



**R11 Forest Management Plan: Five-Year Stewardship Report
December 2012**



**Alberta Environment and Sustainable Resource Development
Forestry Division
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Executive Summary

The period from 2007 to 2012 marked the first forest management activities conducted in the R11 Forest Management Unit under the direction of the 2007 R11 Forest Management Plan. The R11 FMP delineated a public accountability and reporting process to assess management effectiveness every five years by documenting progress toward plan indicators and targets and integrating updated data, models, and scientific knowledge through minor revisions. Stewardship Reports are the primary tool for assessing progress and communicating this information.

The R11 FMP embraces an overarching management approach of emulating natural disturbances and processes, with prescribed fire chosen as the primary management tool. However, R11-specific knowledge of historic fire regimes or altered fire regimes resulting from fire suppression activities was sparse. As one of the first major tasks initiated after FMP approval, ASRD¹ commissioned M.-P. Rogeau to conduct an in-depth fire history and fire regime study for the R11 FMU to better understand characteristics of the current altered fire regime, characteristics of the historic fire regime, and the degree of departure from historic conditions.

Using 1961-2008 occurrence records from the Forest Protection Branch, Rogeau found multiple recent fire regimes based on natural subregions. Screening of aerial photographs from circa 1950 and fire history field data from tree rings, fire scars, and fire releases also showed multiple historic fire regimes based on elevation (as captured by natural subregion) and fuel continuity. Fire regime simulations were conducted using STANDOR, a landscape disturbance model, to simulate fire ignitions and growth patterns. Outputs from the model identified the parameters under which fire should be reintroduced on the landscape (e.g., areas of shortest mean fire return interval, yearly disturbance rates, natural range of variation around stand age, fire size, fire frequency). A fire regime departure analysis compared the modelling results and recent fire regime results to help prioritize the fire regime regions in greatest need of treatment.

Approximately half of the 47 unique objectives identified within the R11 Forest Management Plan to conserve ecological, economic, and social values within the landbase have direct relevance to planning and managing fires within the FMU. Four fundamental indicators and associated targets require revision in light of the R11 Fire Regime Analyses: these indicators deal with treatment size and residual unburned area within a burn, stand age distribution, rate of disturbance, and use of natural wildfires.

In addition to the completion of an R11 FMU fire regime study, several other notable achievements were recorded over this five-year reporting period including

- completion of the large 5700 ha Upper Saskatchewan Unit 1 prescribed burn that was generally well received by local residents, business owners, and visiting public,

¹ The original R11 Forest Management Plan was prepared by Alberta Sustainable Resource Development (ASRD). In May 2012, this ministry was merged with Alberta Environment to create Alberta Environment and Sustainable Resource Development (AESRD). As the original FMP and the majority of monitoring activities during reporting period were conducted under ASRD, this nomenclature will be applied throughout this Five5-Year Stewardship Report. Future stewardship reports will employ the new ministry name.

- completion of pre-suppression plans and FireSmart harvesting/vegetation management around Nordegg and the Bighorn reserve,
- implementation of joint operations and/or ongoing relationship building with other agencies or adjacent land managers,
- identification of several previously unknown whitebark and limber pine trees/stands,
- significant progress towards setting targets for key wildlife indicators including ungulates and grizzly bears, and
- creation of a short interpretive hiking trail as one component of several communication and outreach activities that provided information on R11 FMP activities to stakeholders and the public.

To summarize progress in meeting the 72 indicator targets during this reporting period, a report card was generated. Grades were assigned as follows: E = Excellent success in meeting target, A = Target met adequately or as best possible given knowledge or logistical constraints (i.e., met with room for improvement), NY = Target not yet met, though progress may be evident, and NA = Target still under development, will be assessed at longer intervals, or will be assessed once Clearwater Landscape Fire Management Strategy is in place. Overall, 75% of the indicators were assigned adequate or excellent success in meeting the outlined target (i.e., the grade distribution was as follows: 35 E, 19 A, 5 NY, 8 NA, 5 defer to other indicators).

Difficulties, particularly with respect to data limitations, were also encountered when considering some indicators during treatment implementation or when assessing the indicators for the Stewardship Report. The original R11 FMP planning guidelines specified that indicators must be derived from currently available government data. Some indicators have not yet been adequately tracked due to the lack of existing data (e.g., breeding habitat/locations of sensitive species such as long-toed salamanders or Harlequin ducks, number of tourism-related operators working within the R11 FMU, harvest of non-timber products). Financial and logistical constraints have prevented the design and implementation of other supplementary data identified in the original R11 FMP (e.g., training of forestry personnel and contractors in rare plant identification, visitor survey to determine experiences).

The next five-year reporting period for the R11 FMP will continue to build on the successes noted here while integrating the fire regime information into treatment planning and implementation.

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1 Introduction

The R11 Forest Management Plan (ASRD 2007) delineated a public accountability and reporting process to assess management effectiveness every five years by documenting progress toward plan indicators and targets and integrating updated data, models, and scientific knowledge through minor revisions. Stewardship Reports are the primary tool prepared to identify and explain differences between planned and actual activities; summarize the outcome of monitoring activities; assess the suitability of plan indicators as they relate to management objectives; describe progress made in implementing management strategies; assess variance from planned targets and responses and discuss implications; discuss emerging resource management issues or trends; outline challenges encountered in plan implementation; summarize recently completed and ongoing research and its application within the FMU; and outline public involvement initiatives (ASRD 2007). The following document represents the first five-year Stewardship Report for the R11 FMP.

Wildfire is recognized as the dominant natural disturbance agent throughout most forested regions of Alberta. The R11 FMP embraces an overarching management approach of emulating natural disturbances and processes, with prescribed fire chosen as the primary management tool. However, R11-specific knowledge of historic fire regimes or altered fire regimes resulting from fire suppression activities was sparse. Information for the FMP and its associated indicators drew heavily upon a study examining provincial-level fire regimes within the analogous natural subregions (i.e., Tymstra et al. 2005) as well as a single local fire history study encompassing a small portion of the FMU west of the Cline River and the adjacent White Goat and Siffleur Wilderness Areas (i.e., Rogeau 1999). Rogeau (1999) examined the historic fire regime from 1470 to 1998, while Tymstra et al. (2005) examined the period between 1961 and 2002, representing altered fire regimes since the onset of fire suppression. In the absence of detailed local information, these studies provided a first approximation of several key fire regime components and the range of natural variability therein. Nonetheless, the importance of local fire regime data cannot be underestimated as factors such as valley orientation, aspect, elevation, fuel breaks, and probability of ignition can influence fire spread patterns and spatial distribution of fires, particularly in mountainous terrain (Rogeau 2009).

As one of the first major tasks initiated after FMP approval, ASRD commissioned M.-P. Rogeau (Wildlands Disturbance Consulting) to conduct a fire regime analysis for the R11 FMU, thereby addressing the paucity of information regarding the R11 fire regime. General results from this comprehensive study and their implications are discussed in Section 2 as they influence how subsequent FMP treatments are applied. Following the fire regime summary, Section 3 presents the 72 indicators/targets as per the original FMP with a new section entitled “2012 Status”. This allows the reader to compare the current status to the baseline status without having both documents in hand. Required revisions to particular indicators are detailed under the indicator and summarized in Section 4. Finally, Section 5 provides additional recommendations for the next five-year period of plan implementation.

2 R11 Fire Regime Analysis

Fire plays a crucial role in the dynamics of many forested ecosystems by influencing plant succession, structure and composition of vegetation, fuel accumulations, nutrient cycling and energy flow, insect and disease populations, wildlife habitat, and ecosystem productivity, diversity, and stability (Kilgore and Heinselman 1990). The fire regime, which is the pattern of fire activity that generally characterizes a given area, is defined by several variables including

- frequency of fires,
- cause (i.e., anthropogenic vs. lightning)
- season of peak fire activity
- range in fire size
- intensity (i.e., surface, passive crown fire, stand replacing), and
- severity (as observed by complexity of vegetation mosaic).

Historic fire regimes created a mosaic of vegetation patterns and structure on the landscape ranging from areas that burned frequently with low intensity, surface fires that left significant residual patches to areas that burned infrequently but with intense crown fires that removed most of the standing timber.

Altered fire regimes arise from post-settlement influences on the landscape, including fire suppression. Decades of fire prevention and suppression activities in Alberta (Murphy 1985) have changed landscape patterns, structure, and conditions from those that may have historically existed. Within the R11 FMU, lack of disturbance from harvesting or wildfires has created low complexity, even-aged, and increasingly older forest stands and has allowed fuel loading and mountain pine beetle risk to reach extreme levels. This area is becoming very susceptible to sudden, dramatic, and massive stand-level changes.

To better understand the characteristics of the current altered fire regime, characteristics of the historic fire regime, and the degree of departure from historic conditions as well as provide the information necessary for a reintroduction of fire to the R11 landscape, an in-depth fire history and fire regime study was completed. Complete details can be found in Rogeau (2009), Rogeau (2010a), and Rogeau (2010b): key findings and information are summarized in this section and the overall process is depicted in Figure 1. The general study area encompassed significant area outside the R11 FMU boundaries to ensure that historical fires crossing jurisdictional boundaries were captured, with the core R11 FMU representing approximately 29% of this Greater R11 Region (Rogeau 2009). Not all areas of the greater study area were included in all analyses: for example, Jasper and Banff National Parks were excluded from the historical fire regime assessment but were used in fire regime simulations.

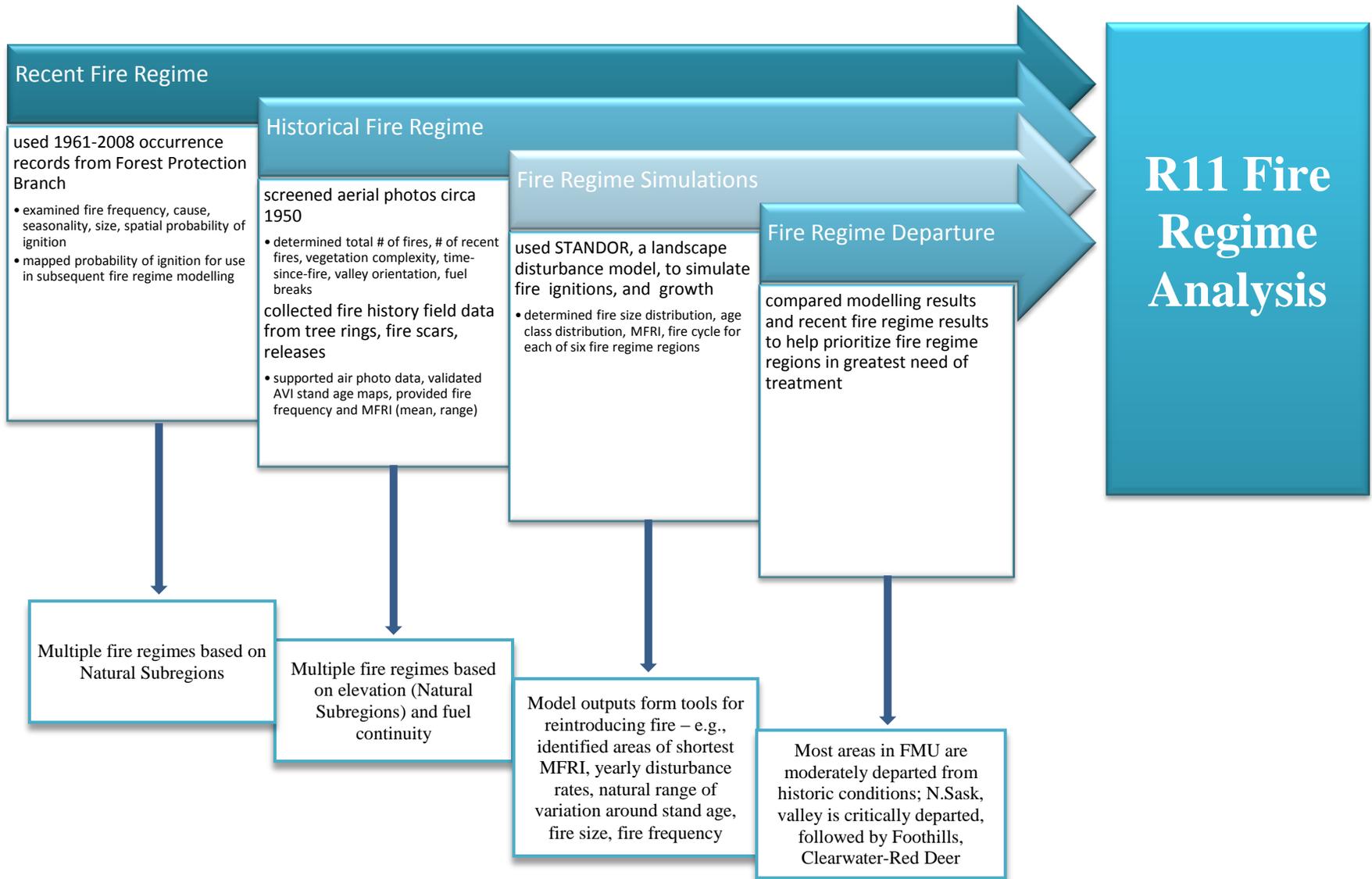


Figure 1. Summary of R11 Fire Regime Analysis process and key outputs.

2.1 Recent Fire Regimes

Recent fire regimes (i.e., altered fire regimes due to suppression) for each natural subregion were determined using Alberta Forest Protection Branch fire occurrence records from 1961 to 2008 to examine fire frequency, fire cause, seasonality of fire, fire size distribution, and spatial probability of ignition. Overall fire regime characteristics among natural subregions were similar when compared between the Greater R11 Region and the R11 FMU (Rogean 2009). Results for analyses completed on the Greater R11 Region are presented below as the Lower Foothills Natural Subregion was not included in the FMU-specific analyses owing to the relatively small amount occurring within the FMU. The Alpine Natural Subregion was not considered in any analyses as the region is largely non-forested.

Rogean (2009) found several different fire regimes corresponding to natural subregions currently in place on the R11 FMU landscape, thus supporting the work of Tymstra et al. (2005) and the approach taken in the R11 FMP (ASRD 2007). The Subalpine, Montane, Upper Foothills, and Lower Foothills Natural Subregions, while similar in some fire regime characteristics, differed in terms of fire occurrence, relative importance of lightning/anthropogenic causes, average fire size, and peak fire seasons (Table 1). For a given natural subregion, however, several differences were noted between Rogean (2009) and Tymstra et al. (2005) as shown in Table 1. This is likely because the latter study examined fire regime characteristics for natural subregions province-wide while Rogean (2009) focused specifically on the Greater R11 Region. Confirmation of multiple fire regimes within the landscape was a necessary first step: subsequent fire history research and management actions to return the fire regime to historic conditions will thus be based on these results.

Table 1. Summary of recent fire regime characteristics by natural subregion as determined for the Greater R11 Region (adapted from Rogeau 2009 and Tymstra et al. 2005). For ease of comparison, the analogous values from Tymstra et al. (2005) are shown in italics immediately below.

Parameter	Subalpine	Montane	Upper Foothills	Lower Foothills
Avg # Fires/10 ⁶ ha/Yr	14	173	41	58
	<i>14</i>	<i>82</i>	<i>28</i>	<i>28</i>
Fire cause	56% lightning 44% human	8% lightning 92% human	51% lightning 49% human	45% lightning 55% human
	<i>57% lightning 42% human 1% unknown</i>	<i>13% lightning 84% human 3% unknown</i>	<i>62% lightning 37% human 1% unknown</i>	<i>44% lightning 53% human 3% unknown</i>
Peak fire season†	July-Sept	April-Sept	May-Sept	May-June
	<i>May-Sept</i>	<i>March-Oct</i>	<i>May-Aug</i>	<i>April-Aug</i>
Mean fire size	55 ha	1 ha	3 ha	16 ha
	<i>16 ha</i>	<i>3 ha</i>	<i>57 ha</i>	<i>77 ha</i>
Mean fire size >10 ha	909 ha (316 ha*)	44 ha	170 ha	739 ha
Area burn rate/Yr	0.10%	0.03%	0.002%	Not calculated
	<i>0.02%</i>	<i>0.02%</i>	<i>0.16%</i>	<i>0.21%</i>
Current Fire Cycle	1,055 yrs	3,590 yrs	51,772 yrs	Not calculated
	<i>4,542 yrs</i>	<i>4,736 yrs</i>	<i>627 yrs</i>	<i>475 yrs</i>
Current Fire Regime	Very few ignitions overall with infrequent large fires burning majority of area; lightning fires typically occur mid-summer, anthropogenic fires occur later summer and contribute almost 2/3 of area burned; Dog Rib fire had strong influence on recent fire regime	Very frequent small fires dominated by anthropogenic causes (especially recreation) since small landbase in R11 is centered on two popular travel corridors; anthropogenic fires can occur in any month, especially May, but more area burned in later summer; no large fires >200 ha	Frequent small and somewhat frequent med-sized fires; spread restricted by proximity to mountainous terrain; lightning fires burn area in May and August, but majority of burn area attributed to anthropogenic fires, especially in later summer	Frequent small to med-sized fires but large fires burn majority of area; anthropogenic causes account for ¾ of area burned; active spring fire season before green-up with anthropogenic causes dominating both frequency and area burned in May, lightning fires dominate in June
	<i>Infrequent small wildfires owing to fuel and landscape discontinuity; very infrequent large, high-intensity wildfires; lightning</i>	<i>Frequent small human-caused wildfires, often in spring; wildfires small in size owing to low fire load and effective</i>	<i>Mostly lightning-caused frequent med-sized and infrequent large wildfires with majority of area burned in summer,</i>	<i>Frequent med-sized wildfires; lightning-caused fires dominate in the summer but spread is restricted by fuel</i>

	<i>accounts for most area burned</i>	<i>suppression in pine fuel types; rare large, high-intensity wildfires are wind-driven fall events</i>	<i>especially June</i>	<i>discontinuities and relatively moist summer conditions</i>
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† estimated from months in which significant burn areas were recorded

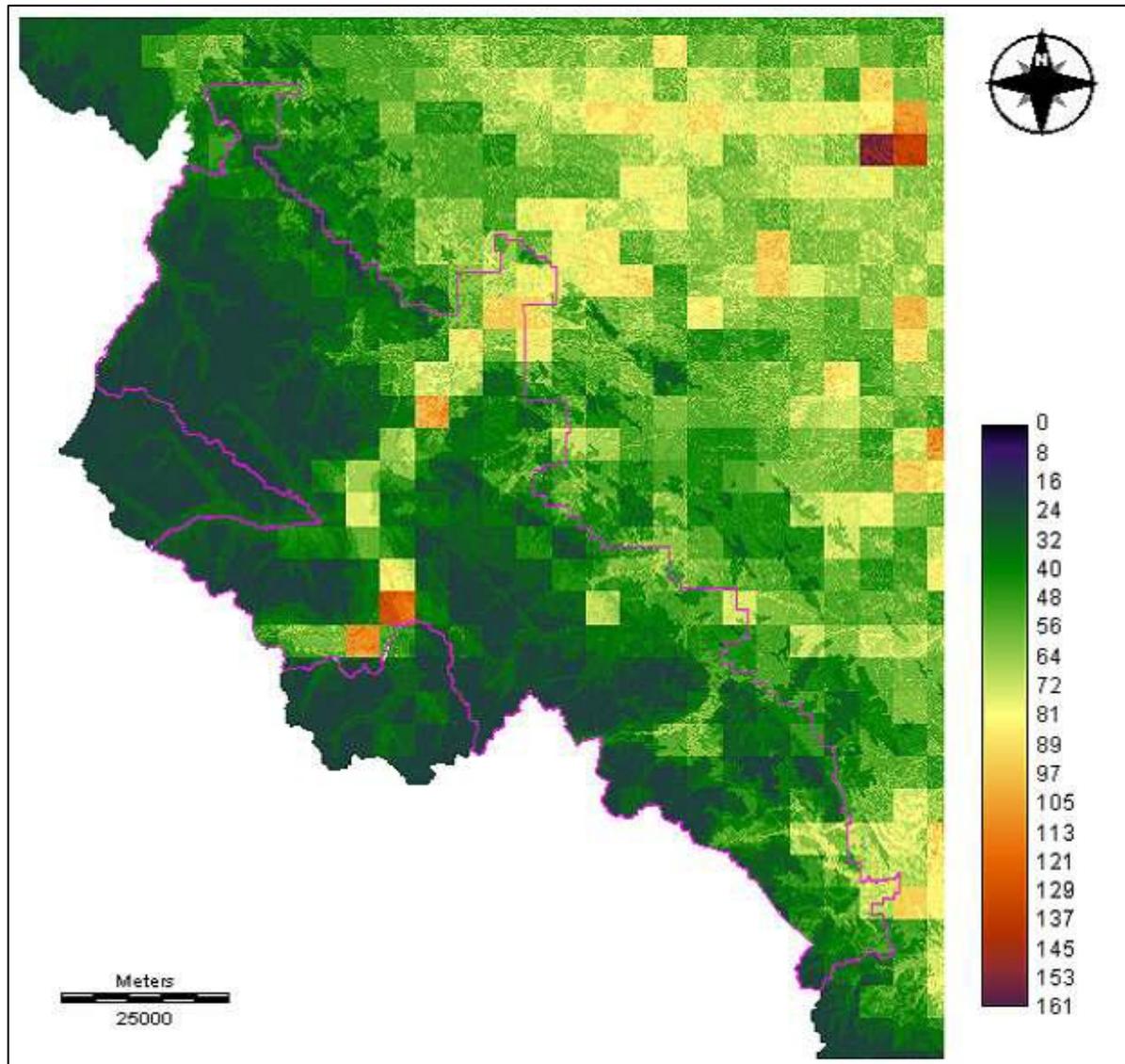
* excluding the Dog Rib fire

Rogean (2009) also developed models to predict probability of ignition for lightning-caused fires and for lightning- and anthropogenic-caused fires combined under the recent fire regime. The probability of lightning ignition model included as predictors, in order of importance:

- density of lightning-caused fires – from fire occurrence records, as density of lightning strikes showed only a weak association with density of lightning-caused fires,
- natural subregion – which captures the trend of increasing lightning fires from high to low elevations,
- lead tree species – since spruce stands support more ignitions than pine stands which support more than aspen, and
- aspect – since south and flat aspects receive more ignitions than north, east, or west aspects.

The probability of all ignitions model was created by overlaying the probability of lightning ignition map with a probability of anthropogenic ignition map, based solely on the spatial distribution of human-caused fires from the occurrence records (Map 1). The probability of all ignitions map subsequently classified the relative cumulative risks into five fire risk zones: very low (<30%), low (31 to 50%), moderate (51 to 80%), high (81 to 100%), and very high (>100%). Important to note, however, is that these zones predict probabilities of ignition not probabilities of burning, which are influenced by fuel type and fire weather (Rogean 2009).

Lightning-caused fires are more common several kilometres east of the R11 FMU owing to the factors discussed above. Of the lightning fires occurring within the FMU, concentrations are found along the North Saskatchewan River, on the eastern fringe, and in the south portion by the Red Deer, Dormer, and Panther Rivers (Rogean 2009). Human-caused fires are concentrated along Hwy 11, in the Red Deer Valley, and near the junction of the Ram River and Hummingbird Creek (Rogean 2009). When the probabilities of both lightning and human-caused ignitions are combined in the models, the areas of highest concern in the R11 FMU are along Highway 11 and in the southern tip of the FMU, specifically the Clearwater, Red Deer, Panther, and Dormer valleys. Accordingly, these models can be used in fire regime modelling, in combination with values-at-risk mapping in FireSmart planning exercises to identify areas requiring fuel reduction or other protective measures as well as in targeted educational programs to reduce sources of anthropogenic ignition.



Map 1. Probability of all ignitions map from combined probability of lightning and anthropogenic sources of ignition models (taken from Rogeau 2009).

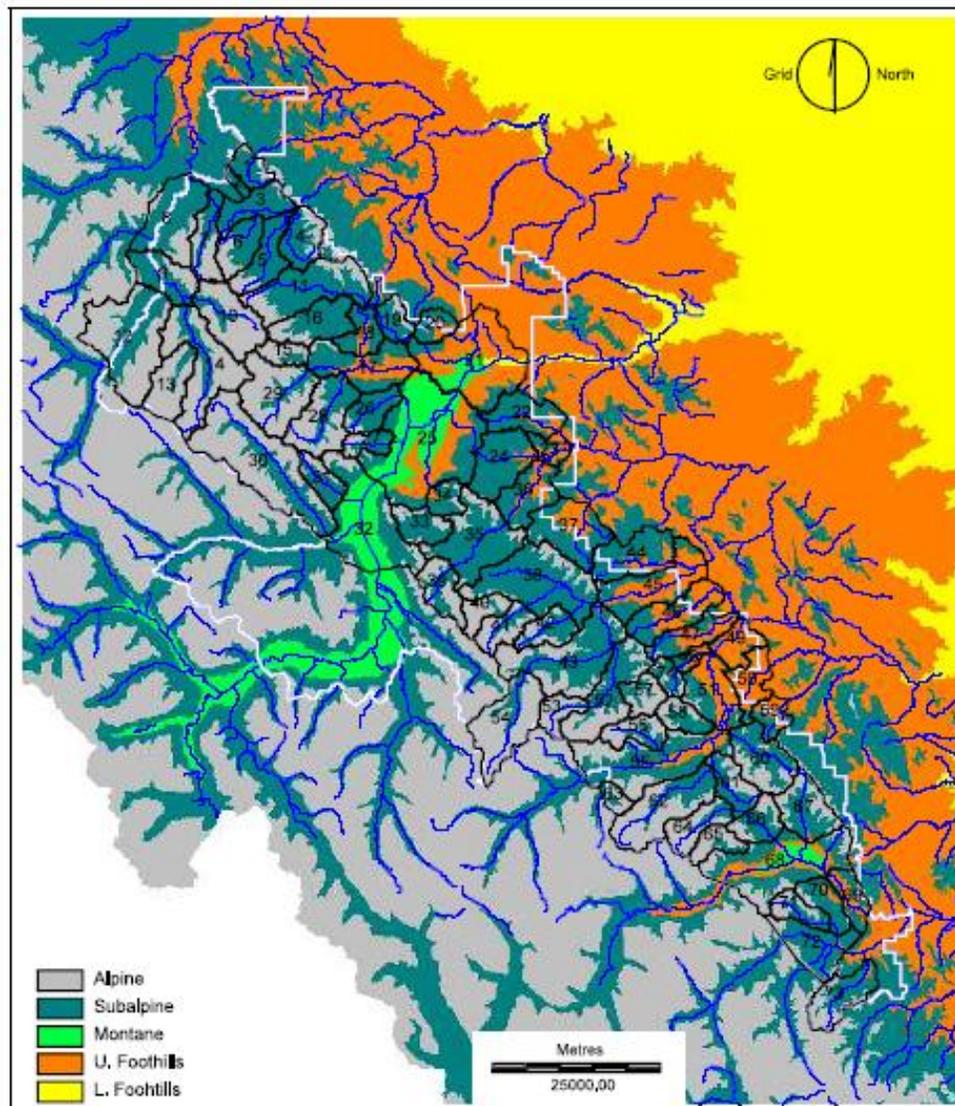
2.2 Historical Fire Regimes

Since the onset of fire prevention and suppression activities in Alberta, two key variables contributing to fire regimes have been influenced: fire frequency and area burned (Rogeau 2009). Historical data prior to fire suppression must be acquired if management actions are to be based on parameters from natural fire regimes. Two primary sources of information were collected or analyzed to obtain this historical data:

- (1) aerial photographs from circa 1950 provided information on the number of fires, type of burning, and range of fire sizes (in the areas and period of time with highest level of confidence), and

- (2) field data was collected for representative areas of the FMU to further examine historical fire regime, validate AVI stand age maps, and provide mean fire return intervals.

A watershed map was created to assist in air photo screening purposes and was subsequently used to look at the effect of topography and in fire modelling. Watersheds were delineated along the height of land and were a minimum six kilometres in length. When a significant change in valley orientation occurred, a given watershed was divided to capture this change. Natural subregion boundaries were overlaid on this watershed map. A total of 74 watersheds were identified within the R11 FMU (Map 2).



Map 2. The 74 watersheds identified within the R11 FMU for the historical fire regime analysis (taken from Rogeau 2009).

2.2.1 Historical Aerial Photograph Screening

Historical aerial photographs from circa 1950 were screened to provide information on number of fires and type of burning (i.e., surface, intermittent crown removal, full stand replacing) that occurred historically (Rogean 2009) and thus the way treatments should be applied (e.g., pre-treatment thinning/mechanical clearing, low intensity prescribed burns with significant residual/island remnants within harvest patches, or high intensity prescribed burns/clearcuts). Air photos were examined on a watershed basis to assess four fire parameters: total number of potential fires, number of recent fires (i.e., 1900-1950), vegetation complexity (i.e., categorical proxy for fire severity based on level of patchiness), and time-since-last-fire. Two additional topographical attributes, valley orientation and extent of fuel breaks, were recorded for each watershed. The information interpolated from these photos is most accurate for fires originating between 1900 and 1950 and not accurate for fires originating prior to around 1850. Furthermore, significant air photo quality issues resulted from the age of the original negatives, lowering the confidence level of the fire count and time-since-fire data for many watersheds (see Rogean 2009 for more discussion). This information was later substantiated with empirical field data as discussed below.

2.2.1.1 Fire Regime Parameters

Vegetation Complexity – As a general rule, vegetation complexity increases with increasing fire frequency and decreasing fire severity. Highly complex vegetation is characteristic of an area subject to frequent passive crown fires that leaves patches of unburned trees, while low vegetation complexity is characteristic of areas experiencing high intensity burns as indicated by homogenous forest cover and very few patches of remnant trees. Watersheds with high or very high vegetation complexity were typically main valleys or those influenced by the Upper Foothills fire regime, namely Red Deer, Elk, Peppers, Upper Clearwater, Lower Clearwater, Cutoff, Tershishner, and North Saskatchewan watersheds (Rogean 2009). Of the 44 watersheds with low or very low vegetation complexities, 79% were valleys that were enclosed by rocky ridges and had a greater time-since-last-fire (Rogean 2009).

Total Number of Fires – The number of fires was estimated with the assumption that different patches of forest with different tones and textures represented unique fires, likely represent fires dating back approximately 350 years (1600 to 1950). The fire counts were standardized to the number per 3,500 ha (i.e., the average size of a watershed unit in this study) to allow comparison among watersheds of varying sizes. Watersheds in the northwest corner of the FMU must have experienced significant fire activity at some point, despite the fact they have not seen much fire activity since 1825-1850 (Rogean 2009). Other areas with a high number of fires include Canary, headwaters of Hummingbird, headwaters of Ranger (as well as a side creek), Lost Guide, Peters, and Lower Red Deer valleys (Rogean 2009).

Number of Fires from 1900-1950 – The number of fires from just 1900 to 1950 was also assessed as better detection of fire boundaries was possible with these more recent fires (relative to 1950 when the aerial photography was flown), and thus this number should be more accurate than the total number of fires. However, for watersheds experiencing a long fire cycle, the chance of capturing a fire is reduced given the relatively short time window.

Only 11% of watersheds showed evidence of more than four fires since 1900, including the North Saskatchewan, middle Ram, and upper Red Deer valleys, and 45% of watersheds showed no evidence of partial or full stand replacing fires since 1900 (Rogeu 2009).

Time-Since-Fire – Based on the most recent fire that was assessed to have occurred in each watershed, a minimum time-since-fire (TSF_1) was estimated as well as a minimum time-since-fire excluding fires since 1900 (TSF_2). There was a general mix of times-since-fire across the R11 landscape, although Lower Abraham Lake, Allstones, and Tershishner watersheds showed the shortest TSF_2. Job Lake fork and Headwaters of the Bighorn River showed the longest TSF_2 in the northern portion of the FMU, while Headwaters of Ram, Ranger, Washout, and Scalp watersheds and a couple of associated side creeks showed the longest TSF_2 in the southern portion of the FMU. This assessment also showed a hiatus in historical fire activity beginning around 1825-1850 (Rogeu 2009). Archival research was undertaken to identify potential factors influencing this shift in fire regime. Rogeu (2009) reports that Scott Stephen, historian with Parks Canada Agency, indicated First Nations shifted from trading beaver furs with the Hudson's Bay Company towards trading plains bison hides with American traders in the late 1820's as opportunities opened up further south until relations with the American traders began to deteriorate in the late 1850's. The possible impacts of small pox on mountain First Nations populations are hard to discern as records are sparse; however, small-pox epidemics began in the 1780's and continued for 80 years with 1837 and 1869 being particularly devastating years (Rogeu 2009). As the R11 FMU lies within a lightning shadow and the fire regime is largely anthropogenically driven, the relative absence of aboriginal ignitions from either of these factors may have left the area almost fire-free for several decades.

Fire Sizes from 1920-1950 – Air photos were also used to map fires from 1920-1950 that had not been overlapped by more recent fires (Rogeu 2009). This provided a range of fire sizes during a period of little to no fire suppression activity. While data from a relatively short, 30-year period may not be truly representative of the much longer historical fire regime, this is the only period from which fire boundaries can be mapped with confidence. Several watersheds with high vegetation complexity, often indicating higher frequency/lower severity fires, were excluded as fire boundaries were too difficult to discern from air photos. Fifteen fires could be mapped with confidence, burning a total of 10,914 ha of the 137,422 ha of forested area in the studied watersheds. All mapped fires fell within the Subalpine Natural Subregion, and the mean fire size was 728 ha (range: 9.5 – 4,220 ha). The fire cycle was 378 years with an annual disturbance rate of 0.26% or 357 ha during this 30-year window.

2.2.1.2 Topographic Parameters

Valley Orientation – Each watershed was given a categorical number code representing the orientation of the main valley and its orientation at an intersection with another valley, as the likelihood of a fire burning in one valley then spreading into another valley is determined by the orientation at intersection (Rogeu 2009). Most of the 16 possible orientations were present and dispersed across the FMU. The valley orientation map was used as a base layer in subsequent fire growth modelling.

Fuel Continuity – Each watershed was classified by its fuel continuity as continuous fuels (i.e., valleys not surrounded by any rocky outcrops), partial fuel breaks (i.e., valleys that are partially bound by rocky ridges, either only at their headwalls or on two sides of their basin), and complete fuel breaks (i.e., valleys that are fully bound by rocky ridges except at the confluence with another valley). At the FMU level, 40% of the area had complete fuel breaks and only 17% had continuous fuels (Rogean 2009). Not surprisingly, watersheds with significant fuel breaks were generally located in the northwest and western portions of the FMU, watersheds with partial fuel breaks were located through more central areas and towards the southern portion of the FMU, and watersheds with continuous fuels were found along the eastern boundary as well as the lower portion of the North Saskatchewan valley (Rogean 2009).

2.2.1.3 Associations between Fire Regime and Topographic Parameters

Relationships between historic fire regime variables and topographic elements including valley orientation, fuel continuity, and natural subregion were examined. Small valleys running in a NW-SE direction that run perpendicularly to any other valley orientations showed a strong tendency to have low vegetation complexities and greater fire frequencies, suggesting a prolonged time since last fire (and thus low vegetation complexity) coupled with a dominant stand replacing fire regime (Rogean 2009). Main valleys tended to have a range of vegetation complexities but lower fire frequencies. A statistical measure of association was used to assess the relationship between the fire regime variables and fuel continuity as well as between the fire regime variables and natural subregions. The associations between the fire regime variables and fuel continuity were over twice as strong (avg = 0.69) as those between fire regime parameters and natural subregion (avg = 0.29; Rogean 2009). The overall Kappa Index of Agreement, a coefficient that measures thematic classification accuracy, is also much greater between fire variables and types of fuel continuity (Rogean 2009). These results indicate that fuel continuity had a strong influence on the historic fire regime and thus needs to receive greater consideration in subsequent analyses and determinations of fire regimes.

2.2.2 Field Data Collection

Field data was also collected for representative areas of the FMU (Rogean 2010a) to further examine historical fire regime, validate AVI stand age maps, and provide mean fire return intervals by watershed and natural subregion. This data will feed into fire growth models to simulate historical fire distributions and thus stand origins. Fire history field data collection focused on study units that represented one or a cluster of watersheds of similar fire regime. Other factors considered in the selection of study sites included clustering of contiguous valleys to create a large block of land where large fire events could be captured, prioritizing valleys currently on the prescribed burn agenda (especially those with a long fire-free period but moderate to high fire activity level at some point historically), and prioritizing valleys based on expected level of departure from fire regime.

Cross-sections were taken from multiple trees at 467 sites distributed across four regions in the FMU (Table 2), representing four different natural subregion/fuel continuity fire regimes. These tree cross-sections were later prepared and examined in the laboratory to count the rings and date evidence of fires (i.e., fire scars and releases²). Complete technical details on site selection, tree selection, sampling, sample preparation, and fire dating can be found in Rogeau (2010a).

Table 2. General description of fire history field study units by fire regime type (adapted from Rogeau 2009).

Fire Regime Type	Field Study Region	Description
Subalpine with partial fuel continuity	Blackstone	Partially bound by rocky ridges, low fire frequency in recent past but increased fire activity in mid-1800s.
Montane dominant with partial fuel continuity	Red Deer - Clearwater	Straddles Subalpine, Montane, Upper Foothills but with partial fuel breaks; level of fire activity since 1900 in Subalpine valley bottoms is greater than other Subalpine areas in FMU likely related to travel corridors between Clearwater to the north and Red Deer to the south.
Montane dominant with continuous fuels	North Saskatchewan valley	Straddles Montane and Upper Foothills; chosen due to use as travel corridor, traditional land use, and planned prescribed burns though only portions not complete watersheds sampled. Rogeau 1999 provides fire history data for area west of Whiterabbit Ck and Cline R.
Upper Foothills dominant with continuous fuels	Lower Ram	East slopes of last rocky ridge; continuous fuels

² *fire scars*: scarred tissues forming a triangular shape at the base of a tree. Fire scars occur when heat kills part of the tree cambium.

releases: sudden increase in growth rate by a dramatic reduction in the competition for light and nutrients from the now dead neighbouring trees. A sustained release for ten years or more is normally associated with a stand replacing natural disturbance event.

From the fire history field data on fire dates and stand ages, mean fire return intervals, range of fire return intervals, number of fires between 1700 and 1950, and oldest stand were identified for each of the sampling regions. This information is shown below in Table 3 broken down by areas or watersheds sampled within a given fire regime type.

Table 3. Summary of different fire regime variables among the sampled fire regime types and the watersheds sampled therein (adapted from Rogeau 2010a). Valley ID is shown in parentheses after the watershed name. MFRI = mean fire return interval, FRI = fire return interval, Fire Frequency = number of fires between 1700 and 1950, Oldest Stand = age of oldest stand identified.

