Redstreak Benches Restoration

Prescribed Fire Report

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assisted by PCA Western & Northern Service Centre and National Fire Centre

2009

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Introduction

The Redstreak Benches Restoration prescribed fire took place within a 100-hectare unit on the eastern bench of the Columbia Valley, located above the Village of Radium Hot Springs in Kootenay National Park. This prescribed burn follows the initial burning of the area on April 21, 2005.
Ignition was commenced at 1300h, April 8, 2009 and was completed by 1700h on the same day.

There were two main *objectives* outlined in the burn plan:

- Apply low intensity prescribed fire to the 100 hectare unit to increase native species cover
- Utilize the prescribed burn event to inform key audiences about historic fire regimes and ecosystem restoration. Awareness and accurate information should encourage the public to participate in protected area management and ecological integrity. This may promote concern and understanding for national park issues, and support for the processes required to maintain ecosystem health.

Location

The prescribed burn was located immediately south of the former Kootenay National Park administration building, on a bench above the Village of Radium Hot Springs, British Columbia (Figure 1). The unit is comprised of federal and provincial crown lands and is well contained by existing roads to the east, west and north.

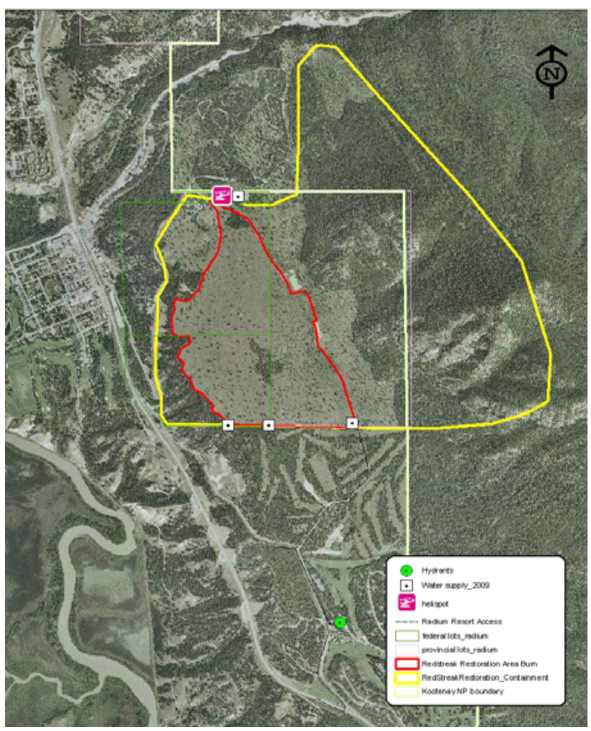

Figure 1. Map showing location of prescribed burn unit in relation to park boundary. Town directly to the west of the unit is Radium Hot Springs, British Columbia.

Fire Environment

The vegetation within the prescribed burn unit falls within the Wycliffe (WY) ecosection (Achuff et al., 1984), with components of both the WY1 and WY2 ecosites. Species composition in these ecosites consists of open Douglas-fir, native bunch grass (e.g. bluebunch wheatgrass *Pseudorogneria spicata* and june grass *Koeleria cristata*), aspen regeneration and a variety of non-native invasive plants, including Perennial sow thistle *Sonchus arvenisis* and bull thistle *Cirsium vulgare*.

Fuel within the burn unit is primarily homogenous C-7 Douglas-fir with O-1 matted and standing grass that has been accumulating since the 2005 burn of this area. There are also pockets of S1 lodgepole slash that remain from the harvesting events that occurred in 2002. The unit is mostly flat with some subtle and variable east facing slopes of up to 20% on the east side of the unit that crest out into the middle of the unit.

Fire Weather

Fire weather on the day of ignition is summarized in Table 1, below. As the table shows, weather and fuel moisture indices were within the prescription parameters outlined in the burn plan.

Name	Date	Time	Temp	RH	Dir	Wspd	Rn24	Rn_1	FFMC	DMC	DC	ISI	BUI	FWI	DSR
			°C	%	°	kph	mm	mm							
Radium	08/04/2009	12:00:00	12.0	35.0	283	4.1	0.00	0.00	86.0	10.2	223.2	3.0	18.3	4.5	0.4
Radium	08/04/2009	13:00:00	14.1	29.9	304	10.6	0.00	0.00							
Radium	08/04/2009	14:00:00	15.7	26.1	304	3.7	0.00	0.00							
Radium	08/04/2009	15:00:00	17.1	21.9	7	4.4	0.00	0.00							
Radium	08/04/2009	16:00:00	18.5	16.9	291	4.2	0.00	0.00							
Radium	08/04/2009	17:00:00	18.4	15.9	279	2.9	0.00	0.00							
Radium	08/04/2009	18:00:00	17.8	15.9	322	4.6	0.00	0.00							
Radium	08/04/2009	19:00:00	13.7	26.0	26	3.0	0.00	0.00							
Radium	08/04/2009	20:00:00	11.9	26.9	21	5.2	0.00	0.00							
Radium	08/04/2009	21:00:00	10.9	29.5	26	5.2	0.00	0.00							

Table 1. Fire weather indices on the afternoon of ignition, as measured by the Radium automated weather station.

Fire Objectives and Measures (from burn plan):

Objective 1

Apply low intensity prescribed fire to 100 hectare unit to increase native species cover

Measures:

- 80-100% area burned within unit
- Flame length not to exceed 1-2 meters, to minimize tree scorch and mortality.
- Promote bunchgrass cover >5% increasing from the 3% measured in 2006. Measured summer following the spring burn as part of existing vegetation monitoring.

- Minimize non-native species to <7%, as measured in 2006. The percent cover increased from 3% to 7% from 2004-2006 in the burned areas of the Redstreak Restoration area. The intent is to maintain or decrease that level of non-native coverage through successive burn treatments.

Figure 2. Typical fire behaviour on day of ignition.

Results Objective 1

With approximately 90-100% of the unit area being burned by low intensity fire (Figure 2), this objective appears to be met according to the area burned measure. However, further analysis of flame length (video footage) as well as post burn vegetation measurement for bunchgrass and non-native species will provide a more detailed assessment of the degree of success.

Objective 2

Utilize this prescribed burn event to inform key audiences about historic fire regimes and ecosystem restoration. Awareness and accurate information should encourage the public to participate in protected area management and ecological integrity. This may promote concern and understanding for national park issues, and support for the processes required to maintain ecosystem health.

Measures:

- Provide visitors and community members the opportunity to attend two organized post burn tours within the Redstreak Restoration area. An interpreter/communications officer will be available to answer questions and provide information. This will likely take place during the summer season following the burn and will be advertised in local newspapers and at the information centre. Key individuals will be personally invited.
- Two media products will be prepared and made available to the media. Ideally a local newspaper such as the Valley Echo or Columbia Pioneer and a large distribution publication such as the 'Calgary Herald' will be approached. Interviews will be conducted by personnel trained in media relations, with photo opportunities also available. Key messages will focus on unit objectives and the restoration of ecological integrity.

Results Objective 2

The following is a description and chronology of Communication activities prior to, during and after the prescribed fire that work towards the fulfillment of Objective 2.

