

# Brittle Escaped Prescribed Fire

## Facilitated Learning Analysis

Huron-Manistee National Forest, Iosco County, Michigan

April 2021



## Facilitated Learning Analysis Team

<b><u>Lisa Lewis</u></b>	Forest Supervisor, USFS R8, Kisatchie National Forest, FLA Team Leader
<b><u>Kim Bittle</u></b>	District Ranger, USFS R9, Mark Twain National Forest, FLA Team Co-Leader
<b><u>Kyle Smith</u></b>	Emergency Management Specialist, USFS WO, NIMO, FLA Subject Matter Expert & Facilitator
<b><u>Russ Langford</u></b>	Deputy Regional Fire Management Coordinator, USFWS R3, FLA Subject Matter Expert
<b><u>David Quisenberry</u></b>	Fire Planner, USFS R8, National Forests in Florida, FLA Subject Matter Expert
<b><u>Darren Turner</u></b>	Regional Fuels Specialist, USFS R4, Regional Office, FLA Subject Matter Expert
<b><u>Brianna Schueller</u></b>	Fire Technology Transfer Specialist, Rocky Mountain Research Station/Wildland Fire Management RD&A, FLA Fire Analyst (LTAN)
<b><u>Mark Hale</u></b>	Deputy Program Manager, Wildland Fire Management RD&A, FLA Fire Analyst (FBAN)
<b><u>Micah Bell</u></b>	Fire Prevention and Education Technician, NPS, Indiana Dunes National Park, FLA Writer

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## 1. Introduction

This Facilitated Learning Analysis (FLA) report is about a prescribed fire project that was declared a wildfire. The FLA Team was delegated to conduct a declared wildfire outcome review utilizing the Facilitated Learning Analysis approach. To learn and understand from events like this, decisions, actions, and events must be viewed in the context of the complex environment in which they occurred. In any complex environment, error and uncertainty persist despite our best efforts to eliminate them. This review takes into consideration the fundamental character of complex systems and is not a critique of ability or performance.

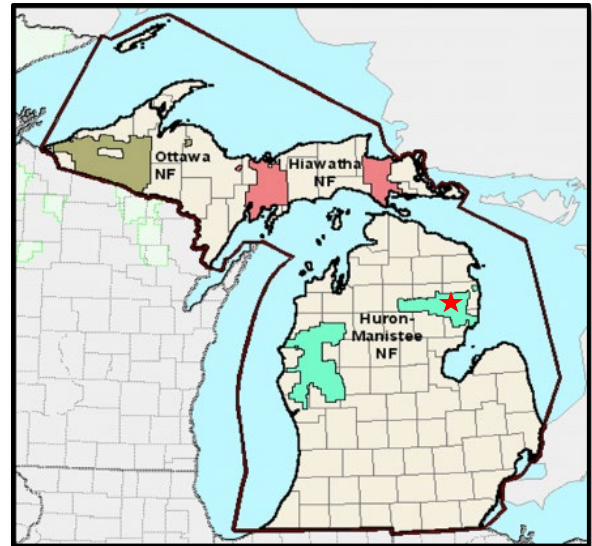
***THIS REVIEW TAKES INTO  
CONSIDERATION THE FUNDAMENTAL  
CHARACTER OF COMPLEX SYSTEMS  
AND IS NOT A CRITIQUE OF ABILITY OR  
PERFORMANCE.***

Our traditional response to unexpected outcomes is to attempt to discover if errors were made so that we do not repeat them the next time. This approach is limited, mainly because complex systems rarely deliver the same conditions again. Successful complex systems are not fixated on creating an error-free system, but in creating an error tolerant system. Error tolerant systems provide room for error and uncertainty to exist without consequence.

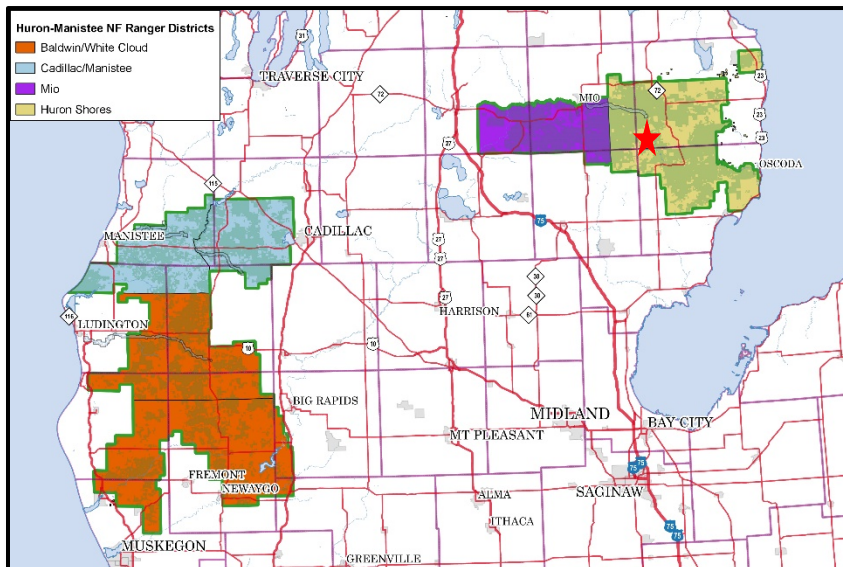
This Facilitated Learning Analysis (FLA) report is a tool to help understand the events, decisions, and actions leading up to and during this prescribed fire declaration. The intent of this FLA is to teach and further build upon the Learning Culture.

## 2. Project Location and Background

The Brittle Prescribed Fire is located on the Huron Shores Ranger District of the Huron-Manistee National Forest, situated on the east side of the lower peninsula of Michigan. The Brittle Prescribed fire for units 20 and 23 are two of many prescribed fire units associated with the Brittle Landscape Fuels Reduction NEPA Project, one of the longest serving and most successful fuels management projects that the District has undertaken. This landscape project serves many purposes with Wildfire Risk Reduction to the Wildland Urban Interface (WUI) being a primary objective. Out of 20 States that make up the Eastern “Area” or Region, the Huron National Forest has routinely seen large, destructive, and



fast-moving wildfires fueled by Jack Pine and Red Pine forests. Between 2000 to 2015, approximately 368 wildfires burned almost 25,000 acres, of which six large wildfires (No Pablo-2000, Hughes Lake-2006, Four Mile-2008, Meridian Boundary & Range 9-2010, Little Mack Lake-2012) burned 20,000+ acres, destroying numerous primary and secondary residences. In 1980, the Mack Lake fire burned 24,000 acres, destroyed 44 homes, and tragically killed a



Forest Service firefighter. This fire had one of the highest rates of spread of any wildfire studied. **The Brittle Landscape Fuels Reduction Project was developed to reduce the risk to one of the most dangerous wildfire prone areas in the entire Eastern Region.**

### 3. Environmental Conditions

During the 2020-2021 winter, the Huron Shores Ranger District experienced a below normal snowpack which created a moderate drought for the Spring. Early Spring continued with below average precipitation and as a result, March and April soil moistures began indicating the effects of this lack of precipitation. Soils within this area of the Huron Manistee National Forest are so well drained, they challenge fire managers because existing fire index tools do not reliably predict fire conditions. As May arrives, all eyes are on the needle moistures of Jack Pine and Red Pine, when the “spring dip” occurs, causing rapid foliar moisture loss in both live and dead needles and making these trees catalysts for large fast-moving wildfires. Almost all the large, significant fires on the Huron National Forest have occurred during spring dip and within Jack Pine/Red Pine timber fuel types.

With the apex of the fire season soon to arrive in a couple of weeks, the skilled fire practitioners on the District keep their eyes and ears to the ground on what they observe in the field. Typically, incremental monitoring of conditions during Spring, especially as they progress to and through mid-May is ongoing and closely watched as Jack Pine crown fire trigger points are on everyone’s

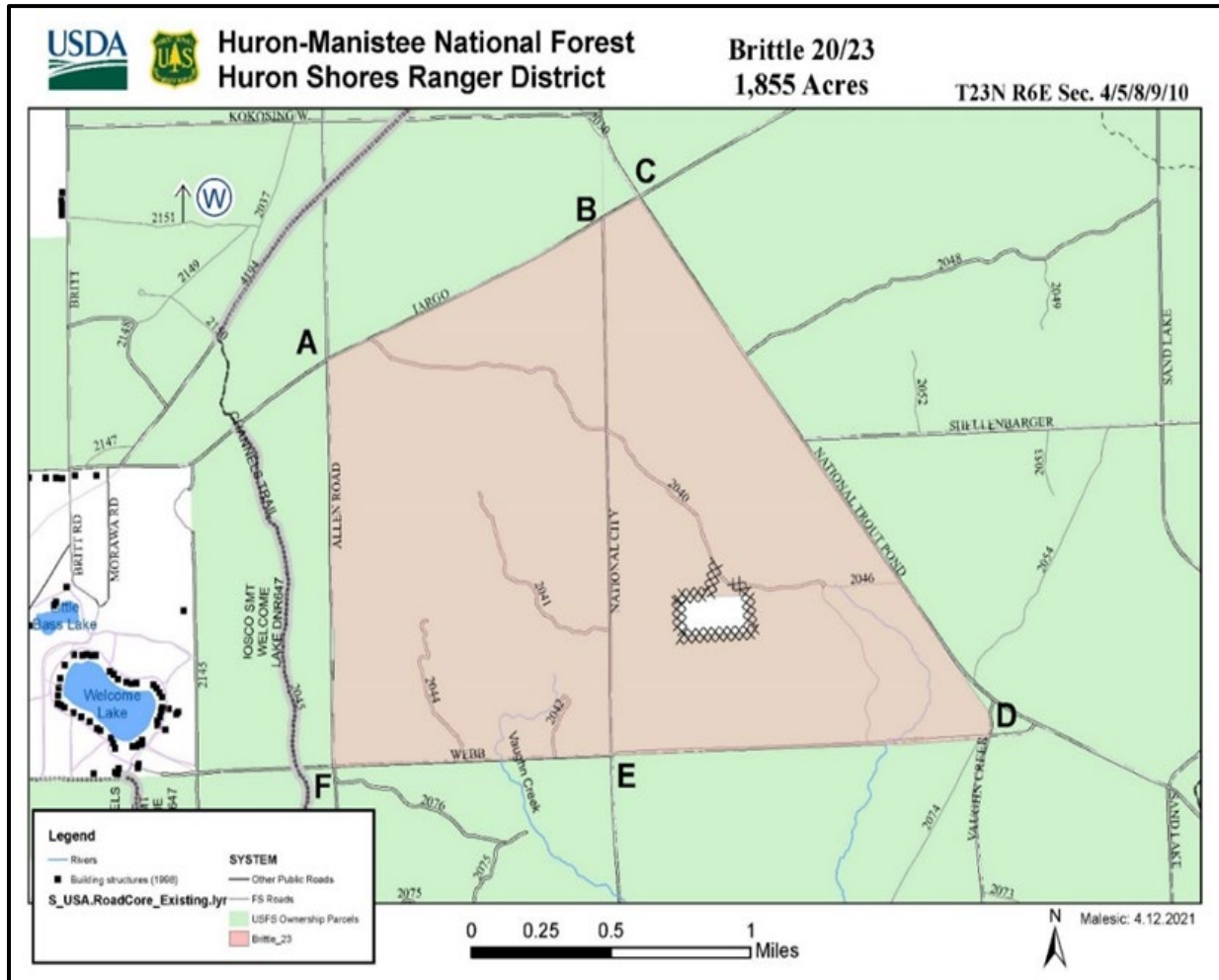


mind. The fire conditions on the ground were not “showing” elevated warning signs yet, however, fire managers and crews were noticing heavy fuel consumption on recent wildfires and portions of prescribed burns. But, for all intents and purposes, the prescribed fire season was going great, with weather providing conditions to meet burning objectives and wildfires were being quickly suppressed and held to minimal size.

However, as April 23<sup>rd</sup> approached, there were gaps between what was being “seen on the ground” and local predictive service and fire behavior indicators as the nearest Remote Area Weather Station (RAWS) was indicating. Live woody fuels moistures for Jack Pine and Red Pine were tracking roughly 2 weeks ahead of where they historically have been in previous years. 10 Hour fuel moistures were setting record lows with 100 Hour fuels below average and nearing record lows. The BI, or Burning Index, which estimates the potential difficulty of fire containment, was forecasted to be below the 90th percentile (22) the day before the burn, however, the actual BI on burn day was above the 90th percentile at 33.



**west** wind. With a Moderate Complexity Rating, personnel and equipment identified in the prescription were available on the District and ready to implement. Although wildfire season and prescribed fire season run concurrently during the spring months, the District boosts its staffing with numerous off-forest resources and personnel to implement their prescribed fire program, meet preparedness staffing requirements, and respond to wildfires as needed. They often do all of the above on a given day.



Map: Prescribed Fire Map

## 5. What Happened?

On April 23, 2021, staff from the East Zone of the Huron-Manistee National Forest gathered to conduct the Brittle Prescribed Fire. Resources assigned that day included 5 engines, 1 dozer, 2 UTVs, 2 squads of firefighters and one helicopter equipped for aerial ignitions with a plastic sphere dispenser (PSD).

The National Weather Service Gaylord Office provided a Spot Fire Weather Forecast at 5am, the morning of April 23<sup>rd</sup>. The chart below shows the acceptable weather conditions from the burn plan, the published General Fire Weather forecast, and the issued Spot Fire Weather forecast.

<b>Weather Parameters</b>	<b>Burn Plan Prescription</b>	<b>General Fire Weather Forecast</b>	<b>Spot Fire Weather Forecast</b>
<b>Temperature</b>	Between 25° and 80°	Between 60° and 65°, except 52°-57° near the coast	Between 59° and 64°
<b>Wind</b>	20' winds at 16 mph, any direction	20' west winds at 10-15 mph, Gusts to 20-25 mph.	20' west winds at 5-11 mph, Gusts up to 23 mph in the afternoon.
<b>Relative Humidity</b>	30% or higher	Min 20%-25%	Min 20%-25%

The Brittle Prescribed Fire Plan's prescription parameters are established to provide flexibility with burning conditions and allow the Burn Boss to mitigate one prescription parameter if needed. If doing so, the Burn Boss will provide justification for burning outside of this parameter, and ensure written justification is provided in the burn boss documentation. The plan also stipulates that no more than one prescription parameter should be mitigated. On the morning of the burn, the relative humidity (RH) provided in both the General Fire Weather Forecast and the Spot Fire Weather Forecast were lower than 30% identified in the Burn Plan and the decision was made to exercise the Burn Plan's flexibility in mitigating a prescription parameter. A request for a "Variance" to this RH prescription parameter from the Agency Administrator, who was on site, was granted shortly after.

After gathering, and completing the on-site briefing, the Burn Boss had crews initiate the test fire at a location along the north edge of the burn unit, between locations B and C on the map. The unit had been attempted 10 days prior but canceled due to the fire intensity being too low to accomplish objectives. At 1030, just after the test fire was conducted, another weather observation was taken on-site. The temperature was 59°, west winds 3-5 mph, with an RH of 33%.

The test fire was deemed successful after 30 minutes, and at 10:38 a.m., the main prescribed fire was initiated. Crews began with hand ignition blacklining along the north line of the fire, extending from points C to B to A on the prescribed fire burn map, and then continued to the east line, from C to D. The Burn Boss asked crews to “hit the line hard with fire” to test that it



*Prescribed fire operation looking west from intersection of Shellenbarger Rd and Trout Rd. USFS*

would hold. Strip firing was used by ignitors to generate a large amount of heat, while fire stayed on the ground surface and continued burning as expected. Head fire moving towards the holding line was estimated to have 2 to 4 ft flame lengths with backing fire having 1 ft flame lengths.

