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Wildfire Tested Fuel Treatments: 2015 Weyakwin and Wadin Bay, Saskatchewan

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Table of contents

List of figures

List of tables

1. INTRODUCTION

In late June and early July of 2015, many large fires burned in Saskatchewan (Figure 1). Two of these fires threatened pre-existing community protection fuel treatments established to protect their villages. This report documents the treatments completed and the influence that the treatments had on fire behaviour as fire moved into them. The two communities that had their fuel treatments challenged were the hamlets of Weyakwin and Wadin Bay. Weyakwin had built a fire guard on the east side of town and thinned 4.6 ha of forest on the west side of the fire guard. Wadin Bay had also completed a thinning project to protect the hamlet from fire moving in from the west and south. Two trips were made to observe and document the fuel treatments and how fire behaved within them. Stand density data was collected within and beside the treatments to describe the fuel environment. Other data sources included fuel treatment plans, fire weather data, fire chronology information and personal communication with those who were involved in the projects and firefighting efforts.

The Canadian wildfire community is interested in documenting cases where wildfire has challenged forest fuel treatments in the wildland–urban interface. Saskatchewan and FPInnovations worked together to capture the conditions and performance of these two challenged fuel treatments.

The report is presented in two sections. Individual fire case studies include fire environment, fire behaviour as well as fuel treatment documentation and then describes the interaction between the forest fire and the pre-established fuel treatments. Observations and conclusions are also presented.

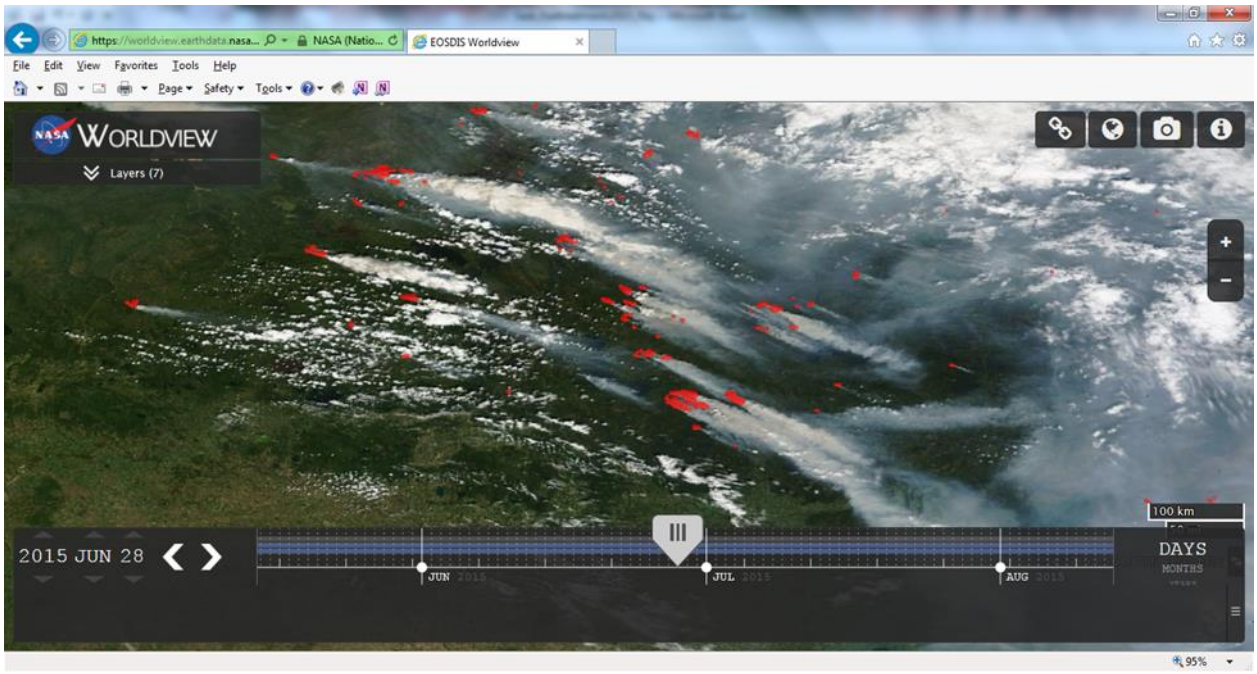

Figure 1. Satellite image of fires burning in north and central Saskatchewan on June 28, 2015