October 2008 - The first set of Fact Sheets for the project (in both English and French) were completed and posted in public locations in 10 businesses in the village of Radium Hot Springs. At this time, stakeholders were contacted regarding the project and no concerns were noted with regards to either the thinning of prescribed fire.
Prior to the commencement of pile burning, a smoke advisory was issued and people on the smoke sensitive list for KNP were notified. Key stakeholders for the project were also notified.

November 20, 2008 - A second set of fact sheets were completed and a meeting with the Radium Chamber of Commerce was held and no concerns were noted. A short information article was submitted to the Radium Newsletter.

December 1, 2008 – A fact sheet to accompany the closure notice as well as the Redstreak Campground Road Closure was put into effect.

February 2009 – The fact sheet was updated on work progress and mechanical thinning.

March 2009: Fact sheet for the prescribed fire as well as the longer term plan for the Redstreak mountain prescribed fire was made public. At this time, few comments regarding impatience with smoke in the area surfaced. Thank you notice for the residents of Radium was issued in conjunction with the fact sheet.

April 1, 2009: Fact sheet released to notify public regarding burning as early as April 6th. Key stakeholders from KNP list were notified and a smoke advisory notice was issued. Smoke Sensitive List was notified 2 days prior to burn operations. All people contacted were supportive of the fire and were pleased to be notified directly by Parks Canada.

April 8, 2009: Ignition day. Information booth was erected at the Radium Visitor Centre from April 8-11. An article regarding the prescribed fire was also submitted to the Columbia Pioneer Newspaper.

May, 2009. Public field trip with Rick Kubian with Wings over the Rockies.

June, 2009: The Village of Radium requested a summary of all Redstreak activities for 2008/09 at a town hall meeting. A report and thank you was submitted to approximately 25 residents, Radium Council as well as Town Managers. No negative comments were received and the Mayor, Councillors and residents were grateful for representation by Parks Canada at the meeting and for information regarding the prescribed fire and thinning program at Redstreak.

Additional comments:
Local residents and businesses largely supported the project. However, due to the long duration of the project, from pile burning to prescribed fire, some were losing patience with regards to smoke.

Fire Behaviour and Effects Monitoring

Data was collected for the following fire behaviour attributes and first order fire effects utilizing a single study area.

- ✓ Fuel Consumption
- ✓ Surface Fire Rate of Spread
- ✓ Fire Intensity
- ✓ Surface Temperature
- ✓ Sub-surface Temperature
- ✓ Flame Length

The study area was laid out in a 120 x 120 metre representative block of relatively continuous fuel that was judged to be located in area that would allow strip ignition to gain equilibrium fire spread and be readily observable. Figure 2 shows the general sampling design for fire behaviour and first order fire effects monitoring. Twenty-five plots were established within the 1 hectare study on a twenty metre grid. At each of these plots temperature sensors were placed on the surface to measure temperature. This grid of temperature sensors was used to calculate rates of spread. At four of these plots a sub-surface array of temperature sensors was used to establish sub-surface temperature flux. Pre and post burn fuel loads were measured along a 100 metre transect on the west side of the study are. Woody fuel moisture content was established using a protimeter along transects on the north and south sides of the study area. Finally, in-stand cameras were used to record video footage of the fire passage through the study area.

Figure 3 shows the general sampling design for fire behaviour and effects monitoring.

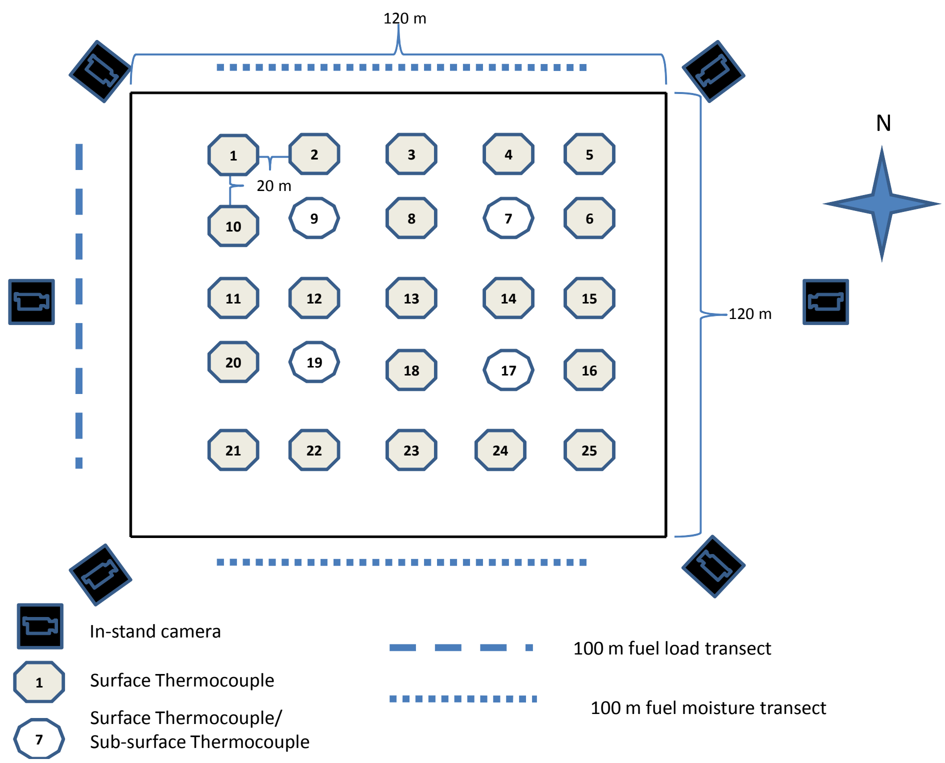

Figure 3. Diagram of the study area showing locations of in-stand cameras, surface thermocouples, sub-surface thermocouples, fuel load transects and fuel moisture transects.

Fuel Consumption Results

The final fuels analysis shows almost complete combustion of the herbaceous cover and over 75% consumption of shrub cover. Complete combustion results can be found in Table 2 below.

	Pre-burn dry fuel weight (Mg/ha)	**Post-burn dry fuel weight (Mg/ha)**	**Consumption (Mg/ha)**	**Consumption (%)**
Herb	12.00	0.41	11.59	96.58
Shrub	3.78	1.11	2.89	76.46
woody 0.6-2.5 cm	0.20	0.16	0.04	20.00
woody 2.5-7.5 cm	1.32	0.65	0.67	0.51
woody >7.5 cm	121.00	110.20	10.80	0.09

Table 2. Pre- and post- burn dry fuel weights and consumption results for Redstreak Burn.

Rate of Spread Results

Figure 4 shows the approximate layout of temperature sensors and results of the rate of spread (ROS) monitoring plot. The speed and direction of spread in the Northern portion of the plot were indicative of flanking or backing fire. Therefore, the rate of spread was calculated based on the more consistent southern half of the plot area (rectangle EFCD; Figure 4). Based on these calculations, the measured ROS was **5.1 m/min** (C_r = 0.23 m/min) in the direction of **159 degrees** (s_z = 8.1 degrees). These results can be considered more accurate than those calculated using data from the entire plot, and also remain valid according the criteria of Simard et al. (1984). Despite the slightly lower C_r and s_z values, the values were also closer to the estimated ROS observed by field personnel during the fire operation.