After an hour and a half of black lining operations on the north and east sides of the prescribed fire, the Burn Boss conferred with Division Z (north and west sides) and Division A (east and south sides) to gauge their level of comfort on beginning aerial ignition. Both Divisions felt comfortable with the amount of black line they had on the ground and approved of the plan to begin aerial ignitions. There was an average of 2 chains of black on the perimeter on the north and east sides of the fire at that time.

The aerial ignition platform, a Bell 407 helicopter flown out of Oscoda, was requested at 11:17 am and was overhead at 11:41 a.m.

After an initial recon of the fire, the Firing Boss in the helicopter told the Burn Boss that everything appeared to be burning well on the ground and he concurred that aerial ignition was safe to begin. At the time, ground crews observed there was not much lift in the smoke, and this was confirmed by the Firing Boss in the helicopter. At 11:51 am, the helicopter began aerial ignition using a Red Dragon Plastic Sphere Dispenser. Initially, 4 passes were made east and west between points A and B on the north edge of the burn unit.

After making the initial 4 passes, the Burn Boss had the helicopter stop firing to allow the lines to come together. After observing good fire effects on the ground, the Burn Boss told the Firing Boss to continue with more strips parallel to A-B and moving south. The Firing Boss then informed the Burn Boss that the helicopter crew was observing a **northerly** wind at approximately 750ft above ground level (AGL).

With a northerly wind, the Burn Boss had concerns that the prescribed fire could potentially cross the burn unit from North to South as a head fire, putting pressure on the south line. After conferring with the Division Supervisors, he made the decision to then have the helicopter conduct ignition from C to D in order to send a flanking fire across the burn unit and prevent a head fire from running south. This was at approximately 12:10pm. The helicopter then made 10 total passes between C and D, pausing between the 3<sup>rd</sup> and 7<sup>th</sup> passes.



*Looking north along Sand Lake Rd at the approximate area the fire crossed the road. NPS/Bell*

The Burn Boss's log shows the first spot fire across the C-D Line (Trout Road) happening at about 12:15 p.m. Subsequent spots occurred at 12:22 and 12:30 p.m. During this same time period, firefighters began to notice the influence of the northerly winds at ground level (12:30 p.m.).

After the helicopters 10th pass, the Burn Boss told the helicopter to stop firing and conduct recon due to the spot fires. Engine crews were able to easily "pick up" the spots and extinguish them. The Dozer was able to quickly put a line around those spots as well, preventing spread.

After working the spots on the east side of the road, Division A notified the Burn Boss that a spot had begun "pretty far off the line" and south of Shellenbarger Road. Additional spots were noted between Shellenbarger Road and Forest Road 2048. At that point, all firing operations ceased, and crews focused on the spot fires. While crews began working the spot fires, the Burn Boss called his immediate supervisor, DIV-2, and requested him to the scene as fire activity was increasing.

The Burn Boss drove east of the prescribed fire along Trout Road, then north on Sand Lake Road to Shellenbarger Road. While heading west on Shellenbarger Road, back towards the prescribed fire unit, the Burn Boss was able to see the large size of the spot fires. He then called Cadillac



*Spot Fires rapidly developing east of burn unit*

Dispatch and requested 2 Fire-Boss Single Engine Air Tankers (SEATS) and an Air Attack platform. This was at 12:53pm. At 1.00 p.m., another On-site weather observation was provided. **The Relative Humidity had dropped significantly and was now at 20%.**

While on Shellenbarger Road, the Burn Boss observed fire with flame lengths of 20' cross the road from north to south in front of him, cutting off his travel route. He then backed

out, retracked his route and tied in with Division A Supervisor and DIV-2 from the Forest. The Forest Supervisor, serving as Agency Administrator, and the District Ranger, an Agency Administrator Trainee, were also on the fire and met with the Burn Boss and Forest DIV-2 northeast of Point C on Iargo Road.

The Burn Boss, Forest Div-2, the Forest Supervisor, and the District Ranger discussed potential conversion of the prescribed fire to a wildfire. The spot fires at that time were estimated to be 250 to 300 acres. A decision was made that if the fire crossed Sand Lake Road, the prescribed fire would be converted to a wildfire. Additionally, the Agency Administrator requested that fire crews work the spot fires for an hour, then re-evaluate trigger points and conversion to wildfire.

At about the same time, the Burn Boss asked Air Attack their thoughts on holding the escaped prescribed fire west of Sand Lake Road. Air Attack advised the smoke column was doing "weird things" and the fire was pushing southeast. Air Attack said he could better advise in holding the fire west of Sand Lake Road in approximately 15 minutes.

At 1400, on-site weather was taken. **The Relative Humidity had now dropped to 18%.**

Approximately 8 to 10 minutes after the trigger point and time frames for re-evaluation were set, the escaped prescribed fire crossed Sand Lake Road. This was reported to the Burn Boss by Air Attack.

**At 2:24 PM, the Brittle Prescribed Fire was declared a wildfire.**



*Picture of Single Engine Air Tanker working east side of the fire.  
USFS/Auriemmo*

## 6. Chronology of Events-Operations

<b>Time</b>	<b>Event</b>
10:02	All resources briefed on scene.
10:18	Beginning test fire.
10:38	Beginning main fire.
11:17	Helicopter requested for aerial ignition.
11:41	Helicopter overhead.
11:51	Helicopter beginning aerial ignition on North Line.
12:08	Helicopter crew noticing northerly wind influence at 750' above ground level (AGL).
12:14	Aerial ignition adjusts to north/south (C to D) firing pattern.
12:15	First spot fire observed in ditch across C-D line
12:52	Stopping aerial ignition, working on spot fires, requesting air attack.
12:53	Burn Boss requests 2 Single Engine Air Tankers (SEATs) and Air Attack. Observes fire cross Shellenbarger Rd from north to south.
1:26	SEATs depart Gaylord, 25-minute eta.
1:30	Burn Boss requests Dozer-252 and BC-21 to respond.
1:45	Dozer 261 loses contact with Swamper.
1:54	Burn Boss requests Type 1 helicopter and to have them "tie in" with air attack.
1:55	Dozer 261 regains contact with Swamper.
2:10	Division Supervisor (DIVS) A on Sand Lake Rd, south of Shellenbarger, with fire north and south of him.
2:24	Declared a wildfire, extreme behavior, disengaging on the ground moving air resources to the head for point protection.

## 7. Findings and Lessons Learned

### A. Current and Predicted Conditions/Situational Awareness

#### Findings

With the National rollout of NFDRS 2016 and the required transition to NFDRS fuels models, there have been significant challenges in evaluating these new fuel models and corresponding fire danger ratings for the given area. With this change, there has been confusion regarding fire danger ratings and staffing levels as a slow adjustment to this modeling has been occurring. The spring of 2021 was essentially the “break-in” period for NFDRS 2016.

Keetch-Byram Drought Index (KBDI) is used as an environmental parameter in the burn plan to help determine fire behavior ranging from the cool to optimal to hot end of the prescription. A value of 350 was used to indicate the hot end of prescription in the burn plan. As seen in Figure 1, KBDI values of 350 have not been observed, historically, until early July using Fuel Model V, a grass fuel model.

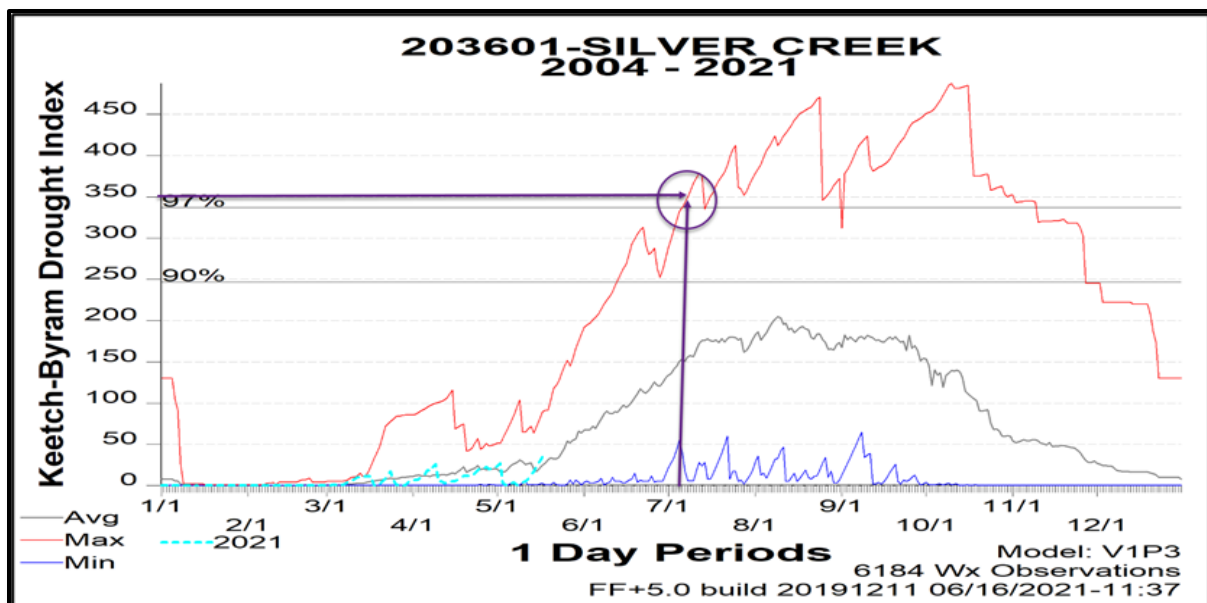


Figure 1: KBDI for Silver Creek RAWs from 2004-2021 over a calendar year using Fuel Model V, showing a value of 350 not being recorded until early July, historically. KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. It is a closed system ranging from 0 to 800 units and represents a moisture regime from 0 to 8 inches of water through the soil layer.

An analysis of the spring season, March to June, showed that historically, KBDI values have not exceeded 180. Additionally, KBDI the day of the burn was well below the historical average with a value of 10 (Figure 2).

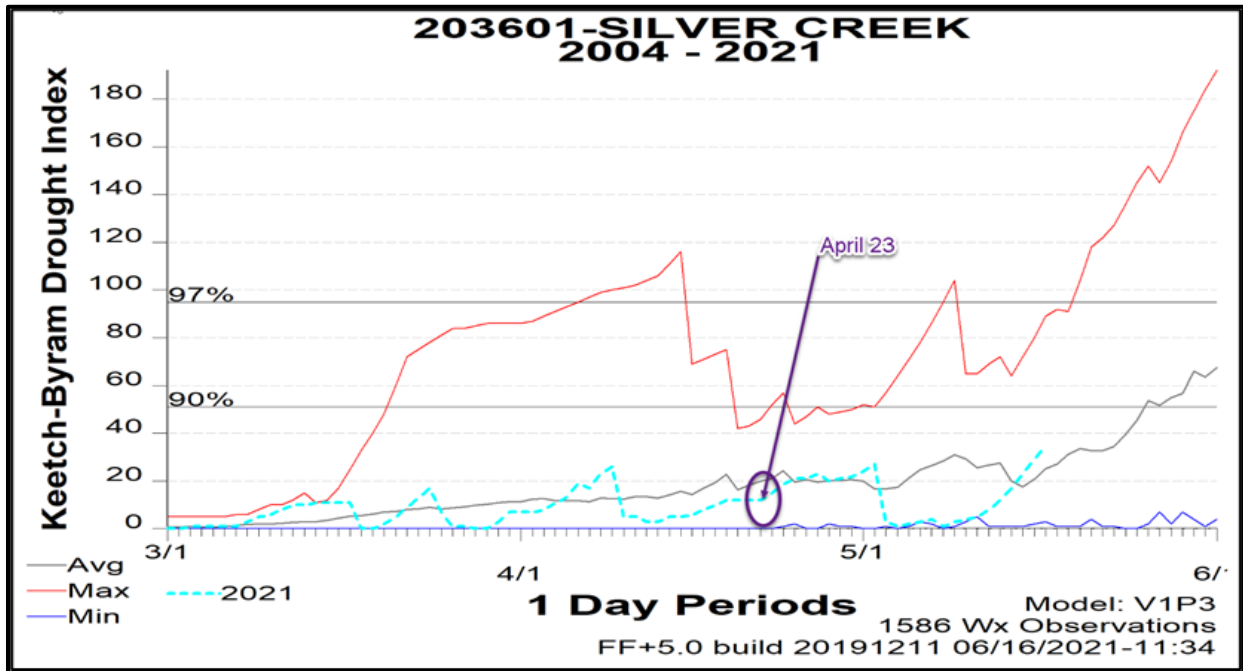


Figure 2: KBDI for Silver Creek RAWS from 2004-2021 (Fuel Model V) showing historic high KBDI for the Spring (180) and KBDI the day of the burn of 10.

Fuel Model X, a brush model similar to Fuel Model V, was also modeled for KBDI, 10-hour fuels, 100-hour fuels and Growing Season Index (GSI) based on recommendations from the Rocky Mountain Research Station. KBDI for the spring season, using Fuel Model X, did not exceed 160 (Figure 3).

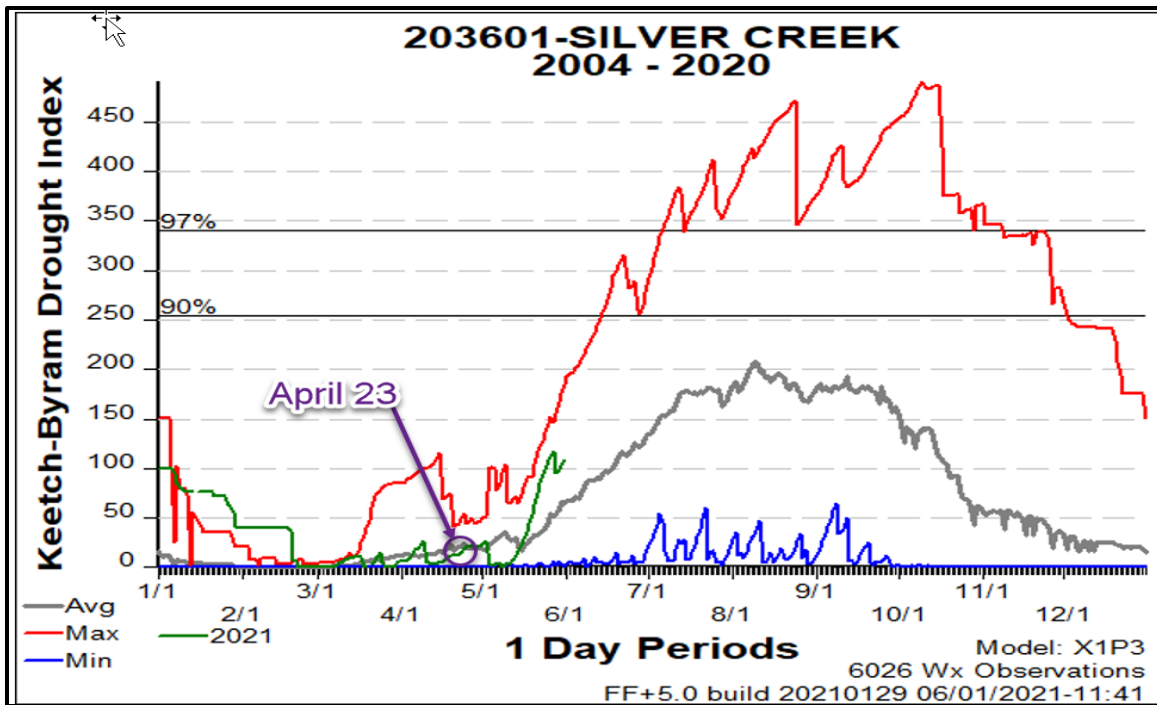


Figure 3: Silver Creek RAWs from 2004-2020 using Fuel Model X, showing the KBDI value the day of the burn below average.

