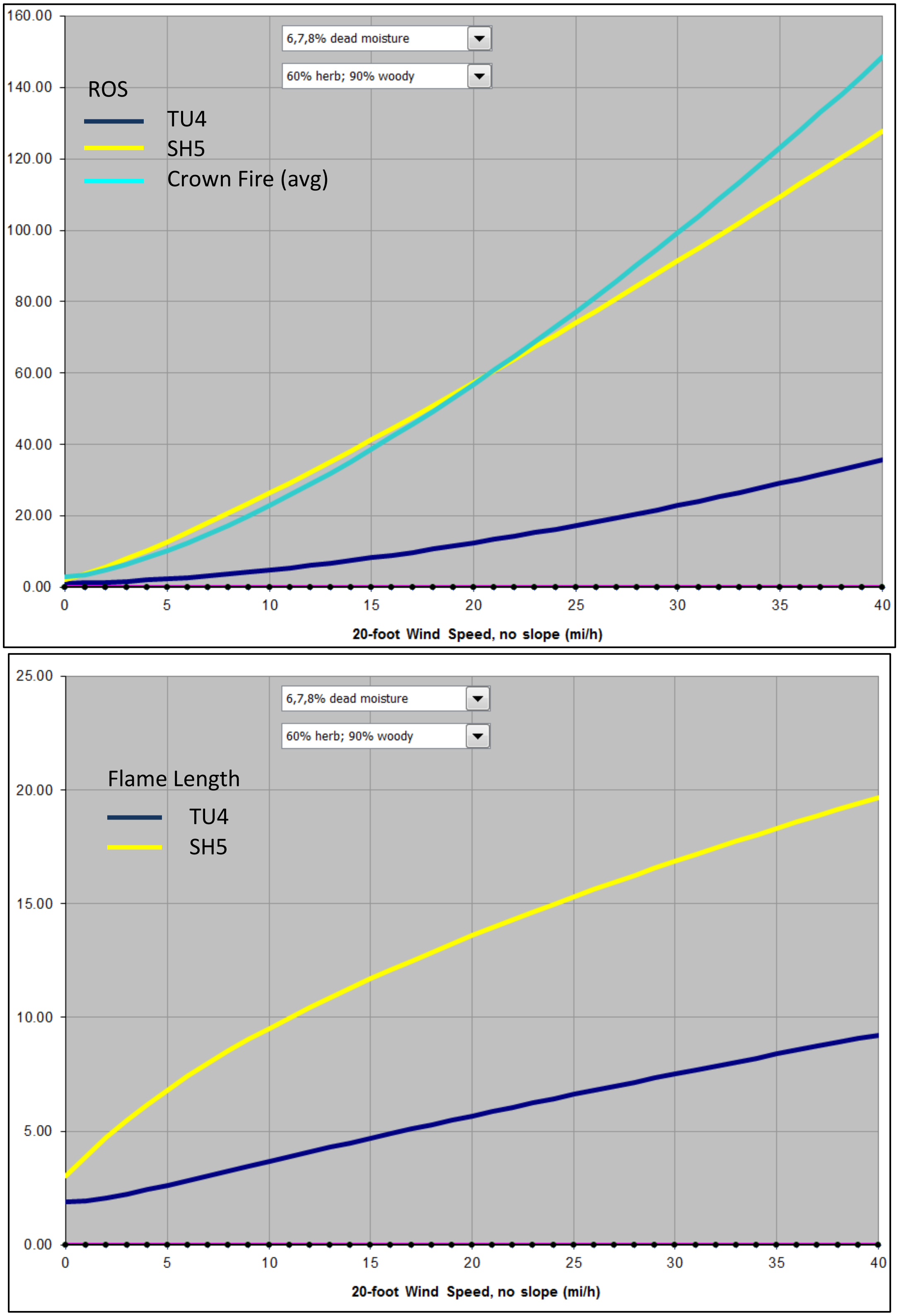



**Figure 6. Rate of spread (ROS) and flame length of FBFM40 fuel models often used to represent black spruce forests in Alaska. Average crown fire ROS included for comparison. Fuel model TU4 has been used to represent black spruce, but the shrub model SH5 better represents fire behavior except for open (woodland) dwarf spruce stands.**

In addition to structures in population centers near the fire perimeter, there are a number of historical and recreational values located within the burned area. As of early June, 19 cultural resources composed of 15 structures, 1 archaeological site, and 3 trails were known to occur within and immediately adjacent to the fire. All but two structures and the trails are documented in the Alaska Heritage Resources Survey, which is an inventory of cultural resources including objects, structures, buildings, sites, districts, and travel ways that are over 50 years old.

There are no federally listed threatened or endangered species known to occur on the Kenai NWR. The Refuge supports numerous fish and wildlife species that may be affected by the fire, including many of interest for wildlife viewing, hunting, and fishing. Fire occurrence early in the season may have a higher negative impact on wildlife that produce young in spring compared to later fires. Moose are widely distributed throughout the area, and the start of the Funny River fire coincided with calving season, which occurs from mid-May to mid-June with a peak around May 23 – 24 on the Kenai Peninsula (J. Selinger, ADFG, pers. comm.). The fire likely disrupted the nesting season of numerous birds, potentially causing nest failure, direct mortality of individual young or eggs, and displacement of adult birds. Some migrant species may have had enough time to relocate and start another nest. A late arrival for birds encountering inclement weather along migratory routes in 2014 may have mitigated some of the negative effects of the fire. Early nesting species, including resident birds and waterfowl, were likely the most affected. Black and brown bear cubs typically emerge from their dens in spring, and individuals of both species may have been negatively affected by the fire. Likewise, wolves are born in May and were still in their dens when the fire started. Several wolf cubs in poor condition were rescued from a den adjacent to a dozer line and taken to the zoo in Anchorage, garnering a lot of publicity. The pups were a major attraction prior to being moved permanently to a zoo in Minnesota in July.

The fire triggered considerable speculation about its potential to increase and enhance moose habitat. Previous large fires, especially the 1969 Swanson River and 1947 Kenai fires, created an abundance of deciduous browse species used by moose, primarily willows (*Salix* spp.), paper birch, and aspen. Succession in these burns has resulted in less forage that, in addition to other factors besides habitat, has been implicated in reduced moose populations in the region. The Swanson River Fire started in early August, during one of the hottest and driest summers recorded at the time, while the Kenai Fire started in early June during a summer that was slightly drier and cooler than average; the Swanson River Fire reportedly burned hotter and more uniformly than the Kenai Fire (Bangs and Baily 1980). The effect of the Funny River Fire on moose habitat is currently unknown. Deciduous species are most likely to germinate on mineral soil exposed by severe burns. The Funny River Fire burned early enough in the season that lower duff layers were still moist, likely minimizing the incidence of burning to mineral soil. However, browse species may exhibit increased growth and sprouting from surviving rootstock, which could rejuvenate mature and heavily browsed stands. Such sprouting can lead to increased shrub availability for moose in a quicker time frame than growth from seed, especially during winter when seedlings are covered by snow and not accessible. Other species of herbivores, many of which serve as prey for carnivores and raptors, could also benefit from post-fire habitat changes.

Kenai NWR supports 21 different species of fish, including 5 species of salmon and several species of trout. Some spawning areas occur in upper reaches of streams located in steep terrain that may experience erosion and increased runoff following the fire.