The fire entered the plot area at 13:26:15 from the west and took 999 seconds, or 16 minutes, 39 seconds, to completely cross the monitoring plot area. The overall spread directions of 148 or 159 degrees are both reasonably consistent with the Radium weather station wind reading at the time (wind direction of 304 degrees at both 13:00 and 14:00 translates into a predicted spread direction of 124 degrees).

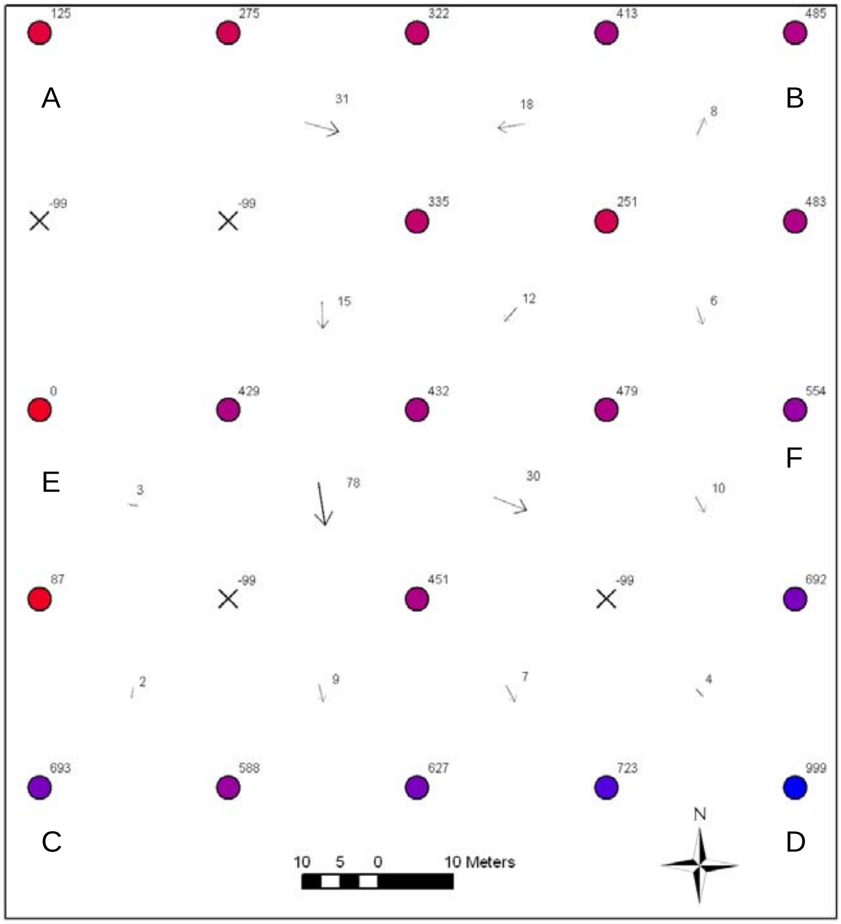

Figure 4. Diagram of the ROS plot layout and results. Circular plots represent the locations of buried thermocouple timers that recorded the fire arrival times; colours are scaled from earliest (red) to latest arrival (blue). Numbers beside plot circles represent elapsed seconds from 13:26:15, when the first timer recorded the fire location; plots represented by 'X' (-99) failed to trigger. Arrows indicate calculated spread rates (m/min) and directions between plots. Internal vector arrows in this figure are based on the most likely ROS values between four corners, rather than the average. A, B, C, D, E, and F represent points discussed in text.

Sub-surface Temperature

Temperature data was collected from 4 soil arrays (Plots 7,9,17,19) where temperature sensors were placed at the surface, 2.5 cm, 5 cm, and 10cm below the surface. At plot S19, the sensor at 2.5 cm stopped recording temperature prior to the flame front passage; therefore the data from this sensor was removed from all 2.5 cm analyses. Sensors were excavated from the ground at approximately 1400h, therefore data has been truncated at 1400h for all sensors. Temperature data prior to frontal flame passage at 13:26:15 PM was also eliminated from the analysis. Table 3 below shows the average range of temperatures found at each depth (average of four plots ± one standard deviation).

Surface temperature (0 cm) change was rapid and reached high temperatures associated with the passage of the flame front. However, temperature changes below the surface were still rising at the point when sensors were excavated. One interesting observation was that at plot S7 a significant increase in temperature was noted at 2.5 cm below the surface. This rapid increase may have been correlated to the high temperatures (nearly 300 degrees Celsius) recorded at the surface as the flame front passed.

Future collection of similar data should continue for at least 48 hours. A longer data set will help to determine whether soil temperature increases are due to radiant heat from the passage of the flame front and residual combustion, or if is from radiant 'black-body' energy release (National Wildfire Coordinating Group, 2001). Due to limitations in the amount of data that the sensors are able to store, the data collection interval (time between temperature measurements) will have to be adjusted to allow for 48 hours of data collection.

Previous studies (Massman et al., 2003; Valette et al., 1994) have indicated that changes in soil temperature are influenced by soil moisture and fuel loading. Soil temperature can be moderated by soil moisture, with wetter soils heating up more slowly than those that are drier. Future collection of soil temperature profile data should be coupled with soil moisture data in order to determine potential causes for soil temperature increase differences. Furthermore, fuel loading plots should be representative of loading in the soil temperature plots.

Appendix I shows specific soil temperature profiles for each plot.

Depth	0 cm	2.5 cm	5 cm	10 cm
Mean Min Temp (+/- SD)	22.96 (1.06)	6.27 (2.57)	2.13 (2.89)	0.52 (0.94)
Mean Max Temp (+/- SD)	197.80 (69.45)	11.46 (7.49)	3.58 (3.95)	1.11 (0.86)
Mean Temp Increase (+/- SD)	174.84 (70.04)	5.20 (5.78)	1.44 (1.09)	0.60 (0.51)

Table 3. Mean minimum and maximum temperatures and mean temperature increase (with standard deviations) at soil depths of 0 cm, 2.5 cm, 5 cm, and 10cm below the surface (N=4; N=3 for 2.5 cm values).

Surface Temperature Measurements

A total of 25 WREN type temperature sensors were placed within the monitoring plot (Figure 3). Twenty-two of these sensors recorded maximum surface temperatures as the flame front passed through the plot. The mean maximum temperature across all sensors was 403.18 ^{o}C $\pm$ 105.60. The highest temperature recorded was from plot #14 located in the eastern portion of the plot. However, the lowest maximum temperature (224^{o}C) was recorded at plot #15 directly adjacent to plot #14. Differences are likely due to small-scale fuel or fire spread variables. Temperature sensors locations were chosen to represent even fuel loading within 1m^2, however differential fuel loads in upwind areas may have resulted in fire spreading with different parameters than in a location with higher adjacent fuel loads.