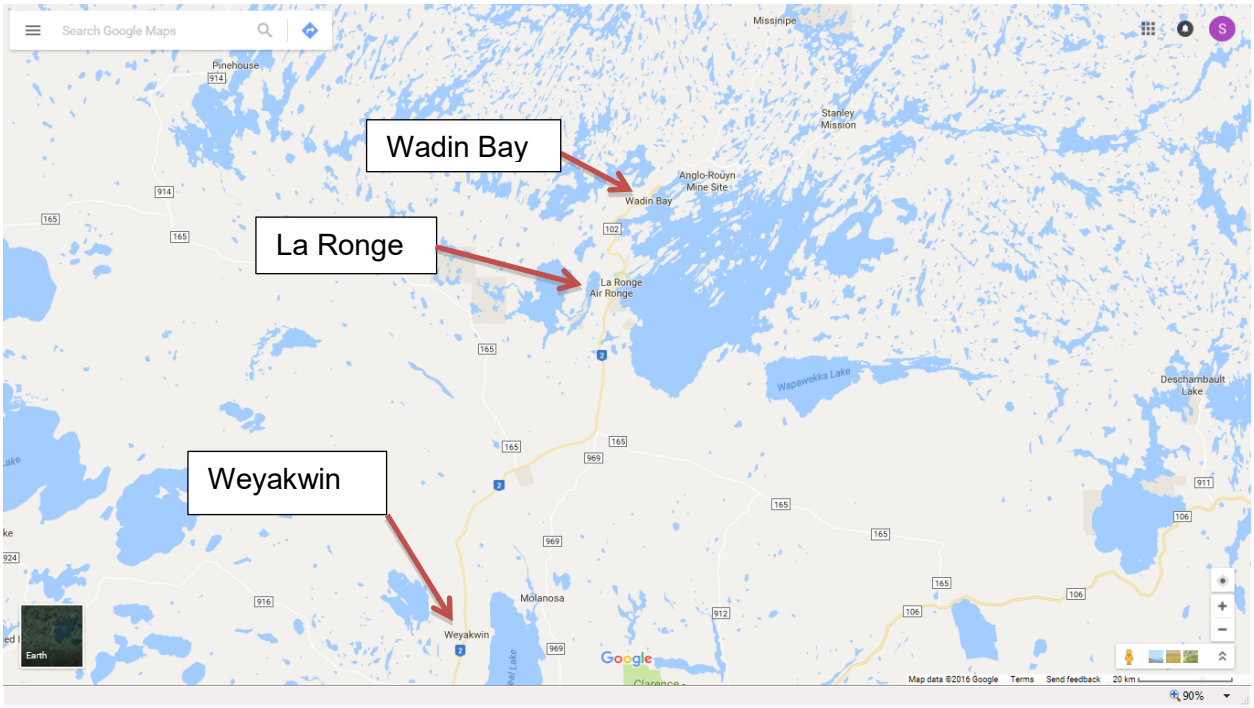

Figure 2. Map showing the location of Weyakwin and Wadin Bay in north-central Saskatchewan

Methodology

Saskatchewan Wildfire Management (WFM) requested that FPInnovations document two cases where wildfire challenged forest fuel treatments near communities. To address this project, FPInnovations completed the following:

1. Two trips to the affected areas, Weyakwin and Wadin Bay. The visits occurred at the end of July, following the extinguishment of the fires, and in October to collect further data.

   The purpose of the July trip was to observe and document the effect that the fires had on the fuel treatments. FPInnovations documented observations such as fuel consumption, percentage of crown fire, size of affected area and scorch height. The purpose of the October trip was to collect stand density data and any other data that was required to complete the case study. On both trips, Saskatchewan WFM personnel accompanied FPInnovations and provided first-hand knowledge of the fire events, fire reports, fuel management plans and other associated data (fire weather reports).

2. Data collected included:
    - Fuel management plans
    - Fire chronology, including size, ignition, spread pattern and date of incident with treatments
    - Fire weather data before and during the fire events
    - Ground-based post-fire evidence of fire behaviour (scorch height, fuel consumption)
    - Stand density before and after treatment
    - Anecdotal fire information (personal accounts)
    - Collected data to fill out field collection forms for the fire behaviour and Fuel Treatment National Surveys for input into a national database

Weyakwin

The hamlet of Weyakwin is located on Saskatchewan Highway 2, between Prince Albert and La Ronge (Figure 2). On July 3rd, 2015, this community was threatened by two fire events. The fire events burned forest to the north, west and south of the hamlet.

To protect the hamlet from potential forest fires, in 2010 and 2011, the community thinned 4.6 ha of forest that abutted a wide fire guard on the east side of the community. This fire guard was 504 m long and 33 m wide (Figure 3). The community has continued to conduct a fuel thinning project within the community limits. The project includes thinning green spaces in and around the community and its structures (i.e., church, hamlet office, houses and streets). Following the treatments establishment, Saskatchewan WFM conducted practices to set up a sprinkler system over its length. This case study focuses on the effectiveness of the thinning treatment, which runs the length of the east side of the hamlet adjacent to the fire guard.