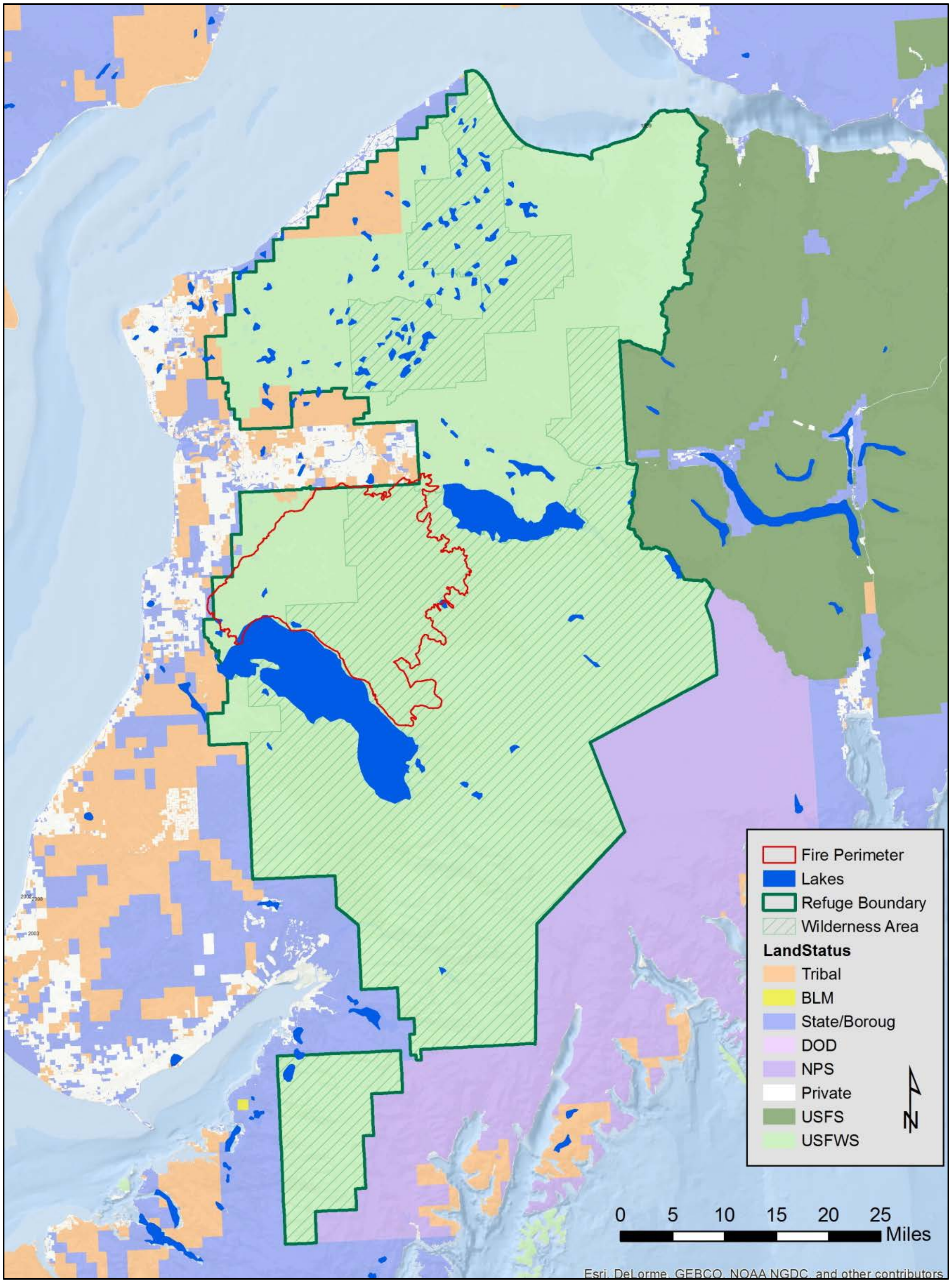



**Figure 7. Land ownership on the Kenai Peninsula.**

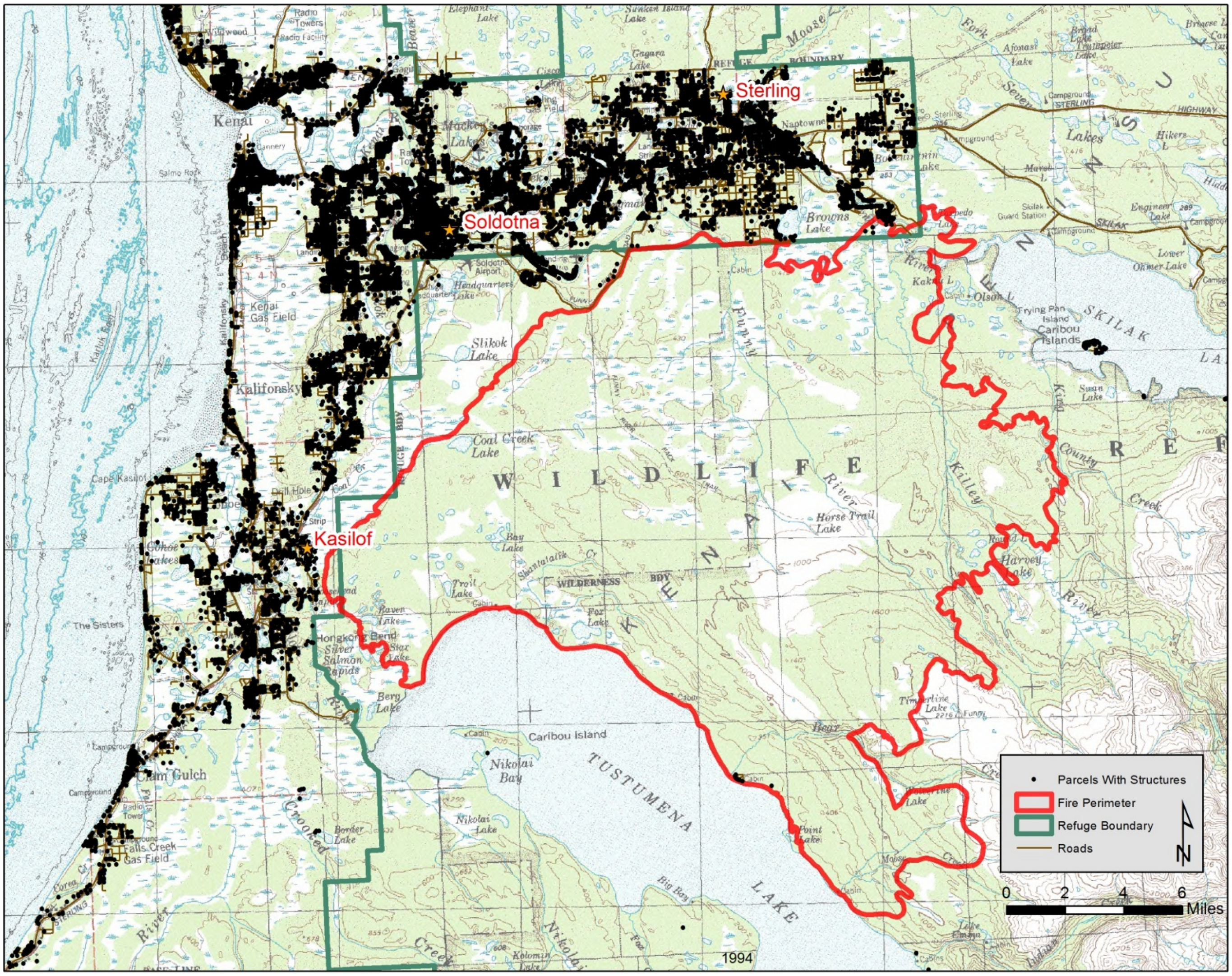



**Figure 8. Parcels with structures adjacent to the fire perimeter. Parcels may contain more than one structure.**


**Figure 9. Examples of subdivision layout and fuel types. In the top photo, clearings of variable sizes containing structures are surrounded by highly flammable spruce forest (dark green) that is prone to extreme fire behavior. Such areas can be difficult and dangerous to defend during a fire, especially when access routes are limited. In the lower photo, deciduous vegetation and sloughs would slow fire spread, but fuels are often next to homes. Photos: Aerial imagery from Kenai Peninsula Borough (top), USFWS (bottom).**

## Fire Planning- Fuel Treatments

There is a long history of cooperative planning for fire mitigation on the Kenai Peninsula. Due to the extended spruce bark beetle infestation, fuels work initially focused on salvage logging of beetle-killed spruce to extract as much value in wood products as possible in addition to removing hazardous fuels. This evolved into a more comprehensive and collaborative approach to hazardous fuels reduction in the region, driven by policy as well as necessity. The National Fire Plan of 2000 stressed coordination among government agencies at the Federal, State, and local levels and included objectives to promote a community-based approach to addressing wildfire and hazardous fuels reduction. Another key policy was the 2003 Healthy Forest Restoration Act (PL. 108-148) that resulted in the development of Community Wildfire Protection Plans (CWPPs). These collaborative efforts to prioritize areas at risk and provide recommendations for reducing the threat of wildfire to communities have become essential for acquiring federal funding for fuels reduction. A group called the Kenai Forest Wildland Fire and Fuels Management Coordinating Committee was formed in 2003. By 2004 they had developed a plan called the All Lands /All Hands (ALAH) Action Plan, revised in 2011 (ALAH 2011), that provided a strategy for implementing the National Fire Plan and Healthy Forest Restoration Act. CWPPs were developed for Kenai Peninsula communities as part of this effort. The ALAH group meets formally twice a year, in addition to routine communication among members, to discuss fuels treatment priorities and strategies. This long-term communication has facilitated fuels mitigation efforts on the Kenai Peninsula and provides the foundation for effective partnerships.

Fuels management options on the Kenai NWR are somewhat limited by the presence of three designated wilderness areas within its boundaries (Figure 7). The Andrew Simons Wilderness Area is located in the area affected by the Funny River Fire, running immediately along the Refuge boundary south of Sterling. Houses and communities border the northern and western boundary of the wilderness area. Although fire suppression is allowed in wilderness areas, many other activities are prohibited and those that may be allowed must undergo a minimum requirements analysis. According to the Refuge Comprehensive Conservation Plan (USFWS 2009), habitat management by mechanical treatment (cutting, crushing, or mowing) is not allowed in designated wilderness, although "prescribed fires or invasive species control may be conducted when necessary to protect life or property, or to restore, maintain, or protect wilderness values" (Section 1.2.1). Manual treatment using hand tools or prescribed fire and use of naturally occurring fires to meet management objectives may be allowed in wilderness, also subject to minimum requirements. These limitations in fuel treatment options make the wilderness boundary lands a primary concern for fire management and heighten the importance of working cooperatively across borders.

### *Shaded Fuelbreak*

Kenai NWR began the planning process for a shaded fuelbreak along Funny River Road in 1998, with implementation starting in 1999 (Figure 10). Fuel types, prevailing winds, and proximity to wildlands just over the Refuge boundary made the Funny River community a high priority for fuels reduction. In addition to community protection, treatments along the boundary provide increased opportunity to use naturally ignited fire within the Refuge's interior to maintain ecosystem processes and achieve fuels management benefits on a landscape scale that cannot be accomplished through mechanical or hand treatments. There was concern that the fuelbreak would degrade the viewshed, and Refuge biological staff had additional concerns about its effect on wildlife habitat, particularly in riparian areas and near wetlands. The final prescriptions, described below, were developed to address these issues. Ultimately, the break

> *We looked at Funny River and said this 'town has a bullseye drawn around it and we want to protect it.' - Doug Newbould, Fire Management Officer, Kenai NWR*

extended along 6.5 miles of Funny River Road adjacent to the Refuge boundary, from milepost 3.0 on its western edge east to milepost 9.5.

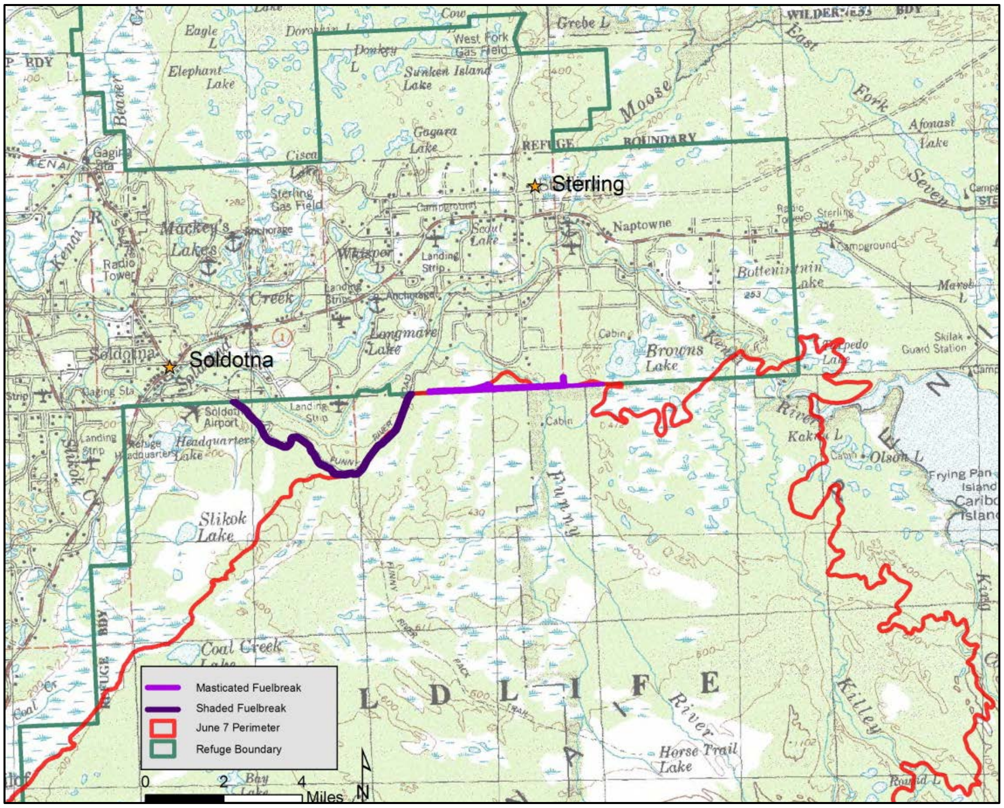



**Figure 10. Location of fuelbreaks on the northern perimeter of the Funny River Fire.**

Implementation was done in stages. Between 1999 and 2002, 127 acres were treated along the full 6.5 miles. In 2005, this was retreated, the fuelbreak was widened to better protect the Salamatof subdivision near milepost 5, and additional trees were removed to reduce the density of black spruce in several areas for a total of 145 treated acres.

## Prescriptions for Shaded Fuelbreak Construction

- 150’ – 250’ wide treatment area inside of right-of-way; width dependent on fuels and location. Treatment up to 500’ wide in high risk areas
- 20’ crown-spacing for white spruce, increased in for black spruce stands as needed
- Pruned lower branches to remove ladder fuels (6’ high for white spruce, adjustable in black spruce depending on tree height)
- Removal of all dead wood and bark beetle-infested trees; offered as firewood for local residents
- Retention of live deciduous trees
- Clumps of deciduous trees and small clumps of spruce sometimes retained for more natural appearance
- Buffer of trees left in riparian areas, stream crossings, and bog/wetland areas, per biologists’ request to limit access and protect viewshed
- Buffer of trees left at gated roads to prevent access by going around the gate
- Debris piles burned on site (burning incomplete following 2013 treatment)

Although the 2009 Shanta Creek Fire did not reach the fuelbreak, it became part of the contingency plan for suppression. This included extensions, maintenance, and improvement of the existing treatment between miles 6.5 and 9.5. One new contingency line followed Woodcut Road, starting at mile 6.5 of Funny River Road and ending at Coal Creek Lake, about 5.5 miles to the south. Another contingency line extended the fuelbreak about 7 miles from its eastern end, from mile 9.5 to beyond Brown's Lake, with a width of about 30' – 50'. Existing clearing along Lake Road was improved and a 50'-wide swath was cut along an all-terrain vehicle trail from the end of the road east to a bog, along the Refuge boundary. For the contingency work, burnable fuels except for live trees were removed. The existing treatment width was widened, and the previously existing buffer at the Woodcut Road gate was removed. Some of this was subsequently improved, but dates of maintenance are uncertain. There was some post-fire rehabilitation along the contingency lines in 2009.

In 2013, an 8A service contract was developed with the Windy Bay Native Corporation to maintain and enhance the Funny River Road treatments from miles 6.5 to 9.5. An additional 0.5-mile segment of the 2009 contingency line was improved east of this. During this effort, the treatment area was widened and brush was removed. Permits were issued for the public to take wood, and piles were burned in a 2-mile stretch running west from mile 9.5. The remaining debris was still in piles in spring 2014. Treatments from mile 3.5 to 6.5 have not been maintained since the 2005 retreatment.

### *Masticated Fuelbreak*

In winter 2012 - 2013, a 3.5-mile long, 200' wide (~60 acres) masticated fuelbreak was constructed starting near the eastern end of Funny River Road along the Kenai NWR boundary under a FWS cooperative agreement with the State of Alaska Division of Forestry (DOF) (Figure 10 and 11). The DOF recognized that the presence of a wilderness area immediately inside the Refuge boundary limited work that could be done within the Refuge. They received permission from Cook Inlet Regional, Inc. (CIRI), a regional for-profit Native corporation created under the 1971 Alaska Native Claims Settlement Act (P.L. 92-203, 85 Stat. 688) to construct the fuelbreak on undeveloped CIRI land bordering the Refuge boundary.

The masticated fuelbreak was designed to serve as an area for firefighters to put in dozer line and conduct backfiring operations to protect the Funny River community if a wildfire ever approached from the Refuge wilderness area. About 0.25 mile of the break was on Kenai Borough property. Vegetation was cut and chipped, but natural barriers (e.g., muskegs, aspen) were incorporated into the design of the break. Width of the fuelbreak was determined by doubling the height of the existing fuels. An additional mile-long swath, also on private land, was cleared to the east of the masticated fuelbreak by hand crews in Fall 2013 to create a 60' separation of tree crowns on each side of a dirt road (Figure 11). A typical approach to designing fuelbreaks is to clear to a minimum of 1.5 times the available fuel height to prevent flame lengths from reaching fuels across the treated area, although this does not prevent embers crossing the fuelbreak. The width of the masticated fuelbreak was increased to twice the tree heights since it was believed that spruce would potentially produce flame lengths of 150' – 200' under average to above average conditions. Reports from personnel on the Funny River Fire indicated that flame lengths up to 300' were observed at several locations near the line.

Debris on the masticated fuelbreak was chipped to large diameter, just enough to break the wood up, resulting in chunks that were up to 4' long and as wide as the original tree width. Large chunks were designed to expedite regrowth of deciduous vegetation from suckers and sprouts. They also help retain moisture and are less likely to smolder for long periods compared to sawdust or smaller chips.