Fireline Operations

Resources and Fireline Organization

Figure 5 shows the Incident command organizational chart for ignition day. In addition to the resources listed on the organizational chart, several other auxiliary crews and personnel were on hand to assist if necessary.

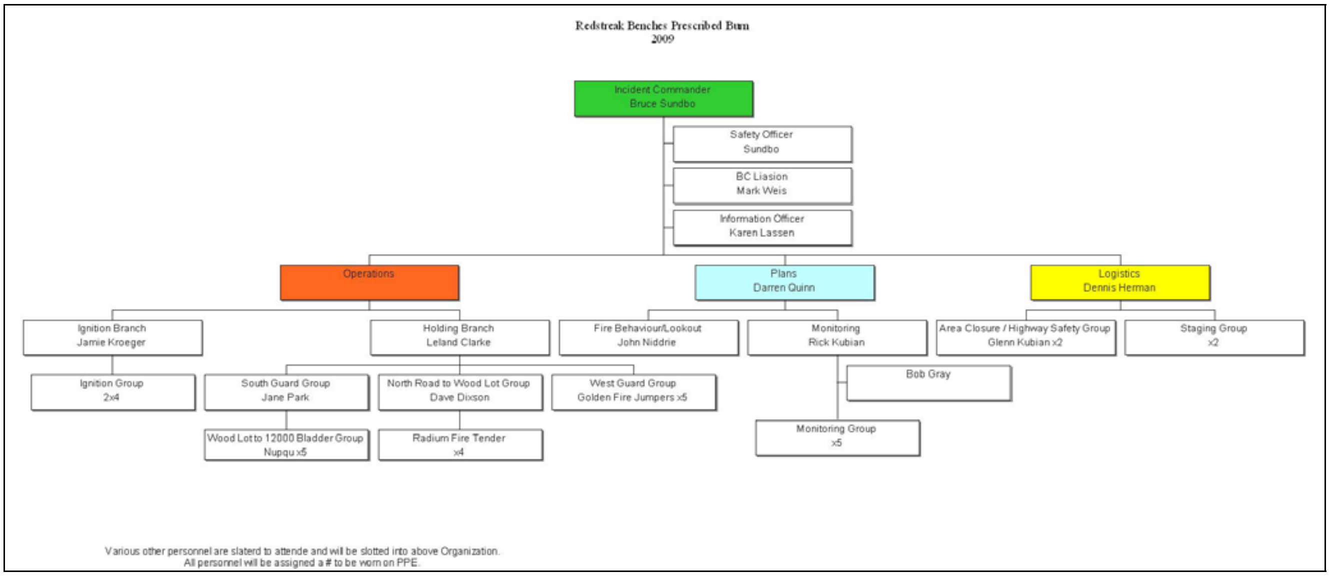

Figure 5. Incident command organizational chart for day of ignition.

Challenges to control lines or suppression efforts

The expected wind direction was from the south, however on the day of ignition, the prevailing winds were from a north/north east direction (see Table 1). Ignition patterns were initiated on the north end of the unit, creating minor smoke issues for ignition crews.
At the south end, blacklining operations were initiated with hand lighting crews commencing on the east and west flank of the unit. However, fuel conditions were drier than expected (snow line along forested edge had melted significantly in days prior to ignition), and control crews were not fully in place. As west flank ignition crew began moving along north end, a hose lay suffered minor damage and 2-3 string rotary bucket drops, as well as wet-lining, were necessary to complete the blacklining operation.
No other significant challenges to control were encountered.

Smoke and venting characteristics

Atmospheric conditions on burn day were conducive to relatively good smoke venting conditions however smoke downloaded locally at Dry Gulch.
The following morning, there were no significant smoke accumulations in the valley bottom.

Conclusions

Although additional post-burn monitoring and analysis are pending, the Redstreak Bench prescribed burn appears to have been successful in achieving its main objectives related to ecological integrity and community/facility protection both within Kootenay National Park and the greater park ecosystem.

The Kootenay National Park Management plan indicates that any prescribed fires must consider the objectives of adjacent land managers (Parks Canada, 2000). This prescribed burn was part of a larger cooperative ecosystem restoration program in the Columbia Valley that enhances critical Bighorn Sheep winter ranges and benefits a number of rare or threatened plant and animal species. As part of a long-term plan for the Redstreak area, this fire represents one of many steps in the continued restoration of the open Douglas-fir/grassland ecosystem. Furthermore, the burn also serves to restore the forest to its natural open Douglas-fir state that is naturally more resistant to intense and difficult to suppress crown fire.

Acknowledgements

The monitoring component of this iteration of the prescribed burn was completed with the cooperation and assistance of volunteer Fire Ecologist Bob Gray. We are thankful for his participation. In addition to regular Field Unit and Service Centre staff fieldwork was completed by Nick Niddrie (Fire/Vegetation Summer Student), Scott Murphy and Dan Perrakis (Western Fire Centre), and Mike Gall (BC Ministry of Environment).