Fire Regime Type/Watershed	MFRI (years)	FRI Range (years)	Fire Frequency (#/250 yrs)	Oldest Stand (date)
Subalpine with partial fuel continuity				
Blackstone (3)	54	6 - 140	18	1710
Smith (4)	78	13 - 203	15	1590
George (5)	84	8 - 255	22	1535
Mons (6)	82	19 - 214	12	1580
Montane dominant with partial fuel continuity				
Upper Clearwater (55)	57	3-240	35	1595
Scalp (66)/Skeleton (61)	59	9-270	35	1595
Red Deer (68 & 69)	61	10-159	16	1660
Montane dominant with continuous fuels				
N. Sask – East of Bighorn R. (21)	22	11 - 129	19	1740
N. Sask – Forestry Trunk Rd, N of River	34	12 - 63	6	1877
N. Sask – Forestry Trunk Rd, S of River	24	7 - 68	10	1820
Along south bank of River (25)	23	11 - 52	13	1840
N. Sask – Between Cline R and Whitegoat Ck (32)	24	5 - 49	13	1831
Upper Foothills dominant with continuous fuels				
Lynx (44)	59	10 - 173	21	1665
Lower Ram (45)	64	4 - 253	29	1640
Elk (46)	39	4 - 174	25	1680
Peppers (47)	71	4 - 286	15	1495

2.2.3 Conclusions

Both recent and historical fire regime analyses point to multiple fire regimes within the R11 FMU, associated with fuel continuity (i.e., complete fuel break, partial fuel break or continuous fuel) and natural subregions (i.e., Subalpine, Montane, Upper Foothills). Fire regime parameters assessed from the historical air photo screening as well as stand ages and fire boundaries determined through field data collection can be used to model a range of potential stand age distributions originating from fires and thus calculate fire cycles. This modelling was completed in Rogeau (2010b).

2.3 Fire Regime Simulations

Fire regime simulations were conducted to determine fire cycles and stand ages during the pre-suppression, pre-settlement era while still accounting for First Nations ignitions. STANDOR, the chosen model, is a landscape disturbance model that uses parameters from the historical fire regime and is calibrated with empirical field data to model fire distribution on the landscape over long periods of time creating simulated stand origin and fire return interval maps. The various data layers and inputs required for use in STANDOR are summarized in Figure 2. Repeated model runs allow the calculation of mean values as well as the standard deviation around those means, which offers a natural range of variation. A particular advantage of the STANDOR model is its ability to track cumulative burned area including areas that may be burned again in part or in whole. Furthermore, the model can track particular areas of the landscape independently, such as areas with a particular fire regime defined by their fuels, topography, and fire weather. The fire cycle values and yearly rate of disturbance calculated with modelling outputs indicate the number of hectares that should be disturbed each year, with the total number of hectares divided among seral stages to ensure the age-class distribution remains within its natural range of variation (NRV).

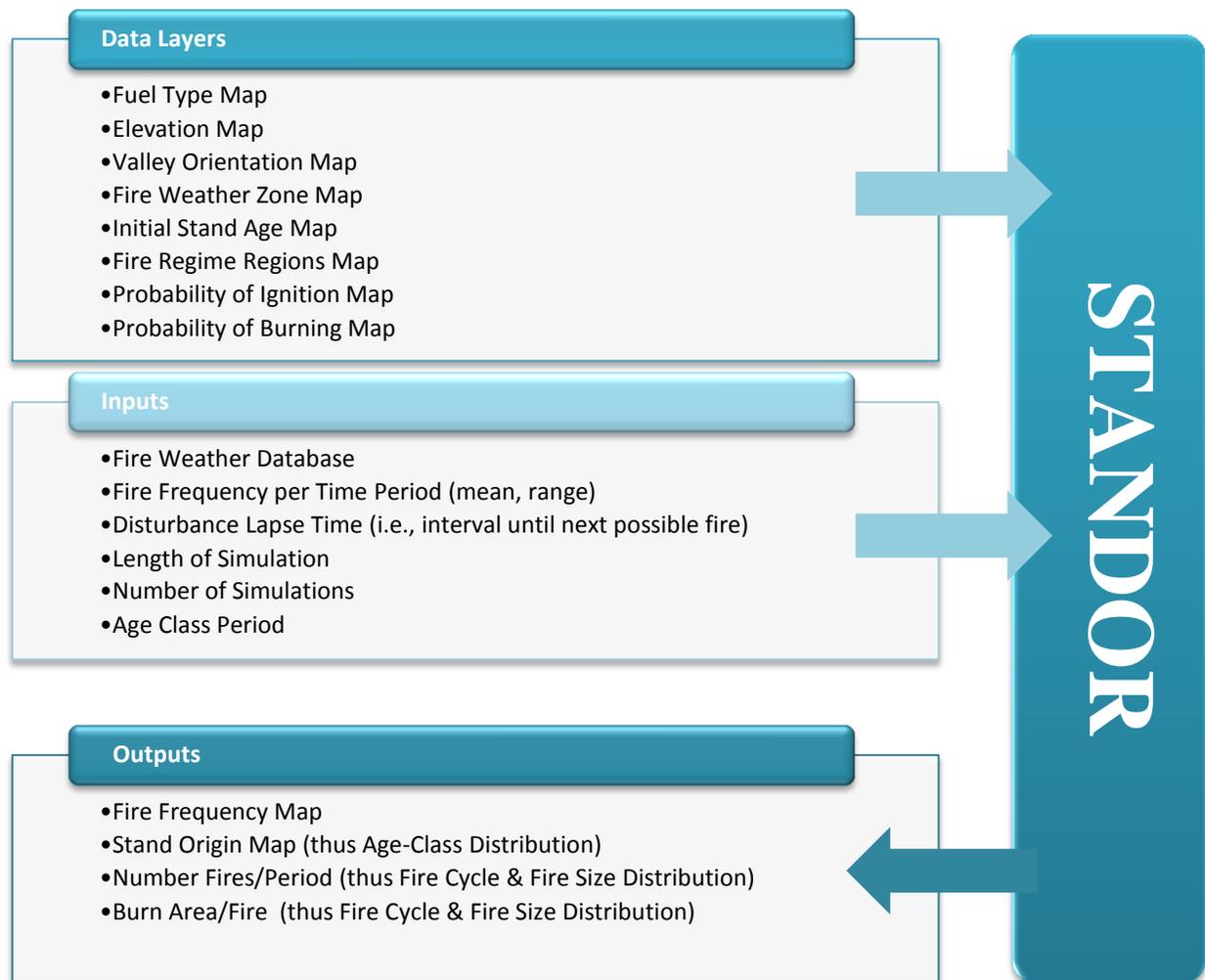


Figure 2. Summary of GIS data layers, databases, and user inputs required for the STANDOR landscape disturbance model as well as outputs produced by the model.

2.3.1 Six Fire Regime Regions

Six fire regime regions were identified for fire regime simulations, representing clusters of contiguous watersheds with shared topographic and fire regime characteristics. These six regions are discussed briefly below (excerpted from Rogeau 2010b).

Blackstone-Wapiabi Region (Subalpine with partial fuel continuity) – This region encompasses the watersheds north of the North-Saskatchewan Valley and east of the alpine region of the Brazeau drainage. These valleys are only partially bound by rocks at their headwaters and by the Bighorn Range to the east. These contiguous valleys have an uninterrupted forest cover and are more likely to see larger size fires.

Brazeau - Coral Region (Alpine with fuel breaks) – This fire regime region encompasses watersheds that are north of the North-Saskatchewan Valley and that are bound by rocky ridges. With the exception of the Brazeau Valley, this alpine setting contains valleys that are narrow and run in a perpendicular fashion to a more important valley. Very few lightning fires are recorded and, with the exception of the Brazeau, human access is difficult.

North Saskatchewan Valley (Montane dominant with continuous fuels) – As the name indicates, this region encompasses only the North Saskatchewan Valley and some of its direct tributaries. The spread of fire in this area is not so much limited by rocky ridges but by Abraham Lake. Note that historically the lake did not exist and would have contributed to the occurrence of larger size fires. However, this is something that cannot be replicated and the output of the models should be realistic of today's environmental conditions.

North Ram - Ram Region (Alpine with fuel breaks/Subalpine with partial fuel continuity) – This region represents an agglomeration of watersheds within the Ram Range. It is bound to the north by the North-Saskatchewan Region and to the south by the Clearwater watershed. The headwaters of most watersheds are in an alpine setting and bound from all sides by rocky ridges, whereas the lower portions of these watersheds, such as the North-Ram, Ram, Onion, and Hummingbird, are only partially bound by rocky ranges and large tracts of forest are continuous. Because of these variations in fuel continuity and valley sizes, it is expected that fire spread will not behave equally across the entire region.

Foothills Region (Upper Foothills dominant with continuous fuels) – All watersheds on the east fringe of the FMU, draining directly into the Upper Foothills were grouped to form this region. Note that the two bottom watersheds (ID 50, 59), while sharing Foothills characteristics, were modelled with the Clearwater Region because they are also highly influenced by upstream burning in this valley.

Clearwater - Red Deer Region (Montane dominant with partial fuel continuity) – All watersheds draining into either the Clearwater or the Red-Deer Valleys were lumped together. Fire history data collection showed that the Mean-Fire-Return-Intervals were consistent in the two main valleys, and that their total number of fires recorded from the 1950 photos was also the same. After some model testing focussing on one watershed at a time, and comparing the outputs to the combined regions, it was found that the fire distribution model was capturing the fire regime in both basins.

2.3.2 Modelling Results

2.3.2.1 Fire Size Distribution

From 10 iterations of 1,000 years, thousands of fires were simulated on the landscape. The average and maximum fire sizes showed that larger fires were associated with wider valleys and greater fuel continuity, while alpine areas produced smaller fires, likely owing to the partial or complete fuel breaks posed by rocky ridges between valleys (Table 4, Rogeau 2010b). Fires greater than 10,000 ha were more likely to occur in the North Saskatchewan and Foothills fire regime regions than in the others, though such events occurred very

infrequently (< 2% of fires). Approximately 95% of the area burned across the FMU came from 51% of the fires in size classes 500 ha or greater (Table 4).

Table 4. Fire size (ha) summary for each fire regime region (adapted from Rogeau 2010b).

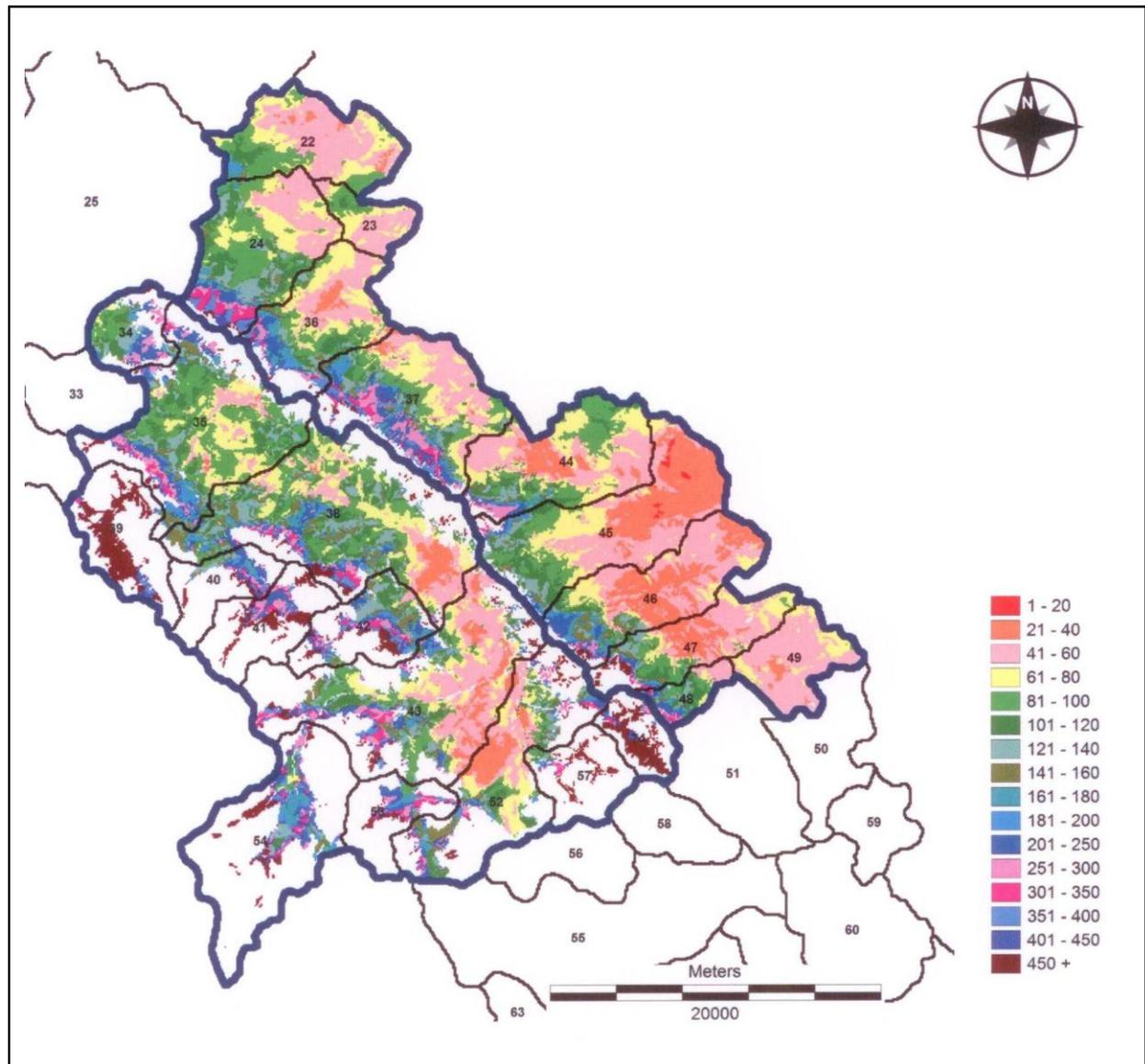
Parameter	Brazeau-Coral	Blackstone-Wapiabi	N. Sask.	N. Ram-Ram	Foothills	Clearwater-Red Deer
Avg	380	983	1,283	600	1,303	837
STD	608	1,627	2,705	1,034	2,020	1,385
Minimum	1	1	1	1	1	1
Maximum	5,851	14,519	36,097	12,456	21,039	18,895
% Fires \geq 500 ha	37%	53%	54%	46%	62%	53%
% Area from Fires \geq 500 ha	89%	96%	98%	94%	98%	96%

2.3.2.2 Age Class Distribution

Ten simulated stand origin maps were averaged to produce a mean stand origin map for each fire regime region, and the mean percent of the landbase in each age class was determined (Table 5). The standard deviation around these means provides a natural range of variation. These mean stand origin maps for the six regions showed younger forests in areas experiencing frequent fires (i.e., short Mean Fire Return Interval) and older forests in areas where the MFRI was longest (e.g., Map 3, see next section).

Table 5. Mean percent of forested landbase in each age class and associated natural range of variation resulting from the simulations for each fire regime region (adapted from Rogeau 2010b). Age classes follow those used in the R11 FMP: young 0-20 years, pole 21-100 years, mature 100-180 years, and mature >180 years.

Age Class	Brazeau-Coral		Blackstone-Wapiabi		N. Sask.		N. Ram-Ram		Foothills		Clearwater-Red Deer	
	AVG	NRV	AVG	NRV	AVG	NRV	AVG	NRV	AVG	NRV	AVG	NRV
Young	12	4-21	13	6-20	34	13-55	18	12-25	24	11-37	21	11-30
Pole	29	19-38	54	38-70	54	38-69	38	27-48	52	36-69	46	35-57
Mature	16	10-23	14	7-21	8	4-12	18	11-24	13	8-19	15	10-21
Old	43	35-50	19	13-25	5	2-7	26	21-31	10	7-13	18	15-21

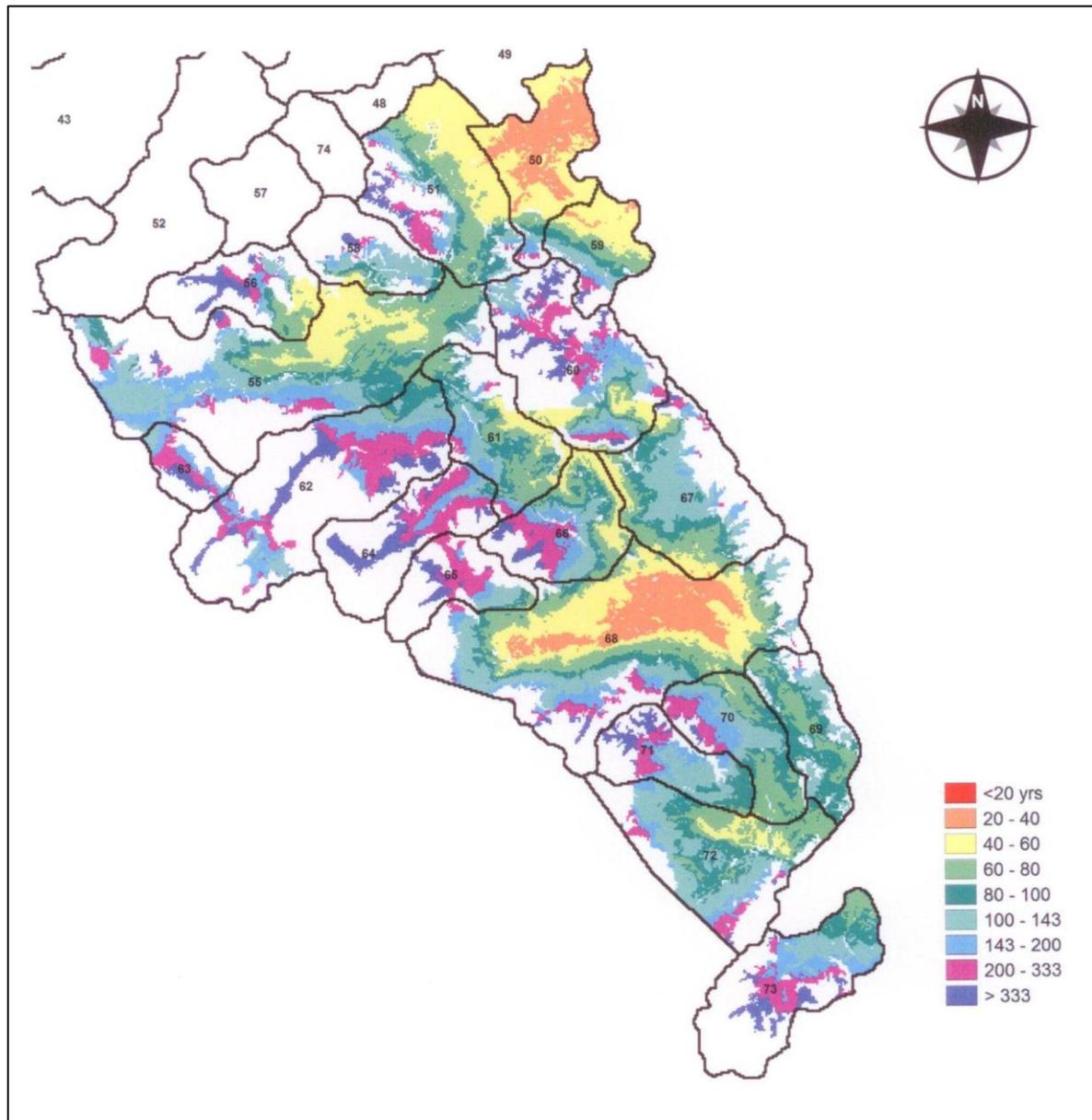


Map 3. Sample of a mean stand origin map for the North Ram – Ram fire regime region (left) and the Foothills fire regime region (right). The categories represent years since stand origin and thus age class of the forest (taken from Rogeau 2010b).

2.3.2.3 Mean Fire Return Interval

For each STANDOR simulation, a fire count map was outputted. The maps for each fire regime region were averaged to show the mean fire return interval (i.e., average number of years between the occurrences of fires at a given point). Map 4 shows an example of the MFRI map for the Clearwater-Red Deer fire regime region. Rogeau (2010b) recommended that these MFRI maps become the foundation for re-introducing fire to the landscape by targeting areas with the shortest MFRI when planning prescribed fires. It is important to note that in areas with short MFRI the fuel load and thus fire intensities would have been

much lower than would be expected now. Furthermore, the STANDOR model does not simulate the fire intensity or residual patches left by fires (Rogeanu 2010b).



Map 4. Sample of a Mean Fire Return Interval map for the Clearwater-Red Deer fire regime region (taken from Rogeanu 2010b).

2.3.2.4 Fire Cycle

Fire cycle is the number of years it would take to burn an area equivalent in size to the entire area of interest, accounting for the fact that some areas may burn more than once while others may never burn (Johnson and Van Wagner 1985). This can be obtained by either

assessing the NRV of fire size, frequency and return intervals, or by summing burn areas over a set period of time. The fire cycle for each fire regime region was compiled using STANDOR to sum all burn areas until they equalled the size of the vegetated landbase in the region (Table 6). This yearly rate of disturbance (ha/yr) or percentage of a given landscape disturbed each year (% area/yr) can be then be estimated by dividing the area of vegetated landbase by the fire cycle or by taking the inverse of the fire cycle, respectively.

Table 6. Fire cycle (years) summary for each fire regime region (adapted from Rogeau 2010b).

	Brazeau-Coral	Blackstone-Wapiabi	N. Sask.	N. Ram-Ram	Foothills	Clearwater-Red Deer
Avg Fire Cycle	180	108	50	115	78	81
NRV Fire Cycle	149-211	81-135	36-65	90-140	59-97	64-98
Vegetated Area (ha)	42,372	27,305	63,814	60,760	41,867	68,997
Avg Disturbance Rate (%/yr)	0.6	0.9	2.0	0.9	1.3	1.2
Avg Annual Burn Area (ha/yr)	236	252	1,275	529	536	853
NRV Annual Burn Area (ha/yr)	201-287	201-337	987-1,773	435-675	433-704	706-1,075

2.4 Fire Regime Conditions Departure

The condition of the land is classified by land managers based on the degree by which current fire patterns differ from historical, natural fire patterns and the relative risk of losing key ecosystem components during a fire. Significant departures indicate an increased risk of losing particular values due to increased probability of high intensity conflagrations that are hard to control.

Departure from historical fire regime conditions was assessed using methodologies developed for Jasper and Banff National Parks (see Rogeau 2008 and Rogeau 2010b for details). Rogeau 2010b reviewed the state of departure for various fire regime components (cycle, cause, size, severity, seasonality, and resulting landscape patterns) within the R11 FMU. In general, data from the historic fire regime analysis, the fire history field data collection, and the fire growth simulation modelling was compared to data from the recent fire regime analysis (1961-2008)³, and a qualitative score representing the degree of

³ The one exception was the fire cycle departure that was assessed by calculating the burn area deficit: the actual amount of burning on the landscape since 1930 compared to the expected amount of burning based on the historic fire cycle.

departure was assigned with 1 indicating a low level of departure, 2 indicating a moderate level of departure, 3 indicating a high level of departure, and 4 indicating a critical level of departure. The qualitative scores for each fire regime variable were weighted according to its importance and the confidence in the data and then summed to give a total score out of a possible score of four. The percent departure score is classified as per the Fire Regime Condition Classification (FRCC) representing the overall degree of departure of the fire regime region from historic conditions (analogous to Schmidt et al. 2002). Results are shown in Table 7 for each fire regime region. Note that Clearwater and Red Deer valleys are presented separately despite sharing a similar fire regime: this addressed an immediate management need as these areas are the focus of some imminent prescribed burns.

Table 7. Cumulative fire regime departure scoring system for the fire regime regions within the R11 FMU (adapted from Rogeau 2010b). The relative weighting of each variable in the Total Score is shown in parentheses. The three FRCC classes are 1: < 33%, 2: 34 - 66%, and 3: > 67% departure.

Fire Regime Variable	Brazeau-Coral	Blackstone-Wapiabi	N. Sask.	N. Ram-Ram	Foothills	Clearwater	Red Deer
Fire Cycle (50%)	1.63	2.48	3.67	2.17	3.08	2.82	2.80
Cause (10%)	1	1	2	1	1	1	1
Size (10%)	4	4	4	4	4	4	4
Severity (15%)	1	2	3	2	3	2	2
Seasonality (15%)	2	2	3	2	1	2	2
Total Score	1.77	2.34	3.34	2.19	2.64	2.51	2.5
% Departure	44.1	58.5	83.4	54.6	66.0	62.8	62.6
FRCC	2	2	3	2	2	2	2

Overall, the North Saskatchewan valley was the mostly highly departed from its historic fire regime, followed by the Foothills, Clearwater, and Red Deer regions. Even the Brazeau-Coral region, which showed the lowest level of departure, was still moderately departed.

2.5 Application of the R11 Fire Regime Analyses to the R11 Forest Management Plan

Of the 47 unique objectives identified within the R11 Forest Management Plan to conserve ecological, economic, and social values within the landbase, approximately half have direct relevance to planning and managing fires within the FMU (Table 8). Four indicators and associated targets require specific consideration in light of the recently acquired information from the R11 Fire Regime Analyses (Rogeau 2009, 2010a, 2010b) and will be discussed below. These indicators deal with treatment size and residual unburned area within a burn (Indicator 1.1.1), stand age distribution (Indicator 1.1.2), rate of disturbance (Indicator 2.1.1), and use of natural wildfires (Indicator 2.1.2). Though not discussed in depth here, several

other indicators are also impacted secondarily by the Fire Regime Analyses because they defer to the stand age distribution.

A key outcome of the Fire Regime Analyses is the identification of six fire regime regions within the R11 Forest Management Unit. The R11 FMP was constructed on the premise of four fire regimes related to natural subregions and thus some indicators were assessed for each natural subregion separately. The fire regime regions identified and modelled by Rogeau (2010b) represent contiguous watersheds that share topographic, fuel break, and fire characteristics, but they are not directly comparable to the initial natural subregion-based fire regimes outlined in the R11 FMP. Accordingly, indicators and targets originally assessed for each natural subregion will shift to assessment within the fire regime regions. This revised approach will allow more specific tailoring of indicator targets and treatment activities to approximate the historic regimes of particular regions within the FMU.

Table 8. Values, objectives, indicators, and targets (VOITs) from the R11 Forest Management Plan that have direct relevance to planning and managing fires within the FMU. Shaded indicators are those that are impacted by new information from the Fire Regime Analysis and that are discussed in detail in the text.

Value	Objective	Indicator	Target
Ecosystem Diversity	Conserve ecosystem diversity by emulating natural disturbance patterns	1.1.1 Treatment size and residual pattern	More than $\frac{2}{3}$ of treatment events greater than 600 ha; planned treatment boundaries and fire skips to provide an average 40% remnant area
		1.1.2 Stand age distribution by area	Areas of young and old forest within the natural range of variation for each natural subregion
	Conserve ecosystem diversity by maintaining or restoring uncommon plant communities	1.2.1 Uncommon plant communities, specifically whitebark pine, limber pine, Douglas-fir, and lowland grassland communities	All known area of each community type inside Protected Areas and 80% of total known area outside Protected Areas to be maintained
		1.3.1 Area of unsalvaged burned forest and blowdown	90% of burned and blowdown areas remaining unsalvaged
Plant Species Diversity	Conserve plant species diversity by maintaining viable populations of native species	1.4.1 Location of individual whitebark and limber pine	80% of identified whitebark and limber pine trees and populations to be maintained
		1.4.2, 1.4.3, 1.4.4 Location of mountain bladder fern, wood anemone, and Lapland rose-bay populations	All identified populations of mountain bladder fern, wood anemone, and Lapland rose-bay to be maintained
Fish Species Diversity	Maintain important habitat for populations of fish species	1.5.1 Area of disturbed riparian habitat	Prescribed fire planning to ensure complete protection of riparian habitats

Value	Objective	Indicator	Target
		1.6.1 Maintenance of stream buffers	Sundre Forest Products OGR for stream buffers met or exceeded on bull trout and cutthroat trout streams
Wildlife Species Diversity	Maintain and restore high quality ungulate summer and winter range	1.9.1 Stand age distribution broken down by habitat capability for elk, deer, and moose	Stand age distribution within the natural range of variation in areas identified as capable of supporting elk, deer, moose, and bighorn sheep
		1.9.2 High quality ungulate winter range and associated movement habitat	Targets not set in 2007 R11 FMP
		1.9.3 High quality ungulate summer range and associated movement habitat	Targets not set in 2007 R11 FMP
	Maintain important habitat for grizzly bear	1.10.1 High quality grizzly bear habitat and associated movement habitat	Targets not set in 2007 R11 FMP
	Maintain important habitat for wolverine	1.11.1 High quality wolverine habitat	Stand age distribution within natural range of variation (see Indicator 1.1.2)
	Maintain habitat for important furbearers, specifically pine marten and red squirrel	1.12.2 Stand age distribution, specifically mature and old-growth	Stand age distribution within natural range of variation (see Indicator 1.1.2)
	Maintain important habitat for Clark's nutcracker	1.14.1 High quality Clark's nutcracker habitat, including whitebark and limber pine stands	80% of identified populations and individual whitebark and limber pine trees maintained. (see Indicator 1.4.1)
	Maintain habitat capable of sustaining future woodland caribou range expansion	1.16.1 Area of mature and old-growth forest	Area of mature and old-growth forest within natural range of variation (see Indicator 1.1.2)
Sensitive Sites	Maintain integrity of biologically sensitive sites	1.17.1 Identified sensitive sites (e.g., Environmentally Significant Areas, mineral licks, major game trails, den sites, etc.)	Prescribed fire planning to ensure complete protection of sites sensitive to burning
Ecosystem Integrity	Maintain natural disturbance patterns at the landscape level	2.1.1 Area disturbed per decade by natural subregion	Periodic disturbance rate of 50% of the median reported fire cycle for each natural subregion ⁴
		2.1.2 Disturbance via natural process where appropriate	Identification of areas where wildfires may be permitted under different HFIs
		2.1.3 Fire intensity	Distribution of Headfire Intensity ranks across the landscape

⁴ Ten-year disturbance targets for forested areas in each natural subregion are as follows: Alpine-378 ha, Subalpine-7966 ha, Montane-1387 ha, Upper Foothills-3579 ha, and Lower Foothills-24 ha. See the R11 Forest Management Plan for further details and disturbance targets for non-forested areas.

Value	Objective	Indicator	Target
Forest Health	Reduce the impact of Mountain Pine Beetle	3.3.1 Stand Susceptibility Index	75% reduction in the area of highly susceptible stands currently projected in 20 years
		3.3.2 Stand age distribution	Stand age distribution within the natural range of variation for each natural subregion (see Indicator 1.1.2)
Science-based Decision Making	Ensure stakeholders and managers are informed by science	5.1.1 Implementation of current research findings in R11	Continual monitoring and implementation of relevant research findings
Domestic Grazing	Maintain trails open to manage livestock and consider cow locations during prescribed fire plans.	6.1.1 Location of cow trails and season of use.	No increased use of riparian areas as a result of treatments; prior consultation with affected disposition holders.
Wildfire Threat	Integrate fire management objectives with overall landscape management objectives	8.1.1 Vegetation management zone map	Appropriate vegetation management zone map developed
	Reduce the threat of large, high intensity catastrophic wildfires	8.2.1 Fire behaviour potential	5% reduction of high and extreme fire behaviour classes over a 20 year period
		8.2.3 Area burned outside containment areas	No hectares burned outside containment areas
Inherent Value	Maintain cultural values and treaty rights	9.1.1 Integrity of traditional sites, burial grounds, ceremonial locations, etc.	Complete protection of traditional sites, burial grounds, ceremonial locations, etc.
	Minimize changes to air quality as a result of prescribed fire treatments	9.4.1 Number of smoke-filled days in high use areas	Less than 5 consecutive smoke-filled days in high use areas as a result of prescribed fire treatments
Recreational Opportunities	Maintain infrastructure	10.1.1 Location of staging areas, washrooms, bridges, campgrounds, trails, roads	No impact to infrastructure from treatments
Community Integrity	Protect community appeal for local residents by protecting private infrastructure and property	12.1.3 Integrity of personal property in or near treatment areas	Complete protection of private property during treatment activities
Information and Education	Communicate the rationale behind and benefits resulting from prescribed fire and harvest treatments	13.1.1 Activities demonstrating communication and education	Ongoing and timely multi-pronged communication and public education program
Multi-agency Cooperation	Employ a multi-jurisdictional approach to managing fire and pests at both the planning and operational levels	14.1.1 Harmonized plan objectives across agency boundaries	Timely and meaningful consultation with stakeholder agencies
		14.1.2 Joint operations among agencies when implementing fire and pest management treatments	Participation in joint treatments with other agencies

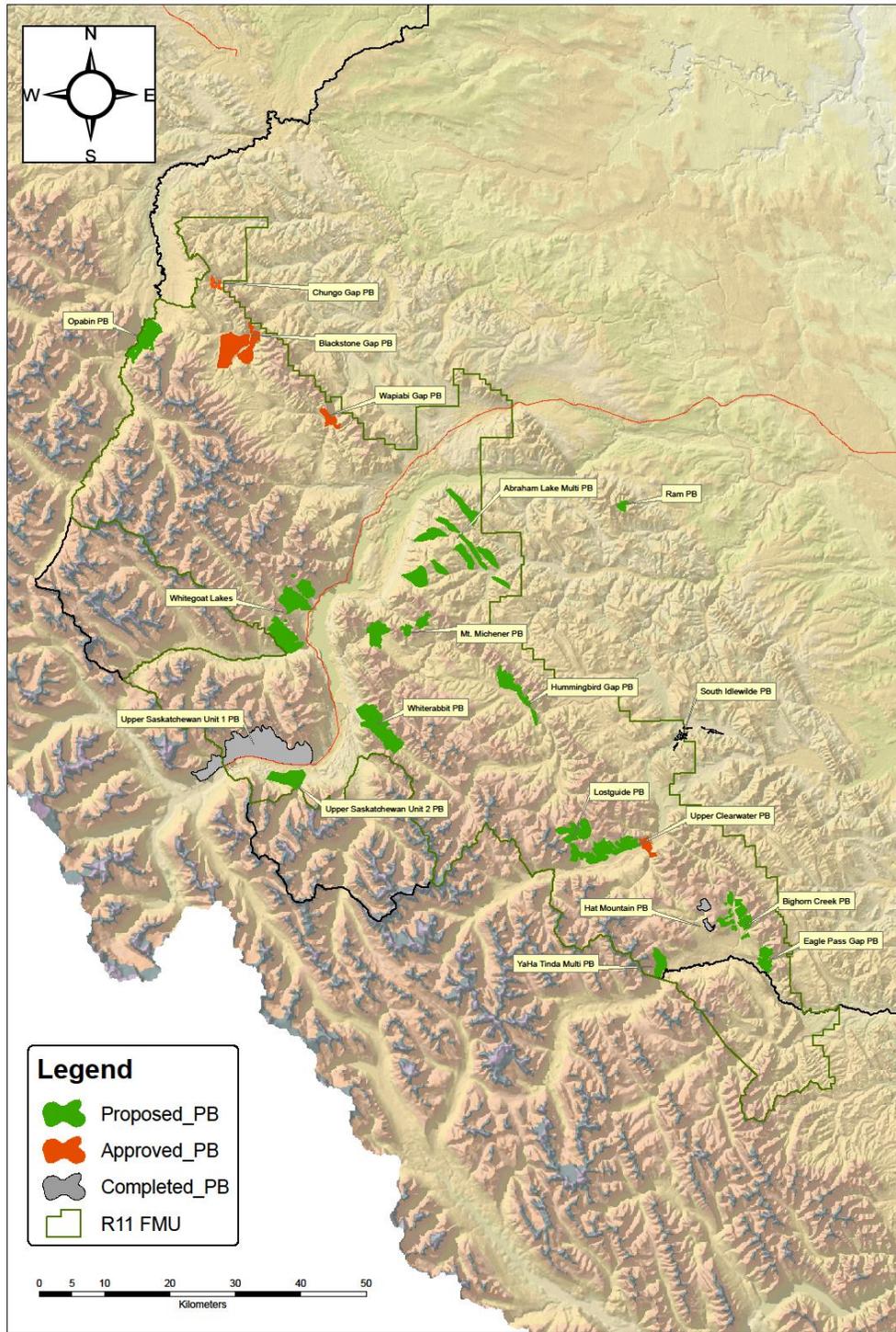
Value	Objective	Indicator	Target
Public Safety	Ensure public safety along existing trails through burned and harvested areas	15.1.1 Identification and mitigation of risk trees in burned and harvested areas	Mitigation of all risk trees along existing trails running through burned and harvested areas

2.5.1 Treatment Size (Indicator 1.1.1)

The Indicator 1.1.1 target for treatment size was greater than two thirds of disturbance events would be 600 ha or larger in size as assessed FMU-wide (ASRD 2007). This target was set based on information from the Highway 40 North Demonstration Project and the Foothills Model Forest Natural Disturbance Program, for which the study area bordered R11 to the north-west and contained a similar compliment of natural subregions (Lower Foothills, Upper Foothills, Montane, Subalpine, and Alpine). In the absence of R11-specific information on historic fire sizes, the Natural Disturbance Program research provided the best approximation of historic disturbance event sizes and their frequency distribution.

The R11-specific fire regime simulation modelling (Rogean 2010b) has now provided historic fire size information for the six fire regime regions (Table 4). Note that there is a slight difference in the disturbance size thresholds employed in Rogean (2010b) and in the R11 FMP target (500 ha vs. 600 ha, respectively). Rogean (2010b) found that approximately half the fires were less than 500 ha and half were 500 ha or greater, but these latter fires were responsible for approximately 95% of the area burned across the FMU. This is consistent with the Foothills Model Forest Natural Disturbance Program research and other fire ecology findings for western North American fires that show the majority of area burned is by large fires. Analysis of the recent R11 fire regime, on the other hand, showed that in general there were too few fires and that not enough area was being burned by large fires (i.e., 500 ha or greater) (Rogean 2009, 2010b).

There are currently 14 prescribed burns scheduled or proposed for the R11 FMU (Map 5, Table 9): 70% of these are 600 ha or greater in size, compliant with the original Indicator 1.1.1 target for disturbance event size. Future prescribed burn planning can now also take into consideration the mean and range in historic fire sizes typical of a given fire regime region (e.g., mean fire size in the North Saskatchewan fire regime region is almost three times greater than in the Brazeau-Coral region, Table 4).



Map 5. Proposed, approved, and completed prescribed burns in the R11 FMU.

Table 9. Proposed and approved prescribed burns for the R11 FMU.