Figure 3. View of the fire guard east of Weyakwin
Thinning took place immediately west of the break

The 15WY-Philion fire was ignited by lightning during a large storm that passed through Saskatchewan in late June. The storm was responsible not only for this fire, but several others that also challenged the firefighting resources of Saskatchewan WFM. The Crysto fire to the northwest and the Weyak fire to the southwest were the initial threats to the community before the Philion fire caught up and overtook them to form one very large fire.

Fire Environment

The fire environment is made up of forest fuels, local topography and fire weather. Each is individually described.

Forest Fuels

The Canadian Forest Fire Behaviour Prediction System describes the forest fuels in the area as C-2 and C-3. C-2 is boreal spruce, and C-3 is mature jack or lodgepole pine (Taylor, Pike & Alexander, 1997). Collected stand density data showed that jack pine was the primary species in Weyakwin, with some fir as a secondary species.

Table 1. Stand density description for Weyakwin fuel treatment

	Stems/ha	DBH (cm)
Pre-treatment	3119	14.08
Post-treatment	987	18.25

Table 1 shows that the density of the stand decreased by 2,000 stems/ha, but the mean diameter at breast height (DBH) post-treatment increased by 4 cm compared to pre-treatment. Saskatchewan WFM chose to leave the larger stems while thinning. Surface fuels differed in terms of the area they covered. The pre-treatment photo (Figure 4) shows that the surface was covered to a higher degree than post-treatment (Figure 5), where any fuels that were present were gathered for future disposal.

Figure 4. Pre-treatment stand in Weyakwin

Figure 5. Post-treatment stand

Figure 3 shows that the hamlet is surrounded by dense forest in all directions.

A gravel pit was located to the north of the hamlet across the river, and it acted as a fuel break. This can be considered a non-fuel.

Topography

The area around the hamlet of Weyakwin can be described as flat with small undulations. Fire behaviour predictions would use a scenario with zero slope.

Fire Weather

There was an extended period of build-up in the fire weather for both the Prince Albert and the La Ronge areas before the fire. Prince Albert received only 16.8 mm of precipitation from June 14th to July 3rd. Along with this, it had daily maximum temperatures above 23 °C from June 22nd to July 3rd. La Ronge experienced similar weather: It received only 16 mm of precipitation from June 14th to July 3rd and had daily maximum temperatures above 23.4 $^{\circ}$C from June 24th to July 3rd.

Table 2 shows the weather readings and fire weather index for July 3rd at the Tracy weather station located 30 km north of Weyakwin.

Table 2. Fire weather data at time of fire for July 3rd

Variable	Value
Temperature (°C)	28
Relative humidity (%)	33
Wind speed (km/h)	12
Wind direction (degrees)	240
Wind gusts (km/h)	N/A
Precipitation (mm)	0
Fine Fuel Moisture Code	92
Duff Moisture Code	75
Drought Code	452
Initial Spread Index	10
Buildup Index	106
Fire Weather Index	32

Fire Chronology and Behaviour

The large fire that came into the hamlet of Weyakwin was called 15WY-Philion. It was roughly 45 km wide (west to east) and 30 km long (north to south). Weyakwin was situated on the eastern border of the fire which threatened the hamlet on two days (July 3rd and 4th). The hamlet was evacuated on June 27th as a result of the 15WY-Crysto fire that was burning to the north, and only firefighters remained. The first fire threat occurred on June 29th at 0430 hours. The fire moved toward the hamlet and ran into the gravel pit just north of town (Figure 6). The gravel pit provided a landscape-level fire guard and slowed the fire spread. The Philion fire burned over the Weyak and Crysto fires on the afternoon of July 3rd as it made its run toward Weyakwin from the southwest. The Philion fire engulfed the man-up site on the forest protection base at approximately 1830 to 1845 hours on July 3rd. The fire continued to run north and east in the trees around the base perimeter and helicopter pad and made its way to the main structures on the base.

The following are taken from fire reports for the Philion and Weyak fires:

03/07/2015 20:39 WEYAK fire breached Highway # 2 and ran south side of the Weyakwin base. No structures have been lost as of 2030 hrs. The fire has burnt between the shop and highway as well as between the heli pad and the office. All non-essential personnel have evacuated north on highway # 2. Crew are hotspoting around the base and community.

04/07/2015 18:48 Eugene and crew are working a flare up on the east side of the Weyakwin fire guard towards the river, rank 2-3.

08/07/2015 18:54 Skimmers were re-directed to Montreal Lake due to higher priority. North of Weyakwin River, on the East side of the river flare ups cause some concern of ember transfer into the Weyakwin town site. H302 and H112 were dispatched to bucket, with ground crews are doing their best, and sprinkler line activated tanker support was requested.