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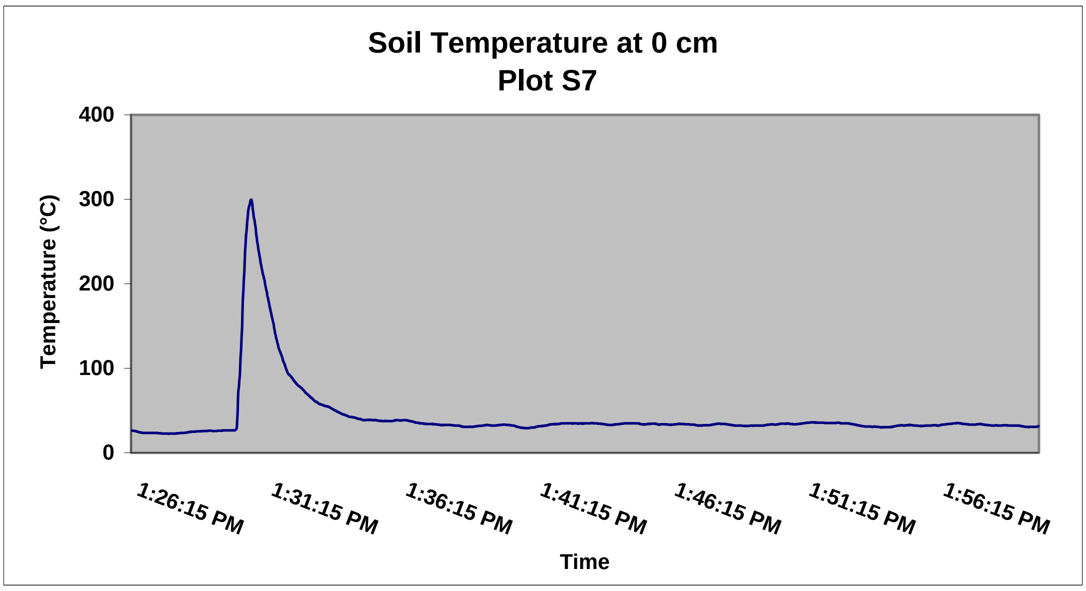
Appendix I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300
200
100
0
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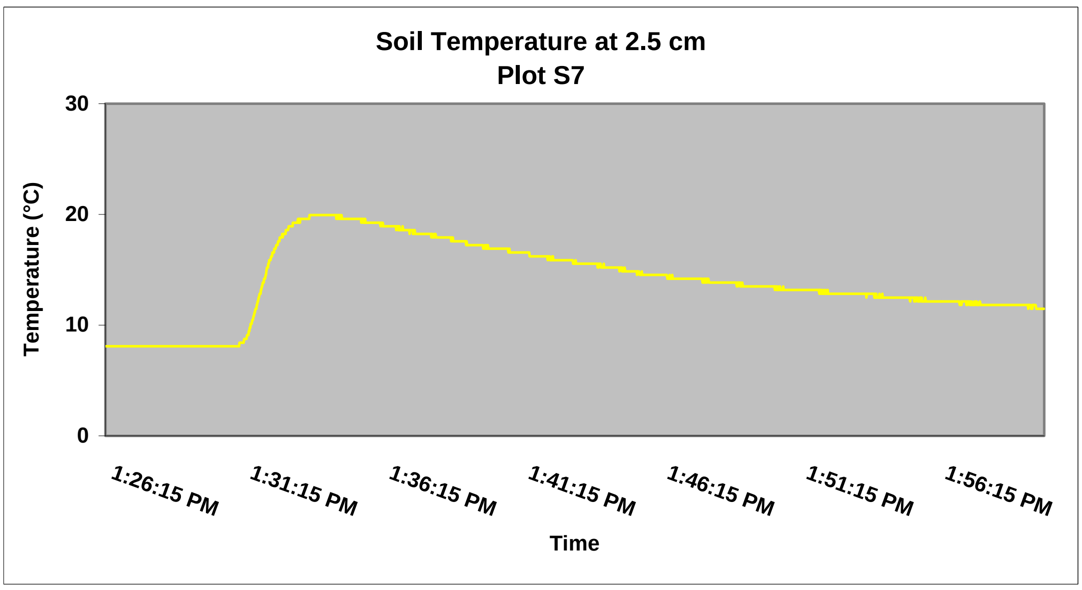
Time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Temperature (°C)
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20
10
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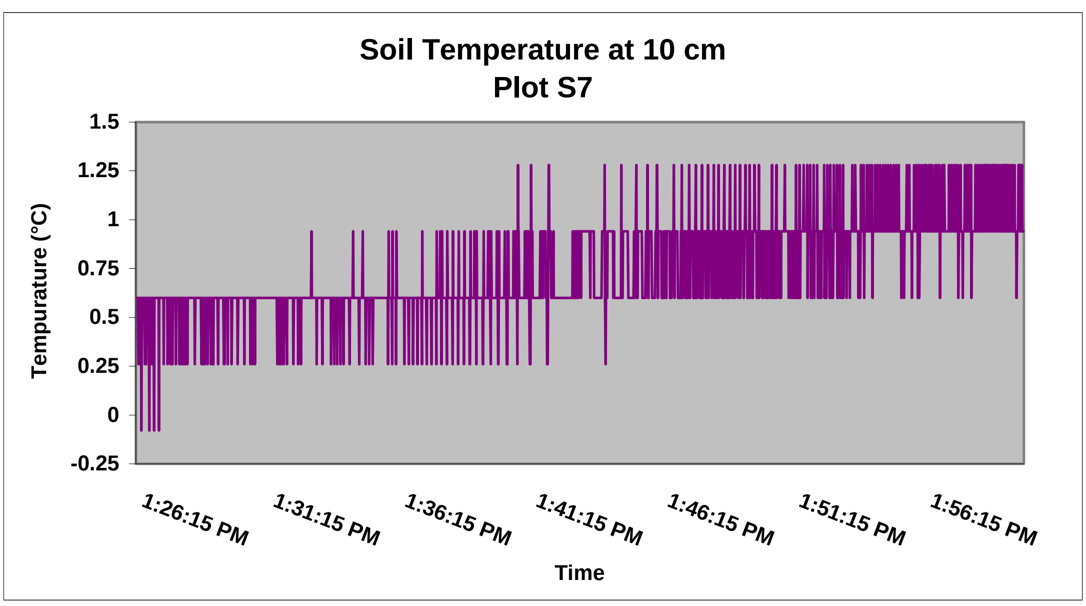