Name	Area (ha)
Abraham Lake multi	3,536
Bighorn Creek	1,021
Blackstone	2,168
Chungo	325
Eagle Pass	458
Hat Mountain	400*
Hummingbird	221
Lostguide	815
Mt Michener	1,364
Opabin	1,299
South Idlewilde	52*
Upper Clearwater Capping	1,915
Upper Sask 1	5,727*
Upper Sask 2	990
Wapiabi	328
Whitegoat Lakes	2,517
Whiterabbit	1,651
<i>Total</i>	<i>24,787</i>

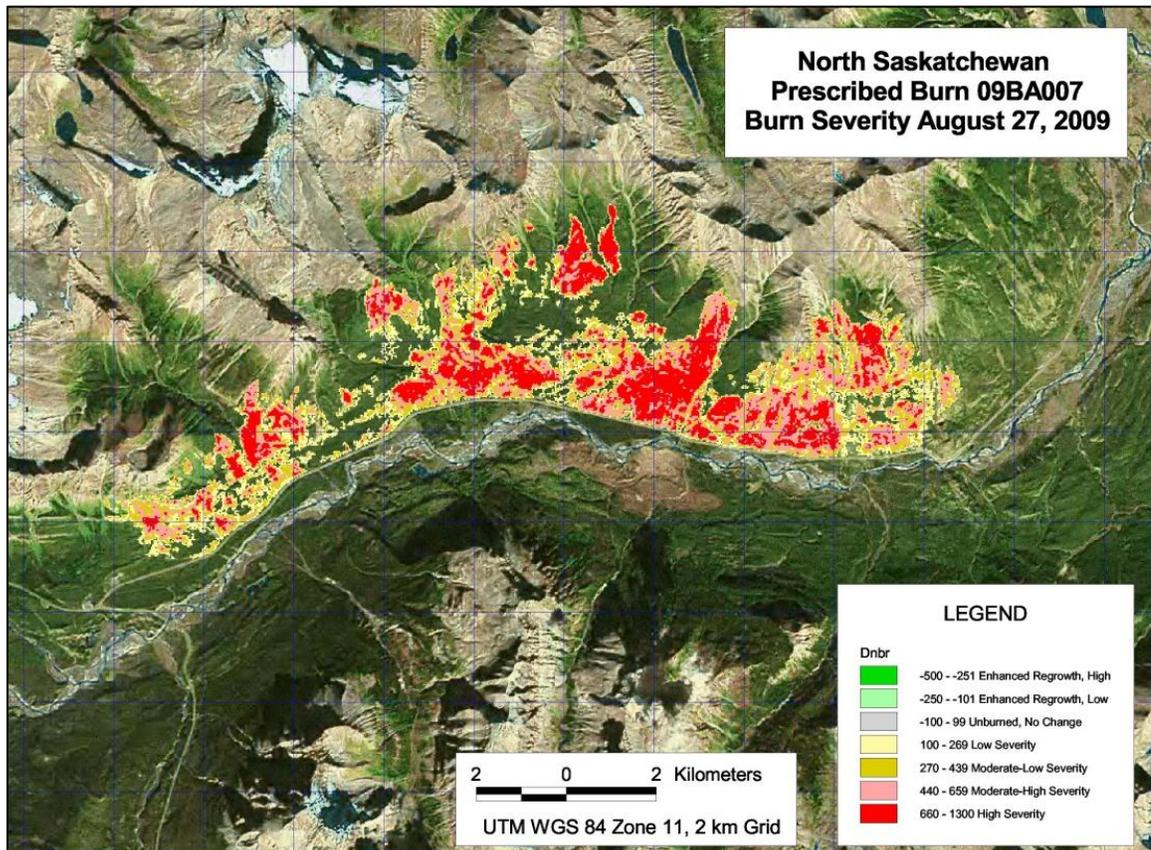
*Completed

2.5.2 Residual Pattern (Indicator 1.1.1)

The Indicator 1.1.1 target for residual structure within treatment events states a minimum 15% of remnant undisturbed forest within a treatment area, with the average amount of post-treatment remnant area falling between 29% and 49% (ASRD 2007). This target was again based on research out of the Foothills Model Forest Natural Disturbance Program (Andison 2003c, Andison 2006c). Because the fire regime model STANDOR did not simulate fire intensity or residual patches (Rogean 2010b), the best information on historic fire severity within the R11 FMU was derived from the historical aerial photo screening (Rogean 2009). Each of the 74 watersheds was assigned a categorical value for vegetation complexity (i.e., high, medium, low) following the general rule of increasing residual structure/vegetation complexity with increasing fire frequency and decreasing fire severity. As this provides no numerical data on amount of residual structure within historical burns, the Foothills Model Forest research remains the best available information upon which to base R11 FMP target.

Most prescribed burn plans identify a target forest cover disturbance, measured by percentage of crown fraction burned (CFB), in the range from 50% to 80% distributed across the overall burn area. At a minimum, aerial reconnaissance both pre- and post-fire is needed to definitively determine the actual percentage of CFB. Ideally however, an analysis of pre- and post-fire Landsat imagery would provide a more standardized determination of burn severity using Normalized Burn Ratio methodology (e.g., Map 6, ASRD and Parks Canada

2010). The associated data products, specifically the fire perimeter and burn severity map, can then be analyzed following Anderson (2006c) for residual structure as islands within the burn unconnected to the outer matrix and peninsulas, corridors, etc. with remaining connections to the outer matrix. The NEPTUNE (Novel Emulation Pattern Tool for Understanding Natural Events) application from Foothills Research Institute is suited to such an analysis of residual structure within treatments.



Map 6. Differenced Normalized Burn Ratio from pre-fire to post-fire for the Upper Saskatchewan Unit 1 prescribed burn.

2.5.3 Stand Age Distribution (Indicator 1.1.2)

Indicator 1.1.2 targeted to move the area of young (<20 years) and old (>180 years) forests to within the natural range of variation for each natural subregion (ASRD 2007). The numerical targets for stand age distribution were established in the R11 FMP by using information generalized from studies in other parts of the province and by applying the negative exponential function to estimate the natural range of variation. This was a simplistic but accepted method for modelling stand age distribution in the absence of local fire cycle data.

Given the level of uncertainty associated with local stand origin data from the Alberta Vegetation Inventory (Rogean 2009), the recent acquisition of local historic fire cycle information, and the relative ease of measuring fire cycle, ASRD has indicated the desire to shift this indicator from stand age distribution within the natural range of variation to fire cycle within the natural range of variation. As a rule, shorter fire cycles will produce a younger age class distribution, while areas with a longer fire cycle will have a stand age distribution biased towards older age classes. The focus of this indicator will be further refined from natural subregions to the fire regime regions outlined by Rogean (2010b). The targets for each fire regime region are thus the average fire cycle and its associated natural range of variation shown in Table 6.

Where other indicators or targets defer to Indicator 1.1.2, they are often attempting to ensure adequate habitat for wildlife species associated with particular age class(es) (i.e., Indicators 1.11.1, 1.12.2, 1.16.1, 3.3.2). The change in this indicator to fire cycle instead of stand age distribution is equally valid for these associated indicators: treatment activities to return fire cycles to within their natural range of variation will by default also produce an age class distribution within its natural range of variation, thereby ensuring habitat as it would have been historically represented on the landscape.

2.5.4 Periodic Disturbance Rate (Indicator 2.1.1)

Indicator 2.1.1 outlined ten-year disturbance targets for each natural subregion based on the previously reported historic fire cycles and the proportional amount of the natural subregion within the FMU (ASRD 2007). The disturbance targets for prescribed burning and harvesting were set at 50% of median fire cycle for each natural subregion, with the assumption that natural wildfires would further help reach the lower end of the natural range of variation in disturbed area.

The R11 Fire Regime Analyses determined mean historic fire cycles for each of the six fire regime regions (Rogean 2010b). While these regions do not correspond completely to the natural subregion-based fire regimes used in the original R11 FMP, the results do show shorter fire cycles and a higher annual disturbance rate in fire regime regions with more montane habitat and less area disturbed annually in fire regime regions with a higher proportion of subalpine/alpine habitat (Table 6). To reflect the new fire regime information, the target for Indicator 2.1.1 will change to a periodic disturbance rate of 100% of the mean reported fire cycle for each fire regime region instead of natural subregion.

2.5.5 Natural Wildfires Where Appropriate (Indicator 2.1.2)

The intent of Indicator 2.1.2 is to promote the use of natural wildfires wherever appropriate in achieving the R11 FMP objectives. If the management of natural wildfires is to be considered as a viable tool, measures must first be in place to ensure the protection of values-at-risk. These measures include the establishment of strategic fuel breaks (i.e., capping units created through previous prescribed burns) and the delineation of natural fire zones outlining options for acceptable limits of spread and acceptable range of Head Fire Intensities. When this Clearwater Landscape Fire Management Strategy is in place, natural wildfires occurring

within fire regime regions more highly departed from their historic conditions can be allowed to burn more frequently and with less suppression efforts, thereby helping to return fire cycles closer to historic levels.

For example, the R11 Fire Regime Analyses identified the North Saskatchewan River valley watershed as being in a severe deficit for fire occurrence (Rogean 2010b). The valley is predominantly within the Montane Natural Subregion, has continuous fuels, and historically (and currently) experienced a high number of human ignitions. Accordingly, the fire regime for this region was characterized by frequent, small human-caused fires with some large fires. The current fire cycle is 3,590 years, while historically the fire cycle would have been 50 years (Rogean 2009, 2010b). Both ongoing and future prescribed burns as well as the Clearwater Landscape Fire Management Strategy will contribute to shortening the fire cycle.

3 Current Indicator Status

This section presents information and updates for the 72 indicators/targets identified in the original FMP. To provide complete background information and the **2007 Baseline Status** of the indicator for comparison purposes, the original indicator sheets are replicated from the 2007 FMP and supplemented with the addition of one or two new sections. The **2012 Status** section provides updated information and current status as of late 2011 based on any monitoring data collected or analyses conducted. As discussed above, some indicators will be revised based on the Fire Regime Analysis results. Thus the **2012 Revision** section is added when indicators are undergoing a change in the indicator or target based on newly acquired research or studies.

Indicator 1.1.1

Value: Biodiversity – Ecosystem Diversity

Objective: Conserve ecosystem diversity by emulating natural disturbance patterns and the range of variation therein (i.e., coarse filter approach).

Indicator: Treatment size and residual pattern.

Target: Treatment size and pattern within the natural range of variation: multiple treatments over a series of years may be clustered to emulate larger natural burns. Greater than two thirds of these treatment events will be 600 ha or larger. The planning boundaries for individual treatment events will provide a minimum of 15% remnant undisturbed forest, with the average amount of post-treatment remnant area falling between 29% and 49%.

Baseline Status: In developing this indicator and the associated targets, the Planning Team reviewed the work done by the Foothills Model Forest Natural Disturbance Program and the associated Highway 40 North Demonstration Project. The Natural Disturbance Program is a large research project that has been studying fire regimes in the Rocky Mountain and Foothills Natural Regions of west-central Alberta. The Highway 40 project is a multi-partner initiative that is demonstrating how research results from the Natural Disturbance Program can be incorporated into a natural disturbance emulation approach to planning industrial activity. Assessing this indicator using methods similar to those of the Highway 40 project demonstrates use of the best available science, a direct recommendation of the Charrette process (Objective 5.1). Although the Foothills Model Forest study did not occur within the R11 FMU boundary, the study area did border R11 to the north-west and contained a similar compliment of natural subregions (Lower Foothills, Upper Foothills, Montane, Subalpine, and Alpine). As a result, the general findings have considerable applicability to the R11 area.

Planning for the Highway 40 North Demonstration Project, which can be viewed in detail at <http://www.fmf.ca/HWY40/project.htm>, utilized two tangible statistics that are relevant to the treatment size and pattern indicators chosen for the R11 FMU. The first is the natural distribution of disturbance event sizes (Andison 2006a). Andison (2006b) defined a disturbance event as “the general area affected by a single episode of disturbance where at least 20% of the vegetation is killed.” For most natural disturbances in R11, this would be the result of a single wildfire, which would occur over the course of a single fire season. The emulation of natural disturbance patterns in industrial activity, as is being demonstrated through the Highway 40 project, applies this concept to a series of closely associated harvest disturbances created over an interval of time, such as a number of months or years. A similar approach can be taken to planning a series of prescribed burn treatment units that are conducted individually to meet logistical needs, but that emulate larger natural patterns when viewed as a single disturbance event.

Research conducted by the Foothills Model Forest Natural Disturbance Program demonstrated that in the Rocky Mountain and Foothills Natural Regions, the majority of wildfires (over two thirds for all subregions) are less than 10 ha (Andison 2003a). However, it is the few large fires that have the greatest impact on the landscape (Figure 3).

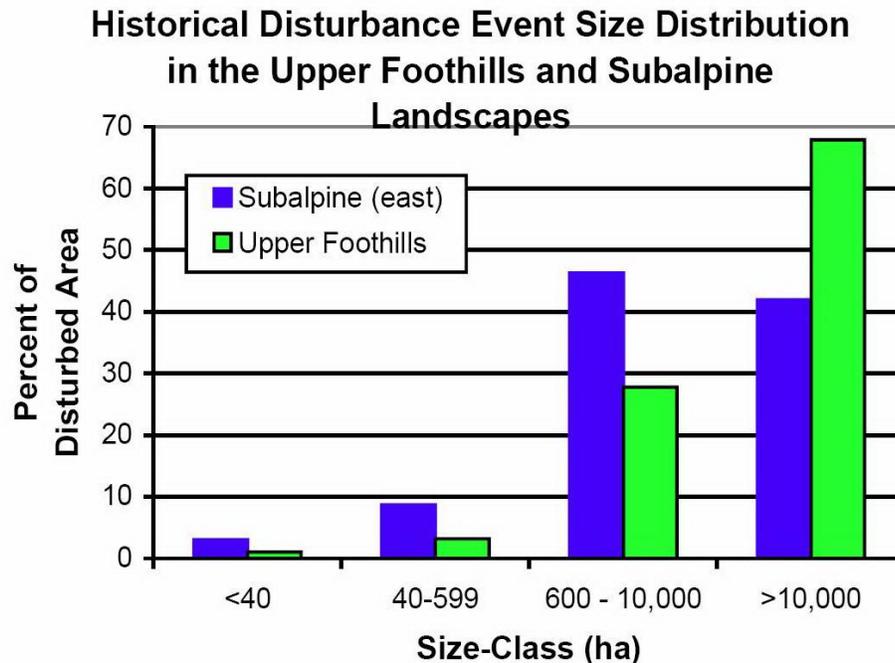


Figure 3. Distribution of historical disturbance event sizes in the Upper Foothills and Subalpine Natural Subregions (taken from Andison 2006a).

Because natural fire event size varies so greatly, the natural range of variation allows for considerable flexibility in planning the size of treatment events within R11. Disturbance events could be either very small (less than 10 ha) or very large (greater than 10,000 ha) and still be within the NRV. To provide further guidance to current and future planners, the Planning Team chose to set a target related to the proportion of large (600+ ha) treatment events that should occur in order to emulate broad natural landscape patterns. As Andison (2003a) found that greater than two thirds of the disturbed area in each natural subregion was associated with events larger than 600 ha, this was chosen as the target for R11 planning. Event boundaries are to be determined using the methods proposed by Andison (2006b), and a maximum implementation period of 10 years will define a single disturbance event.

The second aspect of natural fire patterns that has been used for planning the Highway 40 North Demonstration Project is an assessment of the residual structure left within each event. Within natural fires, especially the larger ones, patches of forest remain unburned. These remnant patches contribute to the mosaic of stand types, enhance biodiversity, and provide cover for large wildlife. Foothills Model Forest research demonstrated that 90% of burns had on average 12%, and up to 30%, of the area within the burn perimeters left undisturbed in island remnants (Andison 2003c). If forest matrix remnants within a fire boundary (peninsulas, corridors, etc.) were also considered, total residual structure ranged between



Island remnant within the Lost Guide burn

15% and 62%, with an average 39% of the area unburned (Andison 2006c). Thus, the target is to leave between 15% and 62% of the total area of individual treatment events as undisturbed forest remnants, with the average for all treatment events falling within the range of 29% to 49% (i.e., $\pm 10\%$ of the 39% average reported by the Natural Disturbance Program). For harvesting treatments, this indicator can be measured using proposed block layout information and adjusted if necessary prior

to harvesting. However, the amount of island and matrix remnants that will remain following a prescribed burn is much more difficult to predict due to the influence of environmental factors such as wind patterns, temperature, and relative humidity on the day of the burn. To ensure that each treatment event falls within the range of 15% to 62% residual structure, planners will strive to ensure that the minimum 15% is matrix remnants retained through boundary planning. Additional island remnants within these boundaries will be created through natural fire behaviour and operational activities at the time of treatment.

Forecast: Using the procedures described above, the operational plan for R11 was assessed using indicators for treatment size and residual pattern. As per Andison (2003a), events were attributed to the natural subregion that comprised the greatest proportion of the event.

Event sizes: The percentage of disturbed area by event size classes is represented in Figure 4. The target of having greater than two thirds of the disturbed area within event boundaries larger than 600 ha should be met. The general pattern, which shows most of the disturbance area occurring in large events is pleasing. However, there is one major difference between the outcome of the proposed treatments and the Foothills Model Forest Natural Disturbance Program information (Andison 2003a): there is a lack of any disturbance events in the 10,000 ha+ range. The Planning Team was left with two options for addressing this issue. The first option was to re-examine the proposed burn events and add additional units to increase the total size of some units to over 10,000 ha. The second option was to proceed with the events as planned and re-examine this issue for subsequent FMP updates. Given the novel nature of the natural disturbance emulation approach being proposed in this plan, the Planning Team opted to proceed with the events as planned for the initial phase of plan implementation. Although no events are expected to be greater than 10,000 ha, at least five proposed events are expected to be greater than 5,000 ha. Events of this size are ecologically appropriate as they fall within the natural range of variability for wildfire size; however, their social palatability is yet to be determined. If, after the implementation of multiple events greater than 5,000 ha, it is found that the public accepts this degree of disturbance, ASRD forest and land managers will consider increasing the size of some events to greater than 10,000 ha.

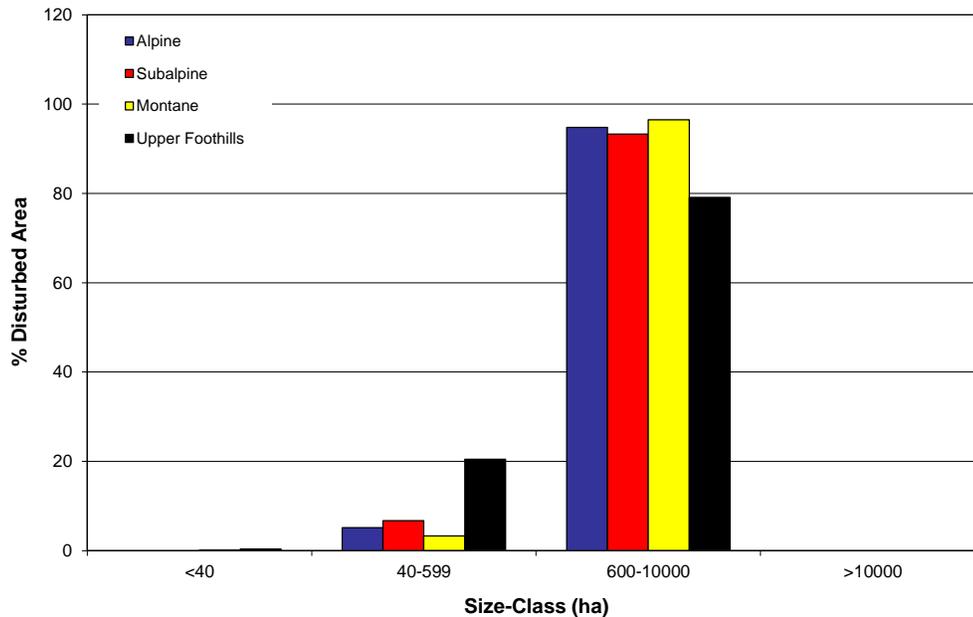


Figure 4. Projected percentage of area disturbed in event size classes for each R11 natural subregion based on proposed harvest and prescribed burn treatments.

Timing of events: When calculating the event sizes, the projected timing of treatments was ignored. The Highway 40 project suggests that adjacent treatment units, which in total comprise an event, should occur within a 10-year span to restrict variation in the plant communities among treatment units. This provides direction to ASRD that once harvest or prescribed fire is initiated in an area, the surrounding treatments should be completed within a 10-year span.

Residual structure: Treatment units proposed thus far for the R11 FMU identify conceptual perimeters and areas. Analysis of these proposed units indicates that approximately 13% of the total treatment area (range: 1%-36%) will be retained as undisturbed matrix remnants through boundary planning. This does not meet the 15% minimum or the 39% average ($\pm 10\%$). Thus, operational plans for harvesting will incorporate additional forested island remnants within harvest units to more closely approach the target. Similarly, prescribed burn plans will have prescriptions designed to remove only 60% to 80% of the crown and leave forested islands where possible to further emulate natural burn patterns and attain the target for residual structure.

Monitoring: Following the completion of treatment activities, event boundaries will be determined using GPS, airphoto interpretation, or satellite imagery. Care will be taken to capture the extent of all island and matrix remnants. Actual event sizes will be calculated using a GIS and reported by natural subregion. The percent residual structure within each event will be calculated through GIS analysis. The average (i.e., mean) undisturbed area for all treatment events completed to date will be reported and assessed against targets. The success of operational or unplanned structure retention activities will be assessed following each disturbance event. A summary of results will be presented in the Stewardship Report.

Response: If event size results are outside of an acceptable range, event sizes can be reassessed in subsequent FMPs. If residual structure results fall below target averages, additional matrix and island remnants will be incorporated during treatment planning.

2012 Status: Six harvest blocks and six prescribed burns were conducted over the five-year reporting period (Table 10). Two wildfires greater than 1 hectare in size also occurred within the R11 FMU (there were multiple small human-caused fires <1 ha; ASRD *unpubl. data*). Event sizes and remnant patches (i.e., residual structure) were determined using GIS following the definitions and methods outlined in Andison (2003b). As per this methodology, prescribed burns occurring over 500 m apart were considered separate events, even though they may represent subunits within a given prescribed burn plan.

Table 10. Summary of harvest, prescribed burn (PB), and wildfire disturbances occurring within in R11 FMU between 2007 and 2011.

Disturbance Type	Natural Subregion	Total Area within Perimeter (ha)	Area of Residual Structure (ha)
Harvest	Montane	146.5	43.0
Harvest	Upper Foothills	47.5	9.8
Harvest	Upper Foothills	29.8	6.1
Harvest	Upper Foothills	47.2	12.2
Harvest	Upper Foothills	293.8	103.8
Harvest	Upper Foothills	90.4	22.4
PB	Subalpine	156.2	5.4
PB	Alpine	249.3	1.9
PB	Upper Foothills	140.6	33.1
PB	Upper Foothills	1.4	0.0
PB	Subalpine	4948.2	1234.6
PB	Subalpine	174.2	46.7
Wildfire	Subalpine	1829.8	56.6
Wildfire	Montane	10.6	1.2

Event Sizes

The R11 FMP target for event sizes was set based on the Andison (2003a) finding that more than two thirds of the disturbed area in each natural subregion resulted from events over 600 ha. Completed treatment activities have not currently met this target as only one prescribed burn and one wildfire event were in the 600-10,000 ha size class, both in the Subalpine Natural Subregion. The majority of treatment events were in the 40-599 ha size class, with one prescribed burn, one harvest block, and one wildfire falling into the <40 ha size class (Figure 5).

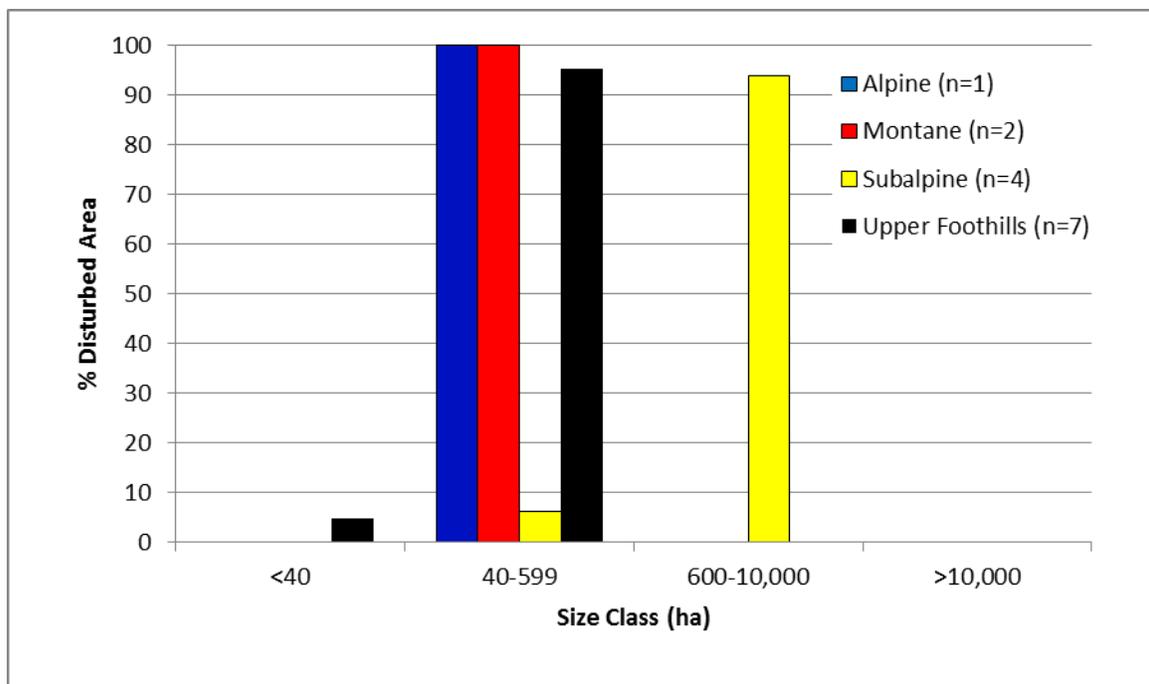


Figure 5. Percentage of area disturbed in event size classes for each R11 natural subregion based on harvest and prescribed burn treatments completed between 2007 and 2011.

Four currently approved or proposed prescribed burns to be completed in the next few years also fall into the 40-599 ha size class in the Subalpine and Upper Foothills Natural Subregions (Table 9). These capping units (see Indicator 2.1.2) must be established as fire guards in advance of larger-scale, more aggressive prescribed burns and managed wildfires within the R11 FMU. The Upper Saskatchewan Unit 1 burn was significant in size (4,948 ha⁵), was carried out efficiently and effectively with joint Parks Canada and ASRD operations (ASRD and Parks Canada 2010), and was generally well received by the public (see Indicators 7.1.2, 12.1.2, 12.1.3). The success of this prescribed burn sets precedence for the subsequent use of large fires to achieve plan objectives within the FMU as capping units and fire guards are completed. The R11 FMP allows for adjacent treatments occurring within a 10-year span to be considered the same event, thus the size class distribution may shift upwards as surrounding treatments are completed.

Residual Structure

The amount of residual structure within harvest and prescribed burn treatments ranged from a minimum 0.5% to a maximum 35%, with the average across all treatments at 20% (Table 10). Thus the target of a minimum 15% remnant undisturbed forest, with the average amount of post-treatment residual structure falling between 29% and 49% was not met. All harvest blocks met the minimum target; however, the average amount of residual structure (avg=26%) was slightly less than the target range for the average. Future harvest blocks

⁵ The total size of the prescribed burn was 5,727 ha, with 779 ha falling within Banff National Park and 4,948 ha within provincial lands.

should be designed with slightly more residual structure to push the average retention into the acceptable range. Prescribed burns deviated considerably more with the average amount of residual structure (avg = 14%) not reaching the minimum acceptable target. This is likely owing to a couple of factors: the importance of adequate post-burn mapping and analysis (discussed below) and the influence of wind patterns, temperature, relative humidity, etc. on natural fire behaviour, operational activities, and thus the ability to ensure adequate residual retention within the fire area. Nonetheless, subsequent prescribed burns must strive to increase island and matrix remnants within the prescribed burn boundary during planning and wherever feasible during operational activities.

Post-burn mapping of the fire perimeter and residual structure within the perimeter is critical to accurately assessing this portion of the indicator as the assessed level of residual structure can vary significantly based on the mapping methodology. For example, the Upper Saskatchewan Unit 1 prescribed burn boundary used to assess this indicator was a Parks Canada boundary derived using Normalized Burn Ratio methodology referenced earlier in Section 2.5.2. When assessed following Anderson (2006c), this GIS layer produced a single event with 25% of the area as residual structure. A similar analysis by Alberta Conservation Association using a preliminary GIS layer created internally based on the NBR methodology with a different burn severity cut-off value produced three events from the same burn and greater than 50% of the area in residual structure (Table 11, ACA *unpubl. data*). The ACA analysis used the NEPTUNE application from Foothills Research Institute to determine event size, event shape, number of patches per event, disturbed patch shapes, percent of event area in matrix remnants, island remnants, total remnants, and sizes of island remnants. Note that the Parks Canada-derived boundary layer for this burn has now been adopted by partnering agencies, including ACA, for subsequent analyses.

This more detailed mapping based on NBR was not completed for other prescribed fires occurring within the R11 FMU over the past five years, and often only the boundary is adequately captured. Accordingly, the amount of residual structure remaining within prescribed fires may be underestimated. Future assessments of residual structure within prescribed burns should employ a standardized method of mapping the burn area including remnants within the boundary and should consider the use of a tool such as NEPTUNE in calculating parameters regarding remnants.

Table 11. Residual structure in the Upper Saskatchewan Unit 1 prescribed burn as assessed using an internal ACA fire boundary and the NEPTUNE application (ACA *unpubl. data*).

Event	Area	Area in Matrix Remnants	Area in Island Remnants	Total Area in Remnants
1	4,223 ha	46%	4%	50%
2	612 ha	62%	2%	64%
3	0.31 ha	14%	0%	14%

2012 Revision: In the fire regime study for the R11 FMU, Rogeau (2010b) found that approximately half the fires were less than 500 ha and half were 500 ha or greater. Thus the target for treatment size, originally set at ‘greater than two thirds of treatment events will be

600 ha or larger’, will be revised to ‘greater than one half of treatment events will be 500 ha or larger’ to reflect this new information. The residual structure target will remain the same.

Indicator 1.1.2

Value: Biodiversity - Ecosystem Diversity

Objective: Conserve ecosystem diversity by emulating natural disturbance patterns and the natural range of variation therein (i.e., coarse filter approach).

Indicator: Stand age distribution by area.

Target: Area of young (<20 years) and old (>180 years) forests falls within the natural range of variation for each natural subregion.

Baseline Status: In the primarily fire-adapted forest ecosystem found in R11, the associated fire regime will determine the amount of forest in various age classes at a given point in time. Maintaining or restoring these broad natural disturbance patterns on the landscape requires an understanding of key fire regime components, namely fire cycle, and the influence of local differences in climate and topography. Fire cycle is the time in years over which you expect a defined area to burn, and it can be used to model natural stand age distribution in a given natural subregion. This modelling method allows the identification of targets for restoring natural landscape patterns. Fire cycle is best determined through local fire regime analyses and modelling; however, local fire regime information is currently only available for a portion of the R11 FMU and no spatially-explicit natural range of variation modelling has been conducted (see the Landscape Description section of the FMP for a more thorough discussion of the R11 fire regime). Accordingly, information for this FMP was generalized from several studies conducted within the same natural subregions in other areas of the province. Although local fire regime data are preferable, these provincial results provide a general understanding of the range of fire cycles that may be natural for the local area, and therefore an approximation of the NRV expected for each forest age class.

The NRV in stand age distribution was estimated using a negative exponential function applied to the range of fire cycles reported for each natural subregion (Tymstra et al. 2005). For this plan, the NRV for each age class was defined as the range between the minimum and maximum predicted values. Although the negative exponential function method of predicting stand age distribution provides a rather simplistic estimate without the inclusion of local fire cycle data, this method is accepted by fire scientists for basic modeling and the establishment of broad fire management goals (Pengelly and Rogeau 2001). This method suits our planning purposes well, with the assumption that the actual fire cycle for each natural subregion within the R11 FMU falls within or near the range reported for other areas of the same natural subregion. Results must be interpreted conservatively, however, as this is a fairly simple method, which does not account for local factors affecting fire patterns within a given natural subregion (e.g., elevation). Ideally, the natural range for stand age distribution would be modeled extensively using local landscape data (e.g., Foothills Model Forest Natural Disturbance Study, Andison 2000), and detailed information for the entire R11 FMU would be valuable. Until such data are available, the negative exponential

function will provide a coarse estimate of the natural range of landscape conditions: stand age data falling outside this range of predicted values are likely in an unnatural condition.

Table 12 to Table 15 demonstrate the amount of young (0-20 years), pole (21-100 years), mature (101-180 years), and old forest (>180 years) that are currently found in each of the R11 natural subregions compared to the estimated natural range. The definitions of young, pole, mature, and old forest were adopted from Andison's (2000) seral stage categories for pine and spruce-dominated stands as these are the dominant forest cover types in R11. Stand age data are not separated by cover class (i.e., conifer, deciduous, mixedwood), as fire cycle lengths are not reported in this manner. This additional detail could be incorporated into future plan updates if local fire regime analyses and modelling are conducted. Finally, data for the Alpine Natural Subregion are not presented as this area is predominantly non-forested.

Table 12. Estimated natural range and actual percentage of the forest area in each age class within the Subalpine Natural Subregion in R11.

Age Class	NRV Minimum	NRV Median	NRV Maximum	Current Percentage
Young	6	15	20	2
Pole	22	41	47	15
Mature	17	20	21	60
Old	14	23	55	23

Table 13. Estimated natural range and actual percentage of the forest area in each age class within the Montane Natural Subregion in R11.

Age Class	NRV Minimum	NRV Median	NRV Maximum	Current Percentage
Young	6	20	39	4
Pole	22	48	53	20
Mature	7	19	21	70
Old	1	13	55	6

Table 14. Estimated natural range and actual percentage of the forest area in each age class within the Upper Foothills Natural Subregion in R11.

Age Class	NRV Minimum	NRV Median	NRV Maximum	Current Percentage
Young	17	23	42	4
Pole	44	50	53	22
Mature	6	18	21	67
Old	1	10	18	7

Table 15. Estimated natural range and actual percentage of the forest area in each age class within the Lower Foothills Natural Subregion in R11.

Age Class	NRV Minimum	NRV Median	NRV Maximum	Current Percentage
Young	16	19	32	0
Pole	43	46	53	10
Mature	11	20	21	45
Old	3	15	20	45

In all natural subregions, the percentage area of forest currently observed in the 0-20 year age class is less than the expected NRV for young forest, while the amount of old forest generally falls within or near the expected range. The exception is the Lower Foothills Natural Subregion; however, these results may be influenced by the small area of R11 that falls within Lower Foothills. All natural subregions have greater area of forest in the mature age class than expected based on a negative exponential distribution. In the absence of fire suppression activities, a greater percentage of this mature forest would likely be converted to young forest annually. Thus, the smaller than expected percentage of young forest (0-20 years) and the larger than expected percentage of mature forest (101-180 years) represents an unnatural landscape condition for multiple natural subregions in the R11 FMU: these age classes will be targeted for restoration work through prescribed burn and harvest treatments.

Forecast: In the absence of prescribed burn and harvest activities, the amount of young forest would continue to fall well below the NRV. Conversely, the amount of old forest would eventually be much greater than the NRV if disease or insect threats such as mountain pine beetle do not kill significant areas.

If the treatment level objectives described in Indicator 2.1.1 are continually met over the long term (i.e., 200-year planning cycle), the amount of young and old forest will be within the target NRV range in the Subalpine and Montane Natural Subregions (Table 16). Although the Upper and Lower Foothills Natural Subregions are not expected to fall within the target range at the end of a 200-year planning cycle, they are expected to align more closely with the NRV (Table 16) than given a status quo scenario for an equivalent length of time. Treatments would need to be conducted at a rate greater than one half the median fire cycle length to achieve the target ranges for foothills areas.

Table 16. Predicted percentage of forest area within the young and old age classes after a 200 year planning cycle, based on disturbance from prescribed burn and harvest treatments alone or treatments plus the current wildfire rate over the last 20 years.

Natural Subregion	Age Class	Treatments alone	Treatments plus wildfire	New fire cycle length (yrs)	Within NRV?
Subalpine	Young	8	9	193	Y
Subalpine	Old	48	42	193	Y
Montane	Young	11	12	131	Y

Montane	Old	36	31	131	Y
Upper Foothills	Young	12	13	117	N
Upper Foothills	Old	32	28	117	N
Lower Foothills	Young	10	10	192	N
Lower Foothills	Old	39	39	192	N

Monitoring: Changes in the stand age distribution will be monitored through GIS analysis of the amount of area in each age class. This will require regular updates of the GIS vegetation inventory data as treatments and natural wildfires occur. A summary of the current stand age distribution compared to the NRV will be presented in the Stewardship Report.

Response: The greatest challenge to meeting the target for this indicator will be implementing an adequate level of ongoing treatments within the FMU. The targets identified under Indicator 2.1.1 are conservative, allowing for a significant amount of wildfire to occur before the amount of young forest exceeds the NRV. As a result, an increase in the treatment level may be necessary.

In the event of a large-scale die-off resulting from disease or mountain pine beetle, a reduction in the treatment level may be required to ensure that the amount of young forest does not exceed the NRV. In anticipation of such a potential outcome, however, the proposed amount of young forest must still be created in the short term as these areas will ultimately form the old forest component of the ecosystem. There may be limited recruitment of young pine trees after a large-scale mountain pine beetle kill as there will be little seed source for natural regeneration. In such a case, the young forest created through prescribed burning and wildfire will be extremely valuable in the long-term continuity of these ecosystems.

2012 Status: The current stand age distribution within each natural subregion following five years of wildfire, harvest treatments, and prescribed burn treatments was determined using GIS. These distributions are shown in Figure 7 to Figure 9 compared to the distribution prior to the onset of FMP management activities in 2007 and compared to the natural range of variation that represents the target. The Alpine Natural Subregion is not presented as it is predominantly non-forested. Similarly, results for the Lower Foothills Natural Subregion must be viewed cautiously as only a small portion of this natural subregion falls within R11 (0.15% of the FMU landbase): few treatments will be targeted in these areas and most of the discussion will focus on the other natural subregions.

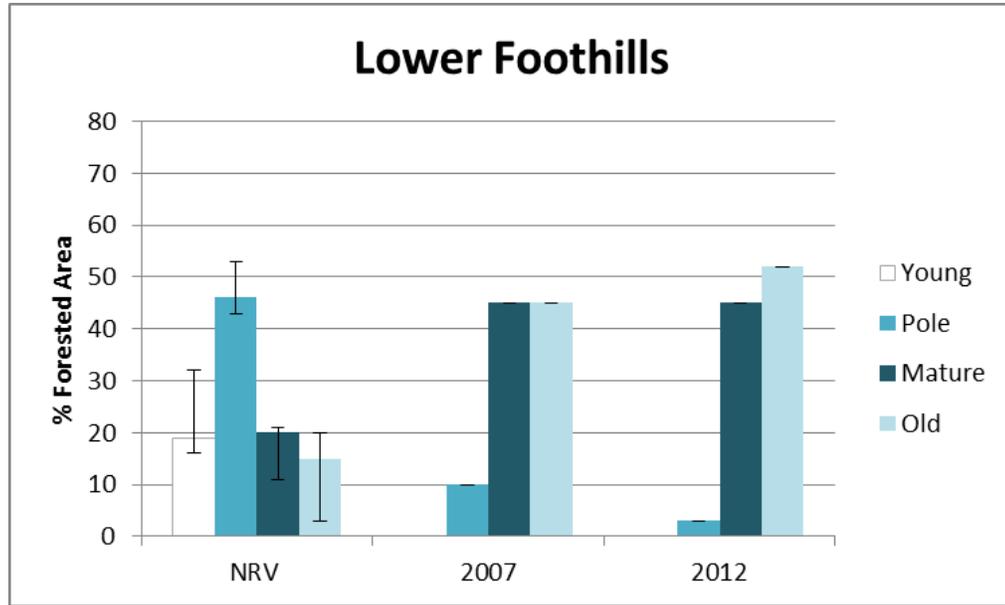


Figure 6. Percent of forested area in each stand age class in the Lower Foothills Natural Subregion in 2007 and 2012. The median value from the natural range of variation is presented, with associated bars representing the range from minimum to maximum values for the natural range of variation.