In contrast, other indices modeled for the purpose of this assessment using Fuel Model X showed above 97th percentile values the day of the burn. In fact, Fuel Model X Burning Index for April 23rd was above the 99th percentile (Figure 4). Fuel Model V values were largely below, at, or slightly above the 90th percentile.”

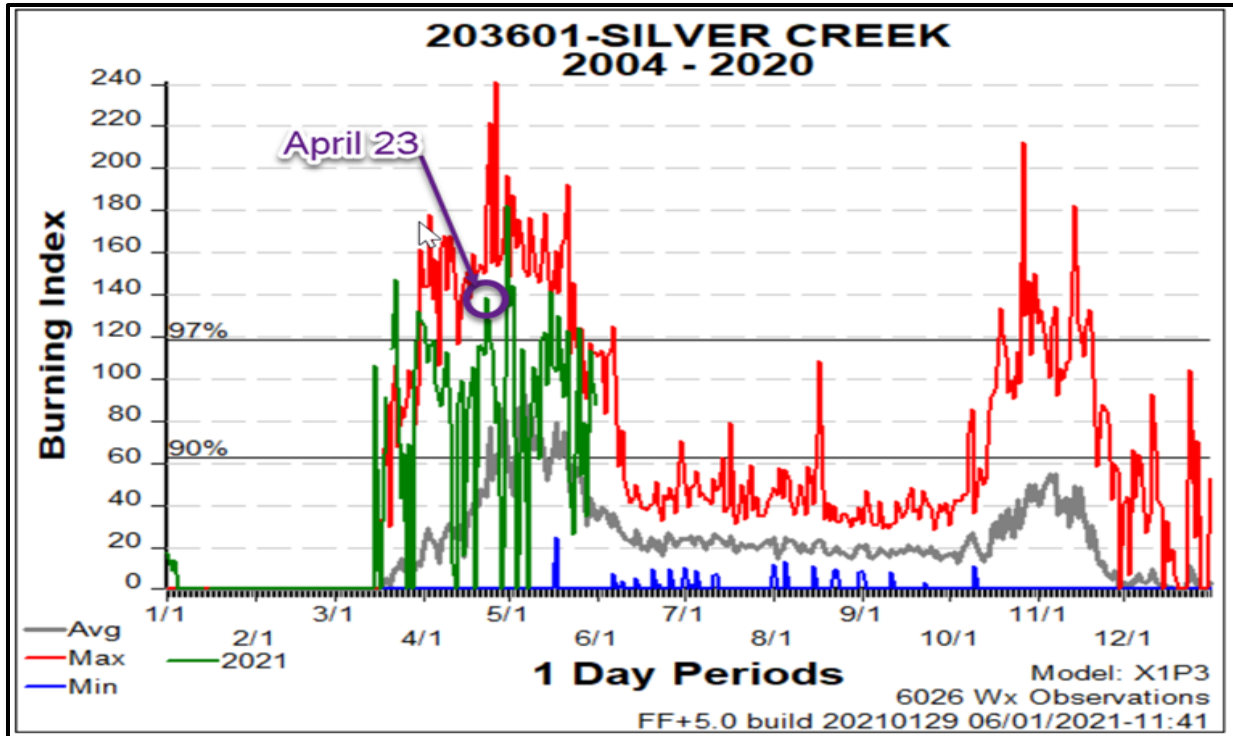


Figure 4: BI for Silver Creek RAWS from 2004-2020 using Fuel Model X showing the BI above the 97th percentile. BI is an estimate of the potential difficulty of fire containment as it relates to the flame length at the head of the fire.

Fine dead fuel moistures for 10-hour and 100-hour fuels were near or below historic lows (Figures 5 and 6).

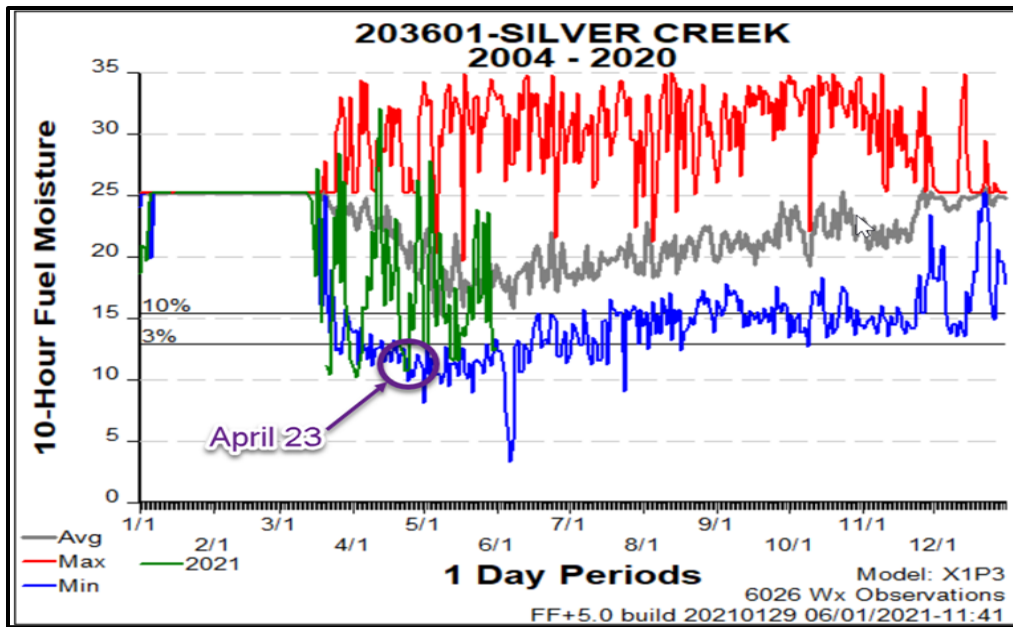


Figure 5: 10 Hour fuel moistures for Silver Creek RAWS from 2004-2020 using Fuel Model X were setting record lows. Dead fuel moisture threshold 10–hour (0.25 to 1 inch diameter), called a time lag, is based upon how long it would take for 2/3 of the dead fuel to respond to atmospheric moisture. Dead fuels respond solely to current environmental conditions and are critical in determining fire potential.

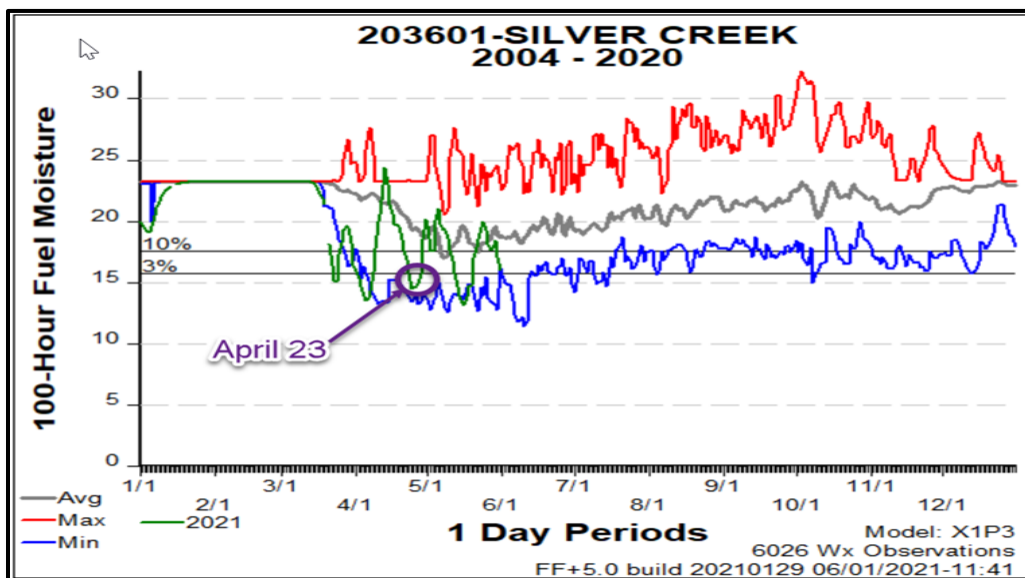


Figure 6: 100 Hour fuel moistures for Silver Creek RAWS from 2004-2020 using Fuel Model X were below average nearing record lows. Dead fuel moisture threshold 100–hour (1 to 3 inches diameter), called a time lag, is based upon how long it would take for 2/3 of the dead fuel to respond to atmospheric

moisture. Dead fuels respond solely to current environmental conditions and are critical in determining fire potential.

Growing Season Index (GSI) was approaching its lowest level, indicating critically dry live fuel conditions (Figure 7). Live woody fuel moistures for Jack-Pine and Red Pine were tracking about 2 weeks early in comparison with previous years data at an average of 102% and 95%, respectively, on April 20.

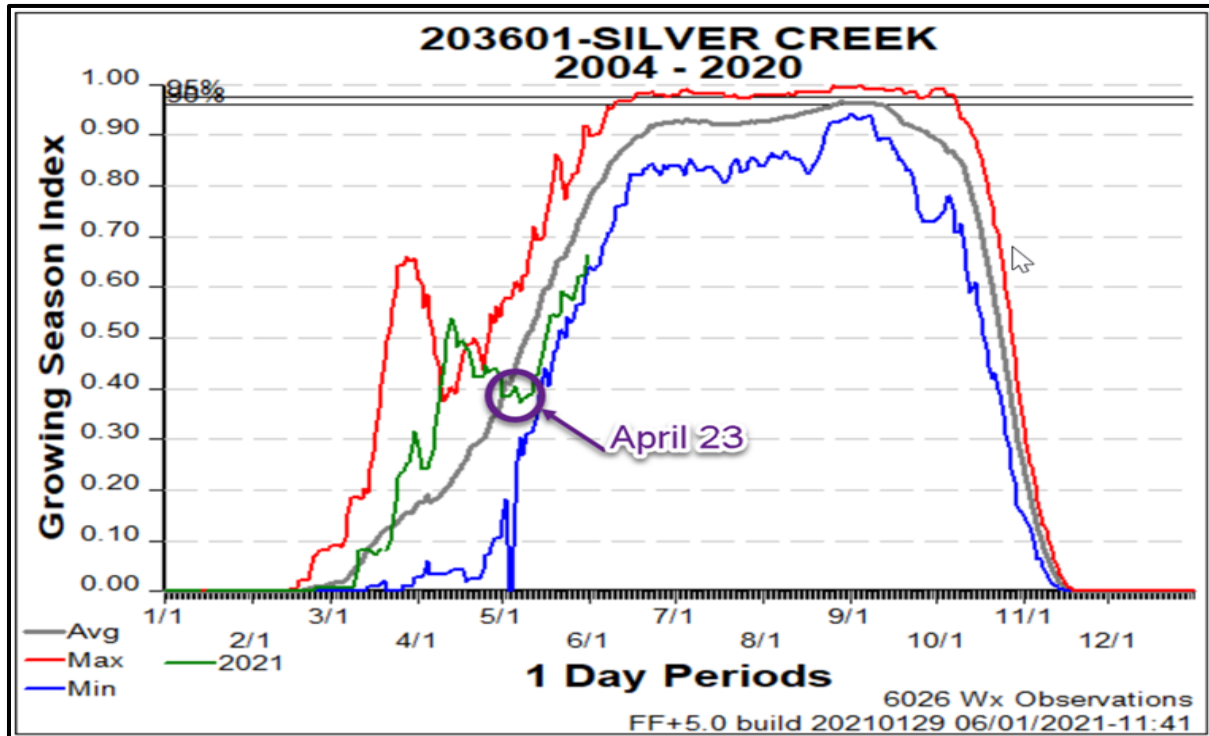


Figure 7: GSI for Silver Creek RAWS from 2004-2020 using Fuel Model X, showing values nearing seasonal lows prior to green-up. GSI predicts the green-up and senescence of live fuels and the influence of water stress events on vegetation. Increasing values of GSI indicate periods of improving conditions for live fuels and decreasing values indicate periods of detrimental weather conditions.

### Lessons Learned

The transition to NFDRS 2016 requires an update to users on the new science and how predictive service tools such as Fire Family Plus and the Weather Information Management System will reflect this change. It will require continuous and ongoing evaluation on determining its effectiveness and suitability for the area. Until this new system is understood, fire managers may be challenged in operational decision making and staffing needs.

KBDI is currently used as a prescription parameter in the burn plan for determining environmental prescription ranges and is unrepresentative of conditions for the area during the spring fire season. Ensuring burn plan metrics are representative is key for preplanning and good situational awareness. Utilizing new fire behavior metrics such as GSI in combination with 10-hour fuels using Fuel Model X could provide better outputs, as GSI in combination with 10-

hour fuels have shown to be a good metric for quantifying crown fire behavior in similar conditions and fuel types in Wisconsin.

## B. Planning

### Findings

The limited number of burn windows available during the prescribed fire season, coupled with numerous time of year related resource management constraints in the Environmental Assessment (EA) created some level of urgency to implement the project and meet the management objectives.

The District utilizes programmatic burn plans as an effective way to group a large, landscape prescribed fire project into one document. However, the prescribed burn plan was prepared in 2019. It is a plan that encompasses many burn units tied to an Environmental Assessment (EA) from 2006. Forest Service Manual 5140 clearly states the burn plan is to be reviewed every year and revised and rewritten if necessary. As opposed to one current and approved burn plan, multiple copies and versions of the burn plan were in circulation among fire personnel as a “centralized” electronic filing system or repository was not made available to house the plan and supporting documents.



The adjacent fuels identified in the prescribed burn plan were not accurate as to what was actually on the ground. The plan identified a timber model whereas the representative adjacent fuel model should have been modeled as shrub fuel model as it was primarily immature Jack Pine.

The prescribed burn plan allows the Burn Boss to move forward with ignition if conditions are outside of one prescription parameter. On the

day of the burn, the relative humidity forecasted in both the General and Spot Fire Weather forecasts were outside of the Burn Plan’s acceptable RH prescription at the “Hot End”. The Burn Boss sought and received an approval to implement the prescribed fire with an RH below the Burn Plan’s acceptable RH “Hot End” parameter. The on-site relative humidity at 2:00 p.m., just before the prescribed fire was declared a wildfire had dropped to 18%. The low relative humidity values present was an environmental factor that enabled the increase in fire behavior, allowing for rapid growth of spot fires across the east line, and hampered spot fire control.

The Prescribed Burn Plan identified wind speeds to be acceptable up to 16 mph. This burn plan wind parameter was developed specifically for 20' winds and not inclusive of gusts that may or may not be present. On the day of the burn, both General and Spot Weather forecasts indicated 20' winds to be below the 16-mph value. However, in both forecasts, wind gusts were indicated to be above 20 mph with the Silver Creek RAWS indicating a gust as high as 28 mph.

Haines Index is not identified in the Burn Plan as a conditional element/parameter and its utility in pre-burn planning and decision making may not have been considered. While the Spot Fire Weather Forecast for the Silver Creek RAWS was a Haines of 5 on burn day, the General Fire Weather



forecasted a Haines of 6, indicating high potential for large fire growth. The atmospheric instability associated with an elevated Haines Index more than likely enabled increased spotting and fire development on April 23<sup>rd</sup>.

The Forest and District have been very proactive in developing and putting in place Cooperative Agreements with partners, State and Federal agencies. It was evident that the agreements are very successful due to the assistance provided during the suppression efforts.

### **Lessons Learned**

Although, strategic and project level (NEPA) planning documents have well thought out considerations and intent, often, they have greater longevity and don't represent changing conditions on the ground and/or account for future situations that make meeting the project objectives challenging in the present day. Burn season limitations in the NEPA documents reduce the number of available burn days. Collaboration is essential between programs to effectively communicate decision points based on constraints due to dates or timing established by NEPA and other outside agencies.