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Plot S7
Tempuratture (°C)
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0.25
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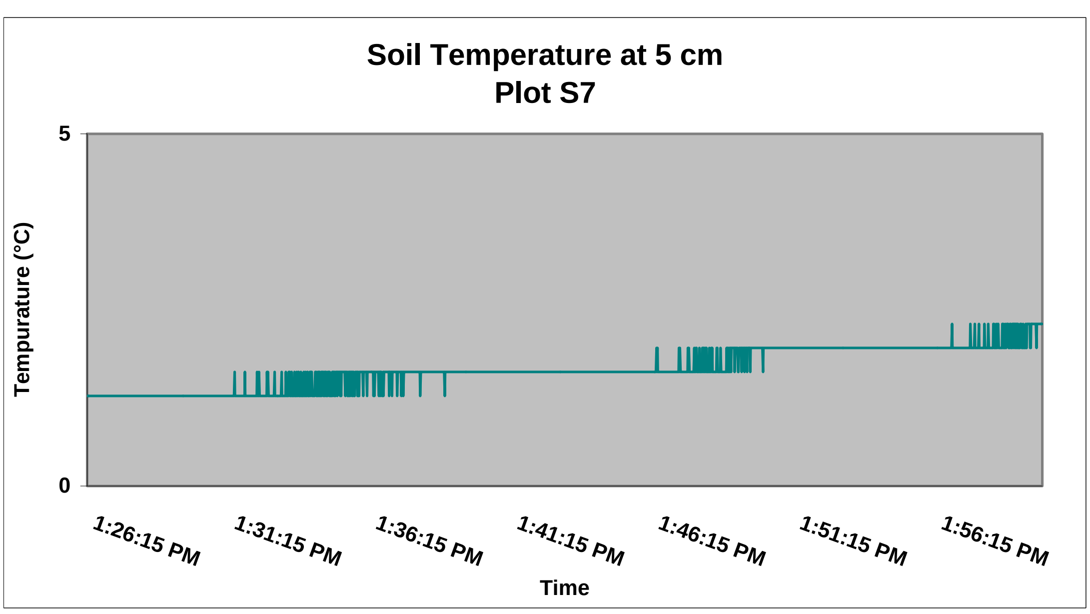
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Plot S7
Tempuratture (°C)
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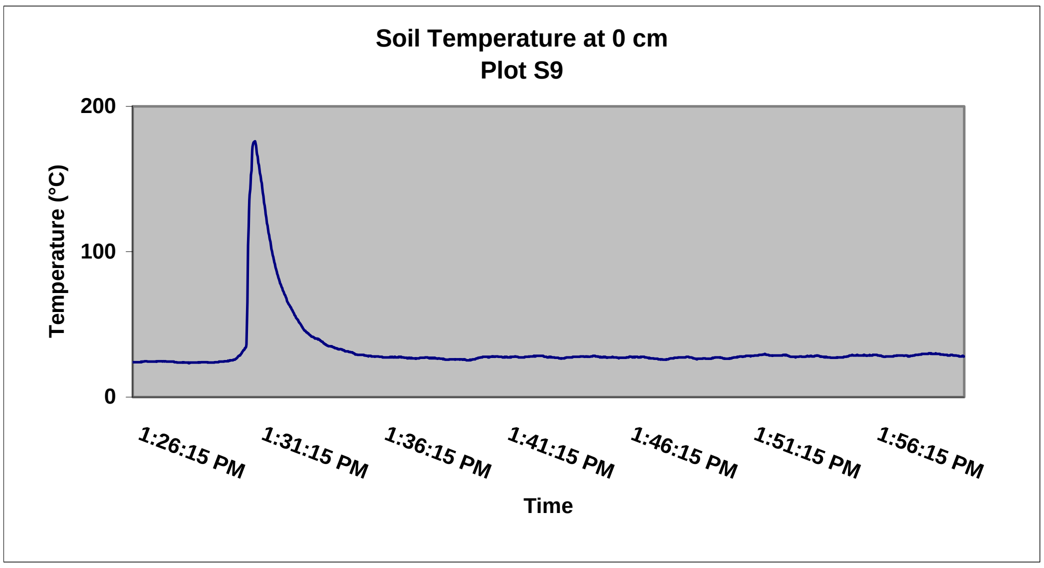
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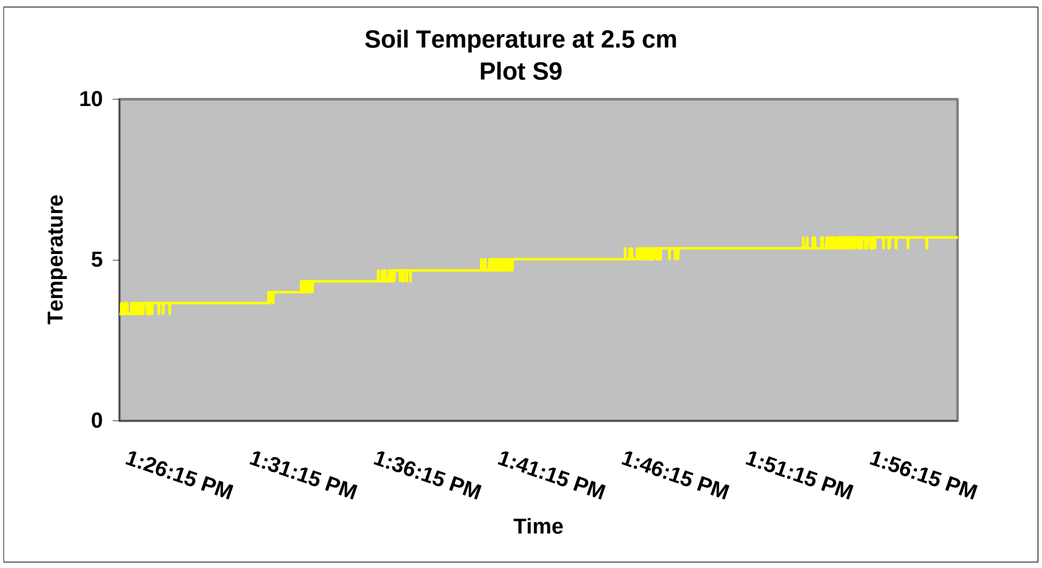