There were two areas of interest where fire encroached near the settlement and where fire spotted into the treated (thinned) area along the fire guard on the east side of town.

The fire burned through and around the large opening south of the forest protection base in a north and east direction into standing timber with intermittent candling and surface fire. Fire spotted across the road to the east side of the fire guard and then a backing fire stopped at the fire guard. Presumably, a fire crew was able to directly action the backing fire at the fire guard.

One large spot fire was found in the fuel treatment adjacent to the fire guard. It was located 140 m from the fire guard and a minimum of 250 m from standing timber, where the spotting originated. Four other spot fires occurred in the hamlet (indicated in blue in Figure 6). One fire burned a structure and others embers fell and burned in non-natural “debris” around homes.

When the initial fire spotted across Highway 2 southwest of the forest protection base, a portion of the fire spread in a north-northeast direction. It consumed the standing timber in a strip between the highway and the forest protection base and burned in a northward direction. This was a high-intensity crown fire that removed both surface and crown material. This area was not treated.

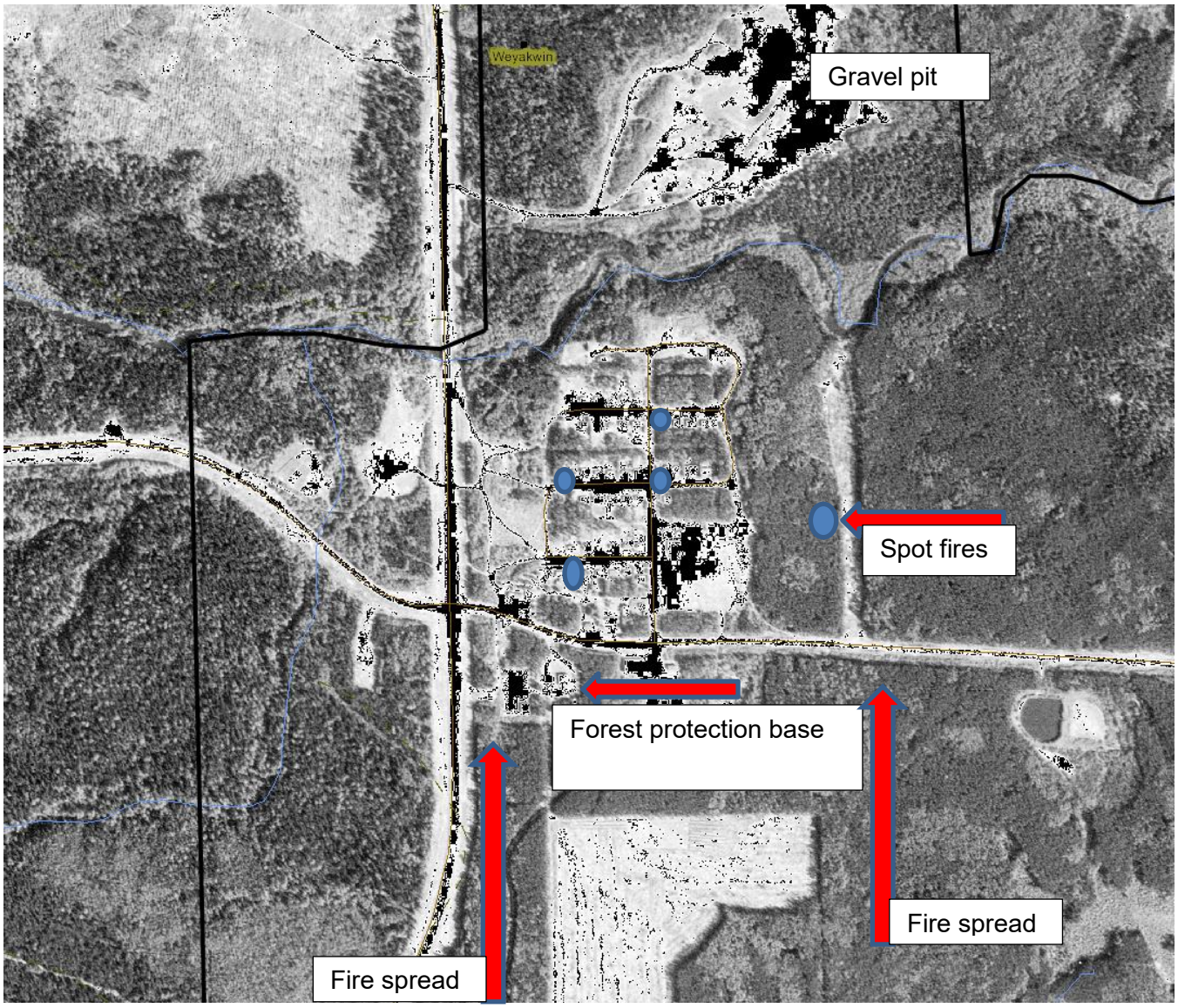

Figure 6. Map of fire spread in Weyakwin
Spot fires are indicated in blue

The predicted fire behaviour using REDapp[1] for the C-3 fuel type in the Weyakwin area on July 3rd is as follows:

Rate of spread (ROS): 7.8 m/min

Head fire intensity: 9252 kW/m

Crown fraction burned: 55%

[1] REDapp is a fire management decision-support tool used to predict fire behaviour.