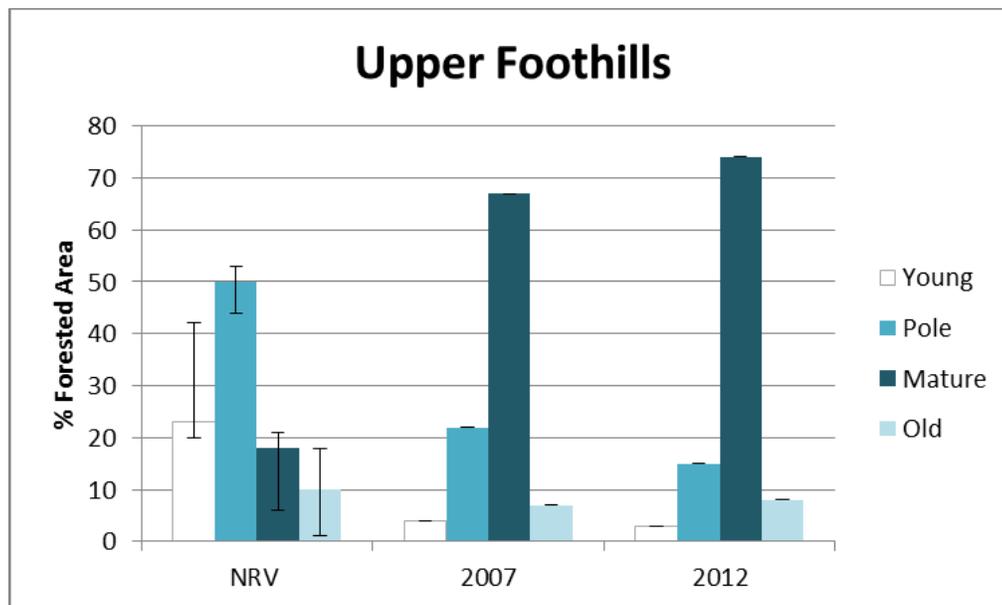


Figure 7. Percent of forested area in each stand age class in the Upper Foothills Natural Subregion in 2007 and 2012. The median value from the natural range of variation is presented, with associated bars representing the range from minimum to maximum values for the natural range of variation.

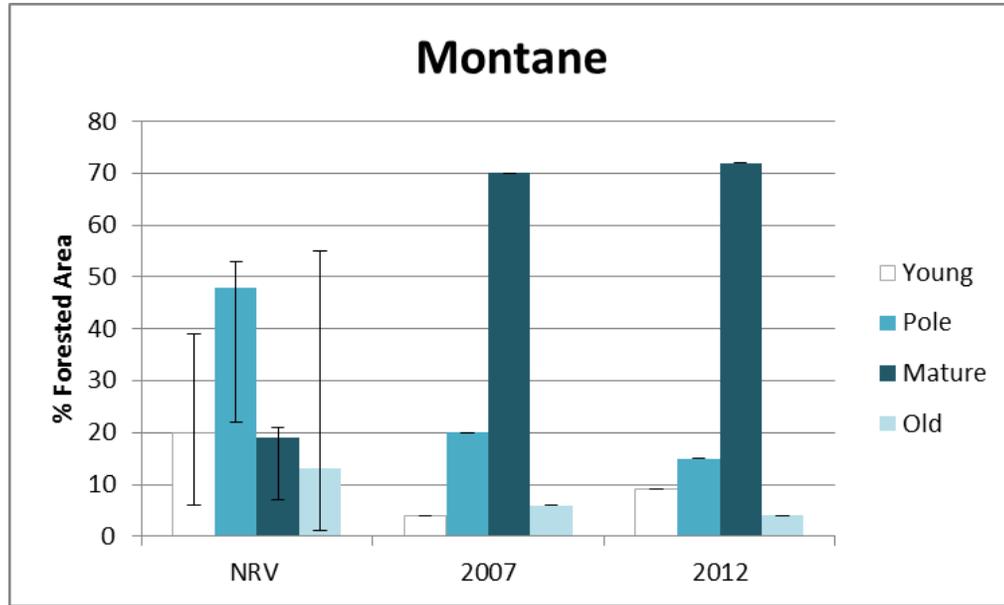


Figure 8. Percent of forested area in each stand age class in the Montane Natural Subregion in 2007 and 2012. The median value from the natural range of variation is presented, with associated bars representing the range from minimum to maximum values for the natural range of variation.

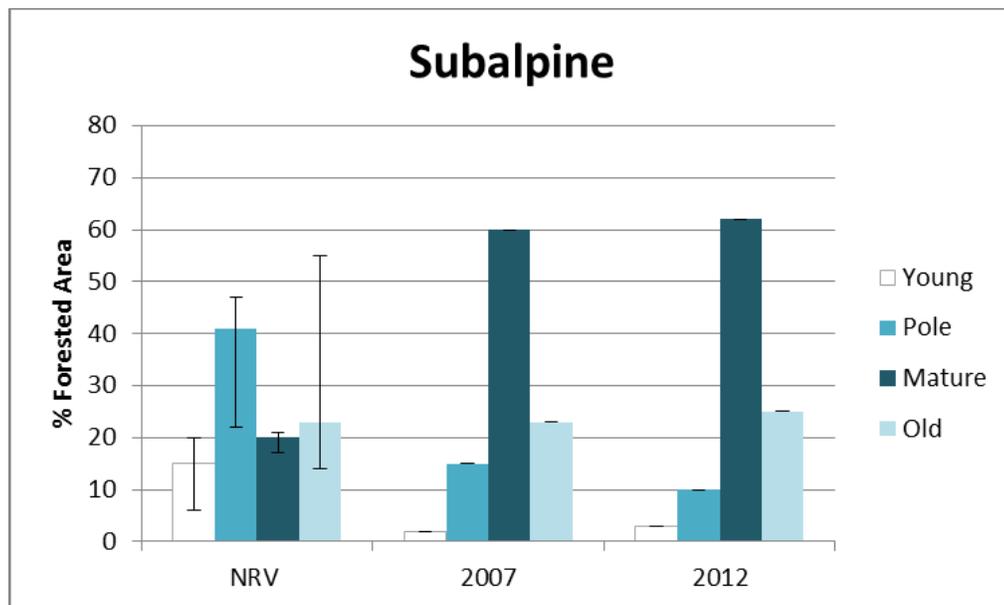


Figure 9. Percent of forested area in each stand age class in the Subalpine Natural Subregion in 2007 and 2012. The median value from the natural range of variation is presented, with associated bars representing the range from minimum to maximum values for the natural range of variation.

In general, the amount of area covered by old forest (>180 yrs) stayed consistent in the Upper Foothills and Subalpine Natural Subregions and decreased slightly within the Montane Natural Subregion. The percent area of old-growth forest fell within the natural range of variation in both 2007 and 2012 for these natural subregions. The amount of area in young forest (0-20 yrs) saw a slight decrease in the Upper Foothills Natural Subregion, a slight increase in the Subalpine Natural Subregion, and a larger increase in the Montane Natural Subregion. These latter two increases are driven in large part by the Upper Saskatchewan Unit 1 and the Hat Mountain prescribed burns that overlapped those two natural subregions. Across all natural subregions, there was a slight increase in mature forest (40-180 yrs) and a slight decrease in the pole stage (20-40 yrs), and these age classes remain consistently outside the natural range of variation. Attainment of this indicator target, among others, is recognized as a long term process: treatment levels proposed in the R11 FMP need to be consistently met over a 200-year planning cycle.

2012 Revision: The level of uncertainty associated with local stand origin data from the Alberta Vegetation Inventory (Rogean 2009), the recent acquisition of local historic fire cycle information, and the relative ease of measuring fire cycle all favour a revision in this target from stand age distribution within the natural range of variation to fire cycle within the natural range of variation. This will be assessed for each fire regime region instead of at the natural subregion level. The fire cycle targets for each fire regime region and the associated rates of disturbance required to reach those targets are shown in Table 6.

Indicator 1.2.1

Value: Biodiversity - Ecosystem Diversity

Objective: Conserve ecosystem diversity by maintaining or restoring uncommon plant communities.

Indicator: Uncommon plant communities, specifically whitebark pine, limber pine, Douglas-fir, and lowland grassland communities.

Targets: All total known area of each community type inside Protected Areas and 80% of the total known area of each community type outside Protected Areas will be maintained, including via burning if the community is identified as fire dependant.

Baseline Status: The Alberta Natural Heritage Information Centre (ANHIC) is housed within Alberta Tourism, Parks, Recreation, and Culture. The purpose of the Centre is to collect, evaluate, and make available information on the elements of natural biodiversity of Alberta – plants, animals, natural plant communities, and landscapes. ANHIC develops tracking lists of elements that are considered of high conservation priority because they are rare or special in some way. Tracking lists serve as a focus for data gathering to increase our knowledge and understanding of the elements of Alberta’s biodiversity. The lists are under constant review and are updated periodically. Elements may be added, deleted, or their status may be revised as data become available. ANHIC also provides complete lists of vascular and non-vascular plants and lichens. This information can be accessed on ANHIC’s website at <http://www.tprc.alberta.ca/parks/heritageinfocentre/default.aspx>.

A review of ANHIC’s 2005 Ecological Community Tracking and Watch List resulted in a list of provincially uncommon community types which are either known to occur (7 types) or can potentially occur (35 types) within the R11 boundaries (Table 17). All seven presently known uncommon community types within the R11 area have been reported from Protected Area sites and include six lowland grassland types and one limber pine – Douglas-fir community type. Remaining potentially occurring community types can be roughly grouped into lowland grassland communities, riparian communities, whitebark or limber pine communities, and various other communities found on mountain slopes. Given the limitations of our current knowledge about plant community types in Alberta and the lack of a good inventory within the R11 FMU specifically, additional uncommon plant community types may be present.

Table 17. Potentially occurring and known ANHIC Ecological Community Tracking List communities within the R11 FMU.

Code	Scientific Name	Common Name	Rank*	Type	Group	Comments
CEAB000050	<i>Abies bifolia</i> – <i>Pinus albicaulis</i> – <i>Picea engelmannii</i> / <i>Empetrum nigrum</i>	subalpine fir - whitebark pine - Engelmann spruce / crowberry	S2	Whitebark or Limber Pine	Forest/ Woodland	Could occur
CEAB000073	<i>Pinus albicaulis</i> – <i>Pinus contorta</i> / <i>Juniperus communis</i> – <i>Leymus innovatus</i> – <i>Linnaea borealis</i>	whitebark pine - lodgepole pine / ground juniper - hairy wild rye	S2S3	Whitebark or Limber Pine	Forest/ Woodland	Could occur
CEAB000074	<i>Pinus albicaulis</i> / <i>Juniperus communis</i> – <i>Arctostaphylos uva ursi</i>	whitebark pine / ground juniper - common bearberry	S2S3	Whitebark or Limber Pine	Forest/ Woodland	Could occur
CEAB000075	<i>Pinus flexilis</i> - <i>Pseudotsuga menziesii</i> / <i>Juniperus spp.</i> / <i>Arctostaphylos uva-ursi</i>	limber pine - Douglas-fir / juniper species / common bearberry	S2	Whitebark or Limber Pine	Forest/ Woodland	Does occur in R11 (Kootenay Plains); locations not mapped
CEAB000076	<i>Pinus flexilis</i> / <i>Arctostaphylos uva ursi</i> - <i>Juniperus horizontalis</i>	limber pine / common bearberry - creeping juniper	S2S3	Whitebark or Limber Pine	Forest/ Woodland	Could occur
CEGL000815	<i>Pinus flexilis</i> scree	Limber pine scree	S1S2 G3Q	Whitebark or Limber Pine	Forest/ Woodland	Could occur
CEAB000054	<i>Antennaria lanata</i> – <i>Artemisia norvegica</i>	woolly everlasting - mountain sagewort	S1	Grassland	Herbaceous	Only known from Whitehorse Wildland; could occur in R11
CEAB000055	<i>Artemisia norvegica</i> – <i>Mertensia paniculata</i> – <i>Leymus innovatus</i>	mountain sagewort - tall lungwort - hairy wild rye	S1	Grassland	Herbaceous	Only known from Whitehorse Wildland; could occur in R11
CEAB000143	<i>Elymus lanceolatus</i> - <i>Antennaria parviflora</i>	northern wheat grass - small- leaved everlasting	S1	Grassland	Herbaceous	Confirmed in R11
CEAB000144	<i>Elymus lanceolatus</i> - <i>Artemisia dracuncululus</i> - <i>Artemisia frigida</i>	northern wheat grass - dragonwort - pasture sagewort	S1	Grassland	Herbaceous	Confirmed in R11

Code	Scientific Name	Common Name	Rank*	Type	Group	Comments
CEAB000025	<i>Elymus lanceolatus</i> - <i>Artemisia frigida</i>	northern wheat grass - pasture sagewort	S2S3	Grassland	Herbaceous	Found in Banff and Jasper NP; could occur in R11
CEAB000142	<i>Elymus lanceolatus</i> - <i>Elymus trachycaulus</i>	northern wheat grass - slender wheat grass	S1	Grassland	Herbaceous	Confirmed in R11
CEAB000147	<i>Elymus lanceolatus</i> - <i>Stipa comata</i>	northern wheat grass - needle-and-thread	S1S2	Grassland	Herbaceous	Confirmed in R11
CEAB000150	<i>Elymus trachycaulus</i> - <i>Koeleria macrantha</i>	slender wheat grass - June grass	SU	Grassland	Herbaceous	Could occur
CEAB000118	<i>Festuca campestris</i> - <i>Leymus innovatus</i> (<i>Elymus innovatus</i>)	mountain rough fescue - hairy wild rye	S2S3	Grassland	Herbaceous	Confirmed in R11
CEAB000026	<i>Koeleria macrantha</i> – <i>Artemisia frigida</i> – <i>Linum lewisii</i>	June grass - pasture sagewort - wild blue flax	S2S3	Grassland	Herbaceous	Could occur
CEAB000140	<i>Pascopyrum smithii</i> - <i>Pyrrocoma uniflora</i>	western wheat grass - one-flowered ironplant	S1	Grassland	Sparsely Vegetated	Confirmed in R11
CEAB000028	<i>Stipa richardsonii</i> – <i>Koeleria macrantha</i> – <i>Antennaria parvifolia</i>	Richardson's needle grass - June grass - small-leaved everlasting	S2S3	Grassland	Herbaceous	Could occur
CEAB000020	<i>Picea glauca</i> / <i>Rosa acicularis</i> / <i>Thuidium abietinum</i>	white spruce / prickly rose / fern moss	S1	Riparian	Forest/ Woodland	Could occur
CEAB000021	<i>Picea glauca</i> / <i>Shepherdia canadensis</i> / <i>Thuidium abietinum</i>	white spruce / Canada buffaloberry / fern moss	S2	Riparian	Forest/ Woodland	Could occur
CEAB000056	<i>Betula occidentalis</i> - <i>Amelanchier alnifolia</i> / <i>Artemisia campestris</i> - <i>Elymus lanceolatus</i> (<i>Agropyron dasystachyum</i>)	water birch - saskatoon / plains wormwood - northern wheat grass	S1	Riparian	Shrubland	Only known from Jasper area; could occur in R11
CEAB000069	<i>Picea glauca</i> / <i>Betula pumila</i> - <i>Salix bebbiana</i> / <i>Carex eburnea</i>	white spruce / dwarf birch - beaked willow / bristle-leaved sedge	S1?	Riparian	Forest/ Woodland	Could occur
CEAB000070	<i>Picea glauca</i> / <i>Thuidium abietinum</i>	white spruce / fern moss	S2S3	Riparian	Forest/ Woodland	Could occur

Code	Scientific Name	Common Name	Rank*	Type	Group	Comments
CEAB000084	<i>Salix drummondiana</i> / <i>Thalictrum venulosum</i>	Drummond's willow / veiny meadow rue	S1	Riparian	Shrubland	Could occur
CEAB000167	<i>Salix bebbiana</i> / <i>Cornus stolonifera</i>	beaked willow / red-osier dogwood	S3?	Riparian	Shrubland	Could occur
CEAB000169	<i>Betula occidentalis</i> riparian shrubland	water birch riparian shrubland	S2S3	Riparian	Shrubland	Could occur
CEAB000162	<i>Cymbella pusilla</i> - <i>Mastogloia smithii</i> - <i>Nitzschia palea</i>	diatom ponds	S1S3	Riparian	Aquatic	Could occur
CEGL001098	<i>Elaeagnus commutata</i> riparian shrubland	silverberry riparian shrubland	SU G2Q	Riparian	Shrubland	Could occur
CEAB000016	<i>Betula papyrifera</i> / <i>Betula occidentalis</i> / <i>Arctostaphylos uva-ursi</i>	white birch / water birch / common bearberry	S1	Slope	Forest/ Woodland	Only known from Jasper area; could occur in R11
CEAB000017	<i>Picea engelmannii</i> - <i>Abies bifolia</i> / <i>Dryas octopetala</i>	Engelmann spruce - subalpine fir / white mountain avens	S2S3	Slope	Forest/ Woodland	High elevation front range type; could occur
CEAB000018	<i>Picea engelmannii</i> – <i>Abies bifolia</i> / <i>Salix vestita</i> / <i>Cassiope tetragona</i>	Engelmann spruce - subalpine fir / rock willow / white mountain-heather	S2	Slope	Forest/ Woodland	Permafrost front range type; could occur
CEAB000019	<i>Picea engelmannii</i> / <i>Leymus innovatus</i>	Engelmann spruce / hairy wild rye	S2	Slope	Forest/ Woodland	Found in Banff & Jasper NP; could occur in R11
CEAB000022	<i>Populus tremuloides</i> / <i>Menziesia ferruginea</i>	aspen / false azalea	S1	Slope	Forest/ Woodland	Could occur
CEAB000023	<i>Populus tremuloides</i> / <i>Leymus innovatus</i> – <i>Aster conspicuus</i> avalanche community	aspen / hairy wild rye - showy aster avalanche community	S2	Slope	Forest/ Woodland	Could occur
CEAB000024	<i>Dryas integrifolia</i> – <i>Carex rupestris</i>	white mountain avens - rock sedge	S1	Slope	Dwarf Shrubland	Could occur
CEAB000065	<i>Penstemon ellipticus</i> talus barren	creeping beardtongue talus barren	S1?	Slope	Sparsely Vegetated	Could occur
CEAB000066	<i>Picea engelmannii</i> – <i>Abies bifolia</i> / <i>Salix planifolia</i> / <i>Hylocomium splendens</i>	Engelmann spruce - subalpine fir / flat-leaved willow / stair-step moss	S1?	Slope	Forest/ Woodland	Could occur

Code	Scientific Name	Common Name	Rank*	Type	Group	Comments
CEAB000067	<i>Picea engelmannii</i> / <i>Salix drummondiana</i>	Engelmann spruce / Drummond's willow	S1?	Slope	Forest/ Woodland	Could occur
CEAB000130	<i>Pinus contorta</i> / <i>Ledum groenlandicum</i> / <i>Vaccinium scoparium</i> / <i>Pleurozium schreberi</i>	lodgepole pine / common Labrador tea / grouseberry / Schreber's moss	S1?	Slope	Forest/ Woodland	Could occur
CEGL001894	<i>Dryas octopetala</i> - <i>Polygonum viviparum</i>	white mountain avens - alpine bistort	S1S2 G3?	Slope	Dwarf Shrubland	Could occur
CEGL005877	<i>Phyllodoce glanduliflora</i> / <i>Sibbaldia procumbens</i>	yellow heather / sibbaldia	SNR G2G3	Slope	Dwarf Shrubland	Could occur

* See Appendix II for a description of ranks.

Whitebark and limber pine communities – Both whitebark and limber pine are species on ANHIC's Tracking List and are seriously threatened by an exotic rust (white pine blister rust), by mountain pine beetle, and by fire suppression activities in Alberta. A report on the status of whitebark pine in Canada will soon be submitted to COSEWIC by Parks Canada for assessment and possible listing under the federal Species at Risk Act (SARA). Known or suspected whitebark pine and limber pine stands likely also have uncommon community types. All whitebark and limber pine communities should be protected within R11, thus their manipulation through prescribed burning should be considered experimental and closely monitored for changes.

Douglas-fir communities – Although Douglas-fir community types could occur within the R11 FMU, research and surveys on plant communities dominated by this species are lacking and a list of potential communities cannot be generated. All Douglas-fir community types within R11 should be reported to ANHIC and monitored, especially those falling within the boundaries of planned prescribed burns.

Lowland grassland communities – Six uncommon lowland grassland communities are known to occur within the R11 FMU, primarily in the Kootenay Plains area, and four others could potentially occur. Historically, these communities likely experienced a high fire frequency, thus prescribed burn treatments should prove effective in their maintenance.

Riparian communities – At least ten of the potentially occurring uncommon community types are related to riparian areas. Maintaining the integrity of riparian areas throughout the R11 FMU will protect these communities (see Indicators 1.5.1 and 1.6.1).

Forecast: All uncommon communities may show an initial decrease in size within burned areas, but fire-dependent communities (e.g., whitebark pine, limber pine, and Douglas-fir community types) should rebound or even expand in size given sufficient time.

Monitoring: Forestry personnel and contractors will be trained by ANHIC staff to identify these community types. Prior to prescribed burn or harvest treatments, potential sites within R11 will be assessed by personnel working in these areas for the presence of uncommon community types, focusing primarily on whitebark pine, limber pine, and Douglas-fir community types. Any new information will be deposited with ANHIC, which maintains an inventory of rare community types in a database as well as a GIS system. New locations of whitebark pine and limber pine will also be reported to ASRD for inclusion in their inventory of these species.

Fiscal and manpower limitations will likely constrain post-treatment monitoring of all identified uncommon communities. Accordingly, permanent sample plots (PSPs) will be established in 25% of the identified communities planned for prescribed burn or harvest treatments as well as in control areas having no active vegetation management (i.e., provincial Protected Areas, areas identified in special feature reports). Design and sampling methodology for the plots will be based on ANHIC's Draft Plant Community Sampling Guidelines as well as methods devised by the Canadian Forest Service and the Whitebark Pine Ecosystem Foundation (<http://www.whitebarkfound.org>). The surveys will provide information about the community

composition, the number of regenerating trees, and the presence of white pine blister rust and overall health of tree species. A given PSP may not sample the entire area of the community, thus the extent of the community will have to be estimated on the ground or from aerial photographs. PSPs will be resurveyed every 10 years. Results of the monitoring will be reported in the Stewardship Reports.

Response: Any reduction in community size greater than 10% will be assessed for potential causal factors and prescribed burn or harvest plans will be adjusted accordingly.

2012 Status: Knowledge of uncommon or rare plant communities throughout the R11 FMU remains sparse, though new occurrences are deposited as discovered to the Alberta Conservation Information Management System (ACIMS, formerly ANHIC; online at <http://tpr.alberta.ca/parks/heritageinfocentre/default.aspx>). The plant communities originally identified as potentially occurring and known to occur in R11 (Table 17) remain on the ACIMS Preliminary Ecological Community Tracking List (Allen 2011). The percent area of rare plant communities occurring within R11 impacted by prescribed burn, harvest or wildfire was determined using GIS to overlay the treatment boundaries with known rare plant community occurrence as identified in ACIMS. No rare plant community occurrences previously identified in ACIMS fell within natural wildfire, harvest, or prescribed burn treatment areas (see below for new occurrences identified within Upper Saskatchewan Unit 1 prescribed burn). It is important to note that although tracking lists for uncommon plant communities can be generated based on known or suspected occurrences within the R11 FMU, relatively few occurrences are confirmed due to the lack of studies, and the total area of each community within the local region or within the broader landscape is rarely known. Furthermore, rare grassland communities that were historically maintained by frequent fires within the North Saskatchewan River valley are becoming increasingly forested due to the departure from the historic fire regime (Rogean 2010b). Opportunities for R11 forest management activities to address this loss of grassland are limited as the areas in question lie primarily within the Kootenay Plains Ecological Reserve, under the jurisdiction of Alberta Tourism, Parks, and Recreation. The management plan for this area does not address the historic role of fire in ecosystem maintenance.

Rare Plant and Community Surveys in the Upper Saskatchewan Unit 1 Prescribed Burn

ASRD forestry staff attempted to identify rare plants and communities at proposed harvest and burn treatment sites; however, financial limitations precluded hiring the rare plant specialists required to provide an exhaustive rare plant and community survey. The Upper Saskatchewan Unit 1 prescribed burn represented an exception. During the planning process for the Upper Saskatchewan Unit 1 prescribed burn, a plant identification expert conducted a rare plant and vegetation survey within the proposed burn boundaries and the immediately adjacent areas of the Kootenay Plains Ecological Reserve (Timoney 2007). The identified plots were subsequently revisited approximately one or two years after the burn and re-surveyed for the presence of rare plants (Caners 2011, Timoney 2012). These studies are discussed below.

Timoney (2007) established 20 permanent sample plots (PSPs) within the proposed prescribed burn boundary and area adjacent to the east boundary to document the presence of rare vascular

plants, bryophytes, lichens, and vegetation communities, and to provide baseline information about the potential effects of fire on species and communities. An additional 17 rare plant plots had been established within the same landscape earlier in the summer under a contract with Parks Canada. PSPs were selected to encompass a variety of elevations and aspects, landscape features, and suspected uncommon vegetation communities. Plot placement was also stratified based on pre-burn fire behaviour modelling into areas that were expected to burn at low and moderate severity as well as control areas that were not expected to burn. Results of the survey found variants of rare plant communities in 75% of the PSPs, with 6 (30%) of the rare plant communities representing their first occurrence in the province. A total of 33 rare plant species were identified including 20 lichen species, 5 vascular plant species, and 8 bryophyte species.

A second rare plant study was conducted in 2010, approximately one year after the prescribed burn (Caners 2011). The goals of the follow-up study were to document bryophytes, vascular plants, and forest structure on the landscape, with a focus on rare species, and to recommend the best ways to monitor species persistence over time. Note that lichens were not surveyed in the 2010 study. All 20 PSPs were revisited as well as five of the additional rare plant plots.

Overall, 25% of all sampled bryophyte taxa and 4% of all sampled vascular plant taxa were considered rare provincially, and 94 rare plant records were submitted to ACIMS. Furthermore, a greater number of species was often observed during post-burn sampling compared to pre-burn sampling in the same plot. A range of burn severity across the study area resulted in eight PSPs that remained unburned or experienced a low burn severity, eight PSPs that experienced moderate burn severities, and four plots that experienced higher burn severities. All rare vascular plants and the majority of rare bryophytes sampled in the pre-burn study (Timoney 2007) were also observed in the study area following the fire, though they may have been locally extirpated from individual plots. Vegetation communities as classified by Timoney (2007) were affected by fire to varying degrees in the sample plots, and their representation within the broader landscape remains unclear. Caners (2011) suggests additional surveys and mapping of plant communities across a larger area is necessary to provide a better understanding of community abundance, distribution, and thus level of protection required.

Although a few plots with limber and whitebark pine experienced higher severity burns likely due to topographical influences on fire spread and pre-existing ground cover of junipers that promoted crowning, most plots remaining unburned or experiencing low burn severities were either dominated by limber pine or occurred at higher elevations with mixed tree species composition, including whitebark pine. Furthermore, sites dominated by limber pine supported large numbers of rare species in unique assemblages (e.g., biological soil crusts on exposed soil were found almost exclusively in open stands of limber and whitebark pine). Rocky outcrops also provided unique microhabitats through the organic matter and soil that accumulate in crevices and the shelter and humidity retention provided by microtopographical features. Again, many of the PSPs experiencing low burn severity or an absence of fire were located in the Whirlpool Point area where rocky outcrops are common. Even within some plots experiencing moderate to high severity burns, microhabitats with a hydric moisture regime ensured the persistence of rare bryophytes. In summary, many rare bryophytes and vascular plants appear adapted to habitats that naturally experience lower burn severities and thus serve as important refugia for these species during a fire disturbance.

Timoney conducted a second follow-up rare plant study the second year following the prescribed burn (Timoney 2012). Nineteen of the 20 PSPs and three of the additional rare plant plots were surveyed. Of numerous factors examined including burn severity, pre-fire basal area, various species richness measures, elevation, percent organic matter, and percent bedrock, burn severity had the greatest influence on vegetation composition two years post-fire. Post-fire retention of rare species ranged from 59% to 82% of an average 17 rare species per plot. Vascular plant assemblages showed more resistance to post-fire change than the bryophyte and lichen assemblages. Impacts to rare whitebark and limber pine communities were also noted, and Timoney acknowledged that long-term impacts will depend on these species' ability to regenerate.

Even in the absence of complete occurrence information, the particular adaptations and habitat associations of a given rare plant/community may help ensure its persistence during prescribed burn treatments. The persistence of these rare plants within the landscape may also provide a colonization source for sites that were impacted more severely by the prescribed fire. Repeated monitoring of the PSPs will determine if rare species that were locally extirpated successfully recolonize the area or whether it is colonized by additional rare species.

Note that further information on the current status of whitebark and limber pine as well as new locations and ongoing monitoring of these species is presented in the 2012 Status section of Indicator 1.4.1. A list of all known rare plants within the R11 FMU (as identified in ACIMS) as well as the impacts of harvesting, prescribed fires, and natural wildfires on their known area can be found in Appendix 1.

Indicator 1.3.1

Value: Biodiversity - Ecosystem Diversity

Objective: Conserve ecosystem diversity by maintaining unique habitats provided by burns and blowdown.

Indicator: Area of unsalvaged burned forest and blowdown.

Target: 90% of burned and blowdown areas remaining unsalvaged.

Baseline Status: In most forests across Canada where timber has been allocated, salvage of merchantable trees is a common practice after disturbances such as wildfire, blowdown events, or insect outbreaks. Post-disturbance salvage is generally driven by three factors: (1) public perception of wildfire as detrimental, (2) reduction of the impact on the Annual Allowable Cut, and (3) economic or policy incentives (Schmiegelow et al. 2006). Knowledge is limited on the cumulative effects of human disturbance following natural disturbance, especially information specific to the foothills and mountains of Alberta. However, available evidence from other ecosystems indicates that post-disturbance salvage logging results in the alteration of stand structural complexity, changes in ecosystem processes, and changes in composition and abundance of species relative to traditional logging in undisturbed areas (see Lindenmayer and Noss 2006 for a review). For example, burned habitats within the boreal forest are often hotspots of biodiversity, in part a result of juxtaposition of live residual patches and burned snags, and contain many bird species associated with late successional stages, while salvaged burns may take decades to recover their complement of species (Schieck and Hobson 2000). Furthermore, elk, moose, and deer in the southern portion of the R11 FMU selected unlogged burned areas and avoided salvage-logged portions of the Dogrib Creek burn (Hebblewhite et al. 2005). The lack of timber commitments within the R11 FMU provides an opportunity to maintain unsalvaged disturbed areas and the unique habitats contained therein. Safety concerns in certain locations, such as along designated trails, may drive some limited salvage of timber within R11; however, 90% of the area of burns and blowdowns will remain unsalvaged. Prescribed burn plans will help determine if dead trees will be a hazard along roads, trails, etc.

Forecast: not applicable

Monitoring: GIS analysis will be used to compare the boundaries of salvage areas to the boundaries of prescribed fires, natural wildfires, or blowdown events. The Stewardship Report will summarize the total area burned/blowdown and the total area remaining unsalvaged each year.

Response: The area remaining unsalvaged may vary from the 90% target within the individual burn or blowdown but not within the landscape. If the target is not achieved at the landscape level, investigations will determine the cause of the deviance, and strategies to retain additional unsalvaged habitats will be developed for subsequent FMPs.

2012 Status: No salvage was conducted in 6,362 ha of prescribed burn area or 1,782 ha of natural wildfire area; however, some salvage occurred following a blowdown event in areas originally harvested for FireSmart purposes near Nordegg. The total of area of blowdown is not tracked, rendering an assessment of the target not possible.

2012 Revision: As the area impacted by blowdown events is not tracked spatially, the target of 90% of burned and blowdown areas remaining unsalvaged cannot be assessed accurately. The revised target will be modified to state ‘any salvage of blowdown events will be minimized and will be reported’ and ‘90% of burned areas will remain unsalvaged’.

Indicator 1.4.1

Value: Biodiversity - Plant Species Diversity

Objective: Conserve plant species diversity by maintaining viable populations of native species (i.e., fine filter approach).

Indicator: Location of individual whitebark and limber pine.

Target: 80% of identified populations/individual trees will be maintained.

Baseline Status: Whitebark pine and limber pine are slow growing, long-lived conifers typically found on dry, wind-swept, rocky sites in montane to upper subalpine habitats. Although their seeds may be eaten by wildlife ranging from squirrels to bears, these pine species rely heavily on Clark's nutcracker for seed dispersal: the birds open cones and hoard the seeds in caches often found in open, windy areas that remain snow-free throughout much of the year. Some of the stored seeds may germinate, and the trees subsequently help stabilize steep slopes, regulate runoff, and facilitate community succession by creating more hospitable microenvironments. Whitebark pine and limber pine are pioneer species that are among the first to establish post-disturbance (i.e., typically wildfire). Given the various ecological functions these trees fulfill, they are often considered keystone species in upper subalpine ecosystems.



Limber pine

Both whitebark and limber pine are on ANHIC's Vascular Plant Tracking and Watch List, and a status report on whitebark pine in Canada will soon be submitted to COSEWIC by Parks Canada for assessment under SARA. These species are seriously threatened by the introduced white pine blister rust, fire suppression activities, and mountain pine beetle. An inventory on the location and status of these two pine species within Alberta has been developed though it is not yet considered complete. There are currently 3 suspected whitebark pine stands and 13 confirmed or suspected limber pine stands within the R11 FMU.

Forecast: Regeneration of these species occurs shortly after a disturbance and subsequent seed dispersal into the disturbed area by Clark's nutcracker. Accordingly, these species should respond positively to prescribed burns within their habitat, provided seed sources and dispersal agents (i.e., birds) remain. As white pine blister rust infestation generally proves fatal for the individual tree, population resilience also depends upon the presence of rust-resistant trees that can act as seed sources.

Monitoring: Potential sites within R11 will be surveyed for whitebark and limber pine during the development of prescribed burn plans and design of harvest blocks. Any new locations will be deposited in the inventory database. Permanent sample plots will be established in 25% of the identified pine stands found in the planned burn or harvest areas as well as in control areas having no active vegetation management (i.e., provincial Protected Areas, areas identified in special feature reports) (see also Indicator 1.2.1). The sample plots will be consistent with PSP methodology devised by the Whitebark Pine Ecosystem Foundation

(<http://www.whitebarkfound.org/>) or the Canadian Forest Service. The surveys will provide information about the presence of white pine blister rust, the number of regenerating pine, and the overall health of the stand. Changes to the stands will be tracked by resurveying the plots every 10 years. Since both of these pine species are fire-dependent, the 10-year surveys will provide information on the regenerative success after burning. Results of the monitoring will be reported in the Stewardship Reports.



Whitebark pine

Response: If natural regeneration is not successful after fire disturbance, a planting program can be implemented. Burn or harvest plans will also be adjusted based on the 10-year surveys.

2012 Status: Both whitebark and limber pine were listed as Endangered under Alberta's *Wildlife Act* in September 2009. An Alberta Whitebark and Limber Pine Recovery Team has been initiated, and recovery plans for both whitebark and limber pine are currently being drafted. Nationally, whitebark pine was designated Endangered by COSEWIC in April 2010, and a status report on limber pine has been submitted for review. When the legal status of Endangered or Threatened under Schedule 1 of the *Species at Risk Act* (SARA) is assigned to a species, a national recovery strategy will be developed. These species continue to be seriously threatened by the introduced white pine blister rust, fire suppression activities, and mountain pine beetle. An inventory on the location and status of these two pine species within Alberta has been developed though it is not yet considered complete.

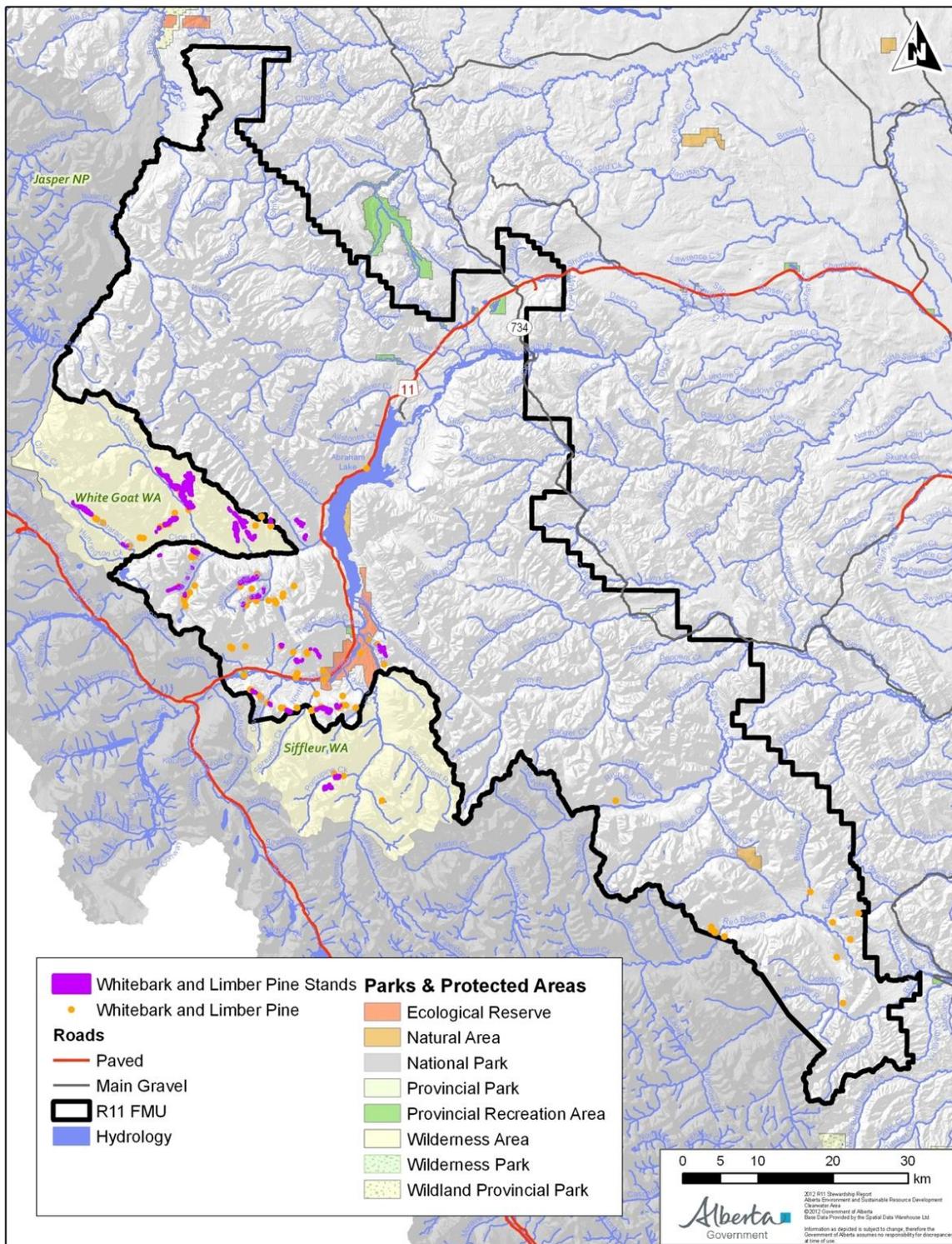
Four plots were established in 2008 in known whitebark and limber pine stands following the protocol *Methods for Surveying and Monitoring Whitebark Pine for Blister Rust Infection and Damage* outlined in the 2004/2005 report by the Whitebark Pine Ecosystem Foundation. No presence of white pine blister rust was reported at the time of plot establishment and plots are on track to be revisited within the next reporting period.