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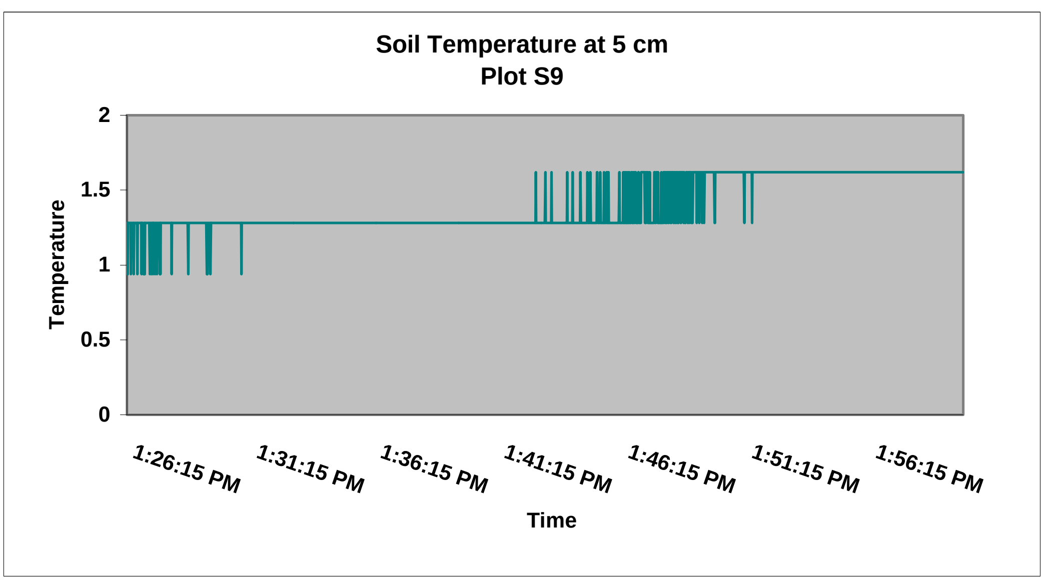
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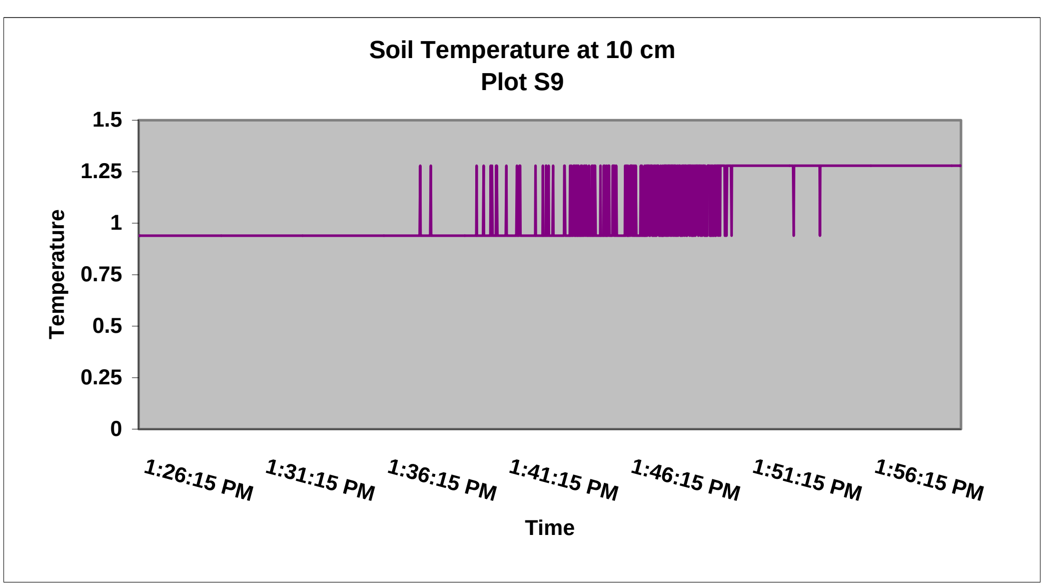
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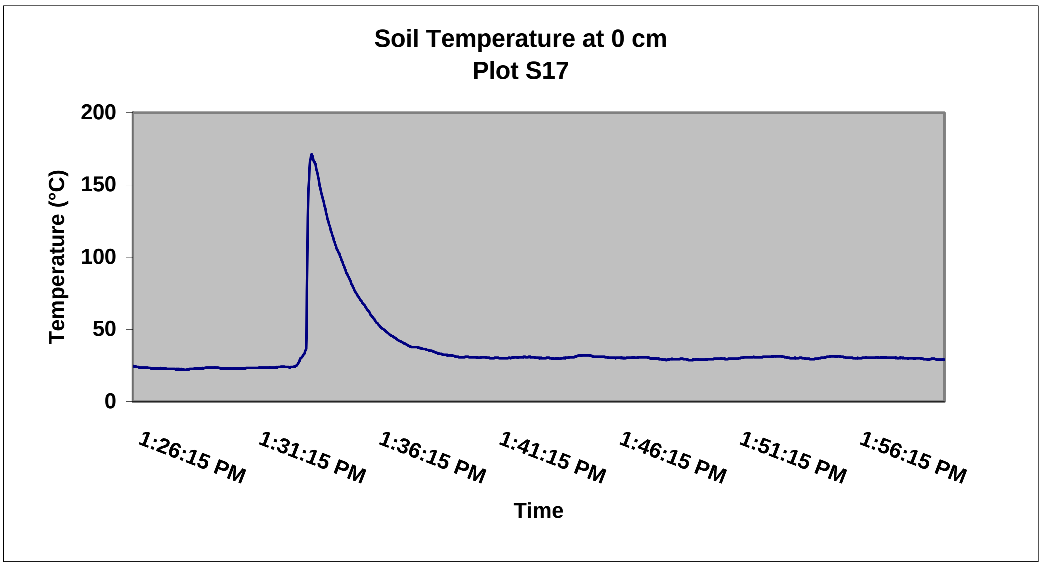
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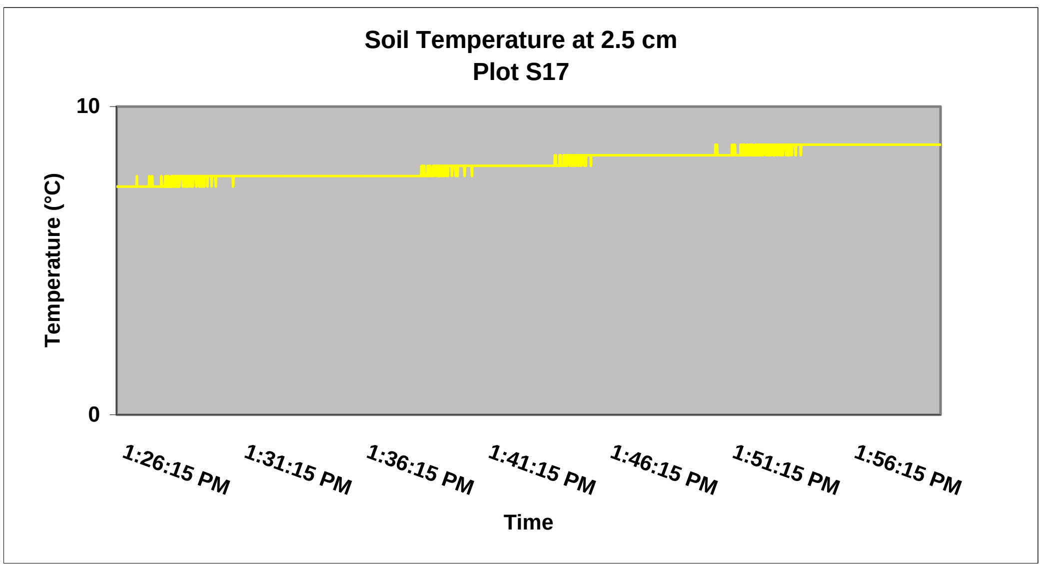
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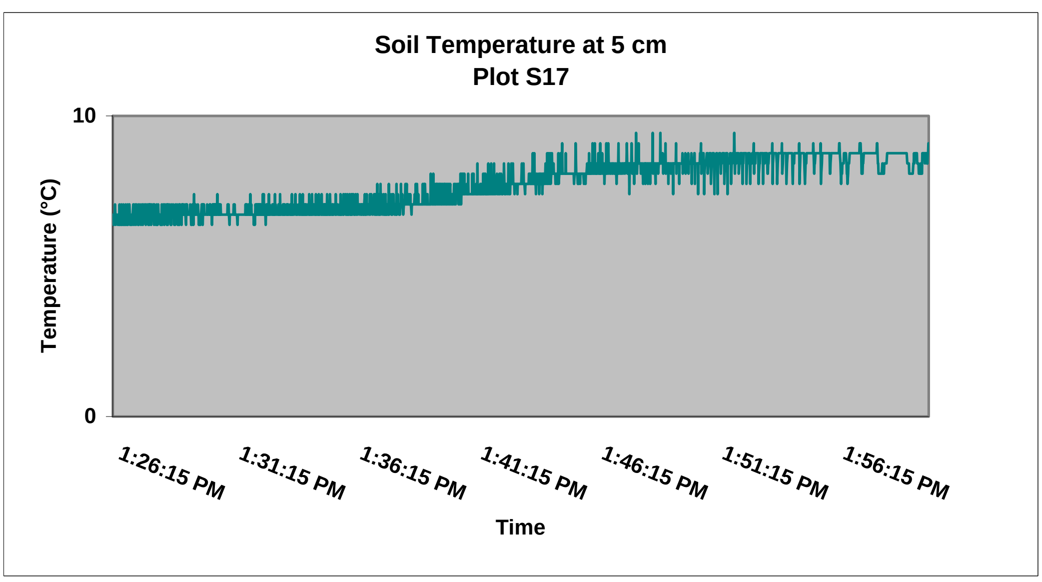