Fire Behaviour in Fuel Treatment

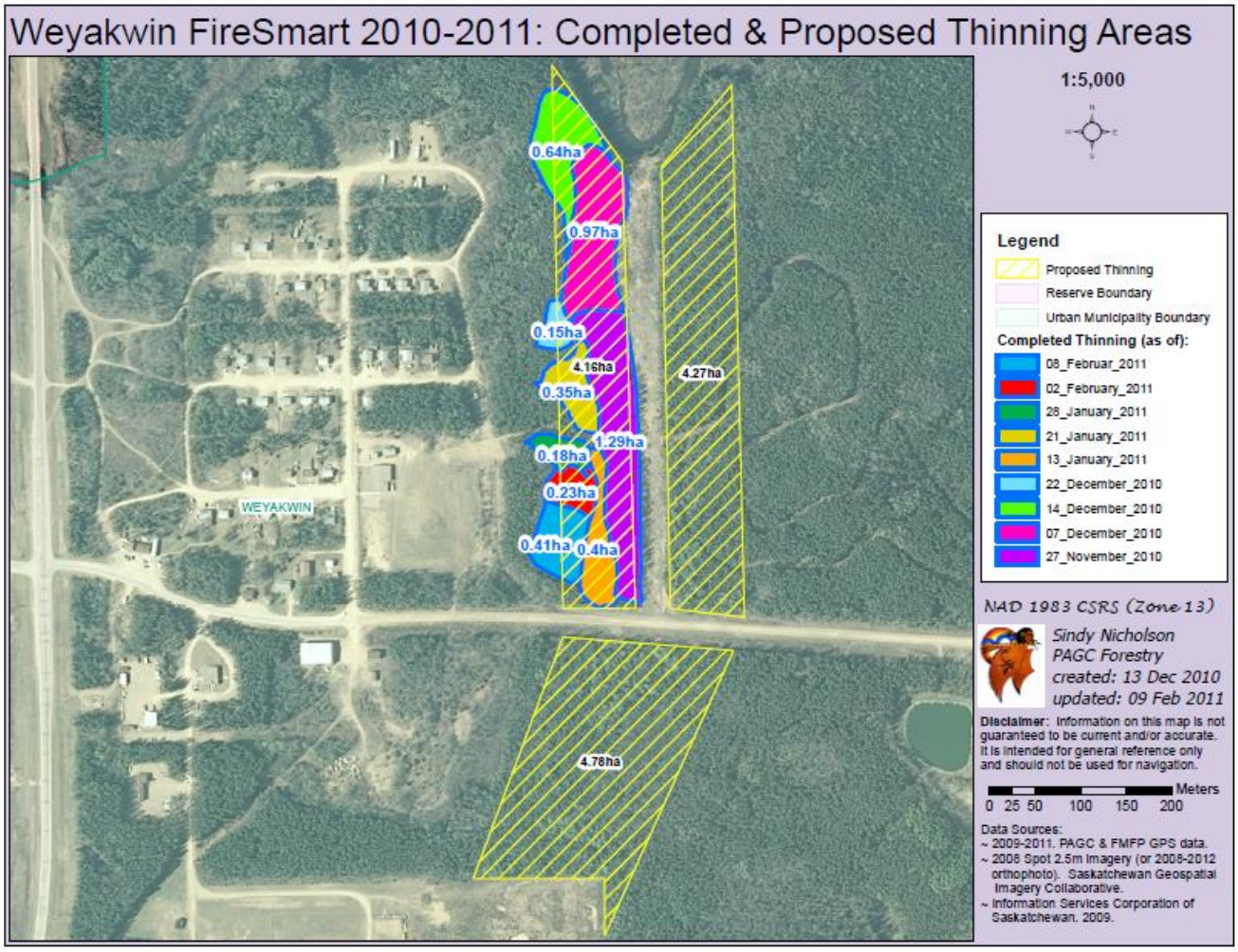

Figure 7. Fuel treatments for Weyakwin
(Courtesy of Saskatchewan WFM)

The areas in colour (Figure 7) were treated by Saskatchewan WFM and Weyakwin in 2010 to 2011. Stand density in the treated areas decreased by up to 2,000 stems/ha. Surface fuels were “cleaned” as well. On the east side of the fire guard no treatments took place, although they were proposed. Fire spread through the 4.78 ha block south of the road (which was also proposed for thinning), and it is this stand that carried the fire up to and across the road via spotting.