A pre-burn reconnaissance of the burn unit and surrounding fuel models ensures conditions on the ground match what is written in the burn plans. It is always good to review the conditions on the ground as to what is written in the document no matter how old the document is. Team conversations are important in determining achievable objectives. Ask your team if conditions have changed and if objectives can still be met using prescribed fire.

Additionally, consider sending burn plans to other Forests for technical review. By doing so, objective feedback and input can be provided, and, in many cases, what seems obvious or unambiguous to the Forest/District planning the burn, outside reviews may indicate serious holes in the planning process, including prescription parameter considerations.

Building flexibility into a prescribed fire plan is required to meet the goals and objectives while operating in a wide range of variability that exists when prescribed burning. However, a high degree of caution needs to be taken when prescribed burns are implemented at the hot end of the prescription. Although a burn plan may have prescription parameter ranges clearly identified in the burn plan, operating at the “hot” end for multiple parameters and indices (low relative humidity, higher winds, low fuel moistures, etc.;;) can lead to hazardous outcomes by leaving little room for implementation adjustments, especially **during** ignition.

Furthermore, close consideration for the inclusion of additional prescription parameters is imperative. Prescribed burn plans are often “rolled over” year to year incorporating the same environmental parameters time and time again. Reexamining “other” indices and their influence on the burn outcome is an important and required step.

## C. Operations

### Findings

Almost two hours after the prescribed burn test fire began, a northerly wind component was observed, and shortly after, the firing plan changed from what was originally planned. Smoke from the initial lines of aerial ignition laid over the burn unit, decreasing visibility for the helicopter to safely operate on its intended mission. The inability for the helicopter to resume aerial ignition and “tie in” lines of fire due to smoke obscuring visibility now required ground crews to quickly modify ignition plans without helicopter support.

Aerial ignition flanking fire was the primary ignition pattern/technique for the main body of the burn unit but ultimately became well-established head fire by having multiple, long, linear lines of fire now being pushed into the unit, because of the short-lived north winds. Fire intensity and resistance to control were both magnified when west winds began to dominate again and converging with the fire set by the ground crews to adjust to the situation.

### Lessons Learned

The reliance on a helicopter as an ignition source for prescribed burning carries some operational risk to firing operations. Although a valuable tool, when a helicopter is unable to perform its mission, be it flight conditions, equipment malfunction, or other, there is little option for a redundant system. Ignition then solely relies on ground firing operations to complete the mission that was assigned for the helicopter and requires a significant and, in

many cases, an unplanned event. Burn managers need to ask themselves-“What will I do if the Helicopter has to sit down due to a mechanical issue or if the Aerial firing device malfunctions? How will I safely deploy ground ignition crews with fire already well established on the ground? How can I cut this fire off if I can’t get ground ignition crews safely into the unit?” Building contingencies for such events needs to be considered and discussed with those involved on the prescribed burn.

The use of flanking fire is an excellent firing technique to reduce fire intensity and is often deployed to reduce negative fire effects often seen by head strip firing and other techniques. Using aerial ignition to perform flanking fire techniques requires considerable amount of coordination to ensure flight lines do not cause an unintended buildup of intensity if the established line of fire is not perpendicular to the prevailing wind and/or the flight path return with ignition is being pushed by the wind itself. If burn units are irregular in shape, this can add further complication.

## D. Human Factors

### Findings

The burn boss is well respected by his peers and coworkers and the relationships between District Fire personnel are strong. They are a “well oiled” and cohesive team. When the prescribed fire began spotting outside of the burn unit and became established, aggressive tactical decisions during the initial attempt to suppress were undertaken. Having a “managed” event move to a potential “incident” created an urgency to act, limiting a thorough and coordinated tactical response to the unplanned fire. The feelings of responsibility and not letting each other down created a higher tolerance for risk in the responders.

“I WAS MISSION FOCUSED. WE’RE GOING TO CATCH THIS.” -DOZER OPERATOR.

Some perspective was shared on the resolve to implement the Brittle prescribed fire due to the pressure to accomplish the assigned fuels target. Additionally, dates for burning restrictions from external sources, as well as seasonal weather constraints, created an additional sense of urgency to complete the burn.

### Lessons Learned

Several personnel described the difference between risk tolerance on wildfires and prescribed burn escapes. During a wildfire, initial attack decisions can be more deliberate and calculated because you are reacting to something beyond your control. Fire personnel identified the potential for negative impacts to the prescribed fire program and looking out for the reputations of co-workers as reason for taking more aggressive actions as the spotting and fire intensity increased.

Numerous pressures or perceived pressures to implement a project, specifically a prescribed burn, is certainly real. Planning sideboards, seasonal/weather constraints, partnership or special funding commitments, regulatory requirements, and performance measures provide a suite of challenges to fire land managers in successfully getting work done on the ground. However, pre-burn decision making needs to ensure that the prescribed fire is implemented at the “right time” and “right place”, and that project safety is at the forefront of the “go-no go” decision to move forward or not.

## E. Communications

### Findings

During the spot fires and resulting contingency actions, there was swift and ongoing dialogue between fire leadership and the Agency Administrator on the status of the situation. The Agency Administrator and the District Ranger were both present on the burn, allowing focus to be placed solely on incident decision making and making the “right call”. This was aided with personnel executing well established trigger points enabling the wildfire declaration process to move forward quickly.

Burn day communications with the local National Weather Service (NWS) was limited to a single request by the District for a prescribed fire Spot Weather forecast and a subsequent on-line delivery by the NWS fire weather forecaster. Differences and gaps between the General Fire Weather forecast and Spot Weather forecast were evident and no attempts were made to contact the NWS office to obtain feedback on these differences.

### Lessons Learned

Having a prescribed fire plan with a well-defined wildfire declaration process in place is critical to making a quick and decisive decision when and if that time occurs. Wildfire declaration delays due to communication gaps between key personnel, unclear declaration procedures, and/or hesitation due to perceived repercussions have all been well documented “lessons learned” for prescribed fire escapes. The Forest and District did not allow that to



happen that day and by doing so, allowed for the a “reset” of strategy and enabled the rapid mobilization to a suppression organization.

Ongoing and timely communications with the National Weather Service can improve prescribed fire outcomes for the future. When inconsistencies exist between weather forecasts and/or if observed weather conditions are not represented as forecasted, reaching out to the NWS is vital for safe operations and imperative in the “go-no go” process.

## F. Consistency/Continuity

### Findings

The Forests have had numerous turnovers of personnel and “actings” during the year. This is a time of transition in the entire Agency, seen in all levels of the Forest Service, not just on this Forest or District. This creates noticeable barriers and capacity challenges in implementing a growing fuels management program with increased demands (targets) and complexities. As heard from the Forest/District personnel, this included:

- ❖ Fire organization workforce shortage due to extended vacancies with Departmental and Human Resource (HR) process delays contributing to the inability to fill key fire positions in a timely manner.
- ❖ The fire organization’s capacity is limited for the size and complexity of the program to successfully implement the prescribed burning program. This places unneeded pressure on employees to complete work and meet targets.
- ❖ In many cases, the number of personnel used to complete prescribed fires on the District are made up of off-forest resources. When using “surge” capacity of off-forest personnel, or resources outside of the Region all together, knowledge and experience gaps for understanding and operating in a dynamic fire and fuels environment can be an operational hardship and presents safety risks.
- ❖ Successful implementation of prescribed fires must be well planned out including determining the capacity of available resources, experience, and qualifications of those available.

Despite these long-term vacancies in key leadership and fire positions, the Forest and District have operated very successfully. A more consistent leadership environment provides continuity in direction, standard operating procedures, and bridging gaps between program areas.

## Lessons Learned

Maintaining adequate fire staffing positions is and will continue to be a challenge to implementing a very active fire management program. When there is flux in leadership or noticeable capacity challenges, additional care and consideration should be given to the management of situations that are otherwise routine or perceived to be low risk. Operational tempo of these activities, including the scope and scale of implementing prescribed fire in complex areas will need thorough and ongoing assessment to safely ensure organizational requirements, both qualitatively and quantitatively.

## G. Internal Constraints

### Findings

The limited number of burn windows during the prescribed fire season, coupled with numerous resource constraints pertaining to seasonality in the Environmental Assessment, created a sense of urgency to implement the project and meet management objectives. Resource concerns for Red Pine mortality, Oak Wilt effects, and Kirtland Warbler impacts added more pressure to move forward with the prescribed burn project.

### Lessons Learned

Collaboration is essential between Forest staff areas, outside partners and regulatory agencies on perceived and/or real impacts to managed resources. Artificial constraints may be placed on the prescribed fire project if a thorough understanding of fire effects or operational impacts to the resource are not discussed during the planning process. Safety of implementing the project is the first priority and pressure to “squeeze” in implementation between these restrictive dates can place hard decisions on burn managers with unintended outcomes.

## 8. Commendations

**Openness and Candor of all staff through the FLA process:** The FLA team was very impressed at how all interviewees were eager to share their individual stories, experiences, and perceptions. They embraced the learning culture of the FLA and showed a willingness to discuss perceived let downs, and describe their lessons learned, despite the inherent tendency to feel bad about and escaped prescribed fire. No one let their pride or ego get in the way of acknowledging areas where improvements can be made.

**Wildfire Declaration:** Management did not delay in declaring the prescribed fire a wildfire. Communication between the Agency Administrator and Fire Managers (Burn Boss, Zone FMO, FFMO) on the status of the situation allowed for the full quick deployment of local resources to

assist in the suppression effort. They did not hesitate as it was exactly what was needed to be done, given the conditions as they were observed on the ground, and given the risks and sensitivities related to nearby private property.

**Strong Relationships with Cooperators:** The District has invested much effort in working with the local fire departments, emergency management, and state cooperators. The years of being proactive in fostering close relations were instrumental during the suppression response.

**Support for One Another:** The Brittle prescribed fire escape is a hard pill to swallow. Planning and implementing any prescribed burn requires a devotion in time and energy. The folks on the District/Forest love the work they do and know that they are making a difference to the land and in protecting others. After an event like this, emotions run deep. “Why burn again?”. “Why take the risk?”. “What will happen next?”. “Is it worth it?”. Thoughts like this are normal for those who have been through it. The employees on the Forest and District who were there, who experienced it, have asked these questions to themselves and to each other. But through support for one another, they rallied. They have looked out for their peers and have expressed a learning attitude to move through it. They will bounce back and be stronger after this.

“What was good out of all of this is I got to see people’s true colors and knew they cared”-Prescribed Burn Participant

**The Success of the Fuels Program:** The Forest and District’s proactive fuels program has reduced the wildfire risk and susceptibility to loss for the communities and other values at risk. Over the years, they have made enormous strides in planning well thought out and executed fuels treatments focused on saving lives and protecting property. This work has not been for the faint of heart. The Huron Shores Ranger District carries significant risk when implementing prescribed burns. Volatile fuels such as Jack Pine, scattered Wildland Urban Interface, and wildfire response workloads create unique and ongoing complexities to delivering a high-quality fuels management program. This work is being done by extraordinary individuals who work as team and display a true “land ethic”.

## 9. Appendices

### A. Appendix 1: Escaped Prescribed Fire Analysis Review

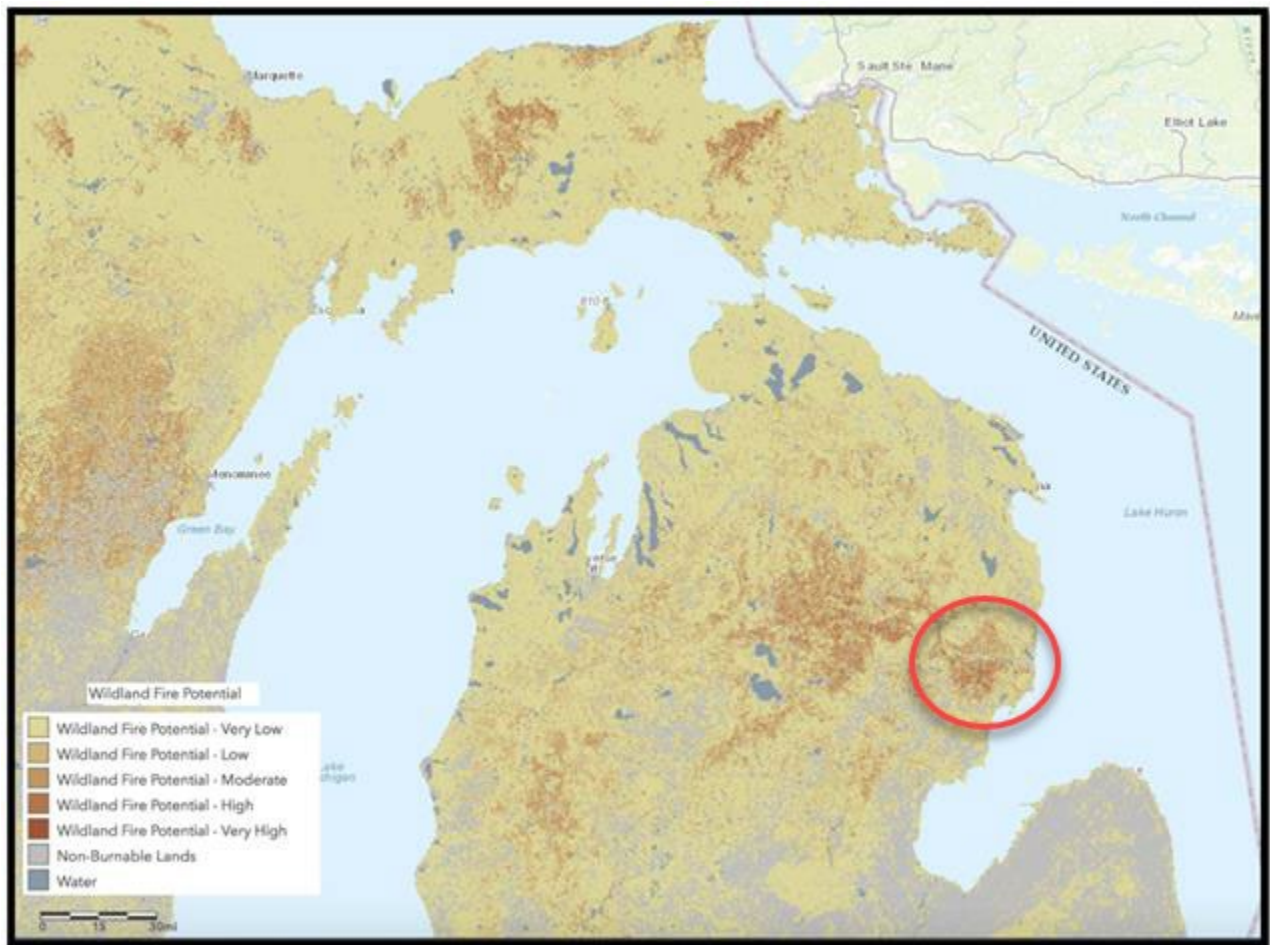
On May 10, 2021, the Eastern Region, Regional Forester, Gina Owens, requested a Facilitated Learning Analysis (FLA) associated with the Brittle prescribed burn. Embedded in the delegation letter to the FLA team was a request for the team to also address the five elements of a declared wildfire review as specified in the Interagency Prescribed Fire Planning and Implementation Procedures Guide (PMS 484). These elements (referred to as “parameters” below) include the following:

1. An analysis of the seasonal severity, weather events, and on-site conditions leading up to the wildfire declaration.
2. An analysis of the prescribed fire plan for consistency with agency policy and guidance related to prescribed fire planning and implementation.
3. An analysis of prescribed fire implementation for consistency with the prescription, actions, and procedures in the prescribed fire plan.
4. The approving agency administrator’s qualifications, experience, and involvement.
5. The qualifications and experience of key personnel involved.