Since the R11 Forest Management Plan was developed, new locations of whitebark and limber pine stands have been identified in addition to the original 3 suspected whitebark pine stands and 13 confirmed or suspected limber pine stands within the R11 FMU. Of a current 161 whitebark and limber park pine locations within the FMU (Map 7), 11 were disturbed by treatment

activities over the five-year reporting period (ASRD, *unpubl. data*), resulting in a 93% retention of identified populations/trees and exceeding the target of 80% retention across the FMU. Alternatively, 772 ha of an identified 788 ha (98%) of whitebark and limber pine stand area exists at the time of reporting (ASRD, *unpubl. data*).

While the FMU-level retention targets were met, greater local impacts on whitebark and limber pine within the boundary of the Upper Saskatchewan Unit 1 prescribed burn were noted. Whitebark and limber pine percent cover was reduced or eliminated in 5 of 12 PSPs (i.e., 58% retention of area, number of individuals not recorded, Caners 2011). Prescribed burn objectives strived for a low intensity surface fire in known and potential whitebark and limber pine stands, as the thick bark on mature trees of both species can help tree survival during low and sometimes moderate severity fires (Johnson 2001, Fryer 2002). Despite this objective, some previously unidentified stands of both whitebark and limber pine were damaged or scorched to varying degrees (from light ground fire to complete burn; e.g., Caners 2011, Timoney 2012). Since the burn, 18 monitoring plots have been established to monitor how the trees handled the fire and to monitor for the natural regeneration of the stands. Increased knowledge from these monitoring plots, increased knowledge of tree/stand locations, and recent species listing both provincially and nationally will help improve protection of whitebark and limber pine during future forest management activities in the R11 FMU.

Whitebark and Limber Pine Stands and Individuals



Map 7. Locations of known whitebark and limber pine individuals and trees.

Indicator 1.4.2

Value: Biodiversity - Plant Species Diversity

Objective: Conserve plant species diversity by maintaining viable populations of native species (i.e., fine filter approach).

Indicator: Location of mountain bladder fern populations.

Target: All identified populations will be maintained.

Baseline Status: Several factors were considered in the selection of individual rare plant taxa to be included in fine-filter, species-specific indicators. In particular, existing data must be available in government files, or new data must be easily collected by Forestry Division staff trained through a few focused workshops provided by specialists (likely ANHIC staff or other provincial rare plant specialists). These limitations eliminated non-vascular plants and lichens as well as the majority of vascular plants that would be difficult to identify by non-botanists. Alpine or non-treed cliff species were also excluded, as no significant impact is expected on their populations from the FMP-related activities. Finally, most riparian species and communities were excluded because riparian systems have high habitat values for many fish, wildlife, and plant species and were specifically considered in other indicators. Three rare plant species were selected and are presented in the following indicators.

Mountain bladder fern (*Cystopteris montana*) is a perennial fern which grows on damp calcareous sites, often by springs or along streams in mixed or coniferous forests. This species is one of 304 rare vascular plant species reported from the five Natural Subregions occurring within R11 and is listed as provincially rare (ranked S2) by the Alberta Natural Heritage Information Centre (see description of ANHIC in Indicator 1.2.1). There are 17 known locations of this species in Alberta, 13 of which are based on historic observations (i.e., last observation date older than 20 years). Aside from two recently reported locations which held a total of approximately 300 individual leaves (fronds), population size of this species in our province is presently unknown. There are no known sites within R11 as of November 2005, though locations have been reported just outside the R11 boundaries. Rare plant data, including information on mountain bladder fern, is lacking for the R11 FMU as a good inventory of vascular plants has never been conducted (except for a few Protected Area sites). However, suitable habitat does exist both near the Hamlet of Nordegg and elsewhere within R11 and could be impacted by harvest or prescribed burn treatments. Any identified populations of mountain bladder fern within the FMU will be maintained by setting aside an adequate area that will not be burned or harvested if possible.

Forecast: No information exists on this species' response to fire or harvest, though populations will likely be at least temporarily removed if burned.

Monitoring: Forestry personnel and contractors will be trained by ANHIC staff to identify this species, and they will assess proposed harvest or burn sites within R11 for the presence of mountain bladder fern while conducting other fieldwork in these areas. If located, the number of individual fronds, their aerial extent, and a GPS location will be recorded. Identified sites will be monitored in consultation with ANHIC. The location and size of any identified populations will be reported in the Stewardship Report.

Response: Any significant downtrend in population size will be assessed for potential causal factors.

2012 Status: Although ASRD forestry staff did not received specific training in rare plant identification during the reporting period, some personnel participated in a rare plant workshop hosted by West Fraser prior to 2007. Incidental observations of rare plants including mountain bladder fern, wood anemone, and Lapland rose-bay could be reported but staff lacked appropriate training and time to make complete assessments of all proposed treatment areas. An expert in plant identification conducted a rare plant assessment within the Upper North Saskatchewan Unit 1 Prescribed Burn during the planning process and found no locations of these rare plants (Timoney 2007). ACIMS does not currently identify any mountain bladder fern locations within R11 or adjacent protected areas. A list of all known rare plants within the R11 FMU (as identified in ACIMS) as well as the impacts of harvesting, prescribed fires, and natural wildfires on their known area can be found in Appendix 1.

Indicator 1.4.3

Value: Biodiversity - Plant Species Diversity

Objective: Conserve plant species diversity by maintaining viable populations of native species (i.e., fine filter approach).

Indicator: Location of wood anemone populations.

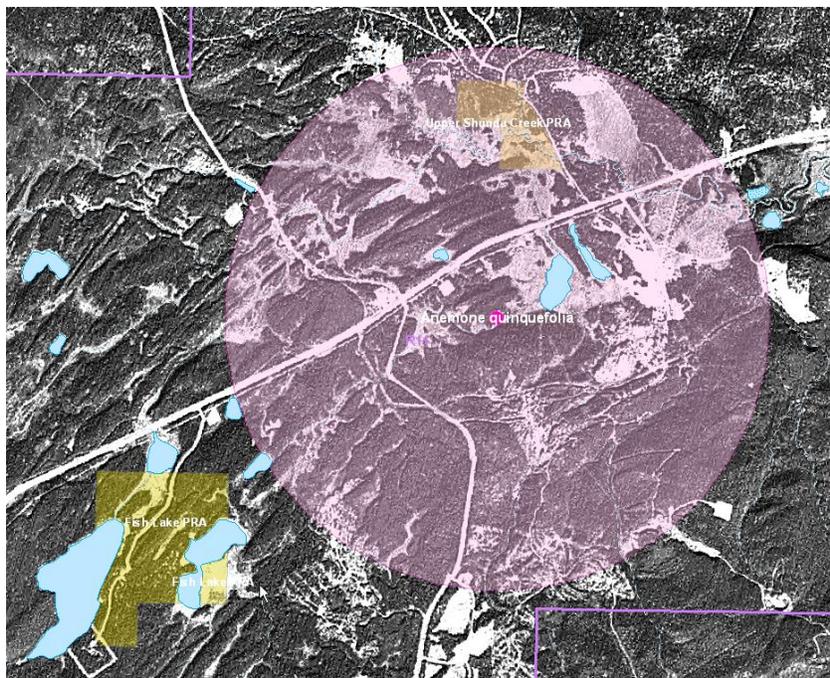
Target: All identified populations will be maintained.

Baseline Status: Wood anemone (*Anemone quinquefolia*) is a delicate spring wildflower that is typically found on sites with rich, moist soil and moderate shade at the edges of deciduous or mixedwood forests. This species is one of 304 rare vascular plant species reported from the five Natural Subregions occurring within R11. Ranked S1 by the Alberta Natural Heritage Information Centre (see description of ANHIC in Indicator 1.2.1), this small flower is one of the rarest species in the province with only one extant and one historical population known as of November 2005. The next closest populations are found in Saskatchewan.



Wood anemone

The only existing population is located just outside the R11 FMU, about 1 km north of Stevens Creek (NAD 83, 573150E, 5839000N; 52 42.217/115 54.733; LSD8 of 14; also LSD5 of 13-43-14-W5), in a lodgepole pine-feathermoss forest with scattered white spruce, fir, wild sarsaparilla, and little understory diversity. This population has been known since 1953 from a specimen collection and was estimated to contain about 500 plants in 1995 and several thousand plants in 1996. The area lies within the Sundre Forest Products Forest Management Agreement area, so logging poses a threat; additional seismic, oil and gas activities could also impact the population. In early 2004, Weyerhaeuser proposed to set aside up to four legal subdivisions to protect this population, although they feared road construction may have eliminated the population in the meantime. The single historic location is based on a 1961 observation within R11 about one mile west of Nordegg (likely a pine-spruce-fir community; Map 8). Population size associated with this historical location is unknown, and there have been no recent attempts to relocate this population. Rare plant data, including information on wood anemone, is lacking for the R11 FMU as a good inventory of vascular plants has never been conducted (except for a few Protected Area sites). If populations of wood anemone are located within R11, they will be maintained by setting aside adequate areas that will not be burned or harvested if possible.



Map 8. Historical location of the only known wood anemone population within the R11 FMU.

Forecast: No information exists on this species' response to fire or harvest, though populations will likely be at least temporarily impacted if burned.

Monitoring: Forestry personnel and contractors will be trained by ANHIC staff to identify this species, and they will assess proposed harvest or burn sites within R11 for the presence of wood anemone while conducting other fieldwork in these areas. If located, the number of individual plants, their aerial extent, and a GPS location will be recorded. Identified sites will be monitored in consultation with ANHIC. The location and size of any identified populations will be reported in the Stewardship Report.

Response: Any significant downtrend in population size will be assessed for potential causal factors.

2012 Status: Although ASRD forestry staff did not receive specific training in rare plant identification during the reporting period, some personnel participated in a rare plant workshop hosted by West Fraser prior to 2007. Incidental observations of rare plants including mountain bladder fern, wood anemone, and Lapland rose-bay could be reported but staff lacked appropriate training and time to make complete assessments of all proposed treatment areas. An expert in plant identification conducted a rare plant assessment within the Upper North Saskatchewan Unit 1 Prescribed Burn during the planning process and found no locations of these rare plants (Timoney 2007). ACIMS currently identifies 1,953 ha of wood anemone within R11 or adjacent protected areas: none of this area was affected by harvesting activities (ASRD, *unpubl. data*). A list of all known rare plants within the R11 FMU (as identified in ACIMS) as well as the impacts of harvesting, prescribed fires, and natural wildfires on their known area can be found in Appendix 1.

Indicator 1.4.4

Value: Biodiversity - Plant Species Diversity

Objective: Conserve plant species diversity by maintaining viable populations of native species (i.e., fine filter approach).

Indicator: Location of Lapland rose-bay populations.

Target: All identified populations will be maintained.

Baseline Status: Lapland rose-bay (*Rhododendron lapponicum*) is a small evergreen shrub that generally grows on moist alpine slopes and upper subalpine sites near timberline. The species is listed as a provincially rare species (ranked S2) by Alberta Natural Heritage Information Centre (see description of ANHIC in Indicator 1.2.1) and is mainly restricted in its Alberta distribution to the central Rocky Mountains region (i.e., Jasper National Park and Bighorn Backcountry, with only one other location found in the Grande Cache area). Four locations within the R11 boundaries are currently recorded in the ANHIC database (Map 9), though this species may be quite frequent, but often overlooked, throughout Job Creek-Coral Creek area and the Wapiabi front ranges (Pharis 2003). Rare plant data, including information on Lapland rose-bay, is lacking for the R11 FMU as a good inventory of vascular plants has never been conducted (except for a few Protected Area sites). Known and newly identified populations of Lapland rose-bay will be maintained by setting aside an adequate area that will not be burned or harvested if possible.

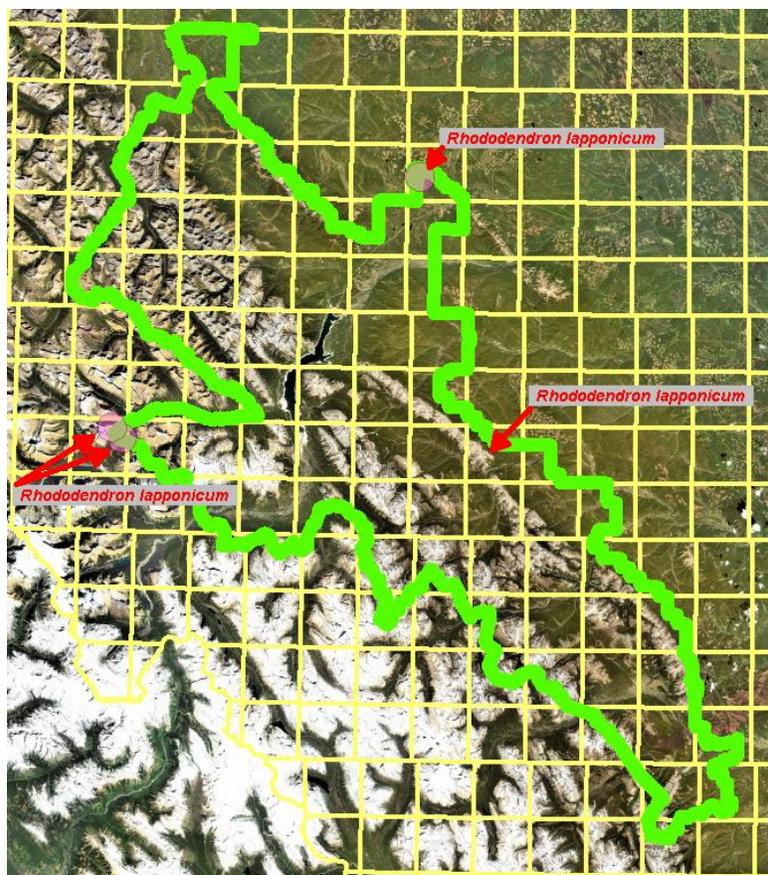


Lapland rose-bay

Forecast: No information exists on this species' response to fire or harvest, though populations will likely be at least temporarily impacted if burned.

Monitoring: Forestry personnel and contractors will be trained by ANHIC staff to identify this species, and they will assess proposed harvest or burn sites within R11 for the presence of Lapland rose-bay while conducting other fieldwork in these areas. The number of individual plants, their aerial extent, and a GPS location will be recorded for both previously known and newly discovered populations. Identified sites will be monitored in consultation with ANHIC. The location and size of any identified populations will be reported in the Stewardship Report.

Response: Any significant downtrend in population size will be assessed for potential causal factors.



Map 9. Locations of known Lapland rose-bay populations with the R11 FMU.

2012 Status: Although ASRD forestry staff did not receive specific training in rare plant identification during the reporting period, some personnel participated in a rare plant workshop hosted by West Fraser prior to 2007. Incidental observations of rare plants including mountain bladder fern, wood anemone, and Lapland rose-bay could be reported but staff lacked appropriate training and time to make complete assessments of all proposed treatment areas. An expert in plant identification conducted a rare plant assessment within the Upper North Saskatchewan Unit 1 Prescribed Burn during the planning process and found no locations of these rare plants (Timoney 2007). ACIMS currently identifies 116 ha of Lapland rose-bay within R11 or adjacent protected areas: none of this area was affected by treatment activities (ASRD, *unpubl. data*). A list of all known rare plants within the R11 FMU (as identified in ACIMS) as well as the impacts of harvesting, prescribed fires, and natural wildfires on their known area can be found in Appendix 1.

Indicator 1.5.1

Value: Biodiversity – Fish Species Diversity

Objective: Maintain important habitat for populations of fish species.

Indicator: Area of disturbed riparian habitat.

Target: Complete protection of all riparian habitats.

Baseline Status: One habitat component considered integral to the persistence of fish populations in R11 is riparian areas, the lands adjacent to streams, river, lakes and wetlands where the vegetation and soils are strongly influenced by the presence of water. Comprising only a small percentage of the landbase, riparian areas are among the most productive of all habitat types and are particularly valuable to both terrestrial and aquatic ecosystems. Important ecological functions provided by riparian vegetation include stabilizing stream banks and channels, regulating temperature and light effects in the watercourse, regulating water flow regimes, filtering runoff before it enters the watercourse, providing long-term recruitment of coarse woody debris and nutrient inputs for aquatic biota, and supplying food and cover for fish species. Accordingly, riparian areas will be protected during the implementation of R11 forest management activities.

Although fire disturbance of riparian areas and sedimentation events can be natural processes, precautions will be taken to ensure treatment activities will not accelerate erosion and sedimentation and will protect sensitive soils and water quality. Protection of water quality during harvest activities is covered in detail in Objective 4.2. Protection of riparian areas and water quality during prescribed burn activities is similarly desirable; however, precision with prescribed fire can be challenging due to topography, fuel types, and local fire weather conditions. Nonetheless, prescribed burn plans will be designed with the protection of riparian values in mind where possible.

Forecast: Complete protection of riparian areas is anticipated in all harvest areas and the majority of prescribed burn areas.

Monitoring: Given the relative paucity of fish inventory data for the R11 FMU, habitat monitoring will be used instead of population monitoring. Post-treatment analyses will determine the amount of the riparian areas disturbed. Results will be presented in the five-year Stewardship Report.

Response: If regular field inspections detect harvest operations occurring within riparian areas, immediate remedial action will be taken to stop, and correct such operations. Riparian areas adjacent to permanent watercourses will likely be used as the boundary between prescribed burn treatments and thus will not be targeted for burning; however riparian habitats in west-central Alberta do experience wildfire disturbance at similar rates as upland habitats (Andison and

McCleary 2002). Therefore, incidental removal of riparian vegetation through prescribed burning will be considered natural and will not trigger action such as adjustments to prescribed burn plans unless excessive impacts are noted (e.g., amount of area disturbed is outside the natural range of variation).

2012 Status: Approximately 10% of the R11 landbase is buffered area around streams and watercourses, protecting the riparian habitat occurring therein. Harvesting treatments attempted to avoid riparian buffers entirely, and field inspections did not identify any contraventions with respect to riparian buffers. A GIS analysis indicated that 11.5 ha of harvest blocks overlapped riparian buffers. Complete avoidance of riparian areas was a challenge in the implementation of prescribed burn activities: 438 ha of riparian buffers were disturbed within a total prescribed burn disturbed area of 6,362 ha (i.e., 7 % of prescribed burn area). Natural wildfires occurring during the reporting period burned 291 ha of riparian buffers within the total wildfire area of 1,782 ha (i.e., 16% of wildfire area). Thus, assuming riparian areas within prescribed burn boundaries burn at the same rate as riparian areas within natural wildfire boundaries, planning activities before and implementation activities during prescribed burns were successful in achieving partial protection of riparian areas.

Indicator 1.6.1

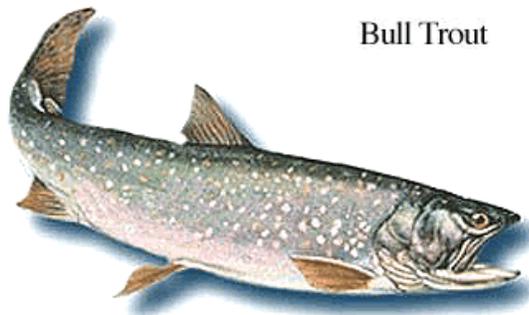
Value: Biodiversity – Fish Species Diversity

Objective: Minimize impact of treatment activities on known bull trout and cutthroat trout streams.

Indicator: Maintenance of stream buffers.

Target: Sundre Forest Products Operating Ground Rules for stream buffers met or exceeded on all bull trout and cutthroat trout streams.

Baseline Status: Recreational fishing holds both social and economic values within the R11 FMU, with bull trout and cutthroat trout two of the most popular sport fish species. Bull trout and cutthroat trout are found predominantly in cool, high elevation, low to mid-order watersheds (summarized in Post and Johnston 2002 and Costello 2006). Unsilted gravel-cobble substrates, stable channels and flows, overhead and instream cover (e.g., boulders, large woody debris, undercut banks, pools), and suitable overwintering habitat further characterize streams utilized by these species. Historically found in all eastern slopes drainages, populations of bull trout have been in decline for the last century, and are now generally confined to less accessible, tributary headwaters of the major river systems including the North Saskatchewan and Red Deer Rivers (Post and Johnston 2002). Accordingly, bull trout are considered a Species of Special Concern in Alberta (ASRD 2006). Information for R11 populations, other than the Upper Clearwater drainage (see Rhude and Rhem 1995; Rodtka 2005), is lacking. Although R11 cutthroat trout populations are introduced, cutthroat trout native to the Bow and Oldman River drainages in Alberta are considered Threatened by COSEWIC. Similar to bull trout, native cutthroat trout are now restricted to the headwaters and upper reaches of tributaries of mainstem rivers (Costello 2006).



Bull Trout

Life history traits (i.e., slow growth, late maturity, alternate year spawning), migratory barriers, habitat degradation and fragmentation, angling pressure, and detrimental interactions with introduced species are thought to limit bull trout abundance. The latter three factors, especially hybridization with introduced salmonid species, have also contributed to cutthroat trout declines over the last century. Habitat loss and degradation, in particular, may result from harvesting operations. Removal of forest cover can decrease the stability and the complexity of habitat through removal of riparian vegetation, erosion of stream banks, removal of large woody debris and coarse substrates, channel alterations, and sediment accumulation in streams (MBTSG 1998). Furthermore, harvesting can cause increases in the rate of runoff leading to flooding

events, cause changes in the groundwater recharge and seasonal flows, and increase stream temperature through a decrease in canopy cover (MBTSG 1998). Wildfires may also lead to a loss of habitat complexity, increased sediment load, and increased temperatures, but habitat may be enhanced through the introduction of large woody debris and subsequently pools (MBTSG 1998). Sestrich (2005) also found that connected bull trout and cutthroat trout populations rebounded within three years following wildfire while non-native brook trout were less resilient to disturbance.

ASRD Fish and Wildlife Division maintains a list of known bull trout and cutthroat trout streams. Harvest activities occurring adjacent to any known bull trout or cutthroat trout stream will adhere to the stream buffers identified in Sunde Forest Products Operating Ground Rules (OGR), the standard adopted for this R11 Forest Management Plan. Prescribed burn plans will attempt to avoid disturbance to riparian areas by utilizing these areas as boundaries between treatment units. Areas with high potential for siltation will be identified. Note that Indicator 4.2.2 also addresses harvest buffer retention to protect water quality and Indicator 1.5.1 addresses the protection of riparian habitats for the benefit of all fish species and populations.

Forecast: Achievement of stream buffer retention is anticipated on all harvest and prescribed burn areas.

Monitoring: The inspecting Forest Officer will conduct regular reviews, and any deviation from the approved Annual Operating Plan will be documented. A summary will be presented in the five-year Stewardship Report.

Response: Immediate remedial action will be taken to correct, where possible, harvesting operations that are not adhering to the OGR.

2012 Status: Streams with known bull trout or cutthroat trout presence were identified from FWMIS (Fisheries and Wildlife Management Information System). To reconcile the base hydrological data layer with the OGR stream classifications (i.e., large permanent, small permanent; Sunde Forest Products 2009), the following reclassifications were made:

- Streams with a Strahler order of 4 and above → large permanent;
- Major rivers → large permanent
- Streams with a Strahler order 3 and below → small permanent, and
- Recurring and indefinite streams → small permanent.

Small permanent watercourses were then buffered by 30 m and large permanent watercourses were buffered by 60 m (following Sunde Forest Products 2009). GIS analyses showed that of a potential 18,041 ha of buffers around known bull trout or cutthroat trout streams within the R11 FMU, 0.17 ha of those buffers fell within or adjacent to harvest blocks treated over the five-year reporting period. Based on the results of 46 field inspections conducted during the reporting period, all harvest treatments adhered to the OGR for stream buffers.

Complete avoidance of riparian areas, however, was a challenge in the implementation of prescribed burn activities, and 65 ha of prescribed burn area fell within stream buffers. Portions of three known or suspected bull trout streams fell within the Upper Saskatchewan Unit 1 prescribed burn area: Owen Creek (found in Banff mostly, but crosses into the R11 FMU near

Highway 11), Thompson Creek, and Timber Creek. These creeks are all suspected to have bull trout in their lower reaches (Rocky Konynenbelt, *pers. comm.*). Although no specific actions were taken to protect these potential bull trout streams during the prescribed burn planning or implementation, larger streams frequently receive default protection (Kevin Heartwell, *pers. comm.*): they are often used as boundaries for burning subunits within the burn (i.e., larger stream banks, due to their topography, often serve as the ignition point with the fire running upslope from there). Furthermore, ignition lines are rarely laid directly across larger streams that are visible from the air.

Indicator 1.6.2

Value: Biodiversity – Fish Species Diversity

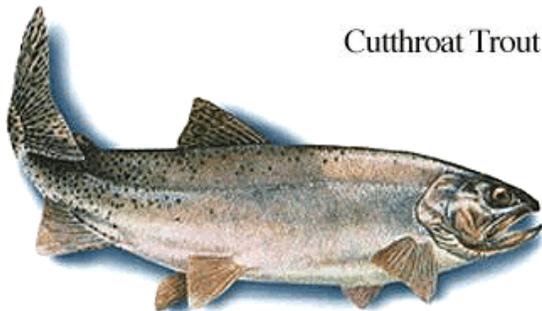
Objective: Minimize impact of treatment activities on known bull trout and cutthroat trout streams.

Indicator: Number of stream crossings.

Target: No permanent crossings wherever possible.

Baseline Status: See Indicator 1.6.1 for general habitat requirements and population information for bull trout and cutthroat trout in Alberta. Habitat loss and degradation are thought to be one of the limiting factors for both bull trout and cutthroat populations (Post and Johnston 2002; Costello 2006), and the construction of roads and watercourse crossings has the potential to impact their habitat. Blockages and hanging culverts form physical barriers to migrating individuals, while removal of riparian cover for road right-of-ways, increased sediment inputs through ditches and eroding stream banks, and channel alterations resulting from crossings can decrease habitat quality and complexity (MBTSG 1998).

Harvest areas identified in the R11 operational plan are reasonably accessible with minimal road construction, and harvesting will be conducted under competitive permits, where ASRD can specify time of harvest, access routes, and crossing types if desired. Access will be coordinated with adjacent land managers whenever possible, although coordination of activities may dictate



Cutthroat Trout

adjustment of harvest schedules to achieve joint roading and reclamation. As most harvest will occur in winter months, construction of new permanent stream crossings is not expected, and any temporary crossings will be removed upon completion of activities. Note that Indicator 4.2.1 addresses the impact of road and watercourse construction on water quality.

Forecast: No new permanent stream crossings are anticipated, unless upon consultation, stakeholders (e.g., Bighorn Steering Committee) request access to be retained for other purposes.

Monitoring: The inspecting Forest Officer will conduct regular reviews. A summary will be presented in the five-year Stewardship Report.

Response: Immediate remedial action will be taken to correct road and crossing construction, maintenance, or reclamation operations that do not comply with the OGR or that are creating impacts in known bull trout or cutthroat trout streams.

2012 Status: During harvest operations occurring under the R11 FMP, five temporary crossings were created. Four logfill or snowfill crossings were temporarily placed on ephemeral streams, and one on a small permanent creek was crossed using a portable bridge. All stream crossings were removed and adequately reclaimed following harvest activities: no variances were noted.

Indicator 1.6.3

Value: Biodiversity – Fish Species Diversity

Objective: Minimize impact of treatment activities on known bull trout and cutthroat trout streams.

Indicator: Timing of instream work.

Target: No instream work from September 1 to April 30 (bull trout streams) or May 16 to August 15 (cutthroat trout streams).

Baseline Status: See Indicator 1.6.1 for general habitat requirements and population information for bull trout and cutthroat trout in Alberta. Habitat loss and degradation are thought to be one of the limiting factors for bull trout and cutthroat trout populations (Post and Johnston 2002; Costello 2006); instream work associated with harvesting activities and road construction can impact habitat and subsequently result in habitat degradation. For example, bull trout habitat quality and complexity can be decreased by the removal of riparian cover, increased sediment inputs, stream bank erosion, and channel alterations (MBTSG 1998).

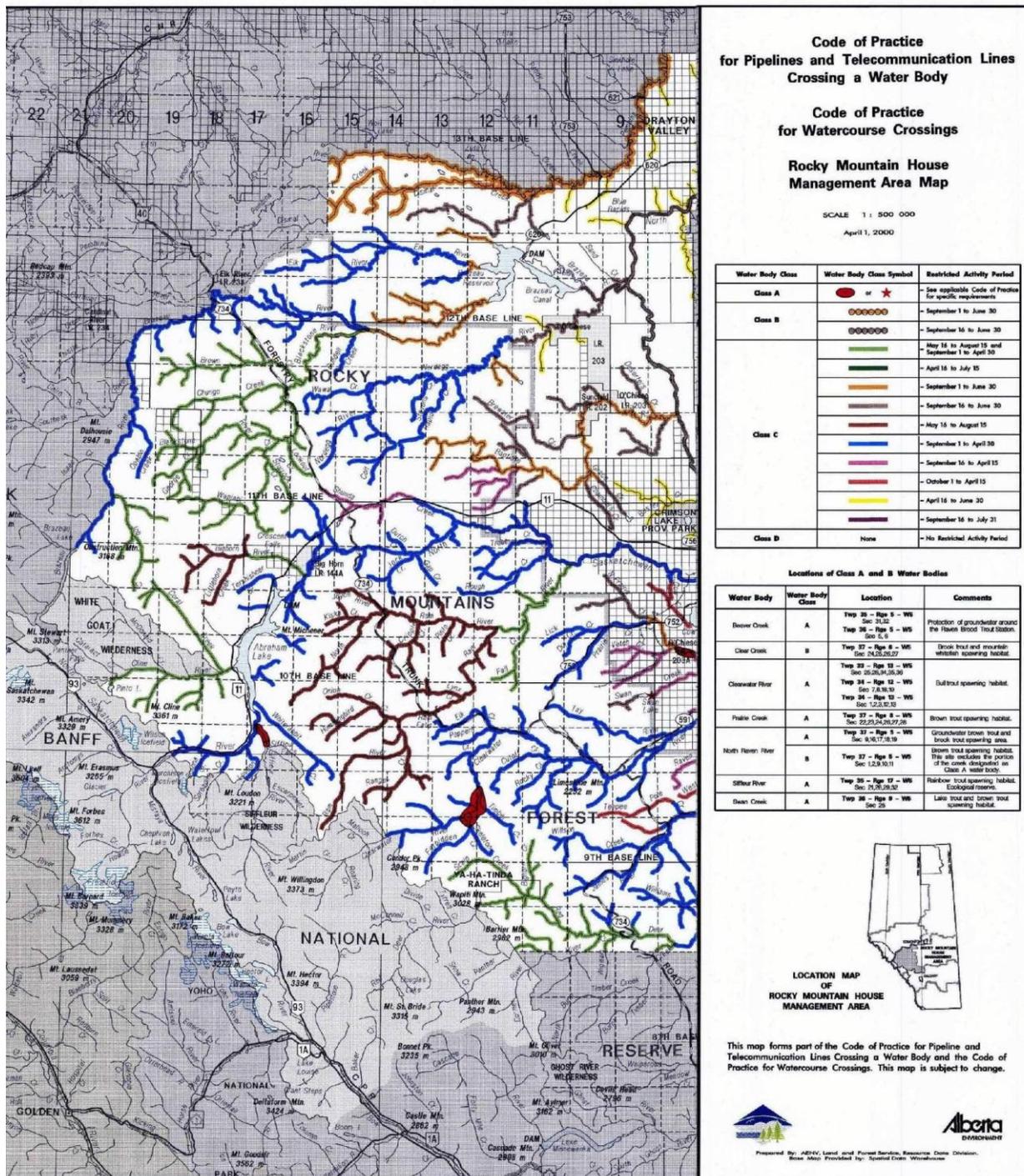
Harvest areas identified in the R11 operational plan are reasonably accessible with minimal road construction, and harvesting will be conducted under competitive permits, where ASRD can specify time of harvest, access routes, and crossing types if desired. Most harvest will occur in winter months and thus should not require any instream work. When bull trout or cutthroat streams cannot be avoided or when instream work is required to cross the streams, work will be conducted as outlined in the *Code of Practice for Watercourse Crossings* under the provincial *Water Act*. Map 10 shows Restricted Activity Periods for specific watersheds within R11.

Forecast: No incidences of instream work are anticipated in bull trout or cutthroat trout streams. If instream work is necessary, adherence to the timing restriction will ensure protection of bull trout or cutthroat trout spawning, incubation, and hatching.

Monitoring: The inspecting Forest Officer will conduct regular reviews. A summary will be presented in the five-year Stewardship Report.

Response: Instream work conducted during the Restricted Activity Period in contravention to the *Water Act* will be detected by field inspections and could result in fines.

2012 Status: During the five-year reporting period, no instream work was conducted on bull trout or cutthroat trout streams as identified in the *Code of Practice for Watercourse Crossings* under the provincial *Water Act*.



Map 10. Code of Practice for Watercourse Crossings map showing the Restricted Activity Periods for various watersheds within the R11 FMU. Watersheds identified in blue contain bull trout while brown indicates cutthroat trout and green indicates both bull trout and cutthroat trout.

Indicator 1.7.1

Value: Biodiversity – Fish Species Diversity

Objective: Maintain the integrity of key instream habitats.

Indicator: Spawning, rearing, and overwintering habitat condition.

Target: No significant increase in sediment load in spawning, rearing, or overwintering areas.

Baseline Status: The introduction of sediments into spawning, rearing, and overwintering fish habitats can have detrimental physiological, behavioural, and population effects (Andersen 1998). High rates of sedimentation can scour out eggs within spawning beds or, alternatively, bury eggs in the spawning beds. Fine sediments can fill the spaces within the gravel thereby reducing the flow of oxygenated water and resulting in impaired respiration or death of embryos. The emergence of hatched fry may be impeded by sediments, and fry further rely on interstitial spaces within gravel beds for cover during rearing. Increased sedimentation levels in watercourses can also cause direct mortality of adults or juveniles through gill trauma, reduce aquatic invertebrate populations, reduce growth rates, disrupt territoriality, displace individuals from preferred habitat to less turbid areas, and infill deep pools required for overwintering (see reviews in Newcombe and MacDonald 1991 and Andersen 1998).

ASRD Fish and Wildlife Division maintains an inventory of spawning, rearing, and overwintering areas in certain streams within the R11 FMU, recognizing that many streams have not been surveyed or existing data is dated. The preparation of prescribed burn or harvest plans will include consultations with fisheries staff to identify known sites. Indicators 1.6.1 to 1.6.3 and 4.2.1 to 4.2.4 detail important measures that will be taken to minimize the potential for harvest-induced sedimentation from adjacent or upstream activities (e.g., maintaining OGR buffers on known fish-bearing streams, minimizing the number of watercourse crossings, avoiding instream work, avoiding bared soil surfaces). When instream work cannot be avoided, the incorporation of proactive, sediment-reduction measures into normal construction practices (e.g., utilizing silt barriers, deflection berms, revegetation) is the next most effective way to minimize impacts on instream habitats. The potential for fire-induced sedimentation depends on fire severity, soil erodibility, steepness of slope, and intensity or amount of precipitation before vegetation has regenerated. Prescribed burn activities will attempt to protect key habitats and minimize sedimentation by retaining riparian areas.

Forecast: Protective measures outlined above will help ensure minimal harvest-induced sedimentation of important fish habitats. Recognizing a degree of unpredictability associated with prescribed fire, protection of riparian areas is anticipated on known fish-bearing streams within prescribed burns.

Monitoring: Post-treatment site visits will assess sedimentation into watercourses. Results will be summarized in the Stewardship Report. Additional fisheries inventories are necessary to

identify additional spawning, rearing, and overwintering sites within R11 and to permit monitoring of population-level responses to treatment activities.

Response: If post-treatment monitoring of run-off from ditches, stream crossings, bare soil, etc. identifies impacts to important habitats, some remedial measures such as additional revegetation may be utilized; however, there are few options for rehabilitating the impacted habitat. The harmful alteration, disruption, or destruction of fish habitat is an offence under the federal *Fisheries Act*, and may result in charges being laid by the Department of Fisheries and Oceans.

2012 Status: Knowledge of spawning, rearing or overwintering sites within the R11 FMU is incomplete as FMU-wide inventory has not been completed, nor is one planned. As per Indicators 1.5.1, 1.6.1, 1.6.2, and 1.6.3, riparian areas were avoided during harvest treatments; all OGRs pertaining to stream buffers were met or exceeded; no new permanent crossings were created; and instream work was avoided. These measures should have reduced the likelihood of harvest-induced sedimentation into spawning, rearing, or overwintering fish habitat. However, no post-treatment monitoring of sedimentation into watercourses was completed, nor did baseline, pre-treatment data exist for comparison purposes. No sedimentation events were noted by staff working in treatment areas after the treatment events.

Indicator 1.8.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Ensure treatment activities do not unduly benefit either predator or prey populations.

Indicator: Predator-prey ratio.

Target: Targets to be determined after completion of ongoing research.

Baseline Status: Integral to the terrestrial ecosystem found within the R11 Forest Management Unit are multiple large predators including wolves, cougar, black bear, grizzly bear, and their prey, primarily large herbivores such as elk, mule deer, white-tailed deer, moose, bighorn sheep, and feral horses. (Wolverine, coyotes, and mountain goats are either rare or localized in their R11 distribution and thus will not be considered in this indicator.) Such a diversity of predator and prey species necessarily denotes complex predator-prey relationships. Our understanding is further confounded by a lack of information and difficulties in obtaining accurate population data. For example, wolf and cougar populations are thought to have increased over the past two decades, but these reports are largely based on voluntary harvest summaries or anecdotal records as few rigorous studies have been conducted in the Alberta foothills (e.g., Ross and Jalkotzy 1992, Kuzyk 2002). Similarly, trend counts for elk via annual aerial surveys of open winter ranges have produced highly variable estimates, likely because individuals also use nearby forested habitats where sightability issues limit detection (Merrill et al. 2005).

Predator-prey relationships, their impacts on population dynamics, and the influence of industrial development have been the focus of recent and ongoing research at the University of Alberta (see <http://ursus.biology.ualberta.ca/ceswes/index.htm> and <http://www.ualberta.ca/%7Ekknopff/cougars/index.htm>). The Central East Slopes Wolf Study was initiated in the spring of 2003 and fieldwork is now completed, while only one year of fieldwork in a three-year cougar study has been completed. Results from the wolf study as of late 2005 indicate that numerically about 50% of wolf kills were deer with the other 50% of kills made up of elk, moose, and feral horses, though proportionately more food comes from these larger prey. Fecal analysis from four wolf packs sheds a different light on the predator-prey picture with wolves preferring to prey on moose, using elk in relation to their availability, and preying on deer less than expected based on their abundance (Webb et al. 2006).