Given the extreme fire behaviour elsewhere in the vicinity of the hamlet in areas that were not modified by fuel treatment, it can be assumed that the relatively small area burned was partly the result of the reduction in fuels and the added visibility from the thinning of the stands. The spot fire was 33 x 37 m on uneven ground in a spruce/jack pine stand greater than 12 m in height. The spot was seen quickly and was controlled. Stem-bark char height was 4.0 m inside the spot fire area.

Comparing the treated and untreated stands adjacent to the fire guard, it was concluded that the thinning and light surface cleaning resulted in:

- Ease of movement for crews;
- Less fuel loading and, thus, less fire intensity;
- Safer entry into the stand (LACES acronym: lookouts; awareness/anchor point; communication; escape routes; safety zones).

If this area was left untreated (see Figure 3), the fire would have been more difficult to control. Other areas around Weyakwin that did not have fuel treatments experienced crown fire.

Increased visibility is thought to be one important benefit of thinning a stand. By opening up a stand, firefighters can see farther into the stand and are able to see spot fires and move toward them easily. To test this perceived benefit, smoke bombs were placed in the untreated (Figure 8) and treated (Figure 9) stands and the distance from which the smoke was visible was measured. Observers were asked to stand within the fire guard and provide notice when they were able to see the smoke. The results of the tests are shown in Table 3.

The existing fire guard on the east side of the village increases visibility into the stand, allows the movement of equipment and can increase firefighter safety.

Table 3. Smoke bomb test results and visibility distances

	Distance to visibility (m)
Treated	100
Untreated	40

Figure 8. Smoke 40 m into the untreated stand
The smoke is circled and the fire guard is shown in the foreground

Figure 9. Smoke 100 m into the treated stand
The stand is located directly across the untreated stand, separated by the fire guard

Wadin Bay

Wadin Bay is a “summer community” that is designated a national FireSmart Community, an initiative primarily as a result of wildfires that threatened it in 2006. It is the first recognized FireSmart community in Saskatchewan. In 2006 there were a total of 27 fires within the English Fire complex, which included nine fires in the immediate area of Wadin Bay, and they consumed a total of 69,422 ha of forest. The closest wildfire to Wadin Bay was the English Fire (2,050 ha) to the southwest and the Lynx Fire (8,250 ha) to the northeast. These fires impacted the only transportation route out of town to La Ronge.

Using these fires as motivation, the community came together with Saskatchewan WFM and other government ministries to complete fuel management plans and fuel treatment work within and around the Wadin Bay community (Wadin Bay Fuel Management 2014 Final Report). The community focused on three areas, marked B, D and R in Figure 10. The total area of the treatments is 3.32 ha.

Figure 10. Wadin Bay fuel treatment areas, marked as blocks B, D and R

There were two wildfires close to Wadin Bay at the same time. The Sucker Fire was to the northwest but was under control and only being observed for any further hotspots. The Eli Fire was the wildfire that was threatening Nemeiben, English Bay and Wadin Bay before the Egg Fire came from the southwest and joined with it. The Egg Fire originated far to the southwest by Sikachu and the Clark Fire originated on the west side of Nemeiben. Egg Fire joined with Clarke before the Egg Fire headed northeast. It would have been the northeast side of the Eli Fire that would have come into Wadin Bay. (C. Dallyn, Saskatchewan WFM)

The Egg and Clarke fires ignited on June 6th and burned in the general area of Wadin Bay until June 26th, when they became more active in the vicinity of the town. At this time, sprinklers were set up on about every second house. On June 28th, fire picked up again, but this time, two water bombers quieted the fire. On the evening of July 3rd, 2015, winds increased, and wildfire spread toward Wadin Bay. Just after midnight on July 4th, fire crossed Highway 102 and moved into the community. Abundant smoke resulted in poor visibility. The fire burned three structures (one a permanent dwelling and two seasonal cabins) plus a number of other values (outbuildings and vehicles). As the fire burned into the treated areas, fire spread and intensity were reduced.

Fire Environment

The fire environment is made up of forest fuels, topography and fire weather. Each is individually described.