**Parameter 1: Analysis of seasonal severity, weather events, and onsite conditions leading up to the wildfire declaration.**

### **Seasonal Severity**

A wildfire risk assessment was completed for the Eastern Geographic Area on April 12, 2021, eleven days prior to the prescribed burn escape. The map in Figure 8 indicated areas where there was potential for elevated fire behavior during the spring fire season. Portions of the Northern Lower peninsula of Michigan, including where the Brittle prescribed burn units were located, showed potential for elevated wildfire potential.



*Figure 8: Wildfire Potential Map from page 16 of the Eastern Area Wildfire Fire Risk Assessment Spring 2021, dated April 12, 2021.*

The Huron Shores Ranger District of the Huron-Manistee National Forest experienced below normal snowpack during the 2020-2021 winter which led to a moderately droughty spring.

## The Difference Between 2020-2021 Snowfall and the 1991 to 2020 Normal Snowfall

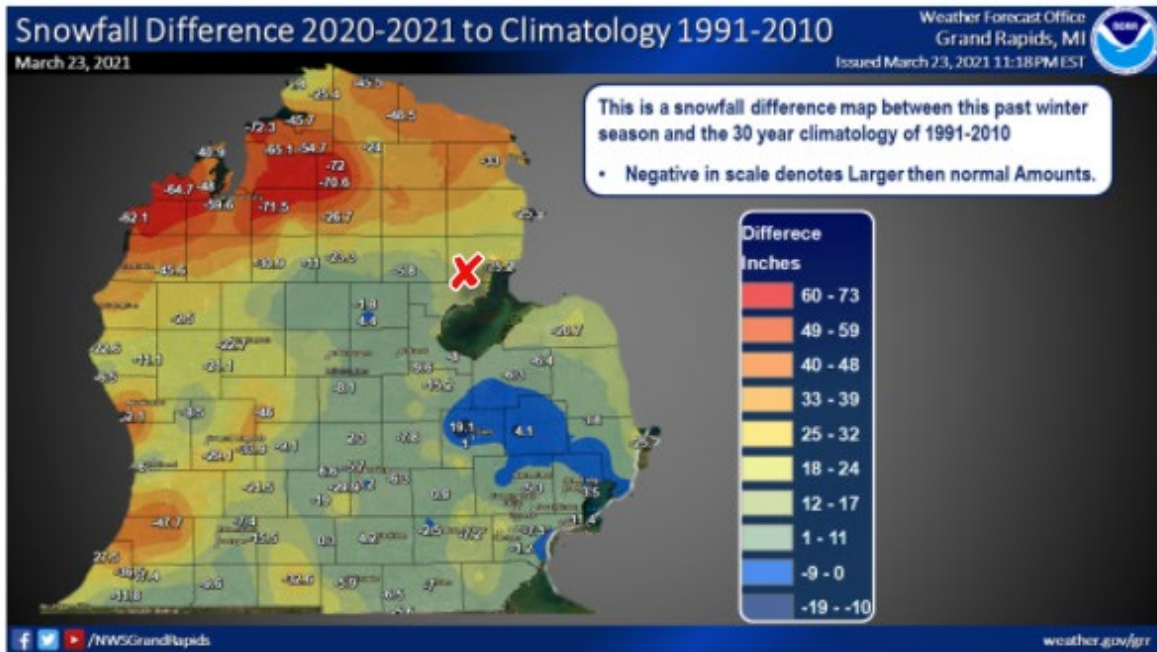
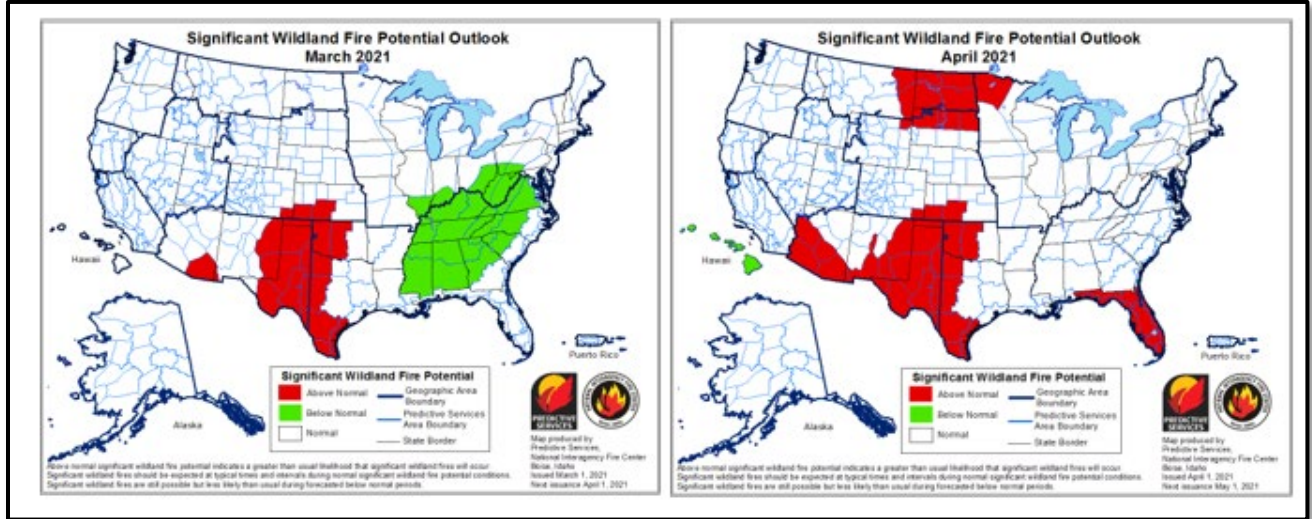
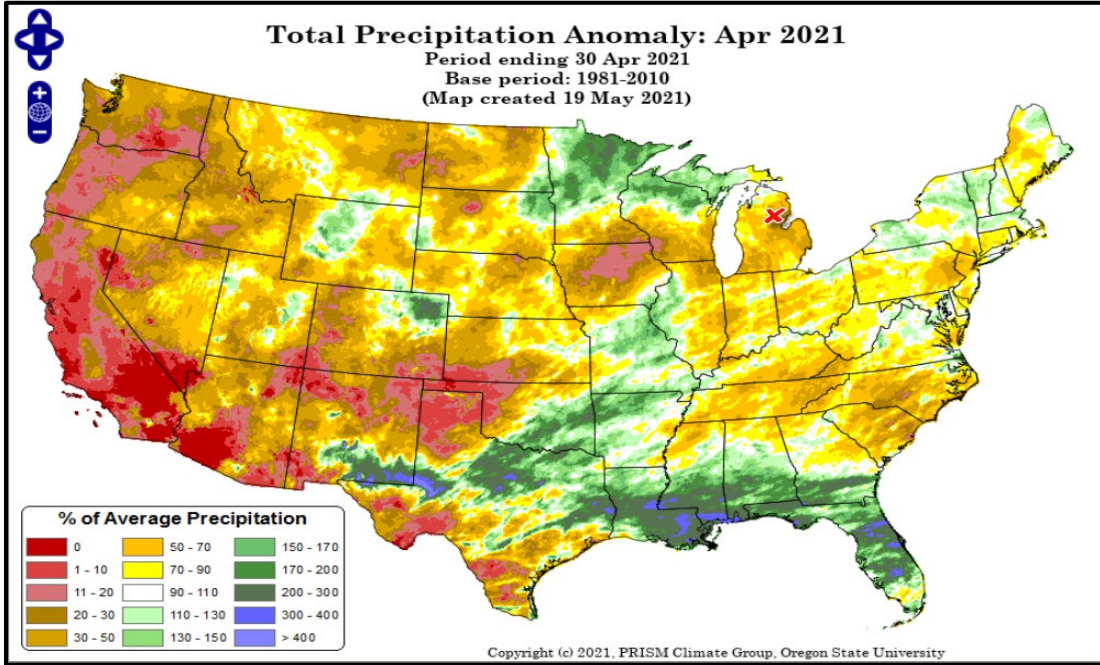
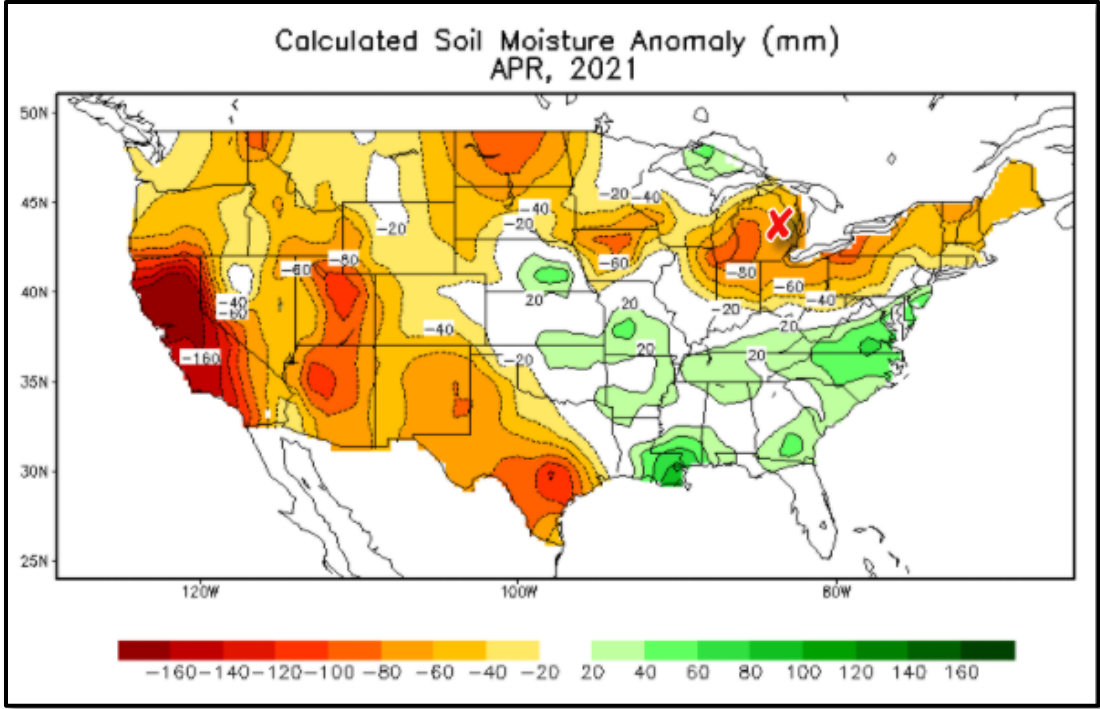


Figure 9 : National Weather Service reported that the area of the fire had about 18-25 inches less snow than the years 1991-2010.

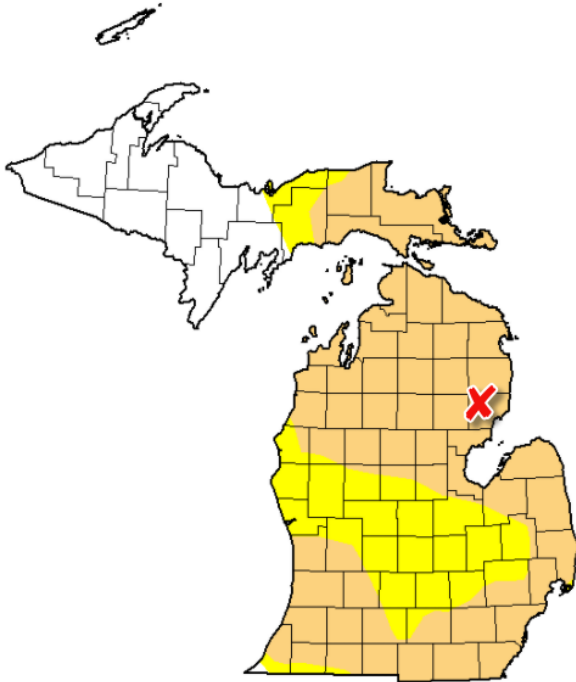
Outlooks released in April indicated soil moisture anomalies and below normal precipitation amounts for the northern Great Lakes region, however, significant fire potential was forecasted to be normal thru March and April. The US Drought Monitor indicated Northern Lower Michigan was experiencing moderate drought in April.





# U.S. Drought Monitor Michigan

**April 20, 2021**  
(Released Thursday, Apr. 22, 2021)  
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
<b>Current</b>	20.03	79.97	57.06	0.00	0.00	0.00
<b>Last Week</b> 04-13-2021	21.66	78.34	17.46	0.00	0.00	0.00
<b>3 Months Ago</b> 01-19-2021	82.42	17.58	0.00	0.00	0.00	0.00
<b>Start of Calendar Year</b> 12-29-2020	86.35	13.65	0.00	0.00	0.00	0.00
<b>Start of Water Year</b> 09-29-2020	67.03	32.97	1.55	0.00	0.00	0.00
<b>One Year Ago</b> 04-21-2020	93.06	6.94	0.00	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:  
Richard Heim  
NCEI/NOAA



[droughtmonitor.unl.edu](https://droughtmonitor.unl.edu)

Fire danger for the spring fire season, based on Burning Index (BI) at the Silver Creek Remote Automated Weather Station (RAWS) near the burn site, had been tracking up and down through the spring and set new record highs in March. The BI indicates difficulty of control of a fire and is based on temperature, humidity, wind, and precipitation duration. The BI was above the 90<sup>th</sup> percentile on April 23.

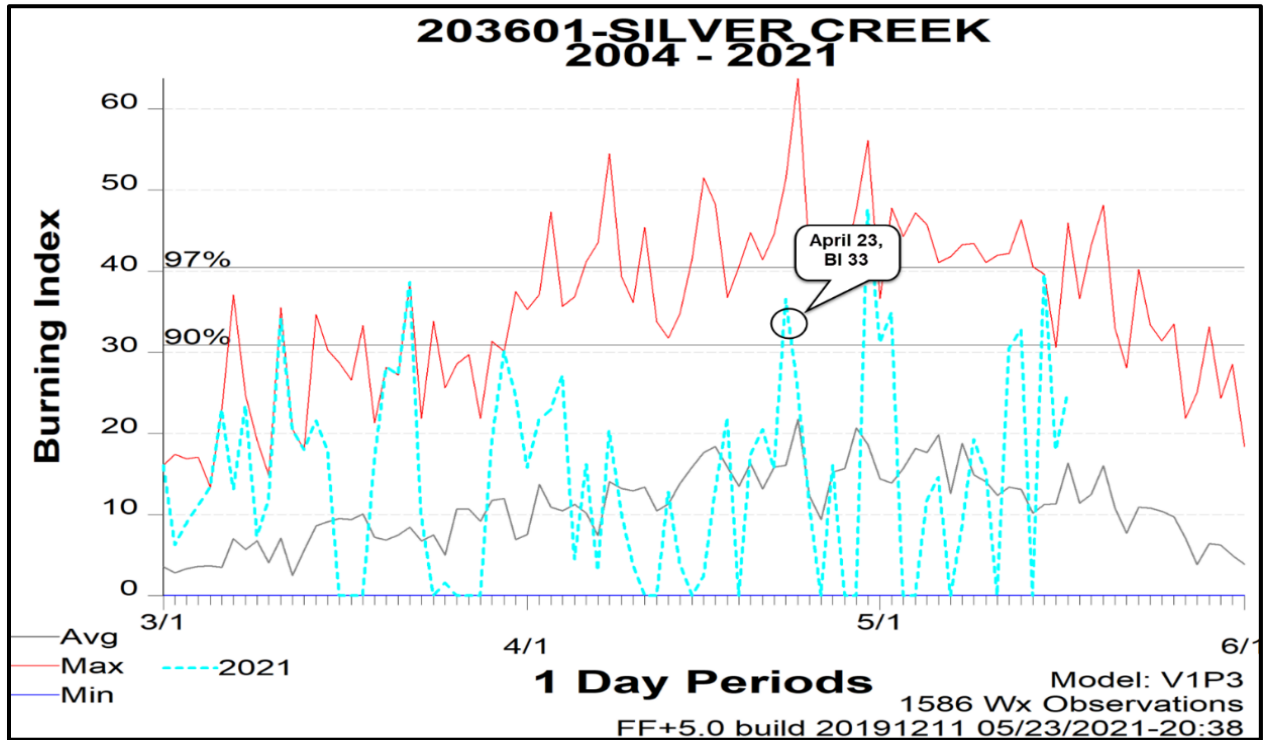


Figure 14: Burning Index for Silver Creek RAWS from 2004-2021 from March 1-June 1. Burning Index Indicates difficulty of control of a fire due to fire behavior and is based on temperature, humidity, wind, and precipitation duration. BI was above average and above the 90<sup>th</sup> percentile on the day of the fire.