Harvest and prescribed burn treatments planned in this FMP will likely benefit herbivore species as young forests regenerate providing high forage availability. Caution must be exercised to ensure any newly created ungulate habitat and the individuals foraging therein are not so attractive to predators that the areas become population sinks (i.e., more predation than the prey population can sustain). Such attractive habitats can also be detrimental if they result in increased predation on alternative prey populations that are already facing other challenges or limitations. For example, elk and moose populations in the Red Deer, Bow, Spray, and Cascade River valleys declined over the same time period that the North Banff woodland caribou herd

experienced a dramatic decline; wolf numbers, on the other hand, increased (see references in Parks Canada 2006). Prey switching by wolves was likely a contributing factor as caribou are more susceptible to wolf predation than other ungulates and are the first prey species to decline and the last to recover (Seip 1991). Although likely perceived as less of a problem, the predator-prey balance could shift in favour of the prey species if treatment activities overachieve. This FMP proposes to monitor the predator-prey ratio as an indicator of how treatments are impacting populations. Given the complexities of a dynamic, multi-predator, multi-prey system and the population data limitations noted above, targets will be neither set nor the predator-prey ratio tracked until after the completion of ongoing research studies.

Forecast: To be determined after the completion of ongoing research.

Monitoring: A complete description of how the predator-prey ratio will be calculated and monitored will not be available until the completion of ongoing research studies. At the current time, available data on ungulate populations is derived from annual aerial surveys. Voluntary trapper harvest reports currently provide the only annual information on predator numbers, though limitations exist with harvest return data as trapper effort and reported success can be influenced by memory recall, furbearer population status, fur prices, weather conditions, landscape and landuse changes, and available time and income (Mullen 2006). Annual aerial survey data are compiled yearly and results will be summarized in the five-year Stewardship Report.

Response: To be determined after the completion of ongoing research.

2012 Status: After examination of the completed research conducted in the dynamic multi-predator, multi-prey system represented in the Clearwater Area (see Indicator 5.1.1 for summary of recent studies and associated references), use of the predator-prey ratio as an indicator required detailed data (e.g., intensive telemetry studies, DNA-based population surveys) that were too fiscally demanding to be collected on a regular basis. Anne Hubbs, ASRD Senior Wildlife Biologist, instead suggested using three alternative predator measures that can be monitored and easily understood:

- a) presence of breeding wolf packs distributed across the R11 FMU,
- b) presence of breeding female cougars distributed across the R11 FMU, and
- c) presence of breeding female grizzly bears within each grizzly bear watershed unit in the R11 FMU.

The following sections discuss the data used to monitor this predator indicator and the targets recently set by ASRD as part of a Landscape Objectives project, as well as the results of annual aerial ungulate surveys and associated population targets for ungulate populations at the WMU level.

Predator Population Monitoring and Targets

Maintaining a suite of large carnivores is often a priority for landscape or conservation planning with the assumptions that (1) they require large, well-connected habitat refugia, which likely encompass the habitat requirements of many other species; (2) they are sensitive to human and environmental disturbance; and (3) they play critical, functional roles in structuring and

regulating ecological processes and populations within the ecosystem (Noss et al. 1996, Ray 2005). For the R11 Forest Management Plan, three large predators (wolves, cougars, and grizzly bears) will be monitored as an indicator of treatment activities on the predator component of the R11 ecosystem. The presence of breeding wolf packs and breeding female cougars within the R11 landscape can be determined from harvest return data. Opportunistic observations of scat, tracks, and sightings or camera trap photos are also reported by ASRD Fish and Wildlife staff working in the field on other projects; however, the harvest return data represent the most consistent and ongoing source of data available at this time.

Due to their Threatened status (see Indicator 1.10.1), grizzly bear populations in Alberta receive closer scrutiny and targeted monitoring. Grizzly bear population units are a management unit based on genetic distinctions within the Alberta grizzly bear population and are usually delineated by major highways on their north and south boundaries. Two grizzly bear population units overlap the R11 FMU: Yellowhead to the north of Hwy 11 and Clearwater to the south of Hwy 11. Grizzly bear watershed units (GBWU) are management units within each population unit delineated based on major watersheds subdivided along heights of land or occasionally along watercourses that approximate an average female grizzly bear home range size (i.e., about 700 km²). Within the Yellowhead population unit, there are 9 grizzly bear watershed units falling entirely within or overlapping the R11 FMU. Within the Clearwater population unit, there are 12 grizzly bear watershed units falling entirely within or overlapping the R11 FMU (Map 11). Methods for monitoring grizzly bears in each population unit are under review and recommendations will be available shortly (Anne Hubbs, *pers. comm.*). The presence of breeding female grizzly bears within each grizzly bear watershed unit will be monitored as per these recommendations.

Targets for the predator measures discussed above are being set by ASRD as part of a Landscape Objectives project and will be released shortly (Anne Hubbs, *pers. comm.*). This indicator will then adopt those targets.

Prey Population Monitoring and Targets

ASRD Fish and Wildlife, in partnership with Alberta Conservation Association, Foundation for North American Wild Sheep, Parks Canada, and Alberta Sustainable Resources and Environmental Management Aboriginal Affairs Branch, conducts annual aerial ungulate surveys to monitor ungulate population trends. Individual Wildlife Management Units are surveyed on a rotational basis every five to seven years, while species on winter ranges are surveyed every two to three years (ASRD 2011). Over the five-year reporting period, the following surveys were conducted: surveys of elk winter ranges within the FMU, elk and moose survey in WMU 328, and surveys of bighorn sheep winter ranges in all WMUs. Population targets are available for each ungulate species in all WMUs. As these targets undergo frequent review and revision, they are not presented here. Instead, where recent surveys have been completed and population estimates calculated for a given WMU, comments are made as to the current population estimate relative to the population target.

Elk Winter Range Survey – Key elk winter ranges within the Clearwater Area were surveyed during January 2008, 2010, and 2012 (ASRD, *unpubl. data*; Hubbs and Feder 2009), with the minimum count surveys designed to provide an indication of general population trend over several years rather than a complete enumeration of population numbers. Not all ranges were surveyed during the latter two seasons, thus data from the January 2007 survey are also provided for comparison in Table 18. The overall minimum herd counts in 2007 and 2008 were approximately 800 animals, with the majority of animals found near Ya Ha Tinda. Counts from the Ya Ha Tinda area surveys in 2010 and 2012 show a generally decreasing trend since 2007 (and before; ASRD, *unpubl. data*).

Table 18. Minimum herd counts from elk winter ranges surveyed within the Clearwater Area (ASRD, *unpubl. data*; Hubbs and Feder 2009). Only ranges where elk were observed are presented.

Elk Winter Range	2007 Minimum Count	2008 Minimum Count	2010 Minimum Count*	2012 Minimum Count**
Brazeau River	5			
Blackstone River		10		
Nordegg		14		
North Saskatchewan River	125	34		
Kootenay Plains	13	90		
Rough Creek		1		
South Ram River	5	76		
Ranger Creek		21		
Elk Creek	39	4		
Upper Clearwater	43	142		26
Ya Ha Tinda	598	408	423	332
Yara Creek			24	
<i>Total</i>	828	800	447	358

* Only ranges in WMUs 318, 416, 418 were flown in 2010

** Only ranges in WMUs 418, 420 were flown in 2012

Elk and Moose Survey - The elk and moose survey was conducted in March 2009 in WMU 328, which partially overlaps the R11 FMU in the area east of Nordegg (Hubbs and Webb 2009). The survey found a total count of 57 moose, indicating a WMU population of 335 (± 90) with 55 bulls per 100 cows and 23 calves per 100 cows. The elk survey found a total count of 43 elk, indicating a WMU population of 241 (± 213) with 5 bulls per 100 cows and 3 calves per 100 cows (though these ratios may be underestimated as many bulls have already shed their antlers and calves can be hard to distinguish from cows by late winter; Hubbs and Webb 2009).

Bighorn Sheep Survey - Bighorn sheep were also surveyed in January 2009 and January 2011 for all WMUs that fall entirely within or overlap a portion of the R11 FMU (Feder and Webb 2009; ASRD 2011). These minimum counts are shown below in Table 19. The minimum total herd size observed since 2005 has ranged from approximately 1100 to 1500 animals (ASRD 2011), which is generally well below ASRD population goals at the WMU level. The herd composition summary is shown in Table 20, with 2007 herd composition shown for comparison. Although the ram to ewe ratio appears to be stable to slightly declining, the lamb to ewe ratio has been declining from 30 lambs per 100 ewes in 2005 to 19 lambs per 100 ewes in 2011.

Table 19. Minimum counts of bighorn sheep from WMUs surveyed during the 2009 and 2011 surveys (taken from Feder and Webb 2009 and ASRD 2011).

WMU	2009 Minimum Count	2011 Minimum Count
326	0	3
328	15	15
414*	55	39
416	2	186
417	8	
418	157	227
420	285	175
422	556	158
426	134	37
428	7	7
429	31	6
430	72	30
432	43	216
434	120	68
738*	6	2
<i>Total</i>	<i>1,491</i>	<i>1,169</i>

* These WMUs are adjacent to the R11 FMU but do not overlap its boundaries; however, they were included in the ACA/ASRD/FNAWS surveys.

Table 20. Herd composition for all WMUs combined from bighorn sheep winter range surveys (taken from Feder and Webb 2009 and ASRD 2011).

Year	Rams per 100 ewes	Lambs per 100 ewes
2005	45	30
2007	40	30
2009	46	24
2011	37	19

2012 Revision: As discussed above, an assessment of the indicator measure of predator-prey ratio is data-limited and fiscally challenging. Accordingly, the new predator indicator will be multi-pronged, focussing on three carnivore species:

- a) presence of breeding wolf packs distributed across the R11 FMU,
- b) presence of breeding female cougars distributed across the R11 FMU, and
- c) presence of breeding female grizzly bears within each grizzly bear watershed unit in the R11 FMU.

Specific targets for this predator indicator are still under development but will be adopted by the R11 FMP once available. The prey component of the indicator has adopted ASRD ungulate population targets at the WMU level.

Indicator 1.9.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain and restore high quality ungulate summer and winter range and associated movement habitat.

Indicator: Stand age distribution broken down by habitat capability for elk, deer, and moose.

Target: Current stand age distribution within the natural range of variation for areas identified as capable of supporting elk, deer, moose, and bighorn sheep.

Baseline Status: Elk, mule deer, bighorn sheep, and moose within R11 hold ecological value as large herbivores and prey species as well as social and economic value in recreational hunting. Young seral stages generally represent high quality ungulate habitat as these species favour early successional vegetation for forage. However, aggressive fire suppression, particularly in forested areas without compensatory timber harvesting, has resulted in progressively more mature and old forests, forest encroachment into grasslands, meadow complexes, and alpine habitats, and thus



Bighorn sheep

habitat loss for many ungulates. The harvest and prescribed burn treatment activities identified in this FMP will restore areas of prime ungulate habitat by returning the stand age distribution to within its natural range of variation. Potential ungulate habitat is defined as per the Canada Land Inventory Land Capability for Ungulates map (see Monitoring below for more details) and the current distribution of stand ages is shown in Table 21 and Table 22.

Table 21. Current 2007 percentage of forest in each age class in areas identified as capable of supporting a given ungulate species throughout the year, compared to the natural range of variation.

Natural Subregion	Age Class (yrs)	Deer	Elk	Moose	Bighorn Sheep	NRV
Subalpine	1-20	4	3	4	1	6-20
	21-100	14	13	13	12	22-47
	101-180	61	62	62	62	17-21
	181+	21	21	21	25	14-55
Montane	1-20	4	4	4	4	6-39
	21-100	16	15	16	21	22-53
	101-180	75	76	75	72	7-21
	181+	5	5	5	4	1-55

Natural Subregion	Age Class (yrs)	Deer	Elk	Moose	Bighorn Sheep	NRV
Upper Foothills	1-20	5	5	3	0	17-42
	21-100	25	24	27	4	44-53
	101-180	64	65	64	80	6-21
	181+	5	6	6	17	1-18
Lower Foothills	0-20	0	0	0	-	16-32
	21-100	12	12	12	-	43-53
	101-180	35	35	35	-	11-21
	181+	53	53	53	-	3-20

Table 22. Current 2007 percentage of forest in each age class in areas identified as capable of supporting a given ungulate species during the winter, compared to the natural range of variation.

Natural Subregion	Age Class (yrs)	Deer	Elk	Moose	Bighorn Sheep	NRV
Subalpine	1-20	4	4	4	2	6-20
	21-100	13	12	13	9	22-47
	101-180	59	61	60	62	17-21
	181+	24	23	23	27	14-55
Montane	1-20	6	6	6	5	6-39
	21-100	19	19	20	25	22-53
	101-180	68	68	67	65	7-21
	181+	7	7	7	5	1-55
Upper Foothills	1-20	5	4	2	0	17-42
	21-100	29	27	31	1	44-53
	101-180	62	63	63	68	6-21
	181+	4	6	5	31	1-18
Lower Foothills	0-20	0	0	0	-	16-32
	21-100	12	12	12	-	43-53
	101-180	35	35	35	-	11-21
	181+	53	53	53	-	3-20

Forecast: R11 forest management activities should create additional habitat for ungulate species by shifting the stand age distribution toward young seral stages.

Monitoring: The Canada Land Inventory has mapped Land Capability for Ungulates throughout many parts of the province. This classification is not based on current or known ungulate production or habitat, but rather on the physical characteristics that determine the land's potential to provide sufficient quantity and quality of food and cover resources. Seven capability ratings are identified ranging from lands with no significant limitations on ungulate production to lands with severe limitations imposed by local conditions (e.g., aspect, snow depth, aridity, etc.). Within these classes, polygons retaining specific potential as winter range habitat are identified,

and the most applicable ungulate species for each area are also noted. The Canada Land Inventory ungulate coverage will be used in a GIS to distinguish areas in R11 capable of supporting survival and reproduction of elk, deer, moose, and bighorn sheep throughout the year (Classes 1, 2, 3, and 1W, 2W, 3W; Map 12) and specifically during the winter (Classes 1W, 2W, 3W) period. The stand age distribution will then be assessed for areas capable of supporting a given species during a given time period (e.g., stand age distribution for areas capable of supporting sheep during the winter; stand age distribution for areas capable of supporting moose at some point during the year). Results will be presented in the five-year Stewardship Report. This will be a landscape-level filter using a general habitat capability map to provide a crude estimate at the operational level: finer detail could be ascertained using more species-specific maps or models that take into account mortality risk from predation or hunting, current landcover, human development, etc. in future iterations of the FMP.

Response: More aggressive harvesting or prescribed burning will be required if the stand age distribution does not return to within the natural range of variation.

2012 Status: Analyses of the current stand age distribution on land capable of supporting the ungulate species of interest throughout the year and just during the winter are shown in Table 23 and Table 24 for each natural subregion. As indicated above, only CLI ungulate polygons of Class 3 (slight limitations) and better were included. With the exception of the old (181+ years) age class, neither the 2007 nor the 2012 percent of forest in the other age classes is generally within the natural range of variation for any ungulate species.

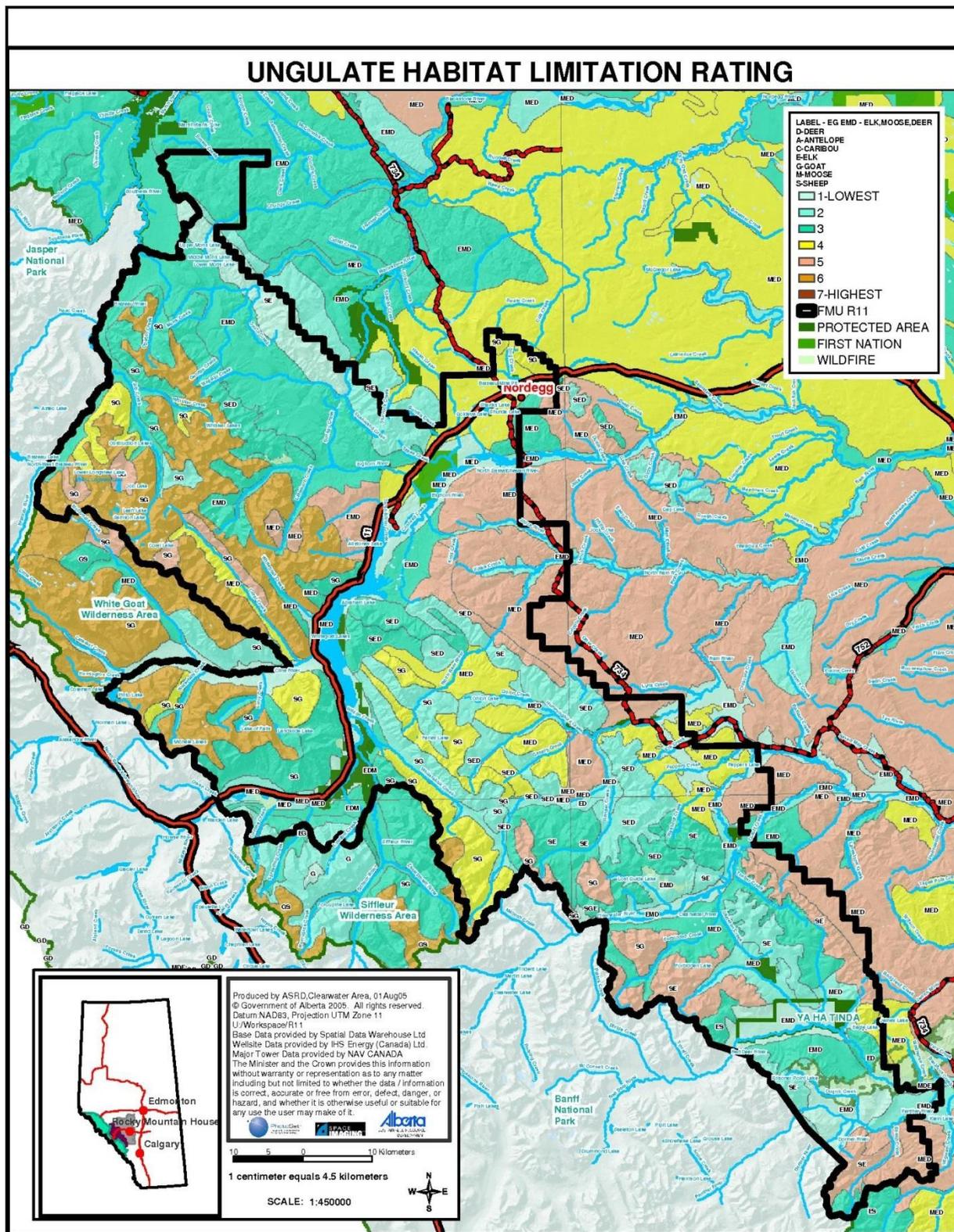
Table 23. Current 2012 percentage of forest in each age class in areas identified as capable of supporting a given ungulate species throughout the year, compared to the natural range of variation.

Natural Subregion	Age Class (yrs)	Deer	Elk	Moose	Bighorn Sheep	NRV
Subalpine	1-20	3	3	4	6	6-20
	21-100	7	6	7	4	22-47
	101-180	68	67	68	62	17-21
	181+	22	23	22	28	14-55
Montane	1-20	10	10	10	12	6-39
	21-100	12	12	12	24	22-53
	101-180	73	73	72	62	7-21
	181+	5	5	5	1	1-55
Upper Foothills	1-20	4	4	2	1	17-42
	21-100	13	13	14	1	44-53
	101-180	77	76	77	88	6-21
	181+	6	7	6	10	1-18
Lower Foothills	0-20	0	0	0	-	16-32
	21-100	5	5	5	-	43-53
	101-180	50	50	50	-	11-21
	181+	45	45	45	-	3-20

Table 24. Current 2012 percentage of forest in each age class in areas identified as capable of supporting a given ungulate species during the winter, compared to the natural range of variation.

Natural Subregion	Age Class (yrs)	Deer	Elk	Moose	Bighorn Sheep	NRV
Subalpine	1-20	4	4	5	10	6-20
	21-100	6	5	6	4	22-47
	101-180	65	65	67	55	17-21
	181+	25	25	23	31	14-55
Montane	1-20	14	14	14	16	6-39
	21-100	15	15	15	29	22-53
	101-180	65	65	64	54	7-21
	181+	6	6	6	1	1-55
Upper Foothills	1-20	5	5	3	2	17-42
	21-100	13	13	14	0	44-53
	101-180	76	75	78	84	6-21
	181+	6	7	5	14	1-18
Lower Foothills	0-20	0	0	0	-	16-32
	21-100	5	5	5	-	43-53
	101-180	50	50	50	-	11-21
	181+	45	45	45	-	3-20

2012 Revision: When this indicator was originally written, the Elk Habitat Effectiveness Planning Tool was under development but not yet available to track elk habitat quality (Merrill et al. 2005, Frair et al., *in prep.*, see also Indicators 1.9.2 and 1.9.3). Given the overlap in deer, moose, and elk habitat potential in the CLI - Land Capability for Ungulates and the relative lack of use of the CLI - Land Capability for Ungulates in operational level planning, the Elk Habitat Effectiveness Planning Tool may have equal utility now in ensuring high quality summer and winter habitat for these other ungulate species. Accordingly, this indicator will be dropped in subsequent five-year Stewardship Reports, and ungulate habitat tracking will instead focus on Indicators 1.9.2 and 1.9.3. Bighorn sheep differ in both habitat association and land potential under CLI from the other ungulate species; another indicator may be considered in the future as deemed necessary to ensure adequate high quality habitat for sheep.



Map 12. Ungulate habitat limitation rating for R11 based on the Canada Land Inventory. A rating of 1 indicates the least limitations and thus the highest habitat capability.

Indicator 1.9.2

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain and restore high quality ungulate summer and winter range and associated movement habitat.

Indicator: Location and extent of high quality ungulate winter range and associated movement habitat.

Target: Not yet completed; target needs to be set using the Elk Habitat Effectiveness Planning Tool.

Baseline Status: Winter is a challenging season for many northern ungulate species as energy costs are higher but forage availability is lower than at other times of the year. Native ungulate species found within the R11 Forest Management Unit include elk, mule deer, and bighorn sheep as well as moose and mountain goat where appropriate habitats exist. Elk will be used as the representative ungulate species in this FMP for both ecological and empirical reasons. In addition to habitat overlap between the generalist elk and other ungulates, snow depth also determines winter habitat use patterns of most ungulates and its effects on elk are intermediary between that of moose and deer. Furthermore, elk within the R11 Forest Management Unit have been the focus of scientific research over the past several years (Merrill et al. 2005), in part to assess the impacts of landscape change on elk populations. Supported by information and technological products from this research, elk winter habitat will be one indicator of landscape changes resulting from R11 forest management activities. Additional ungulate species could be considered in future iterations of the FMP.



Herd of bull elk in R11

Winter habitat components required by elk include available forage, shallow snow depths, security cover, and possibly thermal cover. Typical winter forage includes forbs and shrubs, although grasses will be used preferentially where available. Snow depths exceeding 40 cm can force elk to move to areas with low snow cover and high forage availability such as south-facing slopes (Irwin and Peek 1985) and mature, closed-canopy conifer stands that better intercept snow, while depths exceeding 70 cm can impede movement (Sweeney and Sweeney 1984). Security cover includes habitat that is proximate to foraging areas and contains vegetative diversity to reduce detection by predators. Such cover should conceal 90% of a standing adult elk from a distance of approximately 60 m. Thermal cover (i.e., conifer-dominated stands that

are 10-12 m tall with greater than 70% canopy closure) may only be necessary during severe conditions when temperatures drop and wind-chill increases. Suitable wintering habitats can include grassy meadows, willow flats, creek and river valleys, floodplains, south-facing slopes, and low elevation ridges.

Harvest and prescribed burn treatment activities planned in this Forest Management Plan have the potential to maintain, and in some instances restore, high quality ungulate winter ranges. However, the ability of prescribed fires to enhance elk habitat depends on the wolf predation risk (Hebblewhite 2006): habitat treatments may be less desirable in some areas from an elk forage standpoint but would not result in a predation sink (e.g., higher elevation habitats distant from suitable wolf denning habitat). The Elk Habitat Effectiveness Planning Tool, based on landcover maps, predation risk models, and forage availability models from the Central East Slopes Wolf and Elk Study (Merrill et al. 2005), will be used to set habitat targets and assess the effects of forest management activities both pre-treatment and post-treatment. The planning tool uses resource selection function models that predict occurrence and survival of elk as a function of forage abundance, terrain complexity, predation risk, travel corridors, and human disturbances. Summer and winter seasons are treated separately within the models. Note that at this time, the Elk Habitat Effectiveness Planning Tool is in the final development phase and has not been released for general application. Accordingly, setting targets and forecasting the impacts of proposed treatments on elk winter habitat has not been completed for this version of the R11 Forest Management Plan.

Forecast: A quantitative analysis using Elk Habitat Effectiveness Planning Tool and proposed harvest block and prescribed burn boundaries will be completed for the next iteration of this FMP.

Monitoring: The Elk Habitat Effectiveness Planning Tool will be used to assess post-treatment landscape changes and their impacts on elk winter habitat. Results will be summarized in the Stewardship Report.

Response: Harvest and prescribed burn plans will be adjusted if the location and extent of elk winter range falls below the established targets.

2012 Status: Completed in 2009, the Elk Habitat Effectiveness Planning Tool provides a method by which to assess primary and secondary source and sink habitat for elk in the central East Slopes (Webb and Anderson 2009). The model integrates relative occurrence of elk and wolves based on landcover types, terrain, and human disturbance as well as elk survival. The outputs delineate areas that represent high habitat quality with a high survival probability (primary source) as well as areas with high habitat quality but a higher mortality risk (primary or attractive sink). The five possible habitat states are shown in Table 25. The elk tool was subsequently used to forecast changes in the habitat states resulting from three proposed prescribed burn scenarios on the landscape, to assess FMU-level changes in elk habitat states resulting from actual treatments conducted up to 2010, and to assess local-level changes in elk habitat states resulting from one specific treatment, the Upper Saskatchewan Unit 1 prescribed burn. The results from these analyses are summarized below. Yet to be completed is the establishment of habitat targets for elk winter and summer ranges in the R11 FMU: both ASRD and ACA will

participate jointly in this future exercise. Note that the Elk Habitat Effectiveness Planning Tool has recently undergone an update (Frair et al., *in prep.*), and the updated tool will be used in future R11 Stewardship Reports.

Table 25. Habitat states predicted by the Elk Habitat Effectiveness Planning Tool.

		Habitat Quality		
		Low	Medium	High
Mortality Risk	Low	Non-critical	Secondary Source	Primary Source
	High	Non-critical	Secondary Sink	Primary Sink

Elk Winter Habitat Change Forecast for Three Prescribed Burn Scenarios

To examine the impacts of potential prescribed burn treatments on elk habitat within the R11 FMU, three scenarios were discussed with ASRD Forestry Division fire experts based on a 10-year treatment rate of approximately 14,000 ha (Webb and Anderson 2009). The spatial arrangement of the potential burns on the landscape varied with their relative importance in addressing forest health, wildfire threat, and natural disturbance emulation. The three identified scenarios were as follows:

- 10-year dispersed – placement of 49 burn units addressed immediate threat from mountain pine beetle and wildfire,
- 10-year events 1 – placement of 41 burn units emulated larger natural disturbance events, while still considering threats from mountain pine beetle and wildfire, and
- 10-year events 2 – placement of 28 burn units with the sole focus of emulating natural disturbance events.

At the FMU level, the three scenarios differed very little in their production of source habitat for wintering elk: they each increased source habitat by 3-4% over a no-burn scenario (Table 26). Locally, however, the treatment scenarios may have a greater impact. For example, the 10-year dispersed scenario predicted a 15% increase in winter source habitat within the Cline River watershed subbasin, while the 10-year events 1 and 2 scenarios were predicted to increase elk source habitat by 22% (Webb and Anderson 2009).

Table 26. Predicted amount (km²) of non-critical (NC), secondary source (SSO) and sink (SSI), and primary source (PSO) and sink (PSI) habitat in the winter resulting from each prescribed burn scenario in the R11 FMU (adapted from Webb and Anderson 2009).

Scenario	NC	SSO	PSO	SSI	PSI
No burns	11,552	302	303	1,445	1,066
10-yr dispersed	11,511	312	317	1,447	1,081
10-yr events 1	11,513	308	318	1,448	1,081
10-yr events 2	11,510	309	313	1,460	1,076

Elk Winter Habitat Change Resulting from Recent Prescribed Burn and Harvest Treatments

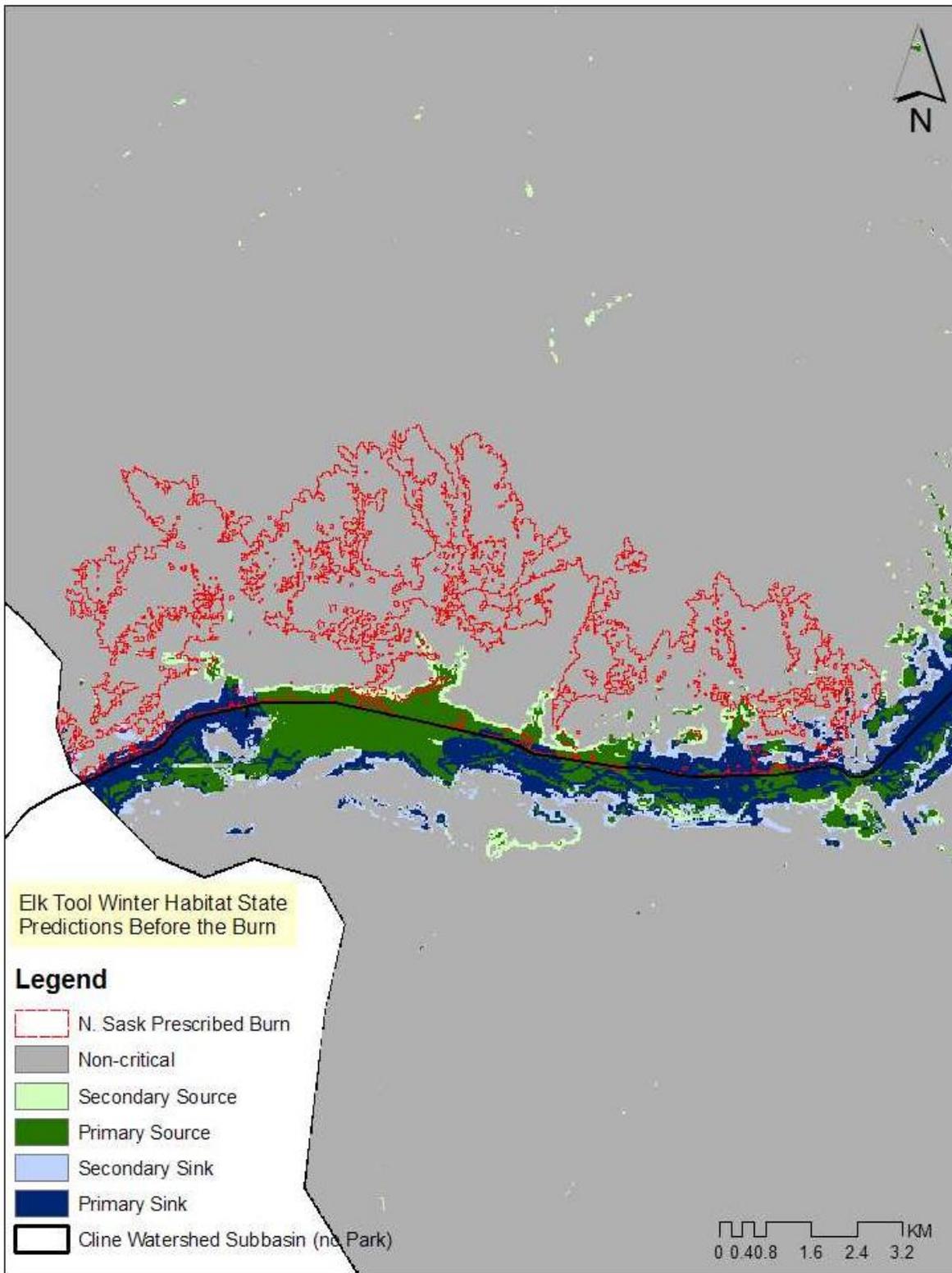
The Elk Habitat Effectiveness Planning Tool was used to compare a baseline landscape condition from 2003 to the current landscape condition (ACA, *unpubl. data*). Any prescribed burn or harvesting treatments occurring up to the end of 2010 (i.e., the most current data updates) as a result of the R11 FMP were captured. Elk winter source habitat increased by 4% while winter sink habitat showed a corresponding 12% decrease over the comparison period (Table 27), indicating the treatments were effective in improving elk wintering habitat at the FMU level. Results for summer elk habitat states are shown in Table 29.

Table 27. Amount (km²) of non-critical (NC), secondary source (SSO) and sink (SSI), and primary source (PSO) and sink (PSI) habitat in the winter before (i.e., in 2003) and after recent (i.e., 2010) prescribed burn and harvest treatments in the R11 FMU.

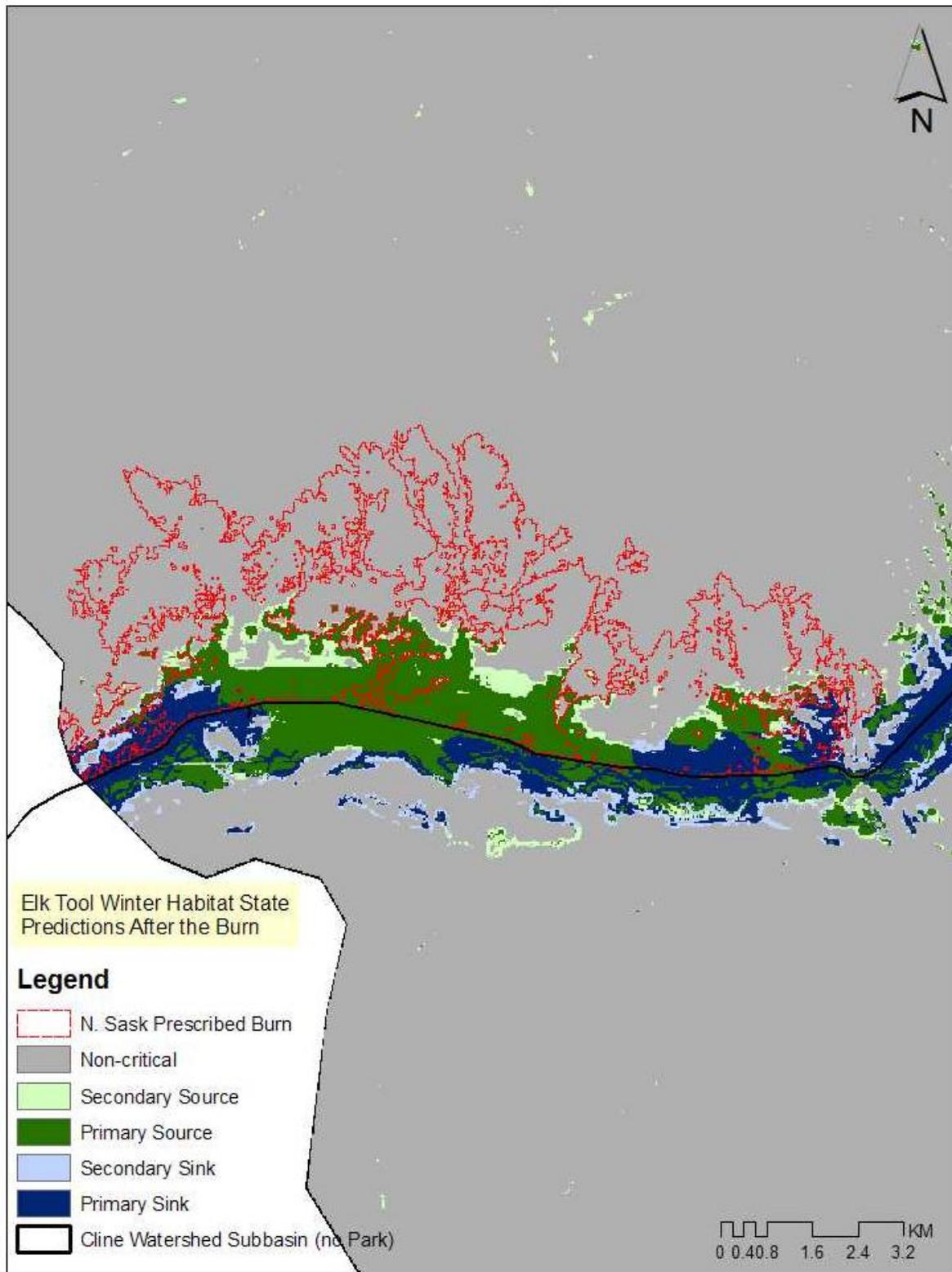
Year	NC	SSO	PSO	SSI	PSI
2003	463	85	89	174	189
2010	467	92	89	171	148

Elk Winter Habitat Change Resulting from Upper Saskatchewan Unit 1 Prescribed Burn

Winter habitat states at a local level within the Cline watershed subbasin prior to the Upper Saskatchewan Unit 1 prescribed burn were also compared to post-burn winter habitat states using the Elk Habitat Effectiveness Planning Tool (Map 13 and Map 14). As winter resources and terrain are often limiting for ungulates, the model results are more striking for the changes in elk winter habitat compared to summer habitat (Indicator 1.9.3). Primary and secondary source habitat increased by 43% and 11%, respectively within the Cline watershed subbasin (significantly higher than the 22% predicted by the 10-year events 1 and 2 scenarios forecast above), with greater connectivity between primary habitat patches. Primary sink habitat also increased by 4%, due to an increase in habitat attractiveness in areas with higher mortality risk (no change in secondary sink habitat). The relative contributions of wolf predation and human-caused mortality resulting from proximity to Highway 11 are unclear as the model does not incorporate the "no hunting" buffer along the highway.



Map 13. Predicted elk winter habitat states within the Cline watershed subbasin prior to the Upper Saskatchewan Unit 1 prescribed burn.



Map 14. Predicted elk winter habitat states within the Cline watershed subbasin following the Upper Saskatchewan Unit 1 prescribed burn.

Indicator 1.9.3

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain and restore high quality ungulate summer and winter range and associated movement habitat.

Indicator: Location and extent of high quality ungulate summer range and associated movement habitat.

Target: Not yet completed; target needs to be set using the Elk Habitat Effectiveness Planning tool.

Baseline Status: Winter range is generally accepted as a critical habitat requirement for northern ungulates balancing high energy expenditures and forage limitations, but recent studies suggest the importance of summer range has been underestimated (Cook et al. 2004; Stewart et al. 2004). Lack of access to high quality summer and early autumn forage can negatively influence body condition and subsequent pregnancy rates in elk (Cook et al. 2001). Ungulate summer range must also provide adequate forage, security cover, and lack of disturbance to meet the energy demands of lactation, calf rearing, antler growth, and accumulation of body stores for the fall and winter period.