Forest Fuels

The 2014 Wadin Bay Fuel Management Report for Saskatchewan Ministry of Environment – Wildfire Management Branch indicated the treated area was “made up of 75% deciduous and 25% coniferous species composed of white birch, trembling aspen, white spruce and balsam fir.” Using these numbers and looking into the FBP Redbook (Taylor, Pike, & Alexander, 1997), the fuel type in town can be considered M-2 boreal mixed-wood – green, made up of 25% conifer and 75% hardwood. Looking at the area around town on Google Earth confirms this. Figures 11 and 12 show that the species composition is close to an M-2 boreal mixed-wood fuel type.

Figure 11. Stand view in Wadin Bay before the stand was thinned
This photo was taken in block B

Figure 12. Same view as Figure 11 after the stand was thinned

Block B	Stems/ha	DBH (cm)
Pre-treatment	1369	13.66
Post-treatment	350	15.35

Block D	Stems/ha	DBH (cm)
Pre-treatment	1942	11.29
Post-treatment	1687	10.92

Block R	Stems/ha	DBH (cm)
Pre-treatment	3119	14.08
Post-treatment	1600	N/A

All three blocks saw a decrease in stand density, some more than others, but all received a thinning treatment.

Topography

In the Wadin Bay area, the terrain rises from the lake uphill to the highway. To the south of town, the terrain is rolling and has some steeper slopes. The fuel management data sheets indicate a slope of 6%.

Fire Weather

The weather leading up to the fire event can be considered the same as what was presented for the Weyakwin area (Table 4). Temperatures were slightly above normal (with some hot days) and dry leading up to the beginning of July. On July 3rd the wind increased between noon and 6 pm from 19 to 26 km/h (based on La Ronge data). Wind gust data was not available. Comments are that it was too windy for aircraft to fly, so it is likely that there were more substantial winds at Wadin Bay than recorded by Environment Canada for La Ronge.

Table 4. Fire weather data at time of fire for July 3rd

Variable	Value
Temperature (°C)	28
Relative humidity (%)	33
Wind speed (km/h)	12
Wind direction (degrees)	240
Wind gusts (km/h)	N/A
Precipitation (mm)	0
Fine Fuel Moisture Code	92
Duff Moisture Code	75
Drought Code	452
Initial Spread Index	10
Buildup Index	106
Fire Weather Index	32

Fire Chronology and Behaviour

Personal communication with a local resident (D. Renaud, July 2015) from Wadin Bay provided good insight into the fire's behaviour and progression into the village. The resident presented a vivid picture of the fire conditions and actions of the community and firefighters. The narrative was a first-hand account of fire behaviour changes and how the treatments assisted the firefighters in controlling the fire within the village.

Figure 13. Fire spread into Wadin Bay on July 3rd

For a complete description of the fire from the Wadin Bay resident, see:

http://wildfire.fpinnovations.ca/174/WADIN%20BAY%20FIRE%20EXPERIENCES.pdf

In summary the resident's observations indicate that the fire blew up on July 3rd and moved into the community from the south along the shore and crossed the highway (at a Y intersection) at night, destroying one house and a number of outbuildings (the fire spotted at least 75 m across the highway and the associated right-of-way). Local residents took to their boats but came back to shore to fill the gas tanks on the pumps for the sprinklers. During a shore visit, they observed where the fire was burning and took action. Blocks B and D were challenged by wildfire. The first house that burned was near the highway, and the other was 75 m away from it. More values at risk were lost (quad, truck, garage, etc.) between the two locations.

Block B had the biggest change in stand density following treatment, and this area was credited with reducing fire behaviour and allowing fire crews to work safely to extinguish both the fire and spot fires (even at night). Crews were able to locate spot fires through the thinned area and then moved safely into the block to work the fires which were burning at a lower intensity than fires in the untreated stands.

Using the REDapp fire behaviour prediction tool, the fire behaviour values predicted using the Fire Weather Index values, the M-2 fuel type (25% conifer/75% hardwood) and the C-3 fuel type are as follows:

Fuel type	ROS (m/min)	Head fire intensity (kW/m)	Crown fraction burned (%)
M-2	3.92	2170	0
C-3	5.14	5884	22

These fire behaviour values are much lower than what was observed when the fire entered the community. Anecdotal evidence suggests that strong winds explain the discrepancy, which does not show in the fire weather data. The ROS would be more suited for the treated area than the untreated sites. Scorch height was measured to be 6 m, which in itself would result in an estimate in fire intensity greater than that calculated above. Smoke was also causing issues with fire behaviour predictions.

Visual evidence shows crown fire crossed into the community in two spots: Across Highway 102 and on the south end along block D (Figure 14). This fire had intensity well over that predicted by the fire behaviour prediction model for the M-2 and C-3 fuel types.

In fire behaviour prediction, it takes 25 km/h winds to create crown fire in M-2 and 20 km/h winds in C-3. At these wind speeds, fire intensities over 10,000 kW/m are predicted. This is a more likely fire behaviour scenario, and based on anecdotal evidence, it is the scenario that should be used.