Other indices indicating that the area was in moderate drought include thousand-hour fuel moisture and the Canadian Forest Fire Danger Rating System (CFFDRS) Buildup Index (BUI). Thousand-hour fuel moistures were tracking near normal but were trending to below average levels for most of the month of April and the BUI was tracking above average days leading up to the burn and was above average on burn day. Increased spring drying elevates the amount of fuel available to burn and supports the possibility that more significant fire behavior can occur as the season progresses.

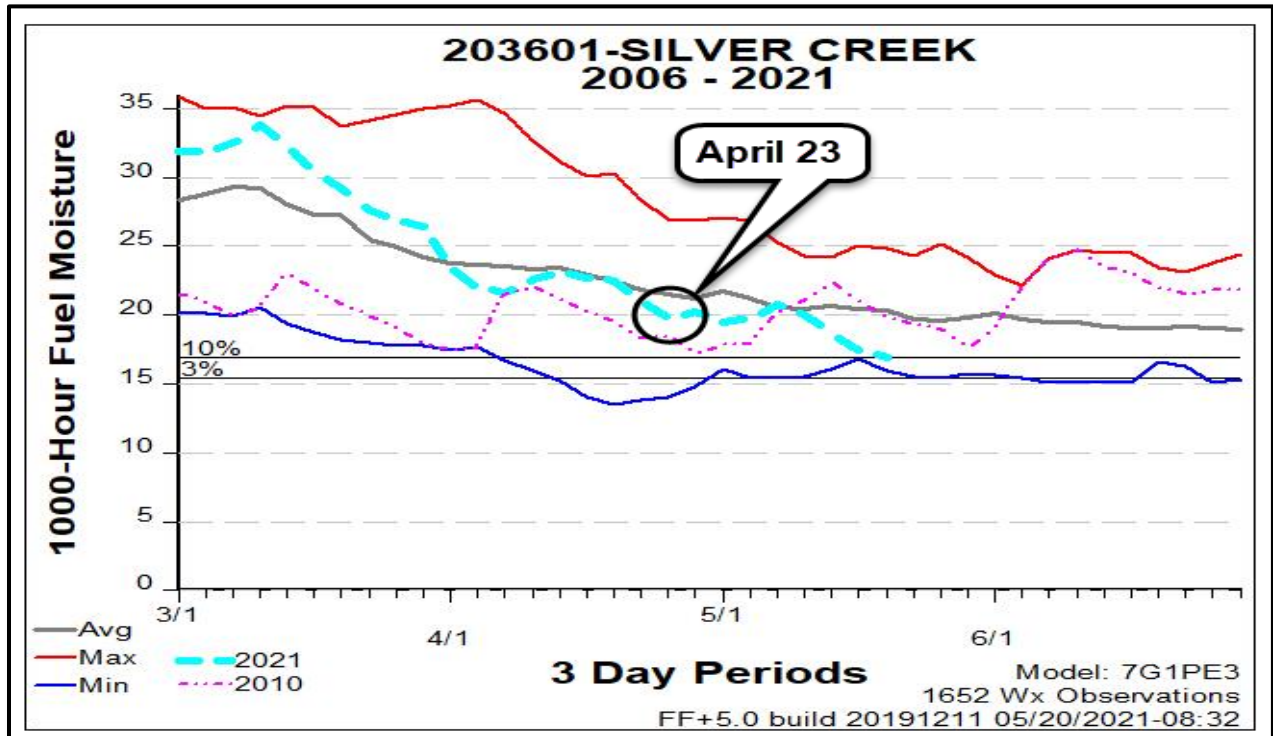


Figure 15: 1000-hour fuel moisture for Silver Creek RAWS from 2006-2021 from March 1-June 31. Indicates 1000-hour fuels were not at record low levels but were trending below average for the month of April. Chart taken from Eastern Area Coordination Center Predictive Services webpage.

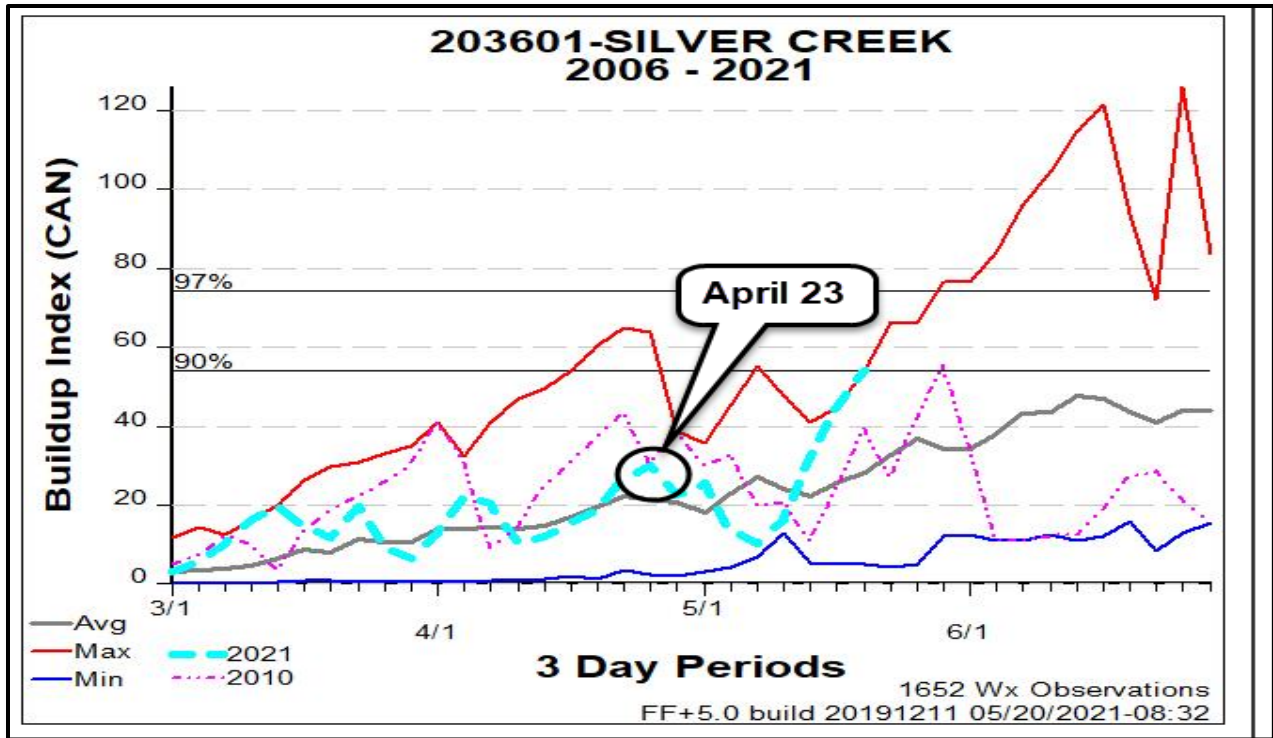


Figure 16: Buildup Index for Silver Creek RAWS from 2006-2021 from March 1-June 31. Buildup Index is a CFFDRS indices that indicates cumulative effects of daily drying factors and precipitation on fuels with a ten-day time lag. Chart taken from Eastern Area Coordination Center Predictive Services webpage.

Local fire managers indicated that conditions in March had been cool and dry with a lot of cloud cover. So, while wildfires they managed were not as “frisky”, they did observe that heavy fuels were consuming in areas that were typically wet and they were having to put dozer line on prescribed burns for holding in areas where they typically can scratch hand line to wet areas. One fire manager mentioned that he had been there for 15 years and it was the weirdest March, in terms of weather, he had ever seen.

While periodic rain was occurring in April, it was not making up for moisture deficits seen in March. Analysis of data collected at the Silver Creek RAWS validated that precipitation amounts were below average throughout most of March and for portions of April. March received 1.45 inches of rain while April saw 1.8 inches.

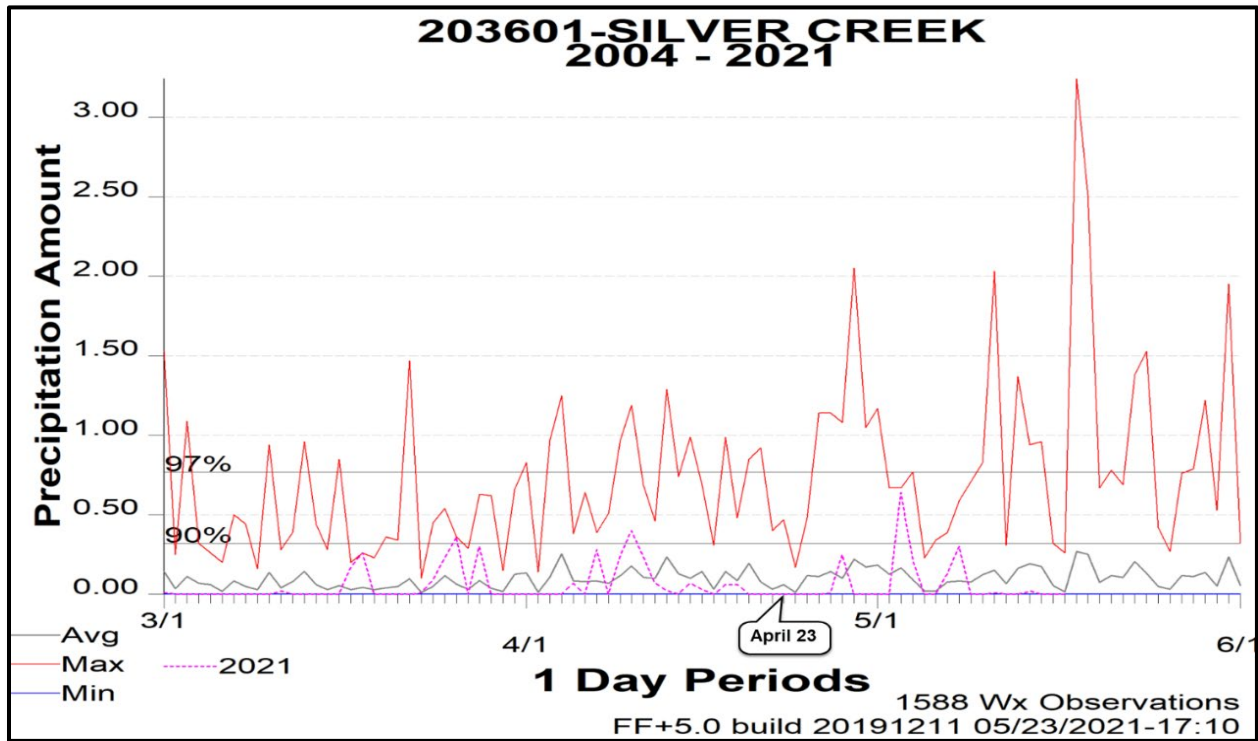


Figure 17 : Fire Family Plus precipitation analysis showing below average precipitation thru most of March and a portion of April. Pink line is precipitation amounts measured at the Silver Creek RAWS in 2021 while the grey line is the average from 2004-2021 from March 1 through June 1.

### Weather Specific to the Area

Despite moderately dry conditions, the Huron Shores Ranger District was having a successful spring prescribed burn season. Weather conditions supported prescribed fire operations on the Forest throughout March and April and objectives were successfully being met. Factors that contributed to difficulty of control on April 23, 2021 include low relative humidity, an unexpected wind shift, and very dry fuels.

The Spot Weather forecast the day before the burn indicated humidity would drop below 30% (high end of the prescription) by 2:00 p.m. and that winds would remain westerly and within prescription, including wind gusts (16mph is high end of prescription). A Haines Index of 4 to 5 was forecast indicating low to moderate potential for large, plume dominated fire growth.

```
.FRIDAY...

Sky/weather.....Sunny (0-10 percent) in the morning. Becoming
                    partly sunny (50-60 percent) during the afternoon.
Max temperature.....57-62.
Min humidity.....23-28 percent.
Wind (20 ft).....Light, becoming west winds 5 to 15 mph.
Mixing height.....0-1100 ft AGL increasing to 8500-9700 ft AGL.
Transport winds.....West 6 to 15 mph increasing to 18 to 20 mph
                    late in the morning.
Vent rate.....Poor to excellent (0-1900).
Haines Index.....4 to 5 OR or low potential for large plume
                    dominated fire growth to or moderate potential
                    for large plume dominated fire growth.

TIME (EDT)      6 AM   8 AM   10 AM  NOON   2 PM   4 PM
Sky (%).....4     6     11    24    45    50
Weather cov.....
Weather type....NONE   NONE   NONE   NONE   NONE   NONE
Tstm cov.....
Temp.....31    35    50    58    61    61
RH.....83    77    45    33    27    25
20 ft wind.....SW 5   W 5    W 7    W 9    W 10   W 10
20 ft wind gust.10    10    14    16    14    16
Mix hgt (ft)....BLW100 100    1100   4600   8900   9600
Transport wind..SW 6   W 7    W 15   W 20   W 20   W 20
Haines index....4     4     4     4     5     5
VRate/100.....0     0     2     9     17    19
```

Figure 18: Spot Weather forecast from April 22, 2021

The Spot Weather forecast for burn day mentioned “critical to near critical afternoon humidity’s and some gustiness”. Forecasted humidity changed from the previous day’s forecast to dropping below 30% by 1300 (rather than 1400) with winds gusting up to 23mph. Relative humidity values were forecasted to be as low as 22% by 1500. The Haines Index was forecasted to be 5, indicating moderate potential for large, plume dominated fire growth.