Establishing the partnership with CIRI was facilitated by having a pre-existing relationship between the DOF and the corporation. Contingency lines constructed during the Shanta Creek Fire illustrated the utility of having a strategically placed fuelbreak in the area. The location was a good tactical choice, but also had the advantage of not being highly visible to the public except for people flying into the airport. Dara Glass, Land Manager for

CIRI, felt that it was the corporation's fiduciary duty as a major landowner and good neighbor to provide protection for shareholders and the general public. CIRI's main concern was trespass, especially from all-terrain vehicles, as this was a pre-existing problem that could be exacerbated by the fuelbreak. Mitigation of this issue has been something DOF and CIRI have had to work through and figure out the best approach. In retrospect, Glass felt that the fuelbreak was so effective during the Funny River Fire that access issues seemed minor in comparison.

Maintenance interval for the masticated fuelbreak is uncertain. Black spruce in the area established 75 years ago, after the 1947 Kenai Fire, and had grown into a fairly dense, tall forest by 2014 (Figure 11). Ideally, deciduous vegetation will grow back, creating a conversion of spruce fuel models to something less flammable.


**Figure 11. Masticated fuelbreak looking eastward, 2013 (left) and hand extension to east of masticated break (right). Note high pre-treatment density of trees, adjacent to fuelbreaks. Photos: State of Alaska DOF.**

## *Funding*

Prior the National Fire Plan (2001) and the National Fire Plan Operations and Reporting System (NFPORS) tracking of fuels project funding on the Kenai NWR was similar to other refuges in that it was reported only in the Fish and Wildlife Service (Service) Fire Management Information System (FMIS). This resulted in completed prescribed fires as an FMIS entry and a void for other fuels treatment accomplishments (fuel breaks, *et al.*) With the implementation of NFPORS, most treatments and all treatment methods are funded as part of a project account which allows ready tracking of corresponding activities, funding, and accomplishments.

Service guidance on fuels treatment reporting in NFPORS delays final reporting of cooperative agreement or contract treatment accomplishments until completion. Often a cooperative agreement or contract is awarded several years before completion. This results in a fiscal and reporting data gap, where it may seem one year has a low accomplishment/ high cost relationship and another year having a high accomplishment/ low cost relationship. The USDA Forest Service enters fuels treatment reports based on agreement or contract award date, helping to maintain a more direct relationship between fiscal allocation and treatment accomplishment data and this may be a model the Service can use in the future.

As a result of various reporting system shortfalls, funding for fuel treatment projects on the Kenai NWR prior to 2005 is difficult to determine. For the last decade, funding for all projects has varied, with peak expenditures in 2005 and 2009 (Figure 12). Funding has been applied in a variety of ways; through contracts with local vendors, by FWS employees performing work on the ground (force account) and through cooperative agreements with local agencies. For contracts and cooperative agreements, tracking of accomplishments is fairly complete. Where FWS employees have performed the work, not all acres are accounted for in NFPORS due to their ad hoc placement or improvement of existing projects and no clear policy on reporting requirements.

The masticated fuel break was initially constructed using a 2011 cooperative agreement between the FWS and the Alaska DOF, Kenai-Kodiak Area. The FWS contributed $181,340 for work conducted over the course of two winters. The 2013 contract with the Windy Bay Native Corporation was used for Refuge-wide Wildland Urban Interface (WUI) projects including some maintenance of the Funny River road shaded fuelbreak. In all over $250,000 was awarded under this contract for handcrew work. Figure 12 also includes National Fire Plan funds used for biological research on fire history on the Refuge from 2005 to 2009.

In comparison, shaded fuelbreaks are significantly more labor intensive than masticated fuelbreaks. An average cost per acre for mastication is estimated at $840 per acre, where shaded fuelbreaks often cost upwards of $3000 per acre. Both types of treatments have their place; when aesthetics are a concern, shaded fuelbreaks are the more selective choice.

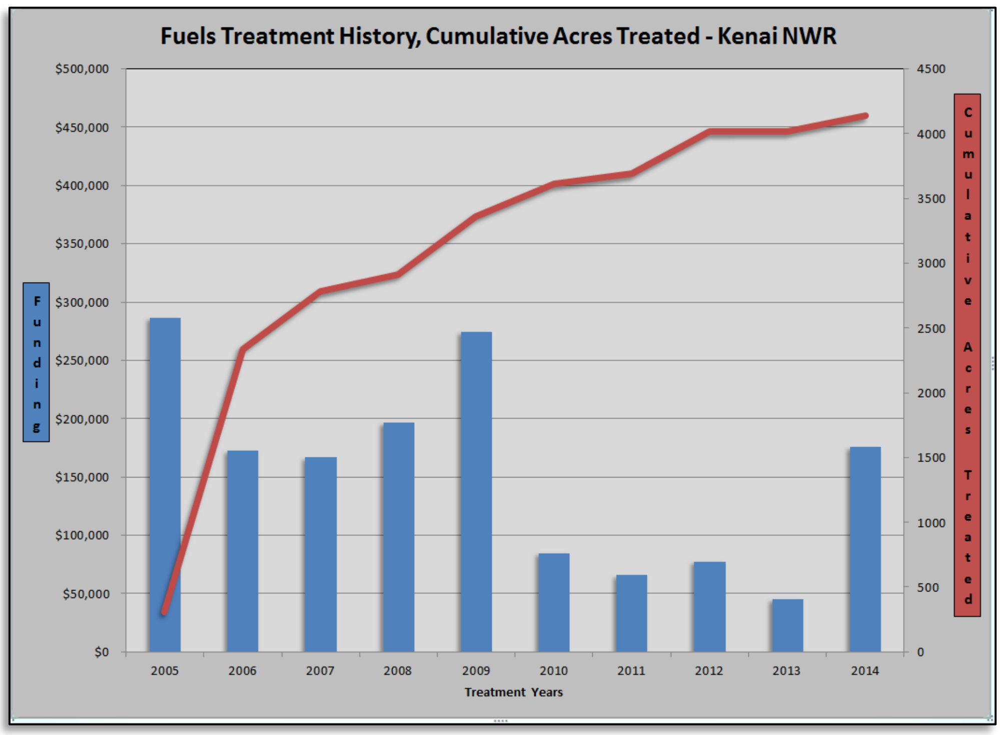



**Figure 12. Ten year treatment history for the Kenai National Wildlife Refuge.**

## The Funny River Fire

The Funny River Fire was ignited by undetermined human activities about a mile west of the Funny River Horse Trail and remained uncontained on its eastern and southern perimeters within the Kenai NWR until the end of August. The fire started unusually early in the fire season for the area, was preceded by a long period without rain, and was driven by high winds at times. Vegetation had not yet greened up, and cured grass facilitated quick spread of the fire. Spruce trees had just started bud burst and were at their lowest foliar fuel moisture levels of the year—the “spring dip.” Winds from the north initially pushed the fire away from population centers, but the fire turned towards the community of Funny River and the town of Sterling when winds shifted. The fire was active on multiple fronts, but the primary focus of this report is the northern perimeter, near the two fuelbreaks. The fire reached the Funny River Road area near the shaded fuelbreak in early morning (0000 – 0500 hr) of May 21. It reached the masticated fuelbreak on May 24. Conditions from ignition of the fire through these time periods, including daily acreage estimates, are provided in Appendix 2.

## *Fire Weather and Fire Danger*

Mean wind speed and direction when the fire reached the fuelbreaks are displayed in wind roses from Soldotna AKKKS in Figure 13. When the fire started on May 19, winds were predominantly from the north, with average wind speed reaching 13 mph and a maximum windspeed of 27 mph. Highest mean and maximum wind speeds tended to occur between 1000 hr to 1900 hr. Relative humidity on the 19th ranged from a minimum of 18% at 1700 hr to a maximum of 63% early in the morning, with most values during the day in the 20% to low 30% range.

Average winds remained primarily out of the north when the fire approached Funny River Road and the shaded fuelbreak late night May 20 to early morning May 21. Mean wind speed was lower than the previous day, between 4 – 8 mph, with some milder winds out of the northeast and the south; the southern winds occurred before midnight on the 20th. Highest average wind speed was between 0100 – 0200 hr at 4 mph. The highest gusts were out of the north, reaching up to 19 mph. By May 24 – 25, when firefighters engaged the fire at the masticated fuelbreak, winds had shifted and were out of the southwest with an average wind speed of up to 13 mph and gusts up to 25 mph. Figure 14 – 16 depict fire behavior in and near the fuelbreaks during this period.

Fire danger indices leading to ignition on May 19 were conducive to rapid fire spread (Figure 17). Conditions were dry, with the last rain recorded prior to ignition on May 7. This enabled the FFMC to reach Extreme levels (≥92) a week before the fire impacted the shaded fuelbreak (Figure 18). It dropped to Very High (89-91) on the 24th, when firing operations were conducted at the masticated fuelbreak and dropped to lower levels May 26 – June 2. Likewise, the ISI was Very High (8-10) to Extreme (≥11) May 20 – 21 but dropped back to Very High by the 24th. The DMC was in the High range (60-79) on May 20 – 21 and was Very High May 23 – 30 as drying continued into the duff layer. The DC remained Low to Moderate throughout the period as it was too early in the spring for lower organic layers to have dried significantly. This maintained the BUI in the Moderate-to-High range as it is derived from the DMC and DC.

Compared to historical conditions, the May 2014 indices were above average and exceeded the historic maximum in some cases. The FFMC set a new maximum value just prior to May 20, but had dropped below average conditions by June 1 (Figure 18). DMC showed a similar trend (Figure 19).

---

*“. . . we were scrambling, behind the curve. Resources were limited, and there were other priorities; it depended on which way the wind blew. If we didn’t have those fuel treatments, I don’t think we could have done what we did. They pretty much saved the day, set us up to do what we did. We didn’t have time to set up defensible lines.” -Oded Shalom, Chena IHC Superintendent*

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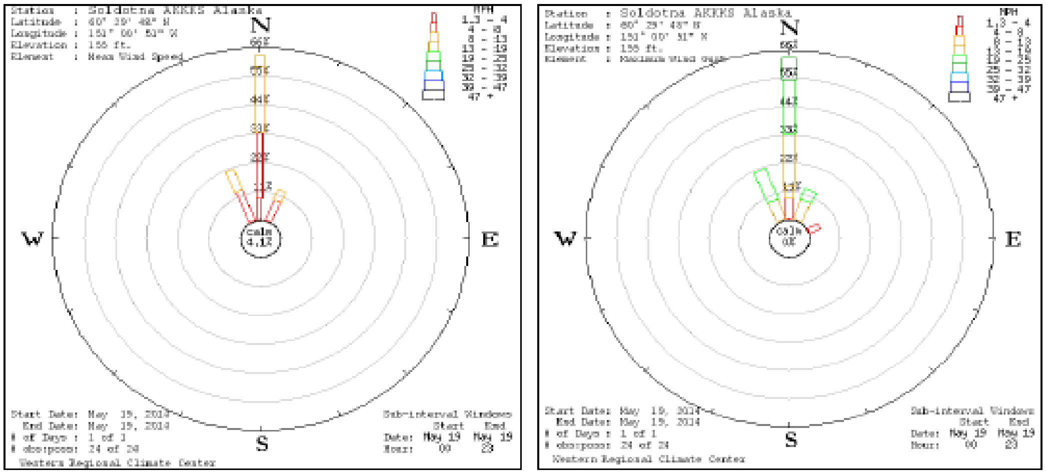
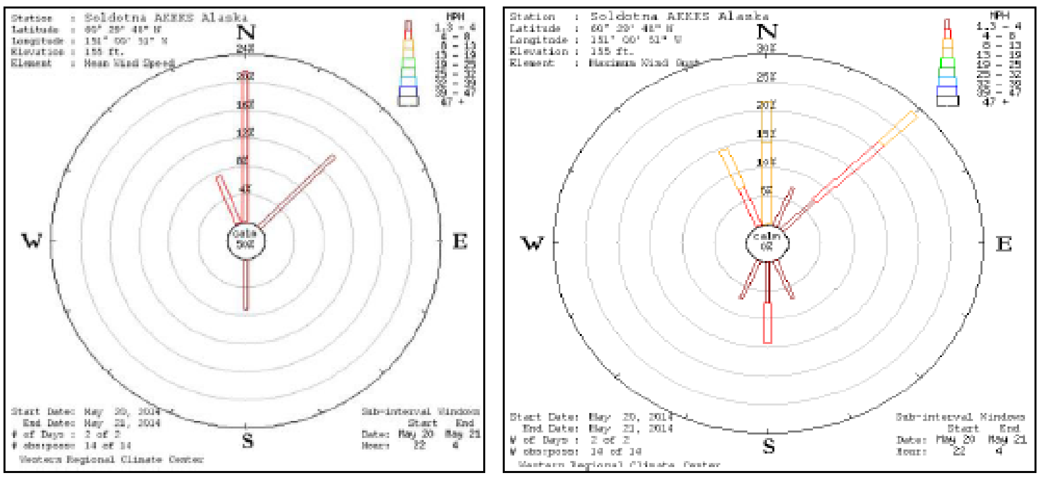
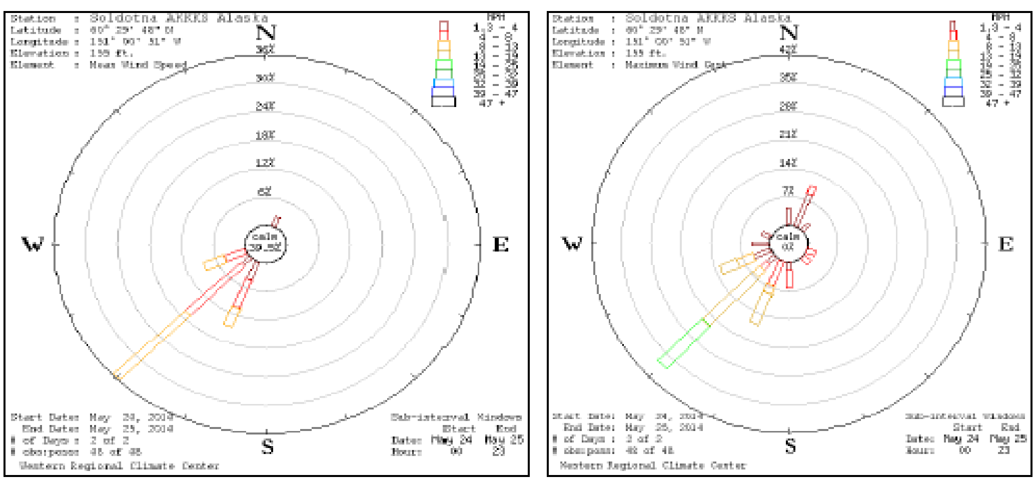



a. May 19, day of ignition: average (left) and maximum (right) wind speed




b. May 20 – 21 2200 – 0500 hr, fire reaches Funny River Road and shaded fuelbreak: average (left) and maximum (right) wind speed




c. May 24 – 25, 00 – 2300 hr, fire reaches masticated fuelbreak: average (left) and maximum (right) wind speed