Of the ungulate species found within the R11 Forest Management Unit, elk are the most general in their summer habitat preferences and graze on grasses and forbs within a variety of habitats also used by other species. Furthermore, elk within the R11 FMU have been the focus of scientific research over the past several years (Merrill et al. 2005), in part to assess the impacts of landscape change on elk populations. Supported by information and technological products from this research, elk summer habitat will be one indicator of landscape changes resulting from R11 forest management activities. Elk summer habitat overlap is not as pronounced with other ungulate species, especially moose and bighorn sheep, as during the winter period. Additional indicators and targets specific to these species may therefore be considered in the next FMP.

Harvest and prescribed burn treatment activities planned in this Forest Management Plan have the potential to maintain, and in some instances restore, high quality ungulate summer ranges. However, the ability of prescribed fires to enhance elk habitat depends on the wolf predation risk (Hebblewhite 2006): habitat treatments may be less desirable in some areas from an elk forage standpoint but would not result in a predation sink (e.g., higher elevation habitats distant from suitable wolf denning habitat). The Elk Habitat Effectiveness Planning Tool, based on landcover maps, predation risk models, and forage availability models from the Central East Slopes Wolf and Elk Study (Merrill et al. 2005), will be used to set habitat targets and assess the effects of forest management activities both pre-treatment and post-treatment. The planning tool uses resource selection function models that predict occurrence and survival of elk as a function of forage abundance, terrain complexity, predation risk, travel corridors, and human disturbances. Summer and winter seasons are treated separately within the models. Note that at this time, the

Elk Habitat Effectiveness Planning Tool is in the final development phase and has not been released for general application. Accordingly, setting targets and forecasting the impacts of proposed treatments on elk summer habitat has not been completed for this version of the R11 Forest Management Plan.

Forecast: A quantitative analysis using Elk Habitat Effectiveness Planning Tool and proposed harvest block and prescribed burn boundaries will be completed for the next iteration of this FMP.

Monitoring: The Elk Habitat Effectiveness Planning Tool will be used to assess post-treatment landscape changes and their impacts on elk summer habitat. Results will be summarized in the Stewardship Report.

Response: Harvest and prescribed burn plans will be adjusted if the location and extent of elk summer range falls below the established targets.

2012 Status: Completed in 2009, the Elk Habitat Effectiveness Planning Tool provides a method by which to assess primary and secondary source and sink habitat for elk in the central East Slopes (Webb and Anderson 2009). The model integrates relative occurrence of elk and wolves based on landcover types, terrain, and human disturbance as well as elk survival. The outputs delineate areas that represent high habitat quality with a high survival probability (primary source) as well as areas with high habitat quality but a higher mortality risk (primary or attractive sink). The five possible habitat states are shown in Table 25. The elk tool was subsequently used to forecast changes in the habitat states resulting from three proposed prescribed burn scenarios on the landscape, to assess FMU-level changes in elk habitat states resulting from treatments up to 2010, and to assess local-level changes in elk habitat states resulting from one specific treatment, the Upper Saskatchewan Unit 1 prescribed burn. The results from these analyses are summarized below. Yet to be completed is the establishment of habitat targets for elk winter and summer ranges in the R11 FMU: both ASRD and ACA will participate jointly in this future exercise. Note that the Elk Habitat Effectiveness Planning Tool has recently undergone an update (Frair et al., *in prep.*), and the updated tool will be used in future R11 Stewardship Reports.

Elk Summer Habitat Change Forecast for Three Prescribed Burn Scenarios

To examine the impacts of potential prescribed burn treatments on elk habitat within the R11 FMU, three scenarios were discussed with ASRD Forestry Division fire experts based on a 10-year treatment rate of approximately 14,000 ha (Webb and Anderson 2009). The spatial arrangement of the potential burns on the landscape varied with their relative importance in addressing forest health, wildfire threat, and natural disturbance emulation. The three identified scenarios were as follows:

- 10-year dispersed – placement of 49 burn units addressed immediate threat from mountain pine beetle and wildfire,
- 10-year events 1 – placement of 41 burn units emulated larger natural disturbance events, while still considering threats from mountain pine beetle and wildfire, and

- 10-year events 2 – placement of 28 burn units with the sole focus of emulating natural disturbance events.

At the FMU level, the three scenarios increased summer primary and secondary source habitat nominally (1-2% combined) over a no-burn scenario, with little variation amongst the scenarios (Table 28, Webb and Anderson 2009).

Table 28. Predicted amount (km²) of non-critical (NC), secondary source (SSO) and sink (SSI), and primary source (PSO) and sink (PSI) habitat in the summer resulting from each prescribed burn scenario in the R11 FMU (adapted from Webb and Anderson 2009).

Scenario	NC	SSO	PSO	SSI	PSI
No burns	7,058	978	1,310	2,789	2,534
10-yr dispersed	6,997	979	1,356	2,784	2,552
10-yr events 1	7,004	981	1,340	2,786	2,556
10-yr events 2	7,006	982	1,334	2,783	2,563

Elk Summer Habitat Change Resulting from Recent Prescribed Burn and Harvest Treatments

The Elk Habitat Effectiveness Planning Tool was used to compare a baseline landscape condition from 2003 to the current landscape condition (ACA, *unpubl. data*). Any prescribed burn or harvesting treatments occurring up to the end of 2010 (i.e., the most current data updates) as a result of the R11 FMP were captured. Elk summer source habitat decreased by 6% while summer sink habitat showed a 14% increase over the comparison period (Table 29; results for winter elk habitat states are shown in Table 27). This loss of source habitat and increase in sink habitat could occur if activities occurring within previous source habitat created temporary access via roads (e.g., for FireSmart harvesting) and subsequently resulted in the conversion of this source habitat to sink habitat. Furthermore, 20 new wellsites were installed within the R11 area since 2003, with associated roads and seismic or pipeline footprints (ACA, *unpubl. data*).

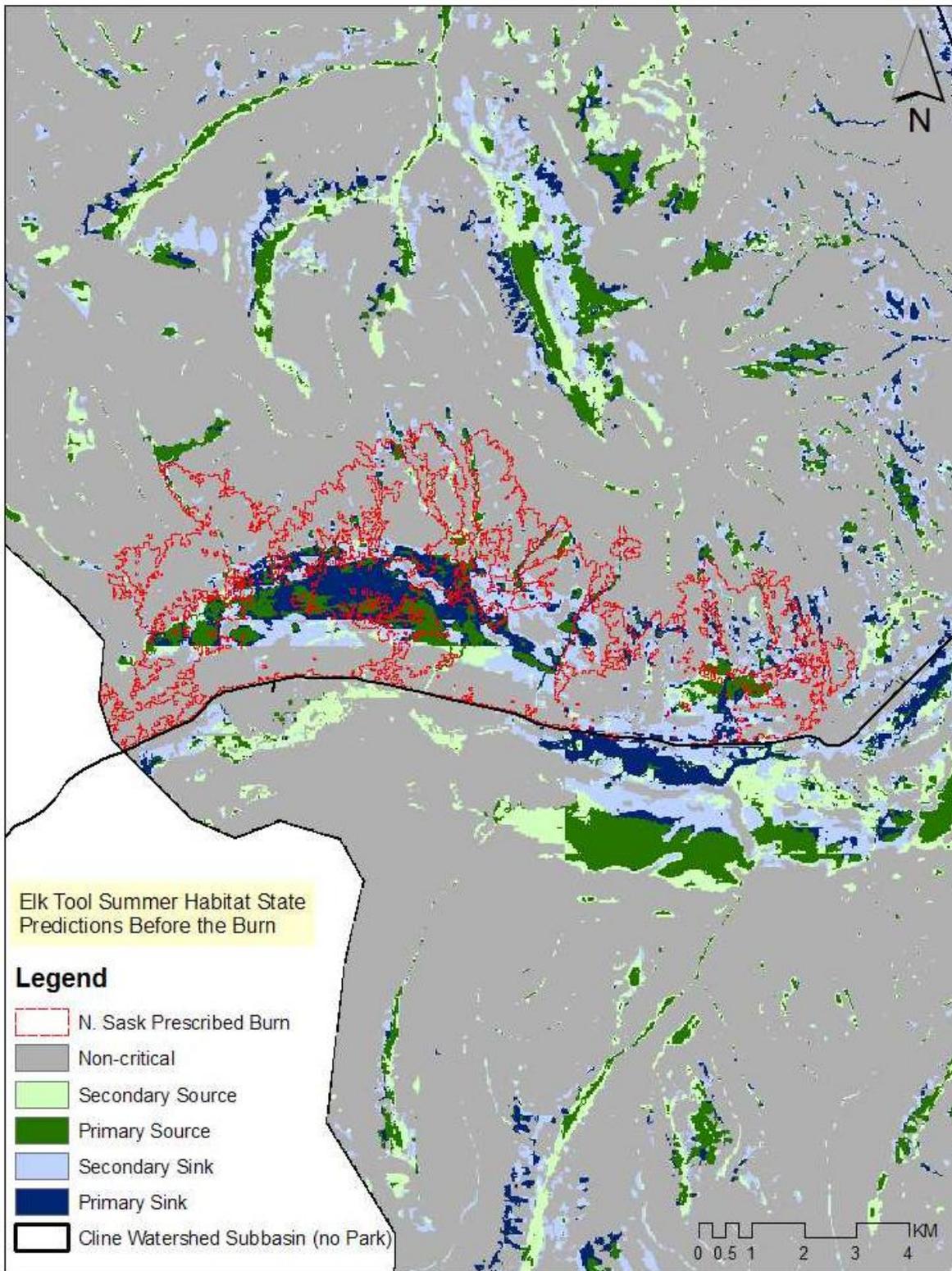
Table 29. Amount (km²) of non-critical (NC), secondary source (SSO) and sink (SSI), and primary source (PSO) and sink (PSI) habitat in the summer before (i.e., in 2003) and after recent (i.e., 2010) prescribed burn and harvest treatments in the R11 FMU.

Year	NC	SSO	PSO	SSI	PSI
2003	290	404	430	95	483
2010	284	364	420	98	563

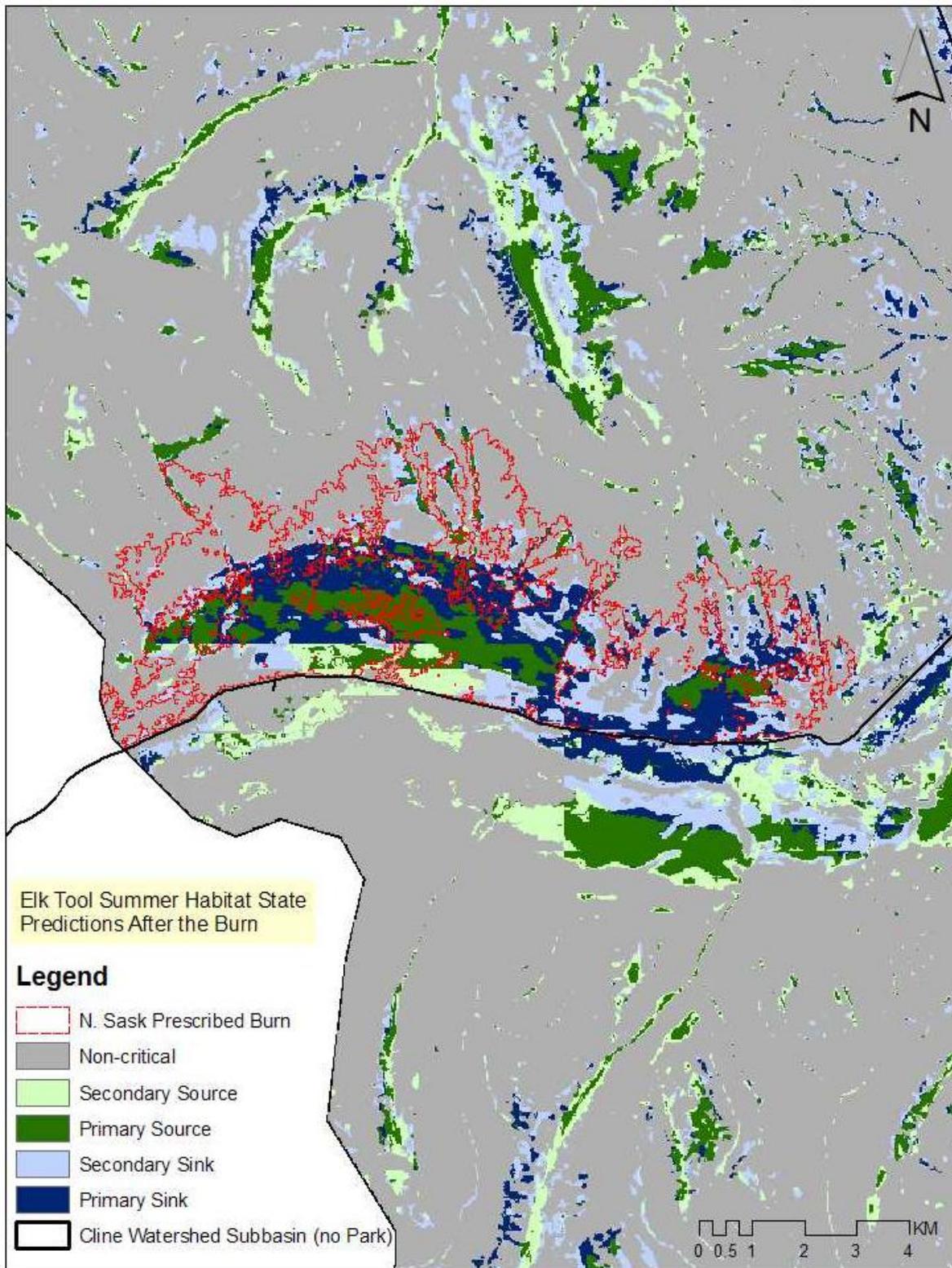
Elk Summer Habitat Change Resulting from Upper Saskatchewan Unit 1 Prescribed Burn

Summer habitat states at a local level within the Cline watershed subbasin prior to the Upper Saskatchewan Unit 1 prescribed burn were compared to post-burn summer habitat states using the Elk Habitat Effectiveness Planning Tool (Map 15 and Map 16). Primary and secondary source habitat increased by 2% within the Cline watershed subbasin. Although there was little change in secondary sink habitat, primary sink habitat increased by 9% due to an increase in habitat attractiveness in areas with higher mortality risk. The overall impact of the prescribed

burn on elk habitat was much more striking for winter habitat states (Indicator 1.9.2), as winter is typically viewed as the limiting season for many ungulates.



Map 15. Predicted elk summer habitat states within the Cline watershed subbasin prior to the Upper Saskatchewan Unit 1 prescribed burn.



Map 16. Predicted elk summer habitat states within the Cline watershed subbasin following the Upper Saskatchewan Unit 1 prescribed burn.

Indicator 1.10.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain important habitat for grizzly bear.

Indicator: Location and extent of high quality grizzly bear habitat and associated movement linkages.

Target: Targets to be determined after the Grizzly Bear Recovery Plan is approved.

Baseline Status: Grizzly bears in Alberta ‘may be at risk’ (ASRD 2006), while federally they are considered a species of ‘special concern’. Human-caused mortality is the primary source of mortality (Nielsen 2004a, Alberta Grizzly Bear Recovery Team 2005), and is facilitated by motorized access and human activity within grizzly bear range. Within the Bear Management Units covered by the R11 boundaries (primarily BMU 4B and BMU 4C), poaching is the primary mortality source.

Grizzly bears require large areas of land: annual home ranges of adult females range from 165 km² to 532 km² while those of males range from 644 km² to 2755 km², depending on the natural subregion in which they are found (see Kansas 2002 for references). Typical forage items include green herbaceous vegetation, roots, berries and pine seeds, ungulates and rodents, and ants. High quality grizzly bear habitat generally encompasses a diverse mosaic of early seral-staged forests and natural openings with vegetative cover for hiding and resting and with suitable forage plants, the use of which varies with dietary needs and the availability and nutritional status of foods. Low mortality risk resulting from lack of human disturbance, availability of den sites, and proximity of movement corridors also characterize high quality habitat, which may be found in wet riparian areas, groundwater seepage areas, and avalanche slopes. Historically, wildfire also would have created the young seral stages associated with high berry and *Hedysarum spp.* production (Hamer 1996a, 1996b); anthropogenic clearings such as regenerating clearcuts, pipeline right-of-ways, and roadside ditches can similarly support forage production.

Extensive grizzly bear research by Foothills Model Forest (FMF) and the University of Alberta has resulted in the development of several important GIS-based tools for land and resource managers to help predict changes in grizzly bear habitat resulting from land management activities and industrial development (Nielsen et al. 2006). Once the draft Recovery Plan (Alberta Grizzly Bear Recovery Team 2005) is approved, regional recovery efforts will be outlined: these FMF Grizzly Bear Planning Tools will likely play a critical role in target-setting exercises at both the regional and R11 levels. Specific components of the FMF application are as follows:

- Landcover Maps – show landscape configuration and plant phenology over time for large landscape areas, based on satellite/remote sensing imagery

- Resource Selection Function (RSF) Maps – show relative probability of grizzly bear occurrence on the landscape, derived from GPS collar locations, landcover habitat maps, and other data layers such as access
 - Mortality Risk Map – shows the probability of human-caused grizzly bear mortality over the landscape, based on known mortality data as well as data on open, motorized linear access routes (such as roads, right-of-ways)
 - Safe Harbours and Attractive Sinks – combines RSF maps with mortality risk map to safe harbours and attractive sinks. Safe harbours are areas with high RSF scores and low mortality risk, while attractive sinks have high RSF scores and high mortality risk.
 - Grizzly Bear Movement Corridors – RSF maps are combined with graph theory to show location and relative rank of important movement corridors on the landscape
- These tools will be used to assess habitat impacts of proposed prescribed burn and harvest plans, though specific targets remain to be established.

Forecast: A quantitative analysis of the impacts of proposed prescribed burn and harvest plans on grizzly bear habitat has not been completed; however, the creation of young seral stages on the landscape should coincide with increased production of berries and hedysarum, two important grizzly bear forage items. Furthermore, access restrictions (as per the *Bighorn Backcountry Access Management Plan*) and the commitment to no new permanent access (see Indicator 11.1.1) should limit mortality risk.

Monitoring: The models and maps contained in the Grizzly Bear Planning Tools will be used to monitor habitat within the R11 FMU. Results will be summarized in the Stewardship Report.

Response: To be determined.

2012 Status: Based on the results of a status update (Festa-Bianchet 2010), grizzly bears were designated as Threatened in Alberta in June 2010 because of the small size of the breeding population, restricted dispersal from adjacent jurisdictions, and the expectation that current and future land use and human activity will lead to declines. A provincial Recovery Plan was approved in December 2007 (Alberta Grizzly Bear Recovery Team 2008). Federally, grizzly bears remain a species of Special Concern, with a status report update initiated in 2010 (Festa-Bianchet 2010).

The provincial Recovery Plan also contains population estimates and priority conservation area maps that provide information and direction for management actions. These products are discussed below followed by a discussion of Recovery Plan targets and their adoption within the R11 FMP.

Population Units and Estimates

Grizzly bear population units are a management unit based on genetic distinctions within the Alberta grizzly bear population and are usually delineated by major highways on their north and south boundaries. Grizzly bear watershed units are management units within each population unit delineated based on major watersheds subdivided along heights of land or occasionally

along watercourses that approximate an average female grizzly bear home range size (i.e., about 700 km²). Two grizzly bear population units overlap the R11 FMU: Yellowhead to the north of Hwy 11 and Clearwater to the south of Hwy 11. Population estimates for six of seven grizzly bear population units in the province were conducted between 2004 and 2008 using a DNA-based Capture-Mark-Recapture analysis, though these population units will need repeated inventories to determine trends (Alberta Grizzly Bear Recovery Team 2008; Festa-Bianchet 2010). Several population parameters calculated based on the inventory results are summarized in Table 30.

Table 30. Grizzly bear population estimate, density, and annual mortality estimates for two population units that overlap the R11 FMU (adapted from Festa-Bianchet 2010). Estimated annual mortality was calculated from the average yearly number of known grizzly bear deaths in each unit from 2004–2008, minus the legal harvests, plus 40% to account for unreported mortality. Documented average annual mortality from 1999–2009 includes data from radio-collared bears, legal harvest, and other known mortalities of uncollared bears (taken from Boulanger and Stenhouse 2009).

Unit	Estimated # of Bears*	95% Confidence Interval	Density – # Bears per 100 km ²	Estimated Annual Mortality (excluding Legal Harvest)	Documented Annual Mortality (including Legal Harvest)	# Bear Deaths at 2.8% Annual Mortality	# Bear Deaths at 4.9% Annual Mortality
Yellowhead	42	36-55	4.8	1.1	4.7	1.2	2.1
Clearwater	45	41-52	5.2	2.8	3.5	1.3	2.2

* Limitations of the population estimates and population viability analysis are discussed in Festa-Bianchet (2010)

The maximum human-caused mortality the grizzly bear population may be able to sustain assuming optimal habitat and high reproductive success is 4.9%, suggesting an annual mortality rate of 2.8% for moderate productivity habitat may be more appropriate (McLoughlin 2003). The Recovery Plan states that the total number of known human-caused mortalities per BMA per year should account for ≤4% of the provincial population per year, and within this total there can be a 4% male mortality rate and a 1.2% female mortality rate (Alberta Grizzly Bear Recovery Team 2008). Although the hunting season was suspended in 2006, estimated annual mortality in the Clearwater population unit currently exceeds these benchmarks, while mortality in the Yellowhead unit approximates the maximum human-caused mortality in moderately productive habitat. The Table 30 estimates also do not reflect the importance of the age-sex composition of the mortality: for example, the loss of a breeding female will have a much greater impact on the population than the loss of a sub-adult male (Festa-Bianchet 2010).

Priority Conservation Areas

Priority conservation areas have been mapped for most of the provincial grizzly bear range (Nielsen et al. 2009). Core areas are those areas essential for food, security, and connectivity having high habitat quality and low mortality risk, while secondary areas provide linkages and buffers that help promote dispersal and population security. Almost all grizzly bear watershed units within the R11 FMU fall within core areas (Map 11).

Indicator Targets Based on the Recovery Plan

Two of the four objectives outlined within the Alberta Grizzly Bear Recovery Plan 2008-2013 (Alberta Grizzly Bear Recovery Team 2008) have direct relevancy for treatment activities conducted under this R11 FMP:

- Maintain current grizzly bear distribution, track availability of suitable habitat, and enhance habitat where appropriate, and
- Reduce human-caused grizzly bear mortality by controlling access development and use, and other human activities in grizzly bear habitat.

Targets for Indicator 1.10.1 were not set during the initial planning process for the R11 FMP, pending the approval of the Alberta Grizzly Bear Recovery Plan. The associated targets that will now be adopted in the R11 FMP at the grizzly bear watershed scale are as follows:

- No net loss of source habitats (i.e., areas with moderate to high habitat value and low mortality risk, Nielsen et al. 2006).
- Maintain or enhance landscape connectivity through linkages, particularly between large⁶ source habitat patches.
- No net increase in mortality risk.
- Ensure R11 treatment activities do not affect open route densities, including all forms of motorized access.

Source Habitat – The amount of source and sink habitat for grizzly bears within the R11 FMU in 2007 was calculated using the Resource Selection Function and Mortality Risk models to determine the amount of the landscape categorized as primary sink, secondary sink, non-critical, primary source, and secondary source habitats. The completed prescribed burn and harvest treatments were then incorporated in the GIS and the calculations were re-run to provide the current (i.e., 2011) habitat states. At the landscape level, primary source habitat has increased over the past five years (4.4%), although there was also a slight increase in primary sink habitat (2.0%). Two grizzly bear watershed units showed decreases in their amount of primary source habitat between 2007 and 2011, and several showed decreases in secondary source habitat (Table 31).

Table 31. Percent change for GBWU in the amount of primary source (PSO) and sink (PSI) secondary source (SSO) and sink (SSI), and non-critical (NC) grizzly bear habitat between 2007 and 2011 (ASRD, *unpubl. data*).

GBWU	PSO	SSO	NC	SSI	PSI
Y77	-4%	-16%	-38%	n/a	n/a
Y81	13%	-1%	-29%	n/a	23%
Y82	39%	23%	-49%	-13%	82%
Y85	124%	28%	-25%	-49%	11%
Y86	23%	-2%	-32%	11%	15%
Y88	83%	37%	-13%	-48%	13%

⁶ A minimum size of 9km² has been used by the USDA Forestry Service and Parks Canada for Banff and Jasper National Parks to define secure patches of adequate size for grizzly bears.

GBWU	PSO	SSO	NC	SSI	PSI
Y97	54%	8%	-22%	4%	26%
Y103	71%	20%	-24%	-24%	10%
Y108	96%	-22%	-33%	-65%	52%
C98	21%	1%	-8%	-10%	27%
C99	13%	-11%	0%	-3%	9%
C104	23%	-9%	2%	-14%	17%
C107	13%	-8%	-1%	-9%	12%
C109	27%	-21%	6%	-10%	9%
C110	-10%	-10%	10%	17%	1%
C111	11%	-11%	-2%	-8%	5%
C112	26%	-10%	-13%	16%	7%
C117	18%	-14%	-3%	-6%	6%
C118	5%	-17%	4%	-9%	8%
C119	46%	-1%	32%	55%	11%
C121	3%	-2%	2%	-6%	1%

Landscape Connectivity – Linkages and movement corridors between habitat patches were not analyzed as this component of the Grizzly Bear Planning Tool application does not update automatically when the treatments are added to the landscape. Additional work with the model and subsequent analyses will be required to provide a current state for this target.

Mortality Risk – Mortality risk was modeled using the Grizzly Bear Planning Tool for GBWU at the inception of the R11 FMP and at the current time (based on the latest data update in 2010). The majority of GBWU show little change in mortality risk (<5% change) over the five-year reporting period: the exceptions are C119 which showed a slightly larger decrease (9.7%) and Y82 which showed a slightly larger increase (14.6%).

Table 32. Mean mortality risk (\pm SD) in each GBWU in 2007 and 2012. Mortality risk ranged from 0=low to 10=high; thus a negative difference indicates a decrease the mean mortality risk.

GBWU	2007 Mean	2007 StdDev	2012 Mean	2012 StdDev	Difference in Means	Combined StdDev
C98	2.96	2.25	2.95	2.18	-0.02	3.13
C99	3.82	2.52	3.85	2.48	0.03	3.53
C104	2.09	1.80	2.13	1.77	0.04	2.52
C107	3.90	2.81	3.74	2.64	-0.15	3.86
C109	3.27	2.33	3.17	2.14	-0.10	3.16
C110	2.97	1.96	2.97	1.91	0.00	2.73
C111	3.71	2.86	3.67	2.75	-0.04	3.97
C112	3.20	2.23	3.27	2.21	0.06	3.14
C117	3.67	2.65	3.66	2.61	0.00	3.72
C118	4.56	2.71	4.56	2.69	-0.01	3.81
C119	3.69	1.92	3.33	2.05	-0.36	2.81
C121	3.70	2.44	3.71	2.38	0.01	3.41

GBWU	2007 Mean	2007 StdDev	2012 Mean	2012 StdDev	Difference in Means	Combined StdDev
Y77	1.02	0.22	1.01	0.20	-0.02	0.30
Y81	1.12	0.89	1.14	0.91	0.03	1.27
Y82	2.72	2.08	3.12	2.29	0.40	3.09
Y85	3.33	2.72	3.12	2.49	-0.21	3.69
Y86	3.45	2.52	3.54	2.58	0.09	3.61
Y88	1.97	2.31	1.93	2.22	-0.04	3.20
Y97	2.72	2.20	2.81	2.25	0.09	3.15
Y103	2.56	2.40	2.43	2.17	-0.13	3.24
Y108	3.33	2.56	3.22	2.39	-0.11	3.50

Open Route Density – Access densities have not changed since initiation of the original R11 FMP planning process; thus existing access densities, based on the latest data update in 2010, were determined for core and secondary grizzly bear watershed units within the portion of the Yellowhead and Clearwater population units that overlap the R11 FMU (Table 33, ASRD, *unpubl. data*). The average open 4WD-accessible route densities for core watershed units within the population units are as follows (avg \pm SD):

- Yellowhead: 0.23 ± 0.29 km/km²
- Clearwater: 0.26 ± 0.21 km/km².

Only one secondary watershed (C112) overlaps the R11 FMU and it has a current density of 0.88 km/km². Note that densities were calculated based on open 4WD truck-accessible routes (e.g., roads, 4WD trails along pipelines) as data were not available for a true open route density calculation (i.e., any road, trail, pipeline, seismic line, etc. on which motorized travel by ATVs, trail bikes, or 4WD vehicles is possible and permissible; Alberta Grizzly Bear Recovery Team 2008). The true open route density may be considerably higher. ASRD Fish and Wildlife, Clearwater Area and Foothills Research Institute are presently conducting a GIS exercise and field assessment to determine if LiDAR (Light Detection and Ranging, optical remote sensing technology) and other data can accurately predict potential and actual use by motorized off-highway vehicles on cut-lines and man-made linear features other than roads. Results may allow refinement of the open route densities and will be summarized in the next Stewardship Report.

2012 Revision: R11 FMP targets have now been set for this indicator at the grizzly bear watershed scale as follows:

- No net loss of source habitats (i.e., areas with moderate to high habitat value and low mortality risk, Nielsen et al. 2006).
- Maintain or enhance landscape connectivity through linkages, particularly between large⁷ source habitat patches.
- No net increase in mortality risk.
- Ensure R11 treatment activities do not affect open route densities, including all forms of motorized access.

⁷ A minimum size of 9km² has been used by the USDA Forestry Service and Parks Canada for Banff and Jasper National Parks to define secure patches of adequate size for grizzly bears.

Table 33. Open 4WD-truck-accessible route densities (km/km²) in core and secondary grizzly bear watershed units in the R11 FMU based on the latest data update from 2010 (ASRD, *unpubl. data*). Shading indicates open route densities that currently exceed the established threshold.

Grizzly Bear Population Unit	Grizzly Bear Watershed Unit	Core or Secondary	Open 4WD Route Density
Yellowhead	Y77	Core	0.21
Yellowhead	Y81	Core	0.46
Yellowhead	Y82	Core	0.94
Yellowhead	Y85	Core	0.00
Yellowhead	Y86	Core	0.25
Yellowhead	Y88	Core	0.00
Yellowhead	Y97	Core	0.05
Yellowhead	Y103	Core	0.01
Yellowhead	Y108	Core	0.17
Clearwater	C98	Core	0.44
Clearwater	C99	Core	0.26
Clearwater	C104	Core	0.12
Clearwater	C107	Core	0.07
Clearwater	C109	Core	0.22
Clearwater	C110	Core	0.51
Clearwater	C111	Core	0.00
Clearwater	C117	Core	0.00
Clearwater	C118	Core	0.11
Clearwater	C119	Core	0.47
Clearwater	C121	Core	0.62
Clearwater	C112	Secondary	0.88

Indicator 1.11.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain important habitat for wolverine.

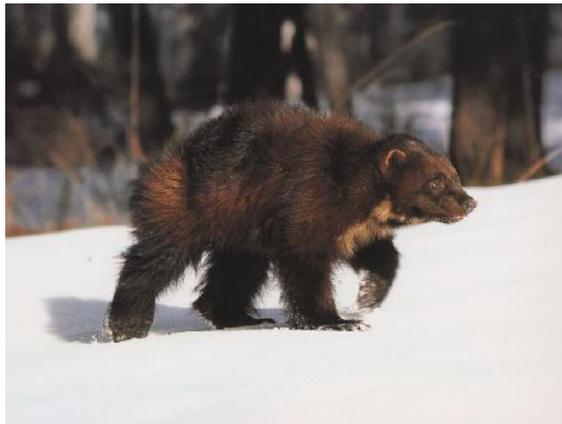
Indicator: Location and extent of high quality wolverine habitat.

Target: Current stand age distribution within the natural range of variation. See Indicator 1.1.2.

Baseline Status: Wolverine is a reclusive, wide-ranging member of the weasel family. Once distributed throughout much of Alberta, their current range is thought to coincide with areas that have the lowest levels of human development, namely the mountains, foothills, and northern boreal regions of the province. However, information is lacking on their distribution, abundance, demographics, and habitat use. Such data deficiencies are reflected in their designation as a species that ‘may be at risk’ (ASRD 2006). Management of wolverine is difficult, although they are classified under the Alberta *Wildlife Act* as a furbearer and thus are subject to limited management through harvest quotas, area closures, and regulated seasons. Historical harvest data indicate that wolverine populations are declining (Poole and Moat 2001).

Wolverine are scavengers of carrion, often that of large ungulates killed by other carnivores, but they will hunt opportunistically for marmot, hare, small mammals, and even ungulates if prey are in a weakened condition or if snow conditions hinder prey escape. Home ranges in other jurisdictions encompass a diversity of habitat types and are usually several hundred square kilometres although sizes may vary with season, year, habitat, age, and sex (see review in Petersen 1997). Such large home ranges

are likely necessary to ensure sufficient availability of food given natural fluctuations in resources. Their apparent aversion to areas with human development coupled with their low reproductive output also contributes to low densities on the landscape. The latter factor results from late sexual maturity, low litter sizes, and low juvenile survival (Peterson 1997). Species with low reproductive productivity, such as wolverine, are characteristically less resilient to population impacts when compared to species with much higher productivity, such as wolves. Limiting influences on wolverine populations are largely speculative given the lack of empirical data, but are thought to include habitat loss, trapping, and reductions in ungulate populations over the last century.



Wolverine

The Alberta Research Council Wolverine Experimental Monitoring Project has developed a protocol for detecting wolverine presence and identity via remote cameras and hair snagging for DNA analysis (Fisher 2005). Preliminary data from this pilot project suggest densities in the foothills are low and that habitat is being heavily impacted by human development (Fisher et al. *in prep*). Densities within R11 remain a mystery as monitoring stations were accessed from the Forestry Trunk Road, yielding little information specific to this FMU. In the absence of adequate information or current research on wolverine populations or habitat use, treatment activities planned in this FMP will maintain a mosaic of habitat types across the landscape by ensuring the current stand age distribution is within the natural range of variation. Furthermore, linkages with other landscapes presumed important for wolverine (i.e., National Parks) will be maintained. Future research or monitoring efforts initiated in or adjacent to R11 will be supported. Inasmuch as wolverine and grizzly bear are both wide-ranging, low reproductive output mammals that are either averse to or negatively impacted by human development, R11 activities to maintain grizzly bear habitat may also provide some benefits for wolverine populations.

Forecast: Impacts of R11 treatment activities on wolverine are not clearly understood nor can they be accurately predicted given the current paucity of information on wolverine populations, distribution, and habitat requirements.

Monitoring: GIS analysis will be used to monitor the stand age distribution resulting from forest management activities. Results will be reported in the five-year Stewardship Report.

Response: Strategies to return the stand age distribution and area to within the natural range of variation will be adjusted in subsequent FMPs if the target is not achieved.

2012 Status: Wolverine were again assessed as May Be At Risk by the *General Status of Alberta Wild Species 2010* (ASRD 2010a). Treatment activities occurring within the R11 FMU will continue to focus on restoring historic disturbance regimes on the landscape, thereby creating a diversity of young, intermediate, and older seral stages. An analysis of the current stand age distribution resulting from forest management activities over the past five-year reporting period is presented in Indicator 1.1.2.

2012 Revision: Note in the associated text for Indicator 1.1.2 that in future Stewardship Reports, the target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation. That change will be mirrored in this target, under the assumption that restoring the specific fire regime characteristic to a particular portion of the landscape will create a diversity of stand age classes in which the associated spectrum of wildlife species will be supported.

Indicator 1.12.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain habitat for important furbearer populations, specifically pine marten and red squirrel.

Indicator: Average number of individuals harvested each year on traplines active for a given species.

Target: No decrease in average number of individuals trapped per year over five years.

Baseline Status: Furbearer species within R11 are valued for their ecological roles as well as the economic resources and lifestyle choices their harvest provides. Most wildlife species relying on young seral stages should benefit from forest management activities within the FMU that will return the amount of disturbed area and the stand age distribution to within the natural range of variation. However, two important furbearers, pine marten and red squirrel, rely on mature and old-growth habitats and thus may experience reduced population sizes following prescribed burn and harvest treatments.



Pine marten

Twenty-eight Registered Fur Management Areas are found in part or in whole within the R11 boundaries (see Map 33 in original R11 FMP). Trappers are required to submit an affidavit detailing all furbearers harvested during the previous year when applying for an annual license renewal (Table 34), and these trapper affidavits are thought to be roughly indicative of furbearer population changes (Poole and Mowat 2001). There is no annual monitoring of marten and squirrel populations: fur harvest returns represent the only way to gauge whether populations are maintained at levels that can support trapping. Fur harvest returns must be used with caution as

trapper effort and reported success can be influenced by a suite of factors including memory recall, furbearer population status, fur prices, weather conditions, landscape and landuse changes, and available time and income (Mullen 2006). Until a more appropriate indicator can be derived, annual fur harvest returns will be used to monitor the impacts of treatment activities on furbearer populations within the R11 FMU.

Forecast: Annual variation is expected, as furbearer populations will respond to variation in food supply (e.g., pine marten may increase in response to a peak in voles; red squirrels will increase following a cone mast). At the trapline level, marten and squirrel populations may decrease significantly if a large prescribed burn or several harvest blocks occur within the trapline. At the

landscape level, however, sufficient habitat will be present to maintain populations in perpetuity, albeit at lower levels than currently present in the abundant mature and old-growth forests, and to provide source populations for regenerating habitats.

Table 34. Fur harvest returns for traplines within R11 from 2001 to 2005.

Species	2001/2	2002/3	2003/4	2004/5	2005/6
Badger	2	21	7	0	0
Beaver	8	4	12	13	42
Black Bear	2	1	1	1	1
Bobcat	0	0	1	0	7
Coyote	22	40	47	22	46
Ermine/Weasel	4	11	16	5	13
Fisher	1	0	0	2	0
Fox	5	4	2	5	9
Lynx	1	3	2	9	4
Marten	154	142	155	110	179
Mink	1	9	5	4	6
Muskrat	1	11	5	2	6
Otter	0	0	0	0	0
Red Squirrel	573	150	186	49	418
Wolf	14	25	15	20	11
Wolverine	0	0	0	0	1
Other (skunk, raccoon)	0	1	2	1	0

Monitoring: The Stewardship Report will summarize the average number of pine marten and red squirrels harvested per trapline each year, excluding traplines where these species were not targeted (i.e., traplines with zero captures for these species). The annual averages will then be examined for population decreases over a five-year period: the use of a five-year window will account for natural variation in populations. One confounding factor in the use of annual fur harvest returns to monitor populations is that Mullen (2006) found trappers in the foothills of Alberta are less likely to maintain an active trapline in areas with less closed conifer forest and more access and industrial disturbance. Thus if traplines experiencing greater disturbance from treatment activities are abandoned even temporarily, population estimates may be somewhat inflated. Given the shortcomings of fur harvest return data (see Poole and Mowat 2001 for a complete review of furbearer harvest data collection and associated limitations), another indicator may have to be considered in subsequent FMPs.

Response: If a significant portion of a given trapline is impacted by treatment activities, options for compensation will be explored through the Trappers' Compensation Program administered by the Alberta Trappers' Association. The program provides compensation to registered fur management licence holders when there are long-term effects of significant habitat changes from

industrial activities such that the trapper can no longer maintain his traditional fur harvest and cannot make up the loss by shifting to other available species of furbearers.