It should be noted that the general forecast for burn day, forecasted drier and windier conditions than did the spot forecast. The General Fire Weather forecast also forecasted a Haines of 6, or high potential for large, plume dominated fire growth. For Spot Weather forecasts, the Haines Index is dictated by the value for the 2.5km by 2.5km cell that was submitted in the request. For General Weather forecasts, the Haines Index is calculating the average value across the zone. Therefore, in the case of the Brittle prescribed burn, the General forecast had a higher Haines Index than the Spot.

```
.REST OF TODAY...

Sky/weather.....Mostly sunny (30-40 percent).
Max temperature.....59-64.
Min humidity.....22 percent.
Wind (20 ft).....West winds 5 to 11 mph. Gusts up to 23 mph in
the afternoon.
Mixing height.....0-1600 ft AGL increasing to 9800-11300 ft AGL.
Transport winds.....West 7 to 16 mph increasing to 18 to 22 mph in
the afternoon.
Vent rate.....Poor to excellent (0-2400).
Haines Index.....5 or moderate potential for large plume
dominated fire growth.
```

TIME (EDT)	7AM	8AM	9AM	10A	11A	12P	1PM	2PM	3PM	4PM	5PM
Sky (%).....	5	6	8	11	13	25	37	50	56	63	69
Weather cov.....											
Weather type....											
Tstm cov.....											
Temp.....	32	37	43	50	56	59	62	63	64	64	64
RH.....	75	67	55	45	38	32	26	23	22	22	22
20 FT wind dir..	SW	W	W	W	W	W	W	W	W	W	W
20 FT wind spd..	5	5	6	7	9	10	10	10	11	11	11
20 FT wind gust.	10	10	12	13	14	16	16	17	18	18	18
Mix hgt (kft)...	0.1	0.1	0.1	0.5	1.6	4.2	7.3	9.8	11	11	10
Transp wind dir.	SW	SW	W	W	W	W	W	W	W	W	W
Transp wind spd.	7	7	9	13	16	18	20	21	22	22	21
Haines index....	5	5	5	5	5	5	5	5	5	5	5
VRate/100.....	0	0	0	1	3	8	14	20	24	24	21

```
MIZ018-024-030-036-042-232015-
Presque Isle...Alpena...Alcona...Iosco and Arenac
Counties...including Eastern Huron NF-
450 AM EDT Fri Apr 23 2021

.TODAY...
Sky/Weather.....Mostly sunny (30-40 percent).
Max Temperature.....60-65...except 52-57 near the coast.
  24 HR Trend.....14 degrees warmer.
Min Humidity.....20-25 percent.
  24 HR Trend.....3 percent drier.
20-Foot Winds.....West winds 10 to 15 mph. Gusts 20 to 25 mph.
Haines Index......6 or high potential for large plume dominated
fire growth.
Smoke Dispersal.....Excellent (2180).
Mixing Height.....9800 ft agl.
Transport Winds.....West around 9 mph increasing to around 21 mph
in the afternoon.
```

Figure 20: General Zone Weather forecast

Remarks within Element 7 of the Prescribed Burn Plan outline, “If burning at the hotter end of 2 or more prescription parameters, the Burn Boss is cautioned that effects are likely to be at maximum allowable ranges for desired objectives. The Burn Boss should not mitigate more than one prescription parameters and justification will be documented in the Burn Day Documentation if burning outside of any of the parameters.”

Environmental prescription ranges for relative humidity in the burn plan were 35-40 percent for optimal burn conditions, 85 percent for cool end burning conditions and 30 percent for hot end burning conditions, respectively. As mentioned in the Spot forecast for April 23rd, relative humidity values were forecast to reach 32 percent by 12:00 p.m. and lower 20s by 2:00 p.m. Actual onsite observations for RH were 31 percent by 1100 am 22 percent at 1230 and 20 percent by 1300.

The table provided below displays a comparison between temperature, wind, and relative humidity as planned in the burn plan prescription, the General Fire Weather forecast, the Spot Fire Weather forecast, and observed on-site weather take throughout the burn duration up to the wildfire declaration.

<b>Weather Parameters</b>	<b>Burn Plan Prescription</b>	<b>General Fire Weather Forecast</b>	<b>Spot Fire Weather Forecast</b>	<b>10:30 AM Weather Observation</b>	<b>1:00 PM Weather Observation</b>	<b>2:00 PM Weather Observation</b>
<b>Temperature</b>	Between 25° and 80°	Between 60° and 65°, except 52°-57° near the coast	Between 59° and 64°	59°	64°	68°
<b>Wind</b>	20' winds at 16 mph, any direction	20' west winds at 10-15 mph, Gusts to 20-25 mph.	20' west winds at 5-11 mph, Gusts up to 23 mph in the afternoon.	Eye Level winds at 3-5 mph, West	Eye Level winds at 3-7 mph, West	Eye Level winds at 7 mph, West
<b>Relative Humidity</b>	30% or higher	Min 20%-25%	Min 20%-25%	33%	20%	18%

The 2020 Huron-Manistee East Spring Pocket Card lists local thresholds for “Watch-out” conditions as combinations of any of the following factors contributing to greatly increased fire behavior; 20-foot wind speed over 15 mph, relative humidity less than 25 %, temperature over 68 degrees and a Burning Index over 31. On the day of the burn, two of these parameters for greatly increased fire behavior were met. The calculated Burning Index in Fire Family Plus was 33 and onsite relative humidity was below 25% sometime after 12:00 p.m. and forecasted to be below 25 % in the spot weather forecast for the 23<sup>rd</sup> until 5:00 p.m.

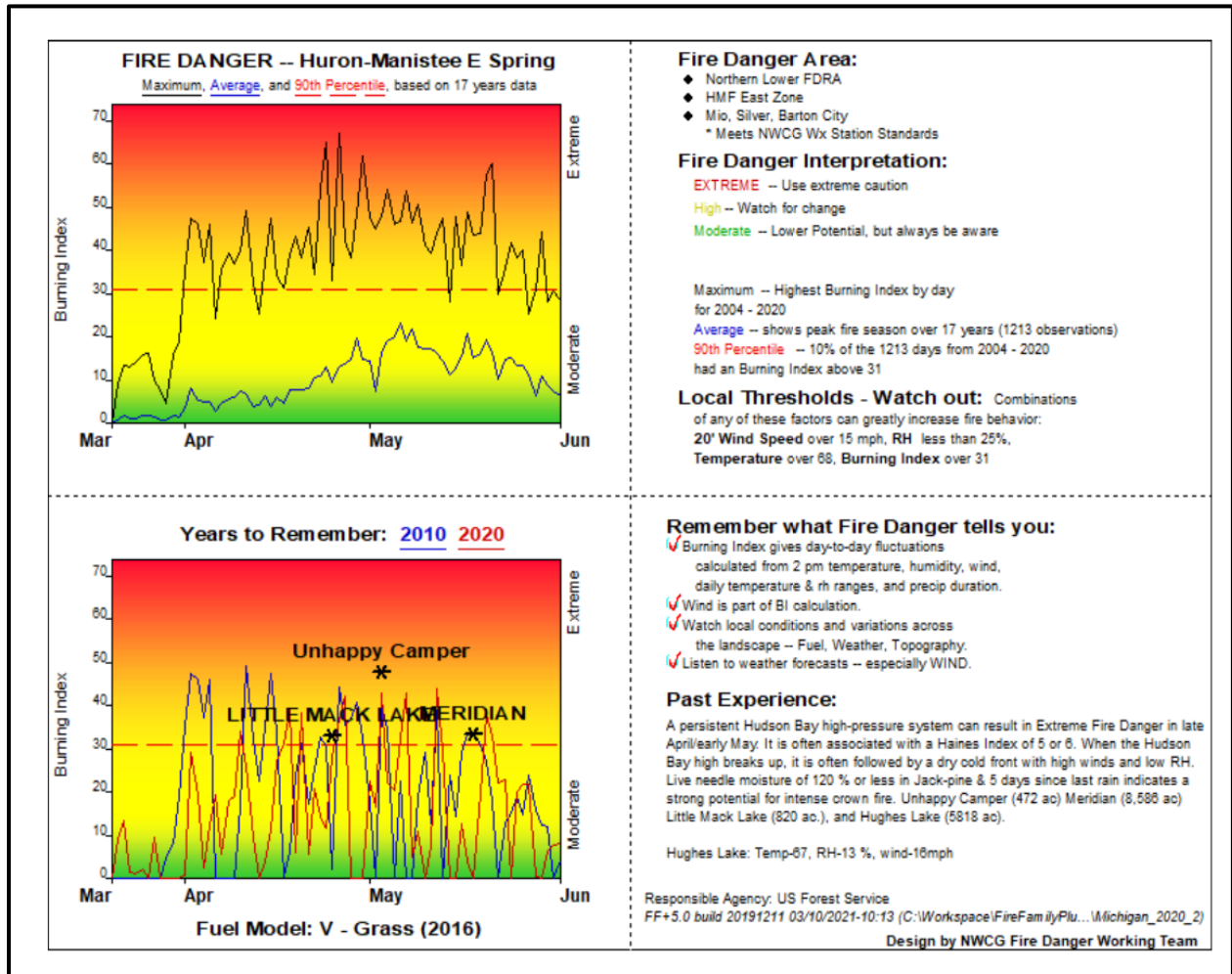


Figure 21: Huron Manistee East Pocket Card updated 3/10/2021

When burning at the high end of the prescription, there is little room for course correction if something doesn't go as planned. In the case of the Brittle Prescribed burn, an errant northerly wind that was observed by burn personnel soon after ignition had begun resulted in changes to the ignition plan for that burn day. In speaking with the National Weather Service, it is highly unlikely that fire intensity created from ignition patterns would have created fire with enough intensity to induce a northerly wind push, particularly one that would have been observed at over 700 ft AGL by the helicopter pilot. It was noted, though, that the Silver Creek RAWS recorded an ENE wind at around 10:00 a.m., indicating northerly flow had been recorded that day just north of the burn unit.

StationID	ObsDate	ObsTime	Temp(F)	RH	WindSpeed	Azimuth	GustSpeed	GustDirection2
203601	4/23/2021	12:00:00 AM	26	60				
203601	4/23/2021	1:00:00 AM	29	55				
203601	4/23/2021	2:00:00 AM	29	57				
203601	4/23/2021	3:00:00 AM	30	57				
203601	4/23/2021	4:00:00 AM	31	60				
203601	4/23/2021	5:00:00 AM	31	62				
203601	4/23/2021	6:00:00 AM	31	64				
203601	4/23/2021	7:00:00 AM	34	61				
203601	4/23/2021	8:00:00 AM	40	53				
203601	4/23/2021	9:00:00 AM	52	38	6	103		
203601	4/23/2021	10:00:00 AM	61	27	7	54	15	56
203601	4/23/2021	11:00:00 AM	65	22	8	265	22	233
203601	4/23/2021	12:00:00 PM	66	19	8	274	22	250
203601	4/23/2021	1:00:00 PM	67	18	7	278	23	106
203601	4/23/2021	2:00:00 PM	68	18	7	273	23	242
203601	4/23/2021	3:00:00 PM	68	18	9	265	28	244
203601	4/23/2021	4:00:00 PM	64	20	9	281	22	242
203601	4/23/2021	5:00:00 PM	63	22	10	255	22	259
203601	4/23/2021	6:00:00 PM	60	25	7	56	25	244
203601	4/23/2021	7:00:00 PM	58	27	7	56	18	55
203601	4/23/2021	8:00:00 PM	54	32	6	58	15	57
203601	4/23/2021	9:00:00 PM	52	32	7	55	12	57
203601	4/23/2021	10:00:00 PM	48	33	3	180	11	61
203601	4/23/2021	11:00:00 PM	42	46	4	60	6	60

Figure 22: Silver Creek RAWS hourly observations on 4/23/2021. Highlighted is the ENE wind recorded at 1000.

## Wind

Observations utilized to develop the Spot forecast for the burn unit were taken from the Silver Creek RAWS, 8 miles southwest of the burn unit, as per the spot forecast request. No onsite observations were provided to the National Weather Service (NWS). Winds forecast in the spot forecast from the NWS for the 23<sup>rd</sup> showed west winds from 0800 until 1700. On the burn unit at approximately 1200, helicopter 7MC observed winds out of the north at 700 feet above ground level that later dropped to the surface impacting the burn unit for approximately an hour before returning to a westerly direction. The Silver Creek RAWS also picked up the north wind change around 1100 and was back to a westerly direction by 1200 according to the NWS in Gaylord. No direct contributor to the wind shift could be determined talking with NWS forecasters and the north wind shift was described as an errant event. The NWS was not contacted when the errant wind occurred for an updated forecast and was not notified of the occurrence until May 21<sup>st</sup>.

## Temperature and Relative Humidity

Temperatures for April were trending above average for the area but were within prescription for burn day. Relative humidity values were forecasted to be critical, and they did fall outside of the high end of the prescription by the time the crew started burning, as mentioned above. The Great Lakes Fire and Fuels site indicated that the area was having poor humidity recover the prior two nights which also likely contributed to the dry fuel conditions in the area.

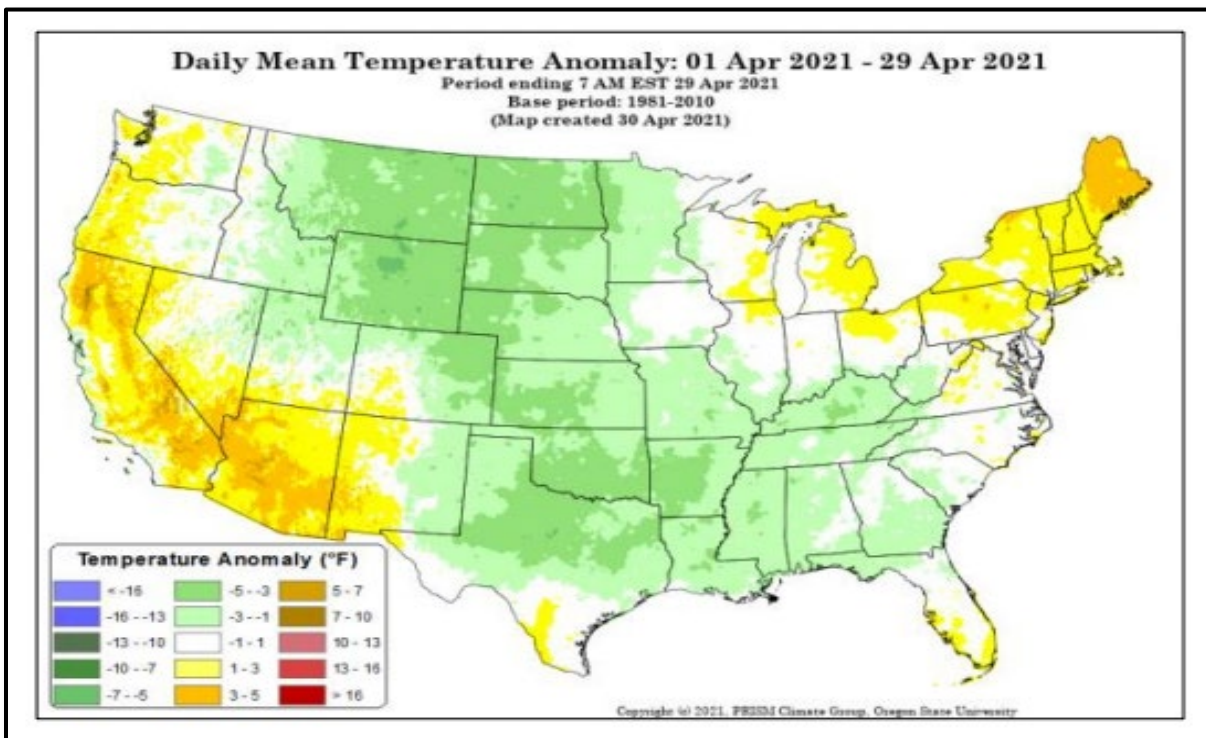


Figure 23 : Daily Mean Temperature Anomaly map for April 1-April 29, 2021 based on historical weather from 1981-2010

### Fuels and Topography

The Brittle Fire is located on relatively flat terrain with continuous pine, oak, and grass fuels. Soils are dry and sandy and support conifer and oak forest types. The area is largely forested with 50-70-year-old red pine and jack pine. Some areas contain northern pin oak and quaking aspen. Surface fuels are primarily needle cast, sedge, and grass with some pockets of logging slash from forest management activities. Some areas have been burned and have low surface fuel loads.

Below average precipitation in March and April contributed to low live woody fuel moistures at the time of the prescribed burn. Live Jack and Red Pine fuel moistures taken on the Huron Shores District in April were tracking about 2 weeks early in comparison with previous years data at an average of 102% and 95%, respectively, on April 20th. It did appear that the “spring dip” was early by about 2-3 weeks this year.