**Figure 13. Wind conditions corresponding to different times during the fire when fuelbreaks were affected. Note changes in wind speed and direction between timeframes.**

**Figure 14. Firefighters conduct burn out in shaded fuelbreak to prevent fire from crossing Funny River Road. Photo: USFWS.**


**Figure 15. Fire activity at 2330 hr, May 23. Photo: CES.**

**Figure 16. Burn out along the masticated fuelbreak. Photos taken on May 26 at 1515 hr (left) and 1455 hr (right) Photos: Chena IHC.**

**AICC Predictive Services**

Print Close

FWI (Fire Weather Indices) for: SDF - SOLDOTNA AKKKS

*Type: RAWS Lat: 60.49 Lon: -151.01 WIMS: 500927 Zone: KKS FWI?: Y*

*Data for 6 Jun 2014 and 29 day(s) preceding, sorted by: **Date***

| | Date | Hr | ATF | RHP | WSM | PREC | FFMC | DMC | DC | ISI | BUI | FWI | DSR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 06-06 | 14 | 67 | 31 | 6 | 0.00 | 90.4 | 47.7 | 235.5 | 7.4 | 63.3 | 20.3 | 5.6 |
| | 06-05 | 14 | 59 | 50 | 4 | 0.00 | 88.8 | 44.0 | 228.6 | 5.0 | 59.4 | 14.5 | 3.1 |
| | 06-04 | 14 | 72 | 29 | 2 | 0.00 | 90.0 | 41.8 | 222.5 | 5.0 | 56.9 | 14.3 | 3.0 |
| | 06-03 | 14 | 67 | 30 | 5 | 0.00 | 84.3 | 37.5 | 215.1 | 2.9 | 52.2 | 8.6 | 1.2 |
| | 06-02 | 14 | 59 | 43 | 4 | 0.00 | 63.8 | 33.7 | 208.2 | 0.7 | 48.0 | 1.5 | 0.1 |
| | 06-01 | 14 | 47 | 84 | 1 | 0.20 | 31.6 | 31.3 | 202.1 | 0.0 | 45.1 | 0.0 | 0.0 |
| | 05-31 | 14 | 50 | 48 | 15 | 0.30 | 58.0 | 47.2 | 206.8 | 1.2 | 60.1 | 4.1 | 0.3 |
| | 05-30 | 14 | 58 | 52 | 6 | 0.07 | 74.3 | 80.6 | 219.5 | 1.2 | 84.0 | 5.3 | 0.5 |
| | 05-29 | 14 | 54 | 69 | 2 | 0.02 | 77.8 | 85.9 | 214.5 | 1.1 | 85.9 | 4.9 | 0.5 |
| | 05-28 | 14 | 55 | 78 | 2 | 0.03 | 73.5 | 84.8 | 209.9 | 0.8 | 84.8 | 3.6 | 0.3 |
| | 05-27 | 14 | 58 | 55 | 1 | 0.07 | 73.7 | 84.0 | 205.2 | 0.8 | 84.0 | 3.3 | 0.2 |
| | 05-26 | 14 | 54 | 53 | 11 | 0.00 | 87.9 | 90.1 | 200.2 | 7.8 | 89.9 | 25.2 | 8.2 |
| | 05-25 | 14 | 61 | 40 | 11 | 0.00 | 89.9 | 88.4 | 195.6 | 10.3 | 88.3 | 30.2 | 11.4 |
| Masticated FB | 05-24 | 14 | 58 | 46 | 11 | 0.00 | 89.8 | 85.7 | 190.3 | 10.2 | 85.6 | 29.6 | 11.0 |
| | 05-23 | 14 | 67 | 22 | 2 | 0.00 | 92.9 | 83.5 | 185.3 | 7.6 | 83.4 | 23.8 | 7.4 |
| | 05-22 | 14 | 64 | 22 | 5 | 0.00 | 92.8 | 79.3 | 179.4 | 9.6 | 79.2 | 27.3 | 9.5 |
| Shaded FB | 05-21 | 14 | 59 | 28 | 3 | 0.00 | 92.8 | 75.4 | 173.8 | 8.1 | 75.3 | 23.7 | 7.3 |
| | 05-20 | 14 | 61 | 22 | 6 | 0.00 | 93.4 | 72.3 | 168.7 | 11.3 | 72.3 | 29.2 | 10.7 |
| Ignition | 05-19 | 14 | 58 | 23 | 13 | 0.00 | 93.4 | 68.8 | 163.4 | 19.9 | 68.8 | 41.3 | 19.7 |
| | 05-18 | 14 | 64 | 22 | 5 | 0.00 | 93.8 | 65.7 | 158.3 | 11.0 | 65.6 | 27.3 | 9.4 |
| | 05-17 | 14 | 76 | 23 | 3 | 0.00 | 93.7 | 61.8 | 152.7 | 9.3 | 61.8 | 23.5 | 7.3 |
| | 05-16 | 14 | 75 | 21 | 4 | 0.00 | 93.7 | 56.6 | 145.9 | 10.0 | 57.5 | 23.9 | 7.5 |
| | 05-15 | 14 | 66 | 25 | 3 | 0.00 | 93.2 | 51.4 | 139.2 | 8.6 | 53.5 | 20.7 | 5.8 |
| | 05-14 | 14 | 68 | 16 | 6 | 0.00 | 93.2 | 47.5 | 133.4 | 10.9 | 50.2 | 23.8 | 7.4 |
| | 05-13 | 14 | 63 | 44 | 2 | 0.00 | 87.7 | 42.8 | 127.4 | 3.6 | 46.5 | 9.8 | 1.6 |
| | 05-12 | 14 | 52 | 67 | 5 | 0.00 | 87.1 | 40.1 | 121.9 | 4.3 | 44.0 | 10.9 | 1.9 |
| | 05-11 | 14 | 70 | 23 | 6 | 0.00 | 92.6 | 39.0 | 117.5 | 10.1 | 42.6 | 20.7 | 5.8 |
| | 05-10 | 14 | 66 | 24 | 5 | 0.00 | 91.5 | 34.5 | 111.3 | 7.9 | 38.9 | 16.5 | 3.9 |
| | 05-09 | 14 | 64 | 24 | 7 | 0.00 | 88.5 | 30.5 | 105.5 | 6.1 | 35.4 | 12.9 | 2.5 |
| | 05-08 | 14 | 62 | 41 | 3 | 0.00 | 76.1 | 26.7 | 99.9 | 1.0 | 32.0 | 1.9 | 0.1 |

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**Figure 17. Fire danger indices reported for the Soldotna AKKKS RAWS May 8 – June 6, 2014.**
**Red bar indicates extreme conditions for an index, orange is very high, yellow is high, blue is moderate, and green is low. Numerical ranges for different adjective ratings vary with index type. FFMC represents ease of ignition and flammability, and DMC indicates resistance to control, providing a good indication of fire behavior. DC incorporates moisture of lower duff levels, which were still moist this early in the season. ISI, BUI, and FWI combine other indices.**

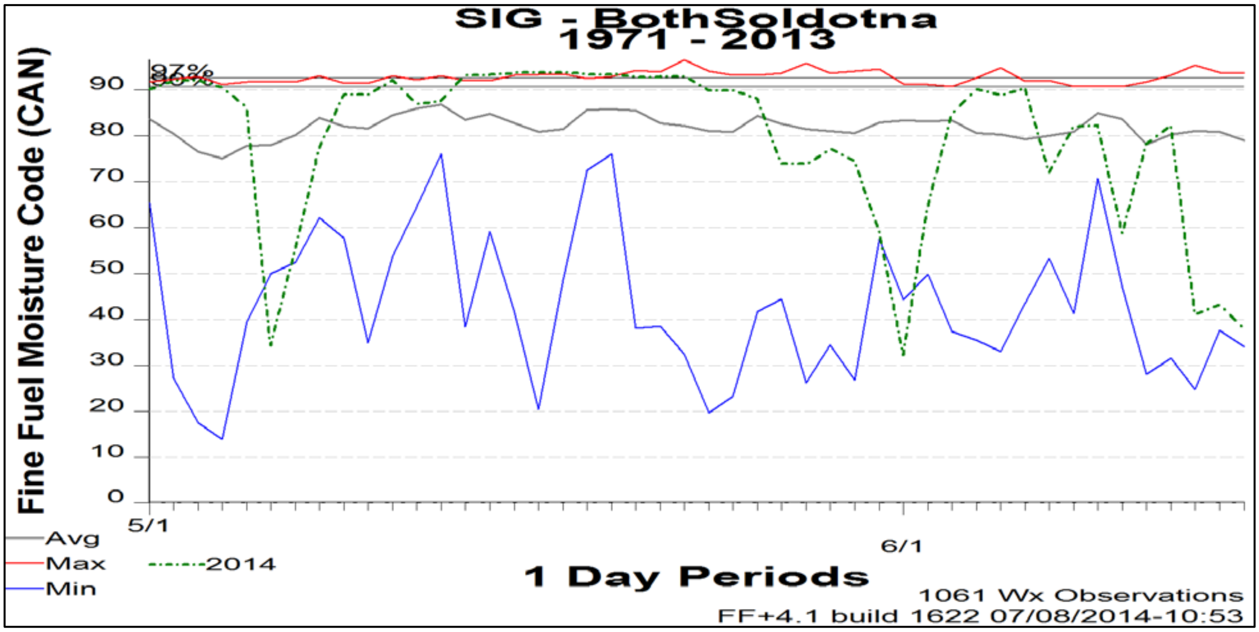



**Figure 18. Average, extreme, minimum, and 2014 trend lines for FFMC, May 1 – June 15, Soldotna AKKKS RAWS and Soldotna manual RAWS.**

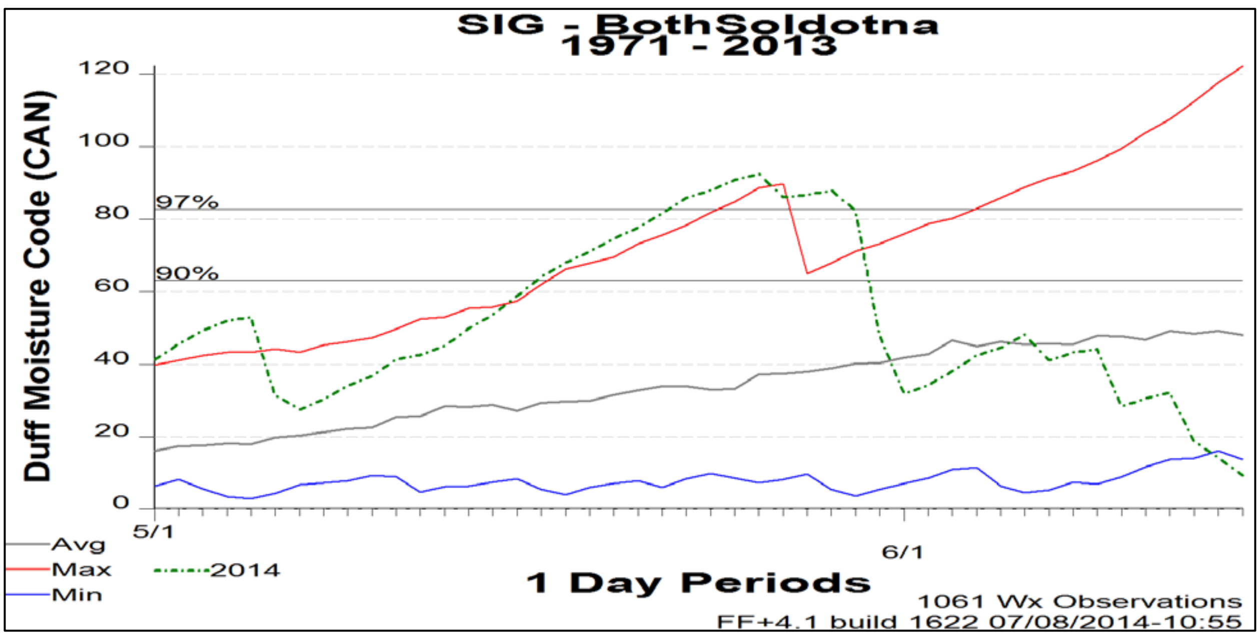



**Figure 19. Average, extreme, minimum, and 2014 trend lines for DMC, May 1 – June 15, Soldotna AKKKS RAWS and Soldotna manual RAWS.**

## What if the Treatments Didn't Exist?

The Incident Commander for the Funny River Fire, Rob Allen, repeatedly stressed the importance of the fuelbreaks in briefings. His narrative in the IMT summary report states: "The shaded fuel break along Funny River Road helped firefighters stop the fire on the road and buy some time to get crews and hose in place on the masticated fuel break south of the community of Funny River. . . Without these two fuels treatments it is highly likely homes would have been lost on the northern flank (Alaska Type 2 Black IMT 2014)." On May 25, the fire spotted across the Kenai River into the Kenai Keys community during a run beyond the masticated fuelbreak's eastern end, suggesting that similar damage may have occurred north of the fuelbreak had it not been in place. In addition to protecting homes, the fuelbreaks contributed to firefighter safety. According to the IMT report, the masticated fuelbreak served as a contingency line, and firefighters had to redeploy to the break when the fire crossed Funny River.