Figure 14. Evidence of crown fire moving into block D

Fire Behaviour in Fuel Treatment

Unlike most fire behaviour observations, these observations are first-hand from those on site rather than forensic reviews following a fire. Local residents and fire department personnel were on site and witnessed and fought the fire. FPInnovations arrived later to view the site and to take measurements.

The community was thankful “that the vegetation thinning project occurred last fall, or the fire probably would have taken out the entire street” (D. Renaud, personal communication, July 2015). This is the only written account of how the treatments responded to fire entering them. The treatments were completed over the winter of 2014–15 and were inspected by Saskatchewan WFM personnel.

Photographs of two of the treatments (blocks B and D) and the resulting fire damage confirm that fire behaviour changed when it moved from the untreated stands into the treated stands. Figures 15 and 16 show block B, and the fire behaviour characteristic to note is the difference in scorch height.

Figure 15. Fire behaviour in the treated stand in block B
Note the scorch height and the openness of the stand

Figure 16. Fire behaviour in the untreated stand directly above the treated stand
Note the higher scorch height than that in Figure 15 and the greater stand density


A


B

Figure 17. A house lost to the fire (*A*); the stands around the house were not treated (*B*)
(Photo A courtesy of Wadin Bay Cottage Association Volunteer Fire Crew)

Crown fire spotted across the highway and continued to spread, entering the community from a southwest direction. It burned a few outbuildings and vehicles before it burned the house shown in Figure 17. The fire then moved into block B, where its behaviour changed. It dropped out of the crowns and became a surface fire. Ground fuel was removed following the treatment, so there was less fuel to contribute to fire intensity. The fire was still intense as the 6 m scorch height shows, but because the stand was opened up, there was no crown fire. With an open stand, the fire department and locals could see the fire and safely move through the treated area to fight the fire directly. The opening of the stand to enable the firefighting crew to enter and attack the fire directly is one of the key benefits attributed to the fuel treatments. Anecdotal comments from those on scene suggest that if it had not been for the thinning in block B, the fire would have carried through to block R and destroyed the other dwellings in Wadin Bay. “The thinned area in ‘B’ [see Figure 10] had surface fire and spot fires in it that we were able to see and action that night” (W. Boehr, Saskatchewan Ministry of Environment, personal communication, July 2015).

The main points that come from the observations are:

- It was an active fire front.
- The fire burned into the treatments.
- Firefighters were able to get into the treated area and suppress spot fires.
- A house and two cabins were lost, and others would have also been lost if firefighters had not been able to use fuel treatment.
- Firefighters could see the fire front and spot fires and were able get into the stand to work safely.

There were no personal observations made on how the fuel treatment in block D responded to the fire, as it was not a safe spot for firefighters to work during the fire event. FPInnovations examined block D several weeks after the fire event and found that the thinning treatment removed half of the stems and cleaned up the surface fuels. The fire evidence shows that a crown fire challenged the fuel treatment area (Figure 14). There is a high proportion of hardwoods in the treatment area. Figure 18 shows the change in fire behaviour as the fire entered the treatment.

Figure 18. A good example of fire damage on left side and the lack of fire damage on the right in block D.

Fire moved just 3 m into the treated area (an old portable sawmill location) and stopped. This is visible in Figure 18, where one side of the photograph shows evidence of fire and the other side shows very little evidence of fire. A higher proportion of hardwoods, slightly damper surface fuels in the area, and the thinning treatment together contributed to the reduced fire spread.

2. CONCLUSIONS

Based on the site visits and information gathered as part of this project, the following conclusions can be drawn:

1. Weyakwin
    - Fuel treatment increased visibility into the stand.
    - Fuel treatment increased firefighter safety in terms of movement and visibility.
    - Under the fire weather conditions the extreme fire behaviour took place, fire crews were able to control and suppress a spot fire that would have likely increased in size and intensity and spread into other values.
    - Items located around homes can act as a receptive fuel for embers to fall into. Keeping these areas clean is a homeowner's responsibility and can contribute to protection of one's town.
2. Wadin Bay
    - An active fire front moved into the community.
    - The fire moved into the fuel treatments.
    - People were able to safely suppress the fire within the treatment area.
    - A permanent home and two seasonal cabins plus other values were lost, and there was potential for further losses.

The Wadin Bay area had very thick stands at pre-treatment, which would have made travel within the stand difficult and dangerous given the observed fire behaviour in untreated portions of the hamlet. The combination of increased visibility and decreased fire intensity enabled firefighters to bring the fire under control and ultimately save several structures from burning.

3. REFERENCES

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