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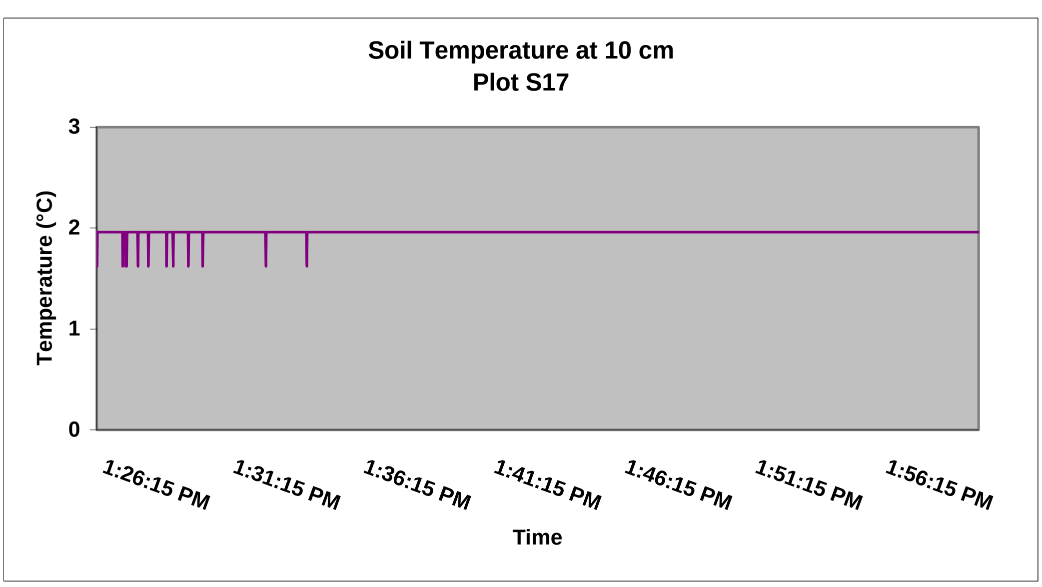
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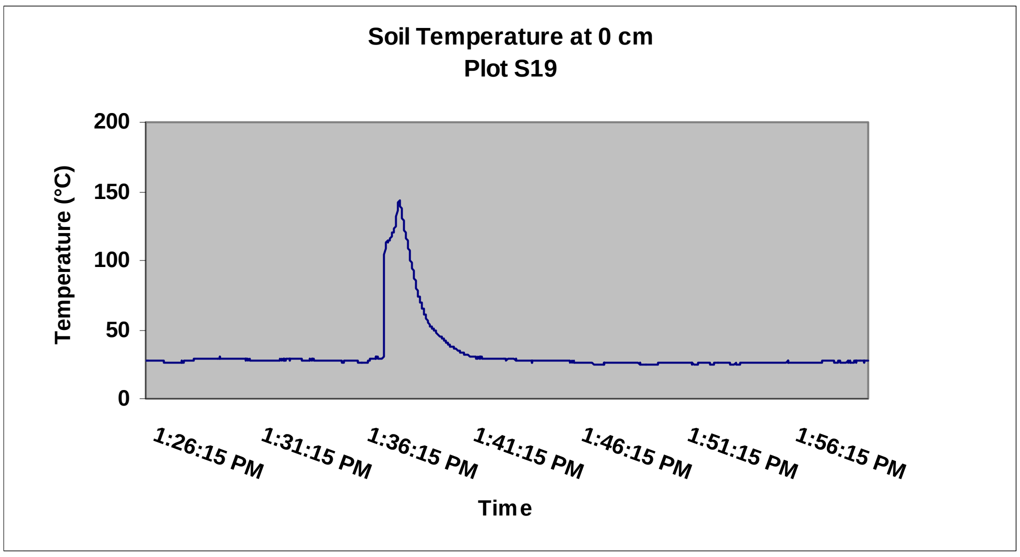
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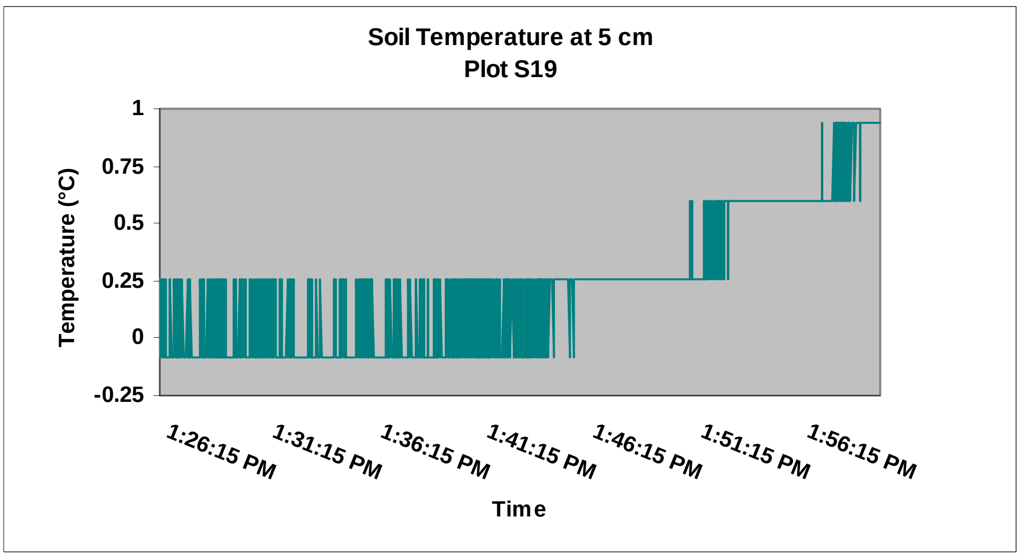
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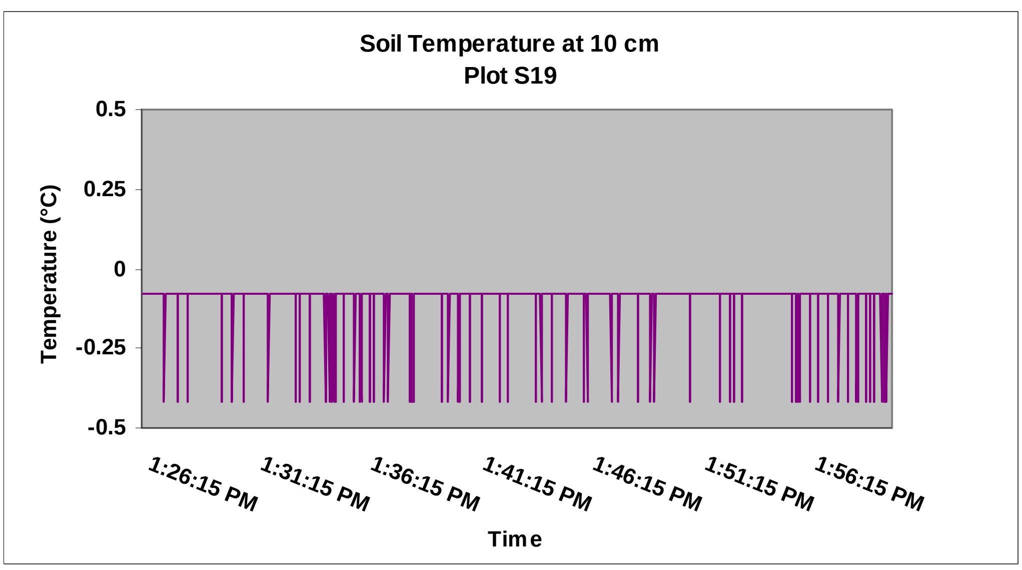
1:56:15 PM
Time


Soil Temperature at 10 cm
Plot S19
0.5
0.25
0
-0.25
-0.5
Temperature (°C)
1:26:15 PM
1:31:15 PM
1:36:15 PM
1:41:15 PM
1:46:15 PM
1:51:15 PM
1:56:15 PM
Time