It is difficult to construct scenarios of what might have happened if the fuel treatments were not in place prior to the fire, despite the availability of numerous computer models that spatially portray paths of fire spread and burn probability. Spotting is a significant cause of fire spread, and the models randomly generate spotting characteristics for each simulation, thus preventing direct comparisons between analyses with and without treatments if spotting is activated. Also, the models do not take suppression activity into account. Despite these drawbacks, comparing pre- and post-treatment model results can provide some insight on treatment effectiveness and help inform future treatment design.

### *Methods*

To determine fire spread potential with and without fuel treatments, analyses were run using the Interagency Fuels Treatment Decision Support System (IFTDSS). The specific workflow used was the Fuels Treatment across a Landscape - Manual Treatment Location. This workflow employs the model Flammap (v. 3.0) and Minimal Travel Time analysis, allowing a display of differences in fire behavior (flame length, rate of spread, crown fire activity, major flow paths, and minimum fire arrival time) pre- and post-treatment.

Analyses were run for two different sets of conditions; those encountered early morning May 21 when the fire reached the shaded fuelbreak and conditions for May 24 when the fire approached the masticated fuelbreak. Analyses were run with and without spotting potential for each time period. The LANDFIRE 2010 landscape was used in all models, with the TU4 fuel model for black spruce changed to SH5 throughout the landscape. Also, TU1, Timber Litter (TL) 1, and TL3 fuel models were changed to TU3 for the entire landscape based on modeling inputs by a Fire Behavior Analyst (FBAN) associated with the IMT during this timeframe.

It was assumed that fuel models were assigned correctly in the LANDFIRE landscape; no changes were made other than the ones noted above. Width of the shaded fuelbreak was estimated as the only available shapefile was from 2003 and did not include changes made during subsequent improvements to the fuelbreak. It is unknown if a GPS was used to create the 2003 shapefile or if the fuelbreak was hand-digitized on a map. A shapefile developed from a GPS track file was available from DOF for the masticated fuelbreak. Widths of the fuelbreaks were adjusted within the model to ensure incorporation of the appropriate number of 30 m x 30 m pixels. When changing fuel models within treatment polygons, changes are made to the full pixel and will only be applied if more than half the pixel is included in the polygon. Selection of appropriate fuel models to represent treated areas can also be problematic, especially in the absence of post-treatment vegetation data. Reported fire behavior in the treatments facilitated selection of fuel models; different models may have been more appropriate under different environmental conditions.

## *IFTDSS Inputs*

Weather, crown fire type, and fuel moisture inputs used in IFTDSS analyses are in Table 1. Fuel model and canopy characteristics were changed within polygon treatment areas as follows. Changes in estimated Rate of Spread (ROS) and flame length resulting in these changes are graphically represented in Figure 20.

Shaded fuelbreak:

- All fuel models representing spruce forest (SH5 and TU models) changed to the TL2 model
- Canopy covers greater than 25% set at 25%
- Canopy Base Height (CBH) for trees taller than 12' and CBH < 6' set to 6'

Masticated fuelbreak:

- All fuel models changed to Slash-Blowdown (SB) 1
- Canopy cover set to 0%

Hand treatment extension of masticated fuelbreak:

- All fuel models changed to TL1
- Canopy cover set to 0%

Ignition lines for the model were obtained from analyses included in the Wildland Fire Decision Support System (WFDSS) and were based on MODIS satellite detection of hot spots. Live fuel moistures were increased on May 24 to represent three days of green up since the May 21 analysis. Model results only consider the effect of the fuelbreaks as treated and do not take efforts of firefighters into account. Burn out operations essentially widened treatment areas, and water and retardant drops are not accounted for.

**Table 1. Fire behavior, weather, and fuel moisture[1] inputs for IFTDSS models.**

| | Fire Engages Shaded Fuelbreak | Fire Engages Masticated Fuelbreak |
|---|---|---|
| Date and Time[2] | May 20, 2200 hr – May 21, 0400 hr | May 24, 000h hr – May 25, 2300 hr |
| Crown Fire Calculation Method | Scott & Reinhardt | Scott & Reinhardt |
| 1 Hour Fuel Moisture | 8 | 8 |
| 10 Hour Fuel Moisture | 8 | 8 |
| 100 Hour Fuel Moisture | 8 | 8 |
| Live Herbaceous Fuel Moisture | 30 | 40 |
| Woody Fuel Moisture | 60 | 70 |
| 20 foot Wind Speed | 9.0 | 16.0 |
| Wind Direction | 180 | 225 |
| Duration of Simulation (minutes) | 600 | 720 |
| Travel Path Interval (feet) | 250 | 250 |
| Spot Fire Probability | 0 and 0.2 | 0 and 0.2 |

[1] Fuel moisture derived from Short Term Fire Behavior analyses in WFDSS conducted by a Fire Behavior Analyst assigned to the Type 2 Incident Management Team for the fire

[2] Date and time used to determine general wind speed and direction from weather station

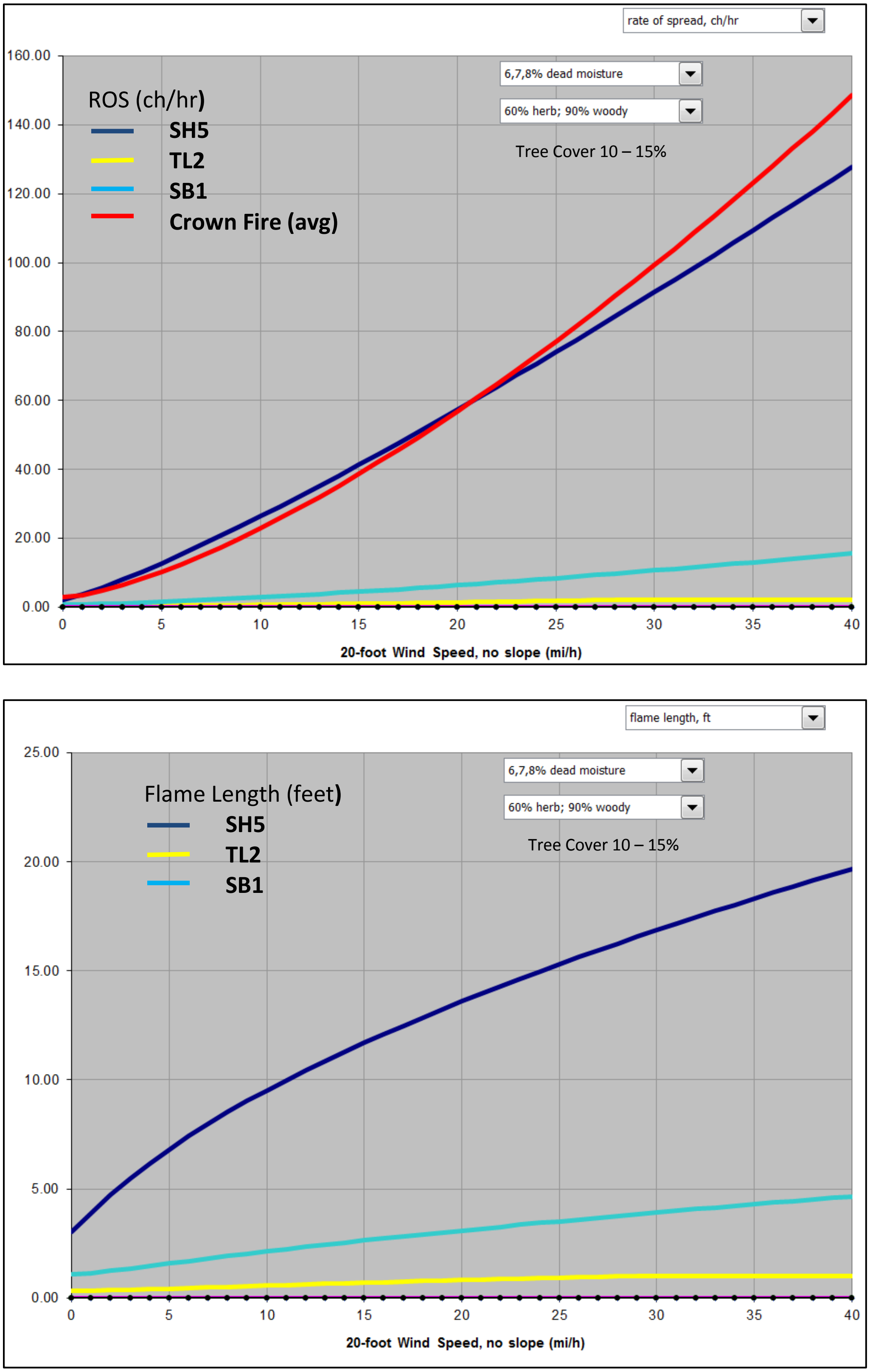



**Figure 20. Comparison of ROS and flame length among SB1, SH5, and TL2 fuel models. SH5 represents pre-treatment spruce forest and TL2 and SB1 represent treatments in the shaded and masticated fuelbreaks, respectively.**

## *Results*

Given wind and fuel moisture inputs, modeled flame lengths and incidence of crown fire and torching tended to be greater on May 24 – 25, when the fire reached the masticated fuelbreak, compared to a few days before when the fire reached the shaded fuelbreak (Figure 21). In both cases, flame lengths exceeded 11 feet, the threshold where control efforts at the head of the fire become ineffective due to probable crown fire, spotting, and major fire runs (Andrews and Rothermel 1981). Flame lengths less than 4 feet are needed for firefighters to attack the fire using hand tools, and heavy equipment such as bulldozers and retardant aircraft are generally effective for direct attack at flame lengths between 4 – 8 feet. Modeled ROS throughout the analysis area May 24 – 25 commonly exceeded 44 chains/hr (0.55 mph) and occasionally exceeded 89 chains/hr (1 mph). In comparison, ROS on May 21 ranged between 17.9 – 29.8 chains/hr (0.22 – 0.37 miles/hr).

### May 21 Analyses

Modeled fire arrival time and major fire flow paths without the shaded fuelbreak in place suggested that the fire could spot over the river with spotting probability set to 0.2 (Figure 22*a*). Within 10 hours, the simulated fire reached the river from the ignition source, a distance of about 1.5 miles. An analysis with the same inputs but with the treatment in place indicated that the fire would not spot across the river and that fire spread would be slightly reduced during the analysis period (Figure 22*b*). Major flow paths indicated that the fire was able to cross the fuelbreak at multiple points, either due to spotting or fire burning through vegetation within the fuelbreak. Comparisons between analyses that include spotting must be considered with caution as they are not equivalent even with the same inputs due to the program's incorporation of random elements associated with spotting occurrence and distance. It is uncertain if the absence of spotting across the river in Figure 22b is a result of this randomness or if the fuelbreak influenced spotting behavior.

When spotting was removed from the analysis, the fire did not cross the river under modeled conditions with or without the fuelbreak in place (Figure 23). As in the analysis with spotting, modeled fire spread was slightly reduced with the treatment in place. There were instances where the simulated fire burned through the break despite the absence of spotting. However, a count of the major flow paths crossing the northern border of the fuelbreak was lower with the treatment (n=26) than without (n=40). Examination of fuel models along the flow paths suggested that the fire crossed the fuelbreak in areas with grass (GR) or Shrub 2 (SH2) fuel models, which were not altered from the original landscape to reflect treated conditions.

The model suggested that post-treatment flame lengths were decreased within the shaded fuelbreak, often to a level where hand crews could safely work (0 – 4'; Figure 24). This typically represented a 70 – 90% reduction in flame length compared to results without the treatment. Likewise, fire was estimated to have dropped out of the crowns to the surface throughout the length of the treatment (Figure 25).