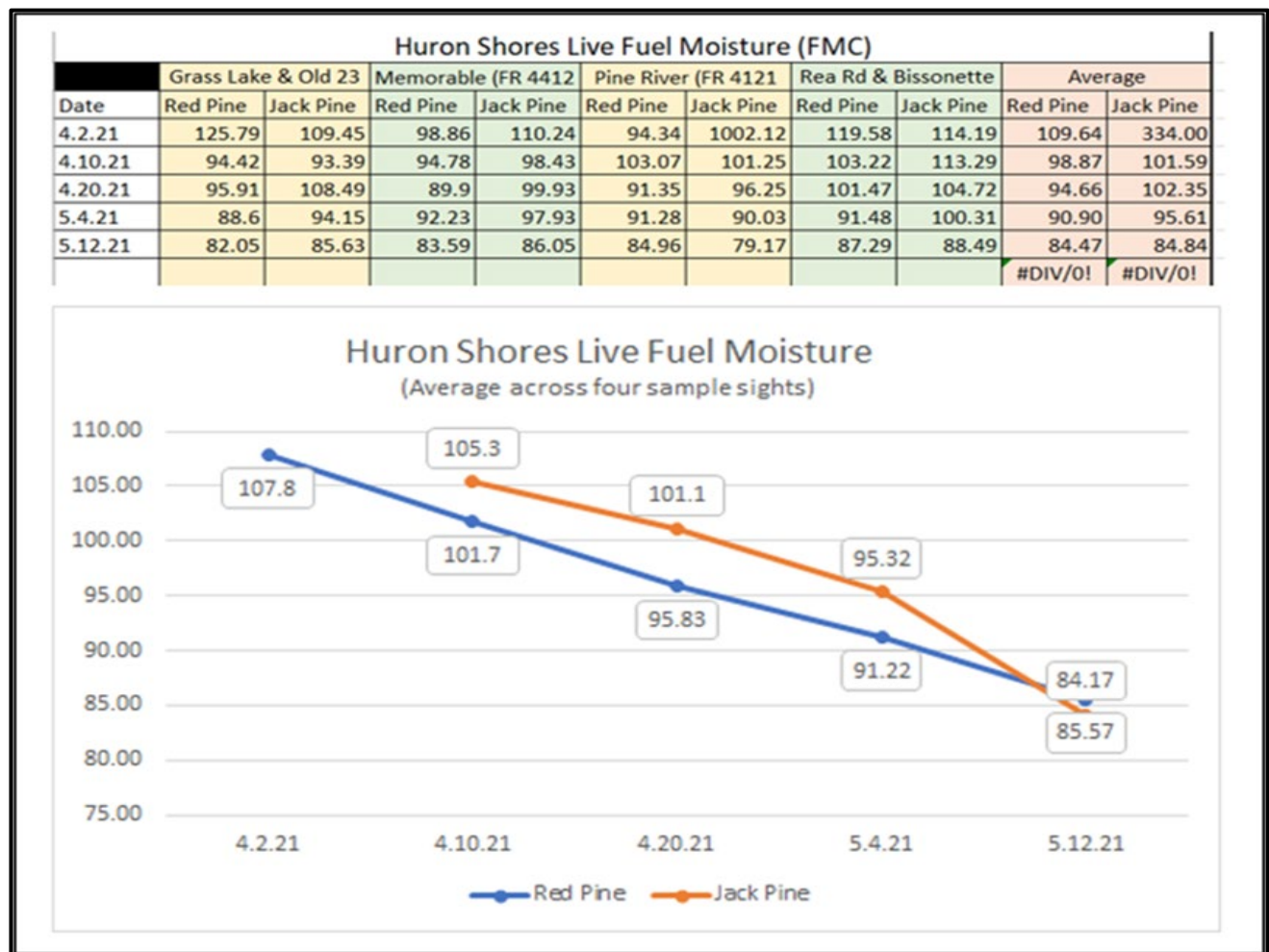


Figure 24: Huron Shores RD Live Fuel Moisture data from April 2-May 12, 2021

Although not listed in the burn plan as a prescription parameter, live fuel moistures of 120 % or less in Jack Pine and 5 days since last rain indicates a strong potential for intense crown fire in the 2020 Huron-Manistee East Spring Pocket Card.

Based on conversations with the burn boss, some fuel models outside the unit as described in the plan did not match what was observed on-site. Some areas referenced as mature Jack Pine was actually immature Jack Pine with dense grass component.

**Parameter 2: An analysis of the prescribed fire plan for consistency with agency policy and guidance related to prescribed fire planning and implementation.**

**Prescribed Burn Plan Review: Brittle Prescribed Burn**

Burn Plan Element	Remarks
<b>Element 1 – Signature Page</b>	Proper signatures are not in alignment with the 5140 FSM. 5142.6 If more than one year has elapsed since approval, a burn plan will be reviewed, updated, as necessary, and approved before implementation.
<b>Element 2a – Agency Administrator Ignition Authorization</b>	Incomplete date, No year on authorization.
<b>Element 2b – Prescribed Fire Go/ No Go Checklist</b>	Good. Has holding boss verbal approval, Recommend actual signature in a timely manner.
<b>Element 3 – Complexity Analysis Summary and Final Complexity</b>	Proper signatures are not in alignment with the 5140 FSM. “If more than one year has elapsed since approval, a burn plan will be reviewed, updated, as necessary, and approved before implementation.” FSM 5142.6  “The Summary and Final Complexity worksheet must be signed and dated by the prescribed fire plan preparer, the technical reviewer and agency administrator. The signed worksheet printed copy is inserted into the prescribed fire plan as Element 3 Complexity Analysis Summary and

	Final Complexity, Prescribed Fire Plan.” PMS484 p.21
<b>Element 4 – Description of the Prescribed Fire Area</b>	Good, Adjacent fuel models not current.
<b>Element 5 – Objectives</b>	Good, suggest updating to SMART objectives
<b>Element 6 – Funding</b>	Good
<b>Element 7 Prescription Narrative and Prescription Parameters</b>	<p>Use of verbal variance approval is not in accordance with agency policy requirements. Prescription variance requires agency administrator signature and attachment to the burn plan.</p> <p>“If the plan needs to be amended, the signed and dated amendments must be attached to the prescribed fire plan (refer to Amendments).” PMS 484 p.18</p> <p>“Amendments to the prescribed fire plan require agency administrator approval and signature.” PMS p.14</p> <p>“All prescribed fire project files must contain the following information. Agencies or administrative units may require additional information. • Prescribed fire plan (and amendments)” PMS 484 p.36</p>
<b>Element 8 – Scheduling</b>	Good
<b>Element 9 – Pre-burn Considerations and Weather</b>	Good
<b>Element 10 – Briefing</b>	Good
<b>Element 11 – Organization and Equipment</b>	Good
<b>Element 12 – Communications</b>	Good
<b>Element 13 – Public and Personnel Safety, Medical</b>	Good

Element 14 – Test Fire	Good
Element 15 – Ignition Plan	Good
Element 16 – Holding Plan	Good
Element 17 – Contingency Plan	Good
Element 18 – Wildfire Declaration	Good
Element 19 – Smoke Management and Air Quality	Good
Element 20 – Monitoring	Good
Element 21 – Post- burn Activities	Good

**Parameter 3: An analysis of prescribed fire implementation for consistency with the prescription, actions, and procedures in the prescribed fire plan.**

- Prescription:
  - Environmental Parameters-Relative Humidity: The Prescribed Burn was implemented with a relative humidity (RH) significantly less than what was indicated in the burn plan. The burn plan called for RH values to be 30% or higher for implementation. On the day of the burn, forecasted RH values as indicated on the General Fire Weather Forecast (Zone) and Spot Weather Forecast were to be below the burn plan RH values. On the day of the burn, forecasted RH values were to be in the low 20’s%. Observed RH values dropped as low as 18%. On the morning of the prescribed burn, a verbal variance to proceed with the prescribed burn at lower RH values was given by the Agency Administrator.
  - Environmental Parameters-Wind: The Prescribed Burn Plan identified wind speeds to be acceptable up to 16 mph. This burn plan wind parameter was developed specifically for 20’ winds and not inclusive of gusts that may or may not be present. On the day of the burn, both General and Spot Weather forecasts indicated 20’ winds to be below the 16-mph value. However, in both forecasts, wind gusts were indicated to be above 20 mph. The Silver Creek RAWS, although not on site, indicated wind gusts to be as high as 28 mph at 1500 on April 23<sup>rd</sup>. Eye-level or near eye-level winds taken on-site at 1300 were 3-7 mph with gusts to 10. It is important to note, eye-level or near eye-level winds are often better indicators of Midflame windspeed and better represent “ground” level winds that are reduced due to obstructions (trees, etc. ;) that may be present on a burn. Twenty foot windspeed, however, is a better indicator for

determining fire ember spotting potential and distance once aloft and can significantly increase fire intensity/behavior. Therefore, on the day of the burn, factoring gust wind speeds and their effects are critically important and should be included in the “decision” to implement even though the 20’ wind speed may be within the acceptable wind parameter. This is especially important when other critical prescribed burn indices, like low relative humidity is present.

- Environmental Parameters-Other: All other environmental parameters were within the prescription as identified in the burn plan.
- Description of Prescribed Fire Area-Fuels: Both fuel models and corresponding fuel loading estimates adjacent to the prescribed burn unit were not representative of those identified and modeled within the burn plan. The fire behavior modeling where spotting occurred was specific to a Timber model but what was observed on-site on the day of the burn was more representative of a Brush-Timber model, consisting of immature Jack Pine pockets intermixed with light flashy fuels-shrub and grass. With the Brittle prescribed burn area being one of the longest implemented projects on the Forest, conditions, primarily vegetation structure and fuels, can become unrepresentative of what was expected on site.
- Actions and Procedures:
  - Firing/Ignition Operations: The firing plan changed after ignition began. Smoke from the initial lines of aerial ignition laid over the burn unit and decreased visibility for the helicopter. The limited visibility prevented the helicopter on subsequent lines of ignition along the east side of the unit to connect or “tie in” with the initial lines. A gap formed between the east to west lines along the north side of the unit and north to south lines along the east side of the unit. Heat and intensity increased as the fire came together in this gap, causing spot fires across the control line. Fire in this area was described as a curtain of fire moving beneath the trees toward the east boundary and may have contributed to spotting.
  - All other actions and procedures were followed as identified in the plan.

**Parameter 4: The approving agency administrator’s qualifications, experience, and involvement.**

The Agency Administrator was qualified at the Journey level and has delegated authority to authorize high complexity burns. She has experience supporting and managing fire suppression and prescribed fire programs for more than 10 years. The Agency Administrator was involved from the review and approval of the Burn Plan, signing the Administrator Pre-Ignition Approval Checklist through the moment the fire was declared a wildfire.

**Parameter 5: The qualifications and experience of all key personnel involved.**

All key fire personnel were qualified in the positions for which they were assigned according to current IQCS records. All other assigned personnel also appeared to have been qualified in their respective positions.

**Brittle RX BURN -- KEY BURN STAFF QUAIFICATIONS**

ASSIGNED POSITION	QUALIFIED YES/NO
Agency Administrator (AADM)	Yes/Current
RXB2	Yes/Current
FIRB	Yes/Current
DIVS (Holding Boss) A	Yes/Current
DIVS (Holding Boss) Z	Yes/Current
Duty Officer	Yes/Current

## B. Appendix 2: Recommendations

- **Planning-Pre-Season**
  - Verify Prescribed burn unit and adjacent fuels models and conditions as part of the annual project area review. Update Burn Plan and supporting documents as needed.
  - Consider meeting with NWS to go over burn project sites for the given year. Provide maps of the units which may help with forecasting and inform NWS personnel of conditions that could create negative impacts to burning operations. This could allow forecasters to watch for these conditions and relay to dispatch, which could then be communicated to the burn boss.
- **Planning-Burn Plan Development and Burn Day Decision Making**
  - Consider utilizing Canadian Forest Fire Danger Rating System (CFFDRS) indices in prescribed burn plans as guidelines for the range of parameters in which objectives can be met with available resources. CFFDRS is a reliable system to help fire managers understand seasonal fire danger trends in the Lake States. Using CFFDRS to supplement NFDRS indices will provide further situational awareness and allow for enhanced decision making.
  - Within Environmental Prescriptions factors (Element 7) of the Burn Plan, and in addition to “Days since last rain” parameter, consider factoring in duration and amount with this element or coupling it more tightly with CFFDRS fuel moisture codes or indices, especially when drought conditions are being observed.
  - Consider Haines Index in prescribed burn day planning and adding this parameter into Burn Plans. Haines Index of 6 can increase fire intensity and resistance to control. Question if holding and/or contingency resources are adequate when there is high potential for large plume dominated fire growth.
  - Incorporate both 20’ wind speeds and gust speeds into burn planning. The burn plan identified 16 mph wind speeds as the “high” end. Gusts speed was forecasted well above 16 mph and can greatly increase fire behavior and intensity which can lead to holding challenges.
  - Consider local critical thresholds from Pocket Card when burning at high end of prescription.
    - 20’ wind speed over 15 mph (Burn day forecast = 16 mph by 1200)
    - RH less than 25% (Burn day forecast = 23% by 1400 with actual onsite RH hitting 22% by 1230).
    - Temperature over 65 degrees (Burn day forecast = 64 degrees at 1500).
    - Burning Index over 31 (Burn day actual = 33)

- Assess and acknowledge variances between General and Spot Weather forecasts. Contact the National Weather Service to evaluate if the Spot Weather forecast will adequately represent on-site conditions, particularly when burning in a drier window at the high end of the prescription.
- Burn Planning and Implementation documentation need to be signed by appropriate signatories.
- **Prescribed Burn Implementation-Weather Observations**
  - Contact the NWS when spot forecast conditions become unrepresentative of onsite conditions to assist with onsite decision making.
  - Silver Creek RAWS is approximately 8 miles southwest of burn unit 23. Have personnel take onsite weather observations for use in Spot Weather forecast request for more precise spot weather calculations or put a portable RAWS station in the unit for NWS to take readings from.
- **Prescribed Burn Implementation-Ignition Operations**
  - Primary and alternate ignition sequences and fire patterns relative to wind direction, burn unit, and flight patterns should be discussed in detail with pilot and flight crew.
  - Sphere and line spacing may need adjustments to increase or decrease fire intensity based on observations of fire behavior. Both for changing weather conditions during the burn period and variations in the fuel type and loading within the unit.
  - Evaluate Ignition firing sequence and patterns, specifically the use of flanking fire over traditional head stripping fire. Although, flanking fire often provides results needed to meet burn plan objectives, when long linear lines of fire are progressed towards a prevailing wind, fire behavior, primarily speed and direction of spread can be quickly altered even with a slight variance of directional change in wind. Furthermore, when utilizing a helicopter to perform aerial ignition to perform flanking firing patterns, the risk of non-conformal lines of firing progression are more likely to occur.
  - When burning at the “hot” end of the prescription with the intent of burning multiple burn blocks, strongly consider burning each unit separately before moving on to subsequent blocks. During elevated or “high” end of the prescription, burning individual burn units as opposed to burning all the units simultaneously, will limit the volume of fire on the landscape at a given time and allow for better control of implementation. Additionally, by burning downwind units first, exceptional “black lines” are created that greatly simplify firing and holding operations for upwind burn unit ignitions. During contingency/emergency situations, unforeseen weather conditions, and/or undesirable fire behavior, many times having the ability “shut” down a large

burn can be complex, whereas burning individual burn units progressively provides manageable “operational tempo”.





Huron-Manistee National Forest  
Huron Shores Ranger District

Brittle 20/23  
1,855 Acres

T23N R6E Sec. 4/5/8/9/10