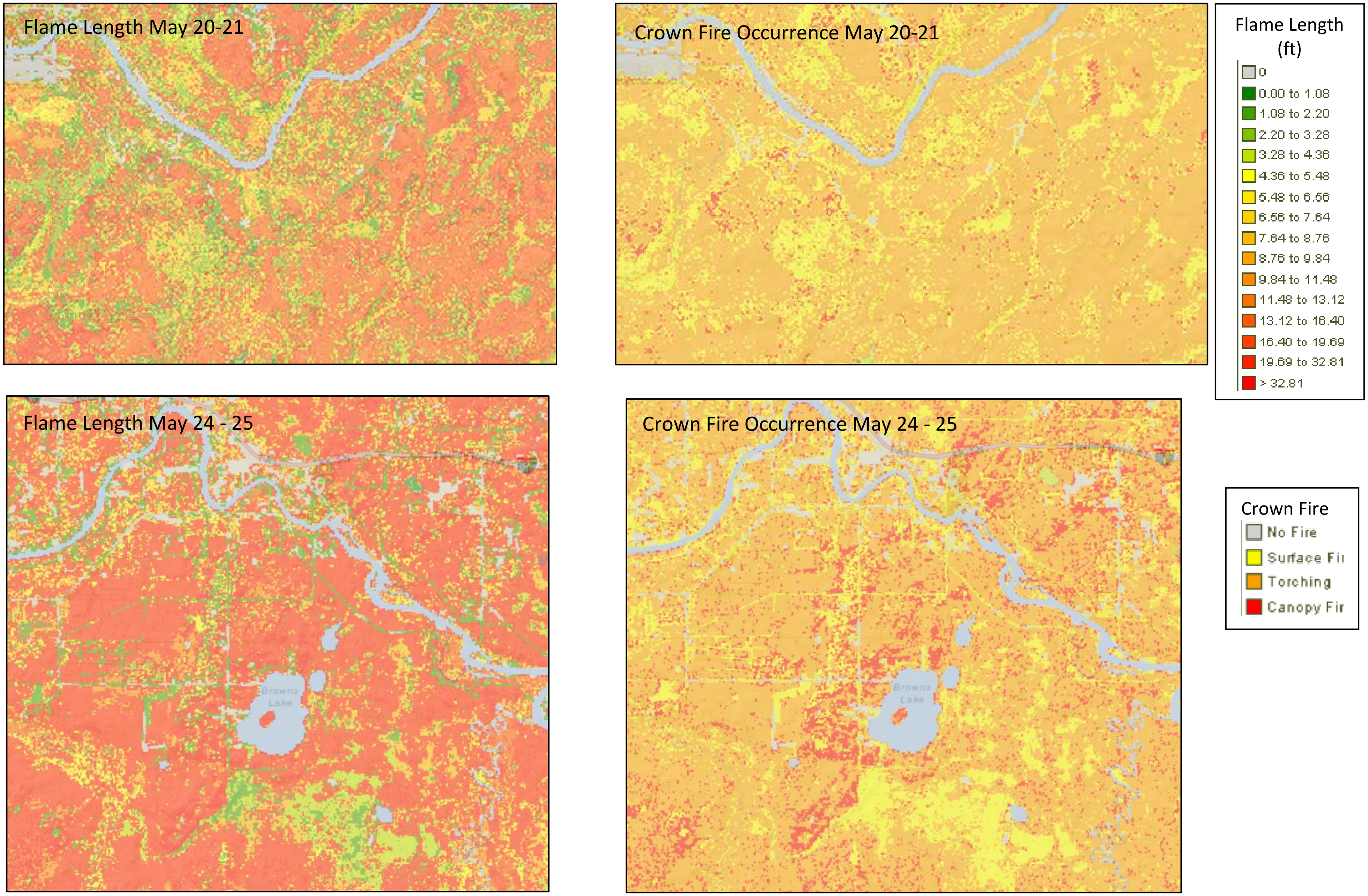



**Figure 21. Modeled flame length and crown fire occurrence in analysis area representing conditions on May 20 – 21 in vicinity of shaded fuelbreak (top) and on May 24 – 25, in vicinity of masticated fuelbreak.**

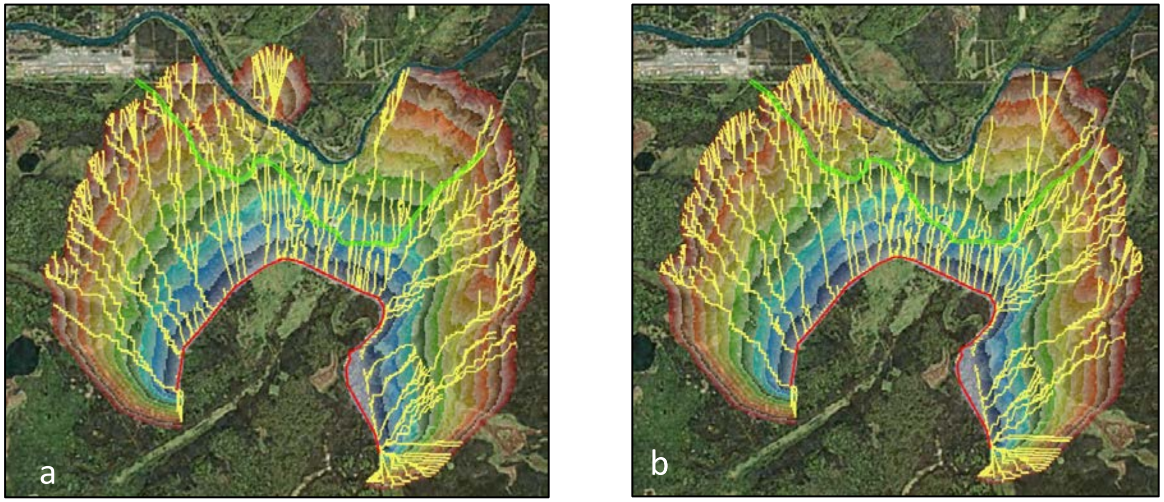
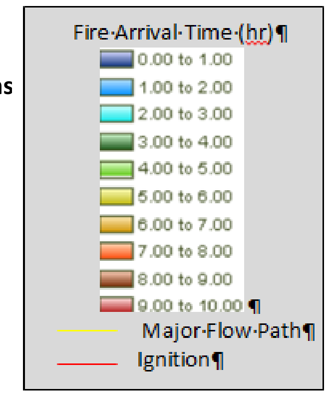



**Figure 22. Modeled fire arrival time and major flow paths with 0.20 spotting probability, pre-treatment (a) and with shaded treatment in place (b). Location of fuelbreak provided in 22a to facilitate visual comparisons**



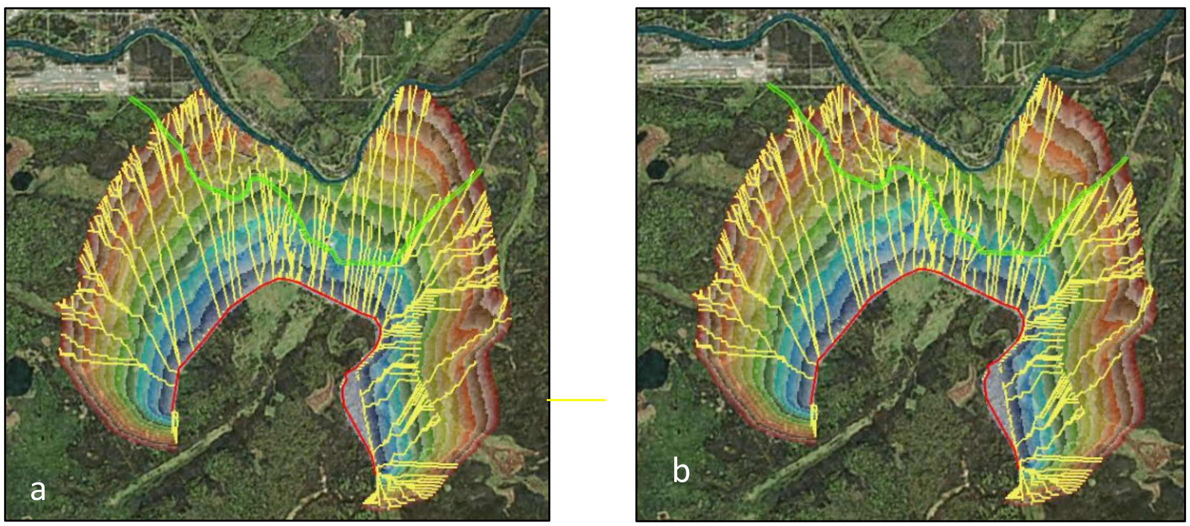




**Figure 23. Modeled fire arrival time and major fire flow paths with no spotting, pre-treatment (a) and with the shaded fuelbreak in place (b). Location of fuelbreak provided in 23a to facilitate visual comparisons.**

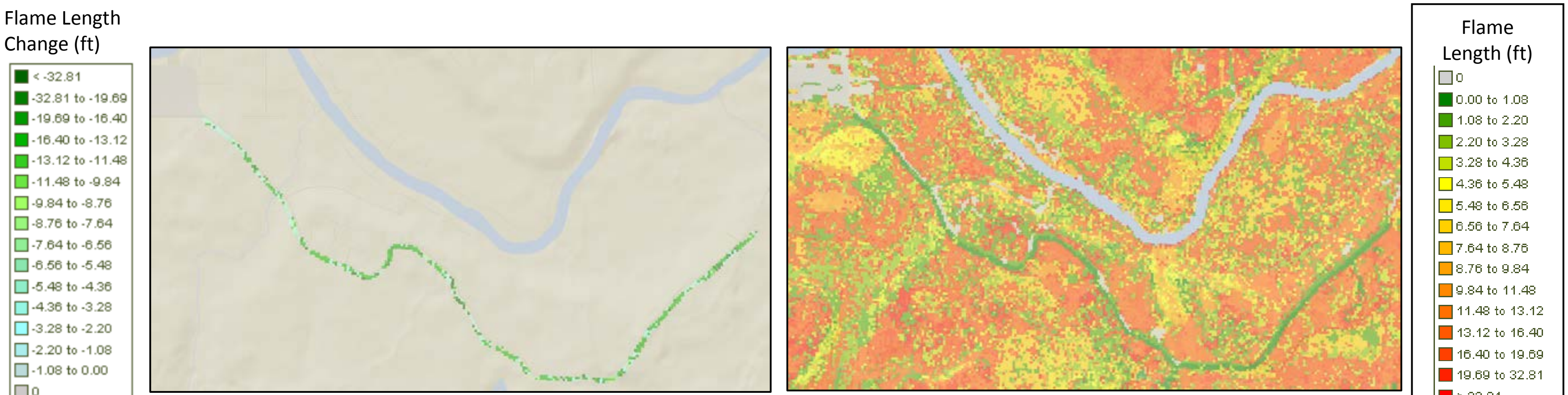



**Figure 24. Modeled change in post-treatment flame length (feet) within shaded fuelbreak.**

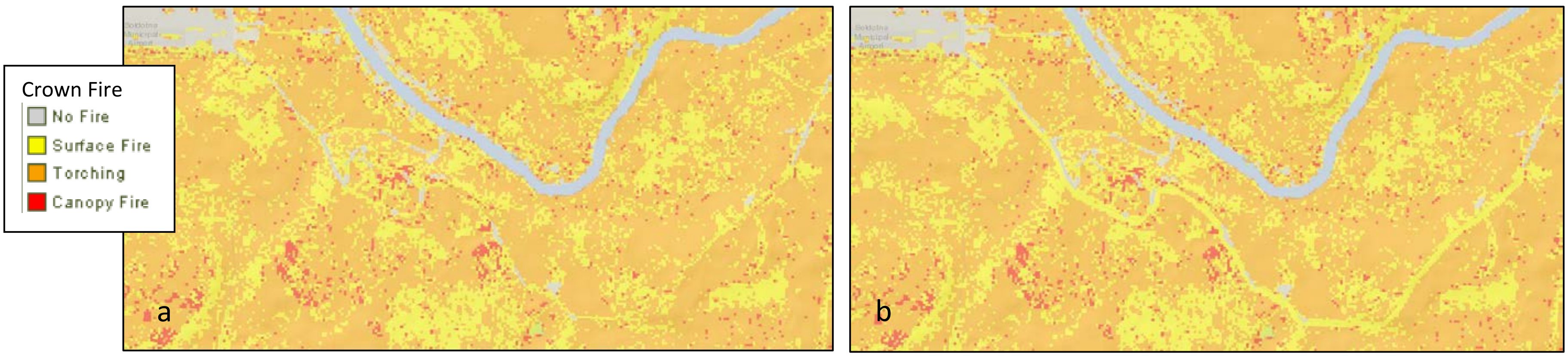



**Figure 25. Comparison of estimated pre-treatment crown fire activity (a) and post-treatment crown fire (b) associated with shaded fuelbreak. Analysis indicated reduced torching and crown fire within the shaded fuelbreak, as indicated by the wider solid yellow band representing the treated area in 25b.**

May 24 Analyses:

Increased winds compared to May 21 resulted in simulated fires crossing the river at numerous locations on May 24 with spotting enabled in the model, regardless of whether the masticated treatment was included (Figure 26). Major flow paths suggested areas along the river where the fire was most likely to spot across, given model inputs. The masticated fuelbreak appeared to result in reduced presence of fire in a few locations northeast of the river, but this could be an artifact of different random spotting characteristics used by the program for each analysis. Fire arrival times appear to be similar with and without the treatment in place.

When spotting was removed from the model, the fire was unable to cross the river with or without the fuelbreak (Figure 27). Although the number of major flow paths crossing the fuelbreak's northern boundary was lower with the treatment (n=27 versus n=43 without treatment), there were still multiple incidences where the fire breached the masticated break. The hand-treated fuelbreak was only breached in one location in the model, on its western edge. The flow paths crossed the fuelbreak when fuel models TU2, TU3, or SH5 abutted its southern boundary, but most of the fuelbreak was bordered by these fuel models including areas that were not breached. In all results, fire moved through the untreated buffer around Funny River.

Examination of modeled changes in flame length and crown fire incidence within the treated areas indicates that the fuelbreak met its intended purpose of creating a safe environment for firefighters to work from. Flame lengths were often reduced by more than 10', resulting in flame lengths of less than 4' in the break (Figure 28). As with the shaded fuelbreak, fire moved from the crowns and onto the ground in the treated area (Figure 29).

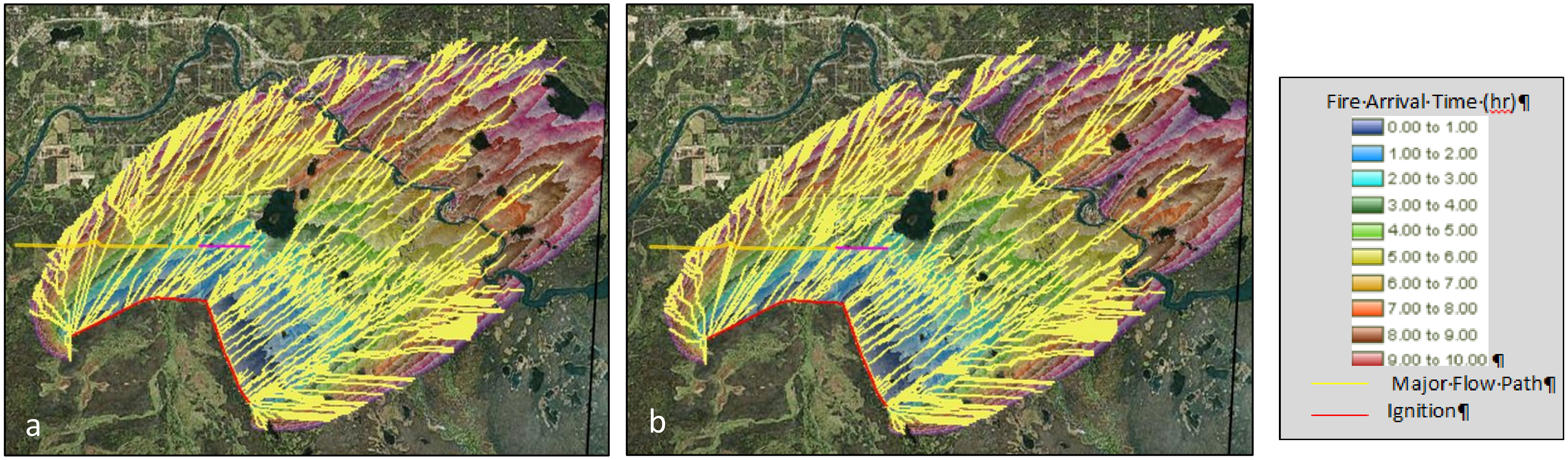



**Figure 26. Modeled fire arrival time and major flow paths with 0.20 spotting probability, pre-treatment (a) and with the masticated/hand treatment (b). Horizontal orange and magenta lines indicate masticated and hand treatments, respectively. Location of fuelbreak provided in Figure 26a is to facilitate visual comparisons.**

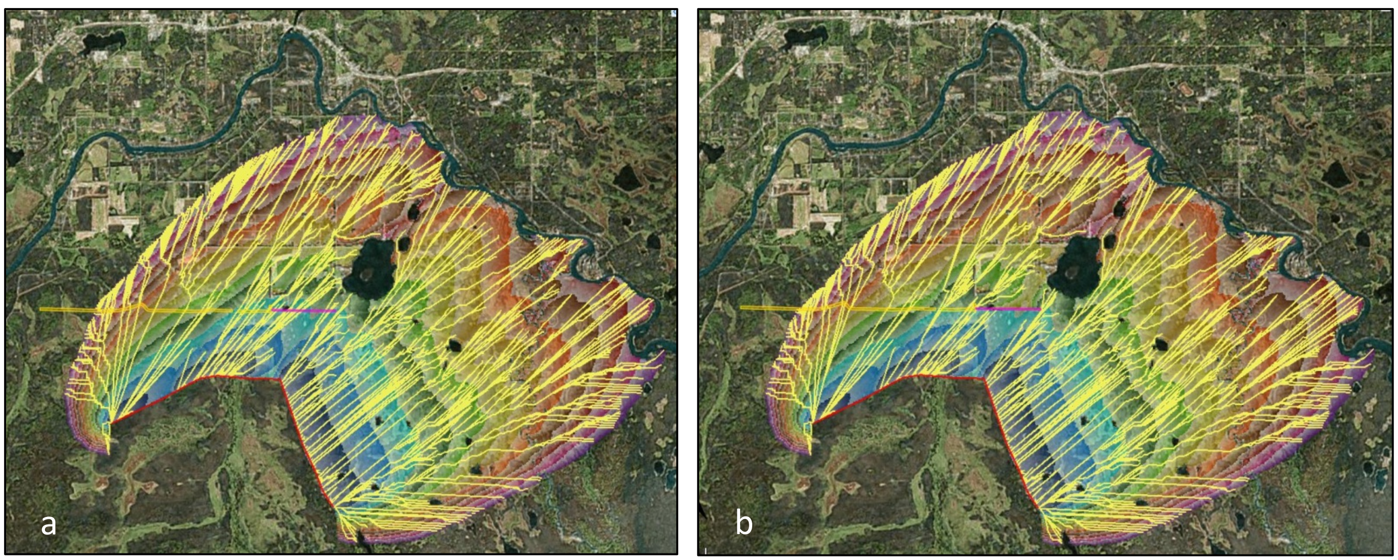



**Figure 27. Modeled fire arrival time and major fire flow paths without spotting; pre-treatment (a) and with the masticated/hand treatment (b). Horizontal orange and magenta lines indicate masticated and hand treatments, respectively. Location of fuelbreak provided in Figure 27a to facilitate visual comparisons.**

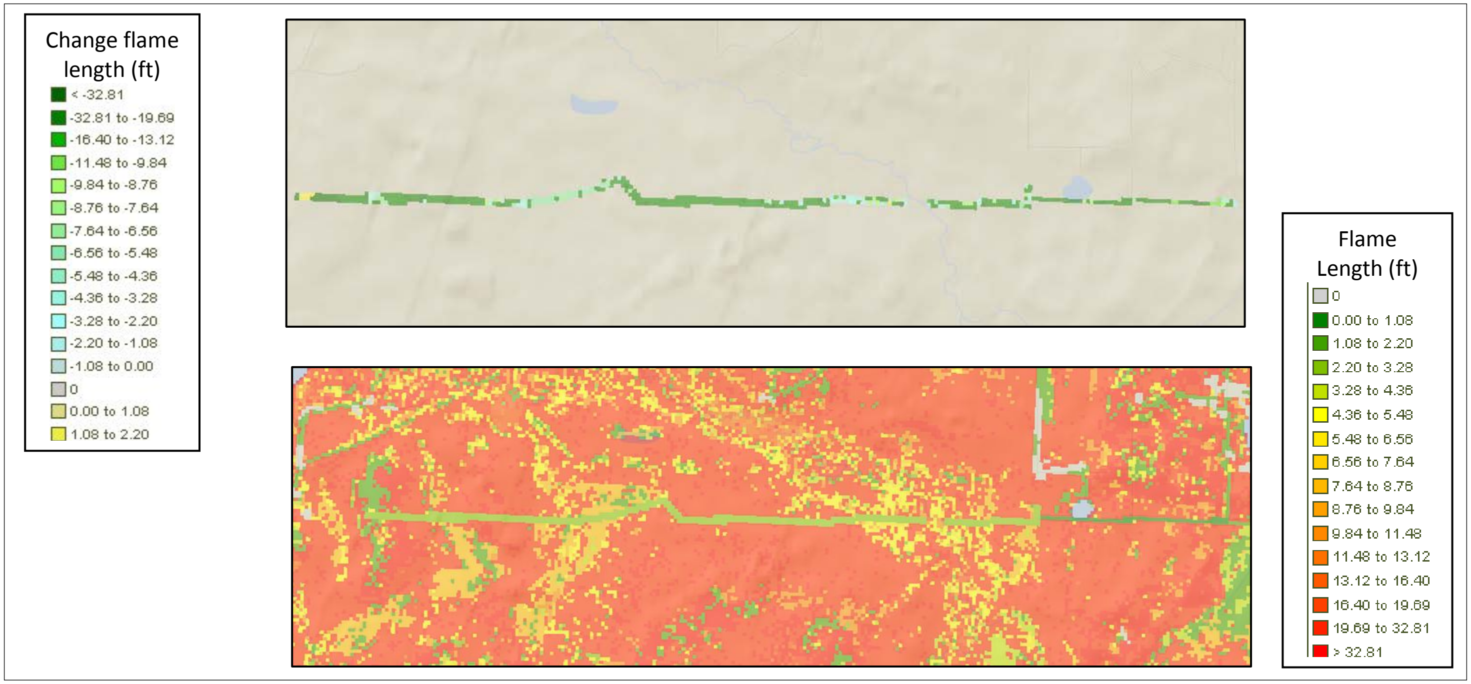



**Figure 28. Modeled change in post-treatment flame length (feet) within masticated and hand-treated fuelbreaks.**

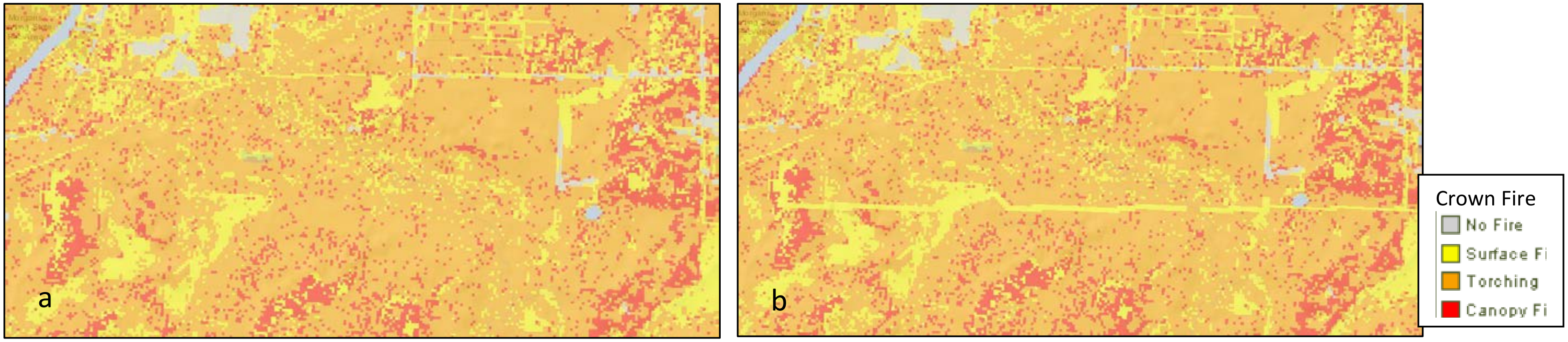



**Figure 29. Comparison of estimated pre-treatment crown fire activity (a) and post-treatment crown fire (b) associated with masticated and hand-treated fuelbreaks. Analysis indicated reduced torching and crown fire within the fuelbreaks, as indicated by solid yellow band representing the treated area.**

## Discussion and Recommendations

The shaded and masticated fuelbreaks bordering the Kenai NWR enabled suppression resources to hold the Funny River Fire south of populated areas, saving numerous homes and expense. Four recreational cabins and two outbuildings were unfortunately destroyed in the fire when it crossed the Kenai River to the east of the fuelbreaks. However, because of the foresight, planning, and cooperation that went into establishment of the fuelbreaks, hundreds of other structures remained unscathed.

> *". . . without those fuelbreaks, we don't know where we would be."-Rob Allen, Incident Commander for the Funny River Fire, May 28, 2014*

The main strength of the fuelbreaks was their ability to change fire behavior to the extent that they provided anchor points for firefighters to safely conduct burn out operations. Without them, it would have been necessary to construct dozer lines from scratch, which may not have been possible in the time frames involved given the rapid spread of the fire and limited resources available early in suppression efforts.

Modeling analyses support the idea that the treatments on their own, without additional suppression activity, curtailed fire spread to a certain extent depending on conditions, but not to the point of keeping the fire south of human development. It is not possible to predict the likely outcome of the Funny River Fire in the absence of the fuelbreaks because of the multiple scenarios that could play out given the myriad combinations of tactical decisions, weather conditions, and chance that determine the fire's final perimeter. All one can say for sure is that the end results would have been much worse without the fuelbreaks.

The Funny River Fire provides a learning opportunity that can aid in the development and placement of future fuel treatments. Given fuel types in the area, prevailing winds, likelihood of spotting, and spotting distances, fire managers can weigh the costs and benefits involved in constructing different types of fuelbreaks. Linear fuelbreaks perpendicular to the wind are easily challenged by spotting, as was seen when the fire spotted over the masticated fuelbreak, Funny River, and Kenai River, as well as in modeling results where the fire spotted across the treatments under input wind conditions and a 0.2 spotting probability. Reports from fire personnel indicate spotting distances of up to 0.5 mile, making it unlikely that a wide enough treatment could be constructed to prevent fire from spotting over. Likelihood of breaching the fuelbreaks could be decreased, however, under different conditions such as lower wind speed and higher fuel moistures.

If spotting over the fuelbreak is going to be a chronic problem even under typical wind conditions for the area, treatment design can be primarily focused on firefighter safety and logistics for conducting burn out or other suppression activities. This may allow construction of narrower fuelbreaks with the understanding that these may need to be widened depending on conditions during the fire. This was done during the Funny River Fire when the dozer line was constructed adjacent to the existing masticated fuelbreak. Another consideration could be to reduce the occurrence of crown fire and spotting potential prior to the primary fuelbreak by establishing a series of treated areas. After observing the behavior of the Funny River Fire under fairly normal weather conditions, DOF is considering future treatments that consist of a 200' masticated fuelbreak with 50' shaded fuelbreaks (20' crown spacing and all the ladder fuels removed) on each side (H. Kent, DOF, pers. commun.). One interviewee who worked in both breaks during the fire indicated that the shaded fuelbreak was easier to work in compared to the masticated break due to lower heat and smoke levels. Although conditions were milder while working in the shaded fuelbreak, he believed it would have worked even with stronger winds. Under dry, windy conditions, the masticated fuelbreak was challenged by spot fires repeatedly, even at its widest portion. The interviewee also suggested that smaller wood chunks in the masticated breaks—or an older break where the wood had more time to mix with soil—may have generated less heat, making the line easier to hold.

Cost and viewshed concerns will also play a large role in treatment design. Public perception on the need for fuel treatments will likely be more favorable immediately after a fire has threatened their homes, and they may be more willing to tolerate less scenic but less expensive options such as masticated fuelbreaks in order to maximize treated acres. Homeowners may also follow Firewise recommendations for their properties after a recent fire, further reducing the future incidence of lost homes.

A number of different modeling programs are available to assist land managers in designing treatments under different scenarios that take into account values as well as weather conditions. The Funny River Fire highlighted some data gaps that would benefit future planning/modeling efforts, could have helped with planning during the fire, and would have allowed better economic assessment of treatment effectiveness.

- Treatment location and width were inconsistently documented, and locations of treatments were not readily available to suppression resources. The masticated fuelbreak was easily recognizable on the landscape, but the shaded fuelbreak was, by design, not as obvious to people on the ground. A central, statewide spatial database of treatments is recommended, with easy access by incident management teams.

- Verification of the LANDFIRE landscape would improve modeling efforts when planning future fuel treatments. A better understanding of potential problems in the landscape will also benefit WFDSS modeling during incidents.

- The shaded fuelbreaks had not been monitored since they were initially established, and current status of fuels was unknown given multiple retreatments. Regeneration patterns in the masticated fuelbreak are uncertain given a lack of data for such treatments in this habitat. Monitoring will provide information that will enable better planning of treatment maintenance schedules, allow assignment of correct fuel characteristics in LANDFIRE and in modeling efforts, and help with budget planning for long-term effectiveness.

<u>Summary of Recommendations</u>

- Neither fuelbreak stopped the fire without additional suppression activities. Focus treatment design on firefighter safety and facilitation of burn outs or other tactics as well as on aesthetics and cost.
- Consider a combination of parallel treatment types to reduce spotting potential.
- Develop a readily accessible statewide map of treatment locations with associated treatment information.
- Monitor post-treatment vegetation to document changes in fuel models and other parameters that affect fire behavior and dictate retreatment schedules.
- Ensure adequate budget tracking over time to enable cost/benefit analyses.
- Continue communication and partnerships among landowners and managers.

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## Appendix 1. List of people interviewed for preparation of this report

Andy Loranger, Refuge Manager, Kenai NWR
Doug Newbould, Fire Management Officer, Kenai NWR
Howie Kent, Fire Management Officer, Kenai-Kodiak Area Office, Alaska Division of Forestry
Hans Rinke, Area Forester, Kenai-Kodiak Area Office, Alaska Division of Forestry
Dara Glass, Lands Manager, Cook Inlet Regional, Inc.
Richard Thompson, Alaska Fire Service, Air Attack Manager (Div. Supervisor, Funny River Fire)
Gordon Amundson, Assistant Fire Management Officer, Fairbanks Area Office, Alaska Division of Forestry (Air Attack, Funny River Fire)
Oded Shalom, Alaska Fire Service, Chena Interagency Hotshot Superintendent

## Appendix 2. Fire Chronology

The following sequence of events is derived from the report developed by the Alaska Type 2 Incident Management Team (IMT) for the period between May 20 – June 7 (Alaska Type 2 Black IMT 2014), from interviews with suppression personnel on the ground (Appendix 1), from daily Situation Reports of statewide fires (http://fire.ak.blm.gov/content/aicc/sitreport/current.pdf), and from the Alaska Interagency Team Facebook page. The period between discovery of the fire and subsidence of fire danger to the Funny River community is covered. Generally, only fire activity on the northern portion of the fire near the fuelbreaks is discussed (Division A).

*May 19, 2014, fire size 7,131 acres*
The fire was reported at 1608 hr, 3 miles south of the Soldotna airport along Funny River Horse Trail in a small stand of birch. Originally estimated at 10 acres, the fire reportedly doubled in size within 10 minutes and moved into logging slash and black spruce. The Chena IHC was already staged in Soldotna and was quickly mobilized, along with DOF engines. Orders were placed for additional resources. By 2000 hr, the fire was estimated at 200 acres. Winds had increased to 25 mph, blowing out of the north and pushing the fire toward Tustumena Lake. The IMT was ordered for delivery on 5/20; Incident Commander was Rob Allen. At 2225 hr: The fire was estimated at 2,500 acres, 6.9 miles long and 0.75 miles wide, with a 0.5 mile head of 200' flame lengths. It had moved to 4.5 miles from Tustumena Lake.

In summary, the fire's initial run was approximately 8 miles over an 8-hour time period, driven by north winds at 20 mph with gusts to 30 mph.

*May 20, fire size 27,870 acres*
By 0828 hr, the fire was reportedly over 20,000 acres. Initial attack forces worked on anchoring the heel of the fire as members of the IMT arrived in Soldotna throughout the day. Winds had diminished to 8 - 12 mph, with the perimeter growing along the eastern and western flanks north of Tustumena Lake.

*May 21: The fire hits Funny River Road and the shaded fuelbreak; fire size 44,213 acres*
The fire made two significant runs between midnight and 0400 hr. It had moved to the northeast and reached Funny River Road at mile 7 at between 0100 - 0200 hr. Flame lengths reportedly reached 75' above the treetops at the edge of the road, with single and groups of trees torching intermittently until 0400 – 0600 hr. Winds were relatively calm, between 2 – 5 mph above the treetops. Embers were lifted into the air, mostly drifting lightly but occasionally pushed a little by the wind. About 6 - 10 spot fires started from embers lofting across the road. Most of these were 50' – 60' from the main fire, with a maximum distance of 100'.

Six Central Emergency Services (CES) engines, two type 6 engines, a water tender, brush trucks, the Chena IHC, and a Type II Initial Attack crew were deployed to prevent the fire from crossing Funny River road and moving towards populated areas. Initially the IHC tried a direct attack along the fire's edge, but spotting was a constant problem. The two crews picked up the spot fires while the engines sprayed water into the trees to increase relative humidity and reduce torching. They skirted the fire to the north/northeast, where it reached the shaded fuelbreak. The fire dropped to the surface upon hitting the fuelbreak, with flame lengths of about 2'. Woody debris piles were located within the fuelbreak following maintenance in 2013, increasing fire intensity in spots, but the fire remained on the surface. According to Chena IHC Superintendent Oded Shalom, the situation would have been more problematic if the fuelbreak was not present and thick trees were next to the road- it would have spotted over.

After this initial run at Funny River Road, crews continued burn out operations over the next several days to reduce the threat to the homes north of the road. The fire continued backing and flanking along the road.

The IMT assumed command of the fire at 0400 hr and established objectives that included containment of the northeast side of the fire.

*May 22, fire size 67,016 acres*
The fire continued to grow on the northeast, southeast, and southwest corners. Crews continued to burn along Funny River Road in an attempt to prevent further runs to the north, and dozers worked east along the northern edge of the fire.

*May 23, fire size 95,080 acres*
The fire continued to burn actively, including at night with evening runs. Type 1 crews from the lower 48 provided additional resources. In Division A, dozers built line directly east of Funny River Road and prepared a contingency hose lay along the masticated fuelbreak. Canadair CL-215 aircraft (Ducks) continued to drop water in Division A as well. The Borough issued an advisory that evacuation might be required for Pollard Loop, near the town of Kasilof on the western edge of the fire.

*May 24 - 26: The fire reaches the masticated fuelbreak;* fire size May 24 – 26, respectively: 109,083, 154,719, and 160,339 acres
Strong winds produced active crown fire in spruce with single and groups of trees commonly torching around the perimeter on May 24-25. Spotting distances were reported to be up to 0.5 miles ahead of the fire. There was significant fire growth in Division A, on the eastern flank. Smoke prevented evaluation of fire spread to the east. The fire was rapidly burning towards the masticated fuelbreak on May 24 under red flag conditions. Prior to this, crews had been able to directly attack the fire in Division A, but they retreated to the masticated fuelbreak when high winds enabled the fire to cross Funny River with potential to burn towards the break. In preparation for burning out, a dozer line (two blade widths) was constructed on the north side, retardant was applied, and a hose lay was in place. At the narrower hand treatment at the eastern end of the masticated fuelbreak (50’ wide rather than 200’), the dozer line was widened to three blade widths.

The fire initially reached the hand treatment. According to personnel on the ground, flame lengths were up to 200’ and flames created a 300’ wide wall at some points, with full crown fire and whorls. The fire was spotting across and into the masticated fuelbreak, with spotting distances estimated at 60 – 150’. The full flame front was reportedly 0.25 – 0.75 miles wide, quartering towards the break. The fire burned intensely in the afternoons and into the evenings, with reduced behavior in the mornings. Fire behavior was most intense during the first 2 days of the burn out (May 24 – 25). In general, crews were able to stay ahead of the fire but got behind when they had to deal with spot fires. One place the fire jumped across was where there was a “dog-leg” bend in the fuelbreak, creating a 30 – 60-acre spot fire on May 25. On the same day, the fire spotted across the Kenai River where the fuel break ended to the east and started spot fires in the Kenai Keys community. These were suppressed, thanks to road access, but it was during this period that four cabins and one outbuilding burned in a roadless area south of Killey Road.

The weather became more favorable on the third day, allowing completion of the burn out. Intense smoke and heat from the burning masticated material made it difficult to conduct the burn out. The Hotshot crew had to burn in strips to reduce exposure to smoke and intense heat. They burned a 20’ – 30’ buffer within the fuelbreak, then lit the trees on the edge of the break closest to the fire, leaving a wider masticated area in the middle. The burning trees created suction, pulling the fire and smoke away from people holding the line. The burn out operation contributed to estimated acreage of the fire on these days.

An evacuation advisory alert was issued for the Funny River Community on May 24, starting at MP7 to the end. An advisory was also issued for the Kasilof community east of the highway. On May 25, the alert for Funny River Road was upgraded to an evacuation order and the road was closed. The Lower Skilak Lake Campground was evacuated. Evacuation advisories were issued for the Kenai Keys/Fueding Road areas and for the Kasilof area, from Sterling Highway 103 to the Kasilof River on the eastern side.

*May 27-29, fire size 193,243 acres*
Higher humidities and light-to-moderate rain provided a reprieve, but fuels under canopies remained dry. Fire behavior was limited to isolated pockets of torching and smoldering. Evacuation orders were lifted for Funny River communities, but direct suppression continued on the north, west, and south flanks. Other areas were mopped up. Old burn scars checked progression of the fire to the northeast. Structure protection continued on multiple fronts. The fire was estimated at 193,243 acres by the end of this period.

*May 30-June 6*
Winds increased—40 mph in some areas—causing isolated pockets on the west side of the fire to display active backing. High winds continued on the 31$^{st}$, but were accompanied by significant precipitation over the entire fire area. Rain continued on June 1, and fire activity was minimal. The IMT began releasing crews and equipment from the fire. The suppression repair plan was developed, and work was started to repair dozerlines. The fire was transferred to a Type 3 organization on June 6.