2012 Status: The annual totals of furbearer species harvested within the R11 FMU over the five-year reporting period were calculated from available trapper affidavits (Table 35). Harvests of some species such as beaver, lynx, wolf, and wolverine were higher than the previous five-year period, while harvests of coyote, fox, marten, mink, muskrat, red squirrel, and weasel were lower than the previous five-year period. Marten harvests dropped from a five-year average of 148 per year to a five-year average of 110 per year. Red squirrel harvests similarly went from a five-year average of 275 to 111. These averages, however, represent harvests FMU-wide across all reporting traplines. As not all trappers target all species, these numbers could be skewed if fewer trappers targeted these species during the reporting period.

The average annual marten and red squirrel harvest returns for RFMAs actively targeting these species are shown in Table 36 for the period between 2006 and 2011. The average annual marten and red squirrel harvest returns between 2001 and 2005 were not presented in the original R11 FMU, and unfortunately no comparisons to the baseline condition can be made at this time.

Cautions regarding the use of fur harvest returns in monitoring furbearer population status (Poole and Mowat 2001, Mullen 2006) remain valid. Thus future updates must continue to seek an improved indicator.

Table 35. Fur harvest returns for traplines within R11 from 2006 to 2011.

Species	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Beaver	13	14	47	18	4
Black Bear	2	1	1	2	0
Bobcat	0	0	1	0	0
Coyote	18	46	25	31	24
Fisher	0	0	0	0	0
Fox	3	3	2	4	6
Lynx	3	8	7	5	5
Marten	119	125	128	99	78
Mink	0	1	2	1	0
Muskrat	0	5	68	0	3
Otter	0	0	2	0	0
Red Sq	183	130	86	131	23
Weasel	13	4	2	2	0
Wolf	15	22	29	9	33
Wolverine	0	0	1	1	3

* Includes data from 14 RFMAs contained entirely within the FMU: 528, 529, 532, 539, 542, 543, 544, 1210, 1284, 1515, 1590, 1656, 1952, 2740

Table 36. Average annual marten and red squirrel harvests between 2006 and 2011 on RFMAs actively targeting those species.

Year	# RFMA Trapped	# RFMA w/Marten	Avg Marten Harvest	# RFMA w/Red Sq	Avg Red Sq Harvest
2006/2007	11	10	11.9	8	22.9
2007/2008	13	9	13.9	5	26.0
2008/2009	10	9	14.2	3	28.7
2009/2010	11	9	11.0	3	43.7
2010/2011	11	10	7.8	3	7.7

Indicator 1.12.2

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain habitat for important furbearer populations, specifically pine marten and red squirrel.

Indicator: Stand age distribution, specifically mature and old-growth.

Target: Current stand age distribution within the natural range of variation. See Indicator 1.1.2.

Baseline Status: Most wildlife species relying on young seral stages should benefit from proposed prescribed burn and harvest treatments that will increase the amount of younger forest within the R11 landscape. However, two important furbearers, pine marten and red squirrel, rely on mature and old-growth habitats and thus may experience reduced populations following forest management activities. The inclusion of an objective specific to species requiring older seral stages represents a balance for those species requiring young seral stages and ensures forest management activities within the R11 FMU will retain the full spectrum of habitats on the landscape. Specific actions will be directed at creating a stand age distribution and residual structure patterns within the natural range of variation. For further details, see Indicator 1.1.2.

2012 Status: Treatment activities occurring within the R11 FMU continue to focus on restoring historic disturbance regimes on the landscape, thereby creating a diversity of young, intermediate, and older seral stages. An analysis of the current stand age distribution resulting from forest management activities over the past five-year reporting period is presented in Indicator 1.1.2.

2012 Revision: Note in the associated text for Indicator 1.1.2 that in future Stewardship Reports, the target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation. That change will be mirrored in this target, under the assumption that restoring the specific fire regime characteristic to a particular portion of the landscape will create a diversity of stand age classes in which the associated spectrum of wildlife species will be supported.

Indicator 1.13.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain important habitat for Harlequin duck.

Indicator: Quality of nesting, breeding, and foraging habitat for Harlequin duck.

Target: No net increase to motorized access (both on- and off-highway vehicles) on streams with historic duck observations.

Baseline Status: Harlequin ducks are small, long-lived ducks that winter at traditional sites along the seacoast and breed in fast-flowing mountain streams, with females likely returning to the area of their natal stream. Prime breeding habitat contains vegetative cover on islands and shorelines, braided channels, lower gradients, cobble and boulder streambeds, clear water for foraging on streambed invertebrates, and lack of human disturbance (MacCallum 2001). These narrow habitat requirements coupled with low food availability in breeding streams appear to limit Harlequin duck distribution and reproductive productivity. Landuse activities that alter streambank or channel characteristics, influence water yield levels, or reduce water quality through increased sedimentation can significantly degrade Harlequin duck habitat (Cassirer et al. 1996). Classified as a migratory game bird, Harlequin ducks are protected under the Migratory Birds Convention Act. Furthermore, the distinct coastal/inland migratory pattern and specialized breeding habitat requirements of this species have led to an Alberta status designation of ‘sensitive’ (ASRD 2006).



Harlequin duck

Very little information exists about Harlequin ducks within the North Saskatchewan and Red Deer River watersheds, although there are numerous streams with potential habitat. Table 37 shows the R11 watercourses on which ducks have been observed as well as the likelihood of breeding based on these observations. Even if Harlequin ducks are observed outside the R11 boundaries but on watercourses that flow in or through R11, duck presence is possible on those watercourses. Studies in the McLeod River watershed have shown harlequins to use

different areas of the river system depending on the season and stage of reproduction (see summary in MacCallum 2001).

Table 37. Watercourses within the R11 FMU on which Harlequin ducks have been observed. Note that the observation location itself may not be within the R11 boundaries. Records of most observations are stored in the Biodiversity/Species Observation Database and are summarized in MacCallum (2001).

Creek/River	Breeding Status
Blackstone River	Breeding
Brazeau River	Breeding
Bighorn River	Unknown
Brown Creek	Unknown
Clearwater River	Probable
Cline River	Unknown
Cripple Creek	Unknown
Elk Creek	Probable
Hummingbird Creek	Unknown
North Ram River	Breeding
North Saskatchewan River	Unknown
Onion Creek	Probable
Ram River	Breeding
Siffleur River	Unknown
Timber Creek	Unknown
Wapiabi River	Probable
Red Deer River	Unknown
Panther River	Unknown

Impacts to Harlequin duck nesting, foraging, and breeding habitat as a result of R11 forest management activities will be minimized in two ways. First, stream quality will be maintained by implementing practices identified in Indicators 4.2.1 to 4.2.4 and by using bridges as the preferred crossing method on streams with historic Harlequin duck observations. Second, human disturbance levels will be minimized by ensuring no net increase in motorized access (both on- and off-highway vehicles) on streams with historic duck observations (see also Objective 11.1). The impacts of prescribed burns on Harlequin duck habitat are unknown: any new scientific information on these impacts will be assessed and management activities adjusted accordingly.

Forecast: Much of the Harlequin duck range in R11 falls within Prime Protection Zone where industrial activity is excluded. Accordingly, new, temporary access will only be created where necessary to conduct forest management activities under this R11 FMP, and all access will be reclaimed upon completion of treatment activities. The lack of industrial activity will also help limit new access for users of off-highway vehicles, who rarely develop new access themselves but instead use existing trails or seismic lines created by industry. Furthermore, access by OHVs is governed by the *Bighorn Backcountry Access Management Plan*, which excludes them from some Forest Land Use Zones and excludes them during the majority of the harlequin breeding season from most other FLUZs.

Monitoring: GIS analysis will be used to determine the amount of motorized access present on streams with historic duck observations and results will be recorded in the Stewardship Report.

Response: Trail closures will be required if the amount of motorized access increases on streams with historic Harlequin duck observations.

2012 Status: The updated *General Status of Alberta Wild Species 2010* assessed Harlequin ducks as Sensitive in Alberta with an estimated provincial population of 2000-4000 individuals. Habitat integrity continues to be threatened by logging, mining, grazing and recreational activities, requiring potential site-specific mitigation of disturbances (ASRD 2010a). Recent inventory and monitoring work has begun within the R11 FMU, following the recommendations of the *Harlequin Duck Conservation Management Plan, 2010-2015* (ASRD 2010c). Results will be presented in subsequent Stewardship Reports.

To assess changes in motorized access on Harlequin duck streams, historic observations were determined from FWMIS. Each observation was assigned to the closest stream in GIS, and 5 km upstream and downstream from that occurrence were identified as potential habitat (i.e., Harlequin ducks usually stay within 5 km of their nesting site, Anne Hubbs, *pers. comm.*). If the stream changed in its classification during the 5 km distance upstream or downstream (e.g., from a small permanent stream to an intermittent stream), the distance was truncated at the change in classification. The stream section was then buffered by 100 m and the buffered stream sections were assessed for changes in motorized access from 2007 to 2011: no increases were found.

Indicator 1.14.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain important habitat for Clark's nutcracker.

Indicator: Location and extent of high quality Clark's nutcracker habitat, including whitebark and limber pine stands.

Target: 80% of identified populations and individual whitebark and limber pine trees maintained. See Indicator 1.4.1.

Baseline Status: Clark's nutcracker is a year-round resident of montane to upper subalpine habitats, although they may migrate to lower elevations in winter. Similar to other members of the crow family, this species is an omnivore and will eat insects, berries, and small vertebrates; however, the Clark's nutcracker primary and preferred food source is whitebark and limber pine seeds. Their relationship with whitebark and limber pine is mutualistic: the seeds represent an important high protein food source for the birds while the pines rely heavily on the birds for seed dispersal through hoarding in caches (Tomback 1998).

Both whitebark and limber pine are seriously threatened by the introduced white pine blister rust, fire suppression activities, and mountain pine beetle. Loss of these habitats would be detrimental to Clark's nutcracker populations, and they are listed as 'sensitive' in Alberta (ASRD 2006).

There is currently no monitoring of Clark's nutcracker populations within the R11 Forest Management Unit, and efforts to ensure population persistence must focus on their habitat. Thus the indicator, target, and monitoring for Clark's nutcracker will follow Indicator 1.4.1 for conservation of the pine species, under the assumption that maintenance and restoration of whitebark and limber pine stands will provide sufficient habitat for current nutcracker populations.

2012 Status: The *General Status of Alberta Wild Species 2010* assessed Clark's nutcracker as Sensitive as (1) their known distribution is restricted to within the province's mountain parks (though see Caners 2011 for evidence of sightings within R11); (2) their dependency on declining species such as limber pine and whitebark pine may cause population declines; and (3) the species may also be susceptible to the West Nile Virus (ASRD 2010a). There is still a lack of monitoring for Clark's nutcracker populations within the R11 Forest Management Unit, and thus habitat monitoring must continue to be used as a proxy. See Indicator 1.4.1 for an update on



Clark's nutcracker

the status of whitebark and limber pine as well as information on the location and monitoring of these species within the R11 FMU.

Indicator 1.15.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain habitat capable of sustaining future woodland caribou range expansion into the R11 area.

Indicator: Area of mature and old-growth forest.

Target: Area of mature and old-growth forest within the natural range of variation; Target could be further refined once west-central habitat planning targets are developed.

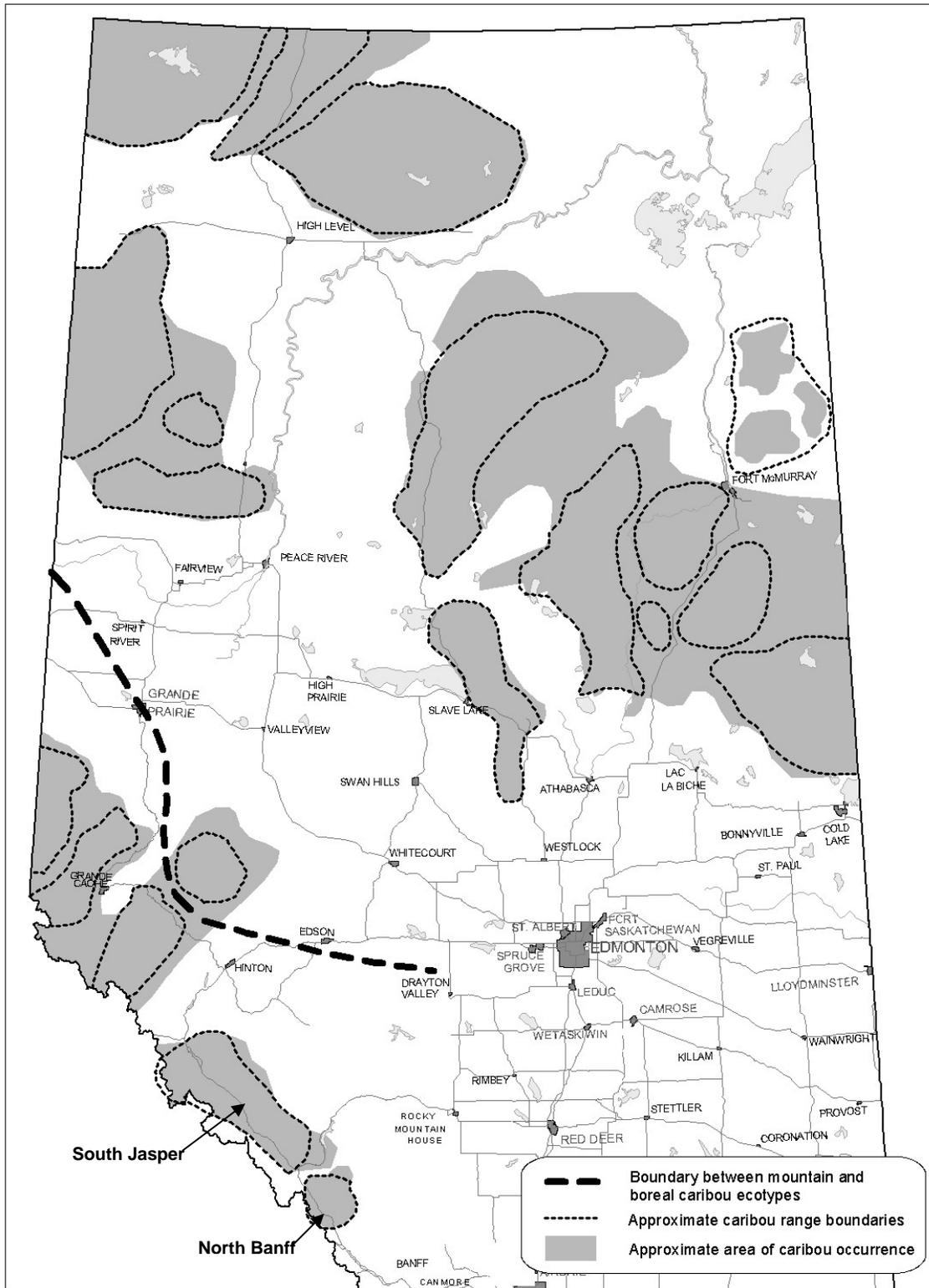
Baseline Status: Woodland caribou are classified as Threatened under both the federal *Species at Risk Act* and Alberta's *Wildlife Act*, prompting the preparation of the *Alberta Woodland Caribou Recovery Plan 2004/05 – 2013/14* (Alberta Woodland Caribou Recovery Team 2005). Woodland caribou are found in low-density populations and, during the winter, use late seral stage habitats that contain abundant terrestrial and arboreal lichens. Large, contiguous tracts of habitat are also necessary to allow dispersion of individuals as an anti-predator strategy, and to provide sufficient undisturbed habitat when other portions of the range have been disturbed. Limiting factors on caribou population size and distribution include habitat change (either from natural processes such as fire or human landuse activities such as increased access and oil and gas development), predation, hunting/poaching, and vehicle collisions (Dzus 2001).



Woodland caribou

No caribou population is currently known to overlap with the R11 FMU, although the core winter ranges of Banff and Jasper populations historically included portions of Siffleur and White Goat Wilderness Areas, where rare sightings still occur, and possibly adjacent areas in the Bighorn Backcountry (Map 17). The southernmost population in Alberta is found in Banff (headwaters of the Clearwater, Siffleur, Red Deer, and Bow Rivers). This population may have declined to less than five individuals (Parks Canada 2006) and is isolated from the next closest population in southern Jasper

(Maligne, Tonquin, Jonas Creek, and Poboktan Pass areas). Thus the North Banff population is at immediate risk of extirpation while the South Jasper population is in decline (Alberta Woodland Caribou Recovery Team 2005).



Map 17. Approximate range boundaries and area of occurrence for the South Jasper and North Banff woodland caribou herds. (taken from Alberta Woodland Caribou Recovery Team 2005)

The Recovery Plan recommends actions must be taken immediately to stabilize woodland caribou populations within their current ranges and support expansion into unoccupied portions of their historic ranges, where possible. Habitat planning targets for caribou winter range in west-central Alberta are still under development, and once completed, consultations with the West-Central Range Planning Team will help refine targets for the R11 FMU. In the interim, however, R11 forest management activities will focus on ensuring the area of mature and old forest is within the natural range of variation (see Indicator 1.1.2) under which caribou populations would have evolved. Clustering of prescribed burn and harvest treatments will help emulate large natural disturbances instead of many, smaller dispersed disturbances. Furthermore, this R11 FMP will adopt the approach taken by Parks Canada (2006) that stresses the importance of heterogeneity of fire frequency on the landscape. Lower elevation montane habitat that is susceptible to mountain pine beetle historically experienced shorter fire cycles than the higher elevation subalpine habitats important to caribou. Thus, prescribed burns within the area of potential caribou occurrence will focus on low elevation, south-facing slopes and avoid high elevation, north-facing slopes to provide areas that allow caribou to spatially separate themselves from wolves, elk, moose, and deer. Prescribed burns planned along the western boundary of R11 will be coordinated with those planned by Parks Canada.

Forecast: Caribou evolved with fire as the dominant disturbance agent on the landscape: when a large-scale fire rendered a given area unsuitable by incinerating the lichen, caribou use patterns would shift to alternate areas within their range. Hence, forest management activities within R11 can maintain habitat suitable for woodland caribou, provided sufficient mature and old-growth forest remains at a particular time.

Monitoring: GIS analysis will be used to monitor the stand age distribution and area of mature and old-growth forest resulting from forest management activities and to assess caribou winter range habitat within R11 once west-central habitat planning targets are established. As there are currently no populations in R11, population monitoring will default to surveys conducted by Parks Canada. Any results from these activities will be reported in the five-year Stewardship Report.

Response: Strategies to return the stand age distribution and area to within the natural range of variation will be adjusted in subsequent FMPs if the target is not achieved.

2012 Status: Woodland caribou continue to be classified as Threatened both provincially and federally. Over the five-year reporting period, an avalanche resulted in the extirpation of the remaining North Banff caribou population (Cichowski 2010, Parks Canada 2011). The South Jasper population, composed of three essentially non-mixing subpopulations, has been largely confined to mountainous areas of their range over the past several decades rather than migrating seasonally to lower elevation forested foothills habitat within their range (Cichowski 2010). From approximately 450 animals in the 1960's, the South Jasper population has declined to fewer than 75 animals (Parks Canada 2011).

The Conservation Strategy for Southern Mountain Caribou in Canada's National Parks (Parks Canada 2011) identifies particular threats and actions taken to address declining caribou populations within the National Parks:

- altered predator-prey dynamics – manage primary prey populations (i.e., elk, deer, moose) to prevent unnaturally high predator numbers which subsequently prey on caribou and plan prescribed fires (and the resulting attractive young seral stages for other ungulate species) in areas away from key caribou habitat
- facilitated predator access to caribou – provide visitors with opportunities for recreation in areas not important for caribou while restricting recreation in caribou habitat and discontinue setting early-season ski tracks that lead to caribou winter habitat thus providing travel corridors for wolves
- direct disturbance to caribou – reduced speed zones on highways in important caribou habitat; periodic seasonal trail and road closures, relocate trails away from important caribou habitat, and educate park visitors to avoid disturbing caribou
- direct elimination of caribou habitat – use prescribed fire in areas away from caribou habitat to maintain a safe distance between caribou and their predators, and use prescribed burns to guard against large fires within caribou habitat
- small population effects – reintroduce or add caribou where herd sizes are critically low.

The West Central Alberta Caribou Landscape Plan specifies a population target of 150 animals for the South Jasper herd, though the plan acknowledges that the reasons for the South Jasper population decline are less clear than for other caribou herds in the province and are not due to resource development (WCCLPT 2008). Accordingly, modelling contained within the West Central Alberta Caribou Landscape Plan deals primarily with caribou ranges for populations found on provincial lands, and the stated plan goal is ensuring self-sustaining caribou populations within their current distribution (i.e., not within R11 FMU). Nevertheless, four of the five guiding principles in the Landscape Plan could have implications for management treatments occurring within R11 should the South Jasper population stop declining and begin a range recovery:

- maintain older forests – coniferous forests >80 yrs old provide the primary lichen food sources and separation from primary prey species and thus wolves
- maintain large patches of intact forest – coniferous forests >80 yrs old and >1000 ha provide more forage and more space to avoid predators and their primary prey
- maintain high intactness (i.e., low fragmentation of patches and high aggregation of patches) – contiguous areas of forest that are >80 yrs old, >1000 ha, and not bisected by man-made linear features or major rivers, and
- manage predator and primary prey populations – maintain a level of primary prey that will support wolf densities of less than 6 wolves/1000 km².

As the R11 FMU represents potential, but currently uninhabited, caribou habitat, management will continue with a coarse-filter focus on returning fire regimes to their historic levels thus ensuring the maintenance of large mature and old-growth forest patches in areas experiencing a longer mean fire return interval. By moving to disturbance targets for fire regime regions (see Indicator 2.1.1), the R11 landscape will be managed at a unit more relevant for caribou populations. For example, the Brazeau-Coral and Blackstone-Wapiabi regions adjacent to Whitegoat Wilderness Area and Jasper National Park have more of their vegetated landscape in older age classes and have longer mean fire return intervals compared to other regions of the FMU (Rogean 2010b). Accordingly, prescribed fire will be applied less frequently in these regions.

The South Jasper herd will also be monitored annually by Parks Canada (Saajke Hazenberg, *pers. comm.*). Indication of sustained population increases and range recovery will trigger discussions between Parks Canada and ASRD biologists and an assessment of planned treatments near the park boundary. Furthermore, the management of predators and associated prey populations on adjacent provincial lands will need to be assessed as current wolf density is estimated at 9.7 wolves/1000 km² in the mountainous areas of the Clearwater Area (Webb 2009), which exceeds the 6 wolves/1000 km² suggested as a maximum density (WCCLPT 2008). Similar discussions will be held with Parks Canada should plans proceed for a caribou captive breeding and/or translocation program to re-establish a Banff herd (Parks Canada 2011).

2012 Revision: This indicator in essence defers to Indicator 1.1.2 (where the target was current stand age for each natural subregion within the natural range of variation). As the Indicator 1.1.2 target is shifting to fire cycle for each fire regime region within the natural range of variation, this indicator will also reflect that change. By restoring the specific fire regime characteristic to a particular portion of the landscape, a diversity of stand age classes will be created in which the associated spectrum of wildlife species will be supported.

Indicator 1.16.1

Value: Biodiversity - Wildlife Species Diversity

Objective: Maintain habitat capable of supporting long-toed salamander populations.

Indicator: Location of potential breeding ponds and lakes (i.e., ideally large, shallow, permanent, and fishless).

Target: Information on whether long-toed salamanders exist and breed in the identified ponds and lakes.

Baseline Status: One of only two salamander species native to Alberta, the long-toed salamander is typically found in montane regions with most populations clustered in mountain passes and associated river valleys (Graham and Powell 1999). The permeable substrates and high soil moistures found along montane valley bottoms often create ideal terrestrial and breeding habitat for long-toed salamanders. Breeding habitat consists of large, shallow lakes with abundant aquatic vegetation and marshy fringes; deep lakes may be used if adjacent wetlands provide shallow, vegetated areas for egg-laying (Graham 1997). The absence of predatory fish such as rainbow trout also appears to be an important feature of breeding ponds and lakes. Closed-canopy lodgepole pine and Douglas-fir characterize the upland terrestrial habitat used by long-toed salamanders, while balsam poplar and willow are found in lowland areas. Graham (1997) found that salamanders in west-central Alberta primarily used well-drained areas with a thick litter layer in close proximity to relatively permanent waterbodies. Most salamanders within the study area were found within 250 m of the breeding pond, although some adults travelled up to 750 m from a suspected breeding pond.

There are no known long-toed salamander populations within the R11 FMU despite the presence of montane river valleys and passes. However, a comprehensive survey of suitable R11 habitat has never been completed. *The General Status of Alberta Wild Species 2005* (ASRD 2006) lists long-toed salamanders as ‘sensitive’ because of their isolated populations focused in mountain pass riparian areas and their vulnerability to potential habitat destruction and alteration associated with industrial, recreational, and transportation development. Accordingly, field inventories of suitable habitat should be conducted as finances permit to determine if populations exist within R11, and potential long-toed salamander habitat should be considered when conducting forest management activities in the interim.

The Foothills Model Forest developed a Habitat Suitability Model for year-round habitat of long-toed salamanders within the Lower Foothills, Upper Foothills, Montane, and Subalpine Natural Subregions of Alberta (Graham et al. 1999). Habitat Suitability Models predict the suitability of a habitat for a given species based on an assessment of how life history characteristics relate to habitat attributes such as habitat structure, habitat type, and spatial arrangement between habitat features. Although the Foothills Model Forest model incorporates distance from nearest pond

with a known long-toed salamander population, alterations to the model may allow its application to determine potential habitat within the R11 FMU.

Forecast: not applicable

Monitoring: The results of any field surveys for long-toed salamanders will be summarized in the Stewardship Report.

Response: Prescribed burn and harvest plans will be adapted if they will impact a pond or lake where long-toed salamanders have been identified.

2012 Status: Long-toed salamanders continue to be a Species of Special Concern in Alberta and were assessed as Sensitive in the *General Status of Alberta Wild Species 2010* due to their few patchy, disjunct populations in mountain riparian areas, potentially declining distribution, and vulnerability to habitat destruction or alteration associated with industrial, recreational, and transportation development (ASRD 2010a). There is still neither long-term monitoring data nor short-term survey data available for salamanders within the R11 Forest Management Unit. Desired future work would include expanding the Researching Amphibian Numbers in Alberta (RANA) work to the R11 area, though limited resources dictate that only pitfall trap sites in the Bow Valley and pond survey sites in the Athabasca Valley are currently monitored on an annual basis (ASRD 2010b).

Indicator 1.17.1

Value: Biodiversity - Sensitive Sites

Objective: Maintain integrity of sensitive sites.

Indicator: Identified sensitive sites (e.g., nationally and provincially significant Environmentally Significant Areas, selected Special Features, mineral licks, major game trails, rocky outcrops, den sites, fish spawning, rearing, and over-wintering areas).

Target: Complete protection of sites sensitive to burning or harvesting (sites not sensitive to such treatments will not require the same degree of protection).

Baseline Status: Numerous habitat features and sites within R11 may be considered sensitive from a wildlife perspective. These could include mineral licks, den sites, raptor nests, hibernacula, major game trails, rocky outcrops, fish spawning, rearing, and over-wintering areas (e.g., Watercourse Code of Practice Class A sites), nationally and provincially significant Environmentally Significant Areas (ESA), and selected Special Features. The locations of such sites and features are maintained through a variety of sources including ANHIC databases, FWMIS, ESA reports, and local knowledge (see Appendix III for a description of ESAs and Special Features in R11). Inventories and databases receive ongoing input from government staff, researchers, non-governmental representatives, and consultants or contractors who identify sensitive features during fieldwork.

Sites considered sensitive to either burning or harvesting (e.g., raptor nests) will be avoided wherever possible when developing prescribed burn and harvest plans. If complete avoidance is not possible, adverse impacts will be mitigated by following the guidelines for buffers around wildlife features (e.g., two ‘sight distances’ for major game trails) as directed by the Alberta Timber Harvest Planning and Operation Ground Rules (Alberta Environmental Protection 1994). In general, the nature and amount of protection required will vary by the type of sensitive site. Sites that are not sensitive to management treatments (e.g., cliffs serving as escape terrain for bighorn sheep) will not be avoided during plan development and implementation.

Forecast: Although complete protection of sites sensitive to burning or harvesting is targeted, there may be limited loss of sites if they cannot be avoided. Overall, a loss of no more than 10% of known sensitive sites will be tolerated, and the integrity of features responsible for the designation of ESAs will not be compromised.

Monitoring: Pre- and post-treatment comparisons of burn or harvest boundaries with GPS locations of sensitive sites will monitor success in avoiding or minimizing the impacts on such sites. The results will be reported in Stewardship Reports.

Response: Locations of sensitive sites will be added to inventories and databases as they are reported.

2012 Status: A thorough environmental assessment detailing vegetation, wildlife, aquatic resources, and historic resources and recommended mitigation was completed for the Upper Saskatchewan Unit 1 prescribed burn (Jacques Whitford AXYS 2007). Rare plants and communities were also surveyed within the burn unit (Timoney 2007; see Indicator 1.2.1). Evidence is lacking that ACIMS databases, FWMIS, ESA reports, etc. were queried for presence of any sensitive sites or that any sensitive sites were given consideration during the planning and implementation of treatments other than the Upper Saskatchewan Unit 1 prescribed burn. However, standard ASRD practices dictate that harvest and prescribed burn plans are reviewed by appropriate staff that can identify any known sensitive sites within the area of interest. Furthermore, any sensitive sites not identified during the consultation process but detected in situ in advance of treatment activities are then afforded protection by operational level personnel if sites are considered sensitive to burning or harvesting.

2012 Revision: As existing procedures already provide a consultative mechanism to identify known sensitive sites such as licks, den sites, significant fish habitat, etc., this indicator will be modified to focus on Environmentally Significant Areas alone. ESAs are not currently captured in the consultation process and would not be identified in the field by operational personnel. The revised target will state ‘complete protection of Environmentally Significant Areas sensitive to burning or harvesting (sites not sensitive to such treatments will not require the same degree of protection)’.

Indicator 1.18.1

Value: Biodiversity - Genetic Diversity

Objective: Conserve genetic diversity by maintaining genetic variation of tree species.

Indicator: Inventory of whitebark and limber pine stands and stored seed.

Targets: 80% of identified populations/individual trees will be maintained (see Indicator 1.4.1) and viable stored seed inventory.

Baseline Status: Populations of a given species that contain a wide variety of genetic combinations can better adapt to changing environmental conditions than populations with relatively little genetic diversity that may be performing well under current conditions. Such genetic diversity may be maintained within populations of a given species remaining in their original habitat or within gene banks. The former is preferred as the populations continue to evolve in response to natural evolutionary processes; however, storing representative samples in gene banks may be necessary in cases where a natural population is threatened.

The Alberta Forest Genetics Resource Council is working with Sustainable Resource Development and Tourism, Parks, Recreation, and Culture to develop a gene conservation strategy that will protect the natural genetic variability of Alberta tree species. The strategy focuses on on-site or in-situ conservation by identifying areas where genetic variability can be protected in wild forest populations, determining the number of trees to be protected for each species, and delineating necessary buffer zones to protect the wild trees. Seed zones have been identified within which seed for reforestation can be collected and freely deployed without any significant loss of adaptation and growth potential. At this time, the seed zones are closely aligned with the Natural Subregions of Alberta. Off-site or ex-situ conservation of species in seed banks such as those at the Alberta Tree Improvement and Seed Centre will sometimes be required to supplement on-site efforts. Furthermore, the *Standards for Tree Improvement in Alberta* provide instructions on how to ensure sufficient genetic variability in artificial reforestation of harvested areas (ASRD 2005).

Both whitebark pine and limber pine are species on ANHIC's Tracking and Watch List and are seriously threatened by an exotic rust (white pine blister rust), fire suppression activities, and mountain pine beetle. An inventory on the location and status of these two pine species within Alberta has been developed, though it is not yet considered complete. Genetic conservation efforts for whitebark pine and limber pine within R11 will focus on maintaining existing individuals and populations in their current habitat (see Indicator 1.4.1), recognizing that these are pioneer species which require fire disturbance. The ASRD Genetics and Tree Improvement Section also maintains a seed inventory for these species. The R11 strategy for conserving the genetic diversity of common tree species will be to allow natural reforestation processes in harvest or prescribed burn treatment areas, thereby avoiding the introduction of new seed stock.



Whitebark pine cones and seed

Forecast: Regeneration of whitebark and limber pine occurs shortly after a disturbance and subsequent seed dispersal into the disturbed area by Clark's nutcracker. Accordingly, these species should respond positively to prescribed burns within their habitat, provided seed source trees and dispersal agents (i.e., birds) remain. As white pine blister rust infestation generally proves fatal for the individual tree, population resilience also depends upon the presence of rust-resistant trees that can act as seed sources.

Monitoring: Permanent sample plots will be established and monitored every 10 years in 25% of the identified whitebark and limber pine stands found in the planned burn or harvest areas (see Indicator 1.4.1 for details). The seed inventory will also be evaluated every 10 years. If rust-resistant trees are discovered in the field, efforts should be made to protect these trees and collect seed for storage. Results of the PSP monitoring and the inventory evaluations will be reported in the Stewardship Reports.

Response: If natural regeneration is not successful after fire disturbance, a planting program can be implemented. Burn or harvest plans will also be adjusted based on the 10-year surveys. If the Manager of the Genetics and Tree Improvement Section determines that the seed inventory is low, a seed collection plan will be developed.

2012 Status: See Indicator 1.4.1 for an update on whitebark and limber pine status as well as an update on number, maintenance, and monitoring of identified populations/individual trees.

Alberta Tree Improvement and Seed Centre (ATISC) has completed both in-situ and ex-situ conservation efforts for whitebark and limber pine in the R11 FMU. Aside from maintaining existing individuals and populations in their current habitat, in-situ conservation focused on a whitebark pine stand in the Waterfall Creek area that has been put under reservation for conservation. The greater emphasis, however, has been on ex-situ collections during this reporting period in order to build up seed reserves as both limber and whitebark have been listed as an Endangered species in Alberta. Additional ex-situ efforts include:

- One bulk whitebark seed collection from Waterfall Creek yielding 7.87 kg of seed archived at ATISC
- 49 single tree whitebark seed collections from Waterfall Creek yielding 4.78 kg of seed archived at ATISC
- Scions from 5 whitebark pine parent trees from Waterfall Creek (subset of parents from the single tree seed collection) collected and grafted onto rootstock at ATISC as grafting pilot for clone bank establishment
- 55 single tree limber pine seed collections from Windy Point yielding 2.45 kg of seed archived at ATISC
- 28 single tree limber pine seed collections from Panther Corners yielding 1.68 kg of seed archived at ATISC

- 1 bulk limber pine seed collection from Whirlpool Point (joint with Alberta Tourism, Parks, and Recreation) yielding 4.12 kg of seed archived at ATISC
- 1 bulk limber pine seed collection from Windy Point yielding 6.26 kg of seed archived at ATISC
- 1 bulk limber pine seed collection from Panther Corners yielding 7.22 kg of seed archived at ATISC

Indicator 2.1.1

Value: Ecosystem Integrity and Productivity

Objective: Maintain natural disturbance patterns at the landscape level.

Indicator: Area disturbed per decade by natural subregion.

Target: Periodic disturbance rate of 50% of the median reported fire cycle for each natural subregion (Source: Appendix III in Tymstra et al. 2005). See Table 38 for disturbance targets for both forested and vegetated non-forest areas in R11.

Table 38. Target treatment rates per decade for the forested and vegetated non-forest (i.e., herbaceous and shrubby meadow) areas of the R11 FMU.

Natural Subregion	Forested Area (ha)	Vegetated Non-forest Area (ha)
Alpine	378	168
Subalpine	7,966	746
Montane	1,387	178
Upper Foothills	3,579	322
Lower Foothills	24	8

Baseline Status: Fire currently occurs at a very low rate in the R11 Forest Management Unit. Over the past twenty years, less than 8,500 hectares of young forest have been created by natural disturbance and prescribed burning (Table 39). This is less than a third of that expected based on the longest reported fire cycles and only 15% of the median reported fire cycles. As a result, the landscape disturbance rate has moved towards a much longer fire cycle than is natural (Table 40). This reduction in disturbance rate has resulted in a significant loss of young forest, an important component of Alberta's natural-disturbance-adapted ecosystems.

Table 39. Forested area disturbed in each natural subregion in the R11 FMU between 1987 and 2006.

Natural Subregion	Area (ha)
Alpine	484
Subalpine	4,368
Montane	960
Upper Foothills	2,408
Lower Foothills	0

Table 40. Current disturbance rate compared to the median and range of natural fire cycles reported in Appendix III, Tymstra et al. (2005).

Natural Subregion	Median Reported Fire Cycles	Range of Reported Fire Cycles	Disturbance Cycle Expected From Recent Disturbance
Alpine	278 yrs	220 – 333 yrs	863 yrs
Subalpine	123 yrs	90 – 300 yrs	897 yrs
Montane	88 yrs	41 – 300 yrs	509 yrs
Upper Foothills	78 yrs	37 – 106 yrs	464 yrs
Lower Foothills	96 yrs	52 – 111 yrs	No recent disturbance

Prescribed burning and harvesting will be used to return the ten-year disturbance rate in each natural subregion to 50% of the median reported fire cycle. The target is set at 50% of the median reported fire cycle in each natural subregion to allow a substantial buffer for an overachievement of these targets through large wildfires or other means, while remaining within the natural range of fire cycles reported throughout the province. Calculating disturbance rates over a ten-year period will also allow flexibility in planning to take advantage of appropriate environmental conditions, as well as to adapt to additional wildfire and other natural disturbance events that may result, for example, from global warming.

Forecast: Ten-year disturbance targets have been developed for each natural subregion, based on reported natural fire cycles and the amount of each subregion within the FMU. If these targets are met, the fire cycle will shift closer to the natural range of variation (Table 41). While the disturbance cycles for the Alpine, Subalpine, and Montane Natural Subregions are expected to fall within the reported range of fire cycles, disturbance cycles for the Upper and Lower Foothills Natural Subregions will be substantially closer to the reported range, but will remain marginally longer than desired.

Table 41. Forecasted disturbance cycles (fire plus mechanical disturbance) for each natural subregion in the R11 FMU.

Natural Subregion	Forecasted Disturbance Cycle Based on Treatment Targets Alone	Forecasted Disturbance Cycle Based on Treatment Targets Plus Recent Disturbance Rates
Alpine	553 yrs	337 yrs
Subalpine	246 yrs	193 yrs
Montane	176 yrs	131 yrs
Upper Foothills	156 yrs	117 yrs
Lower Foothills	192 yrs	192 yrs

Monitoring: The area disturbed within each natural subregion will be calculated using a Geographic Information System. These data will be compared to the targets and reported in the Stewardship Report. The role of global warming in R11 fire cycles will require review and monitoring as relevant data become available.

Response: If the targets are not met, recommendations for plan amendments will be made in the Stewardship Report. Options will include adjusting treatment planning and implementation activities or adjusting targets. The current targets are based on the best available information on fire regimes in each natural subregion found in the R11 FMU (Tymstra et al. 2005). Prior to the next FMP update, a detailed fire regime study should be conducted to provide further guidance for target adjustments.

2012 Status: The area disturbed within each natural subregion over the reporting period was calculated in GIS (Table 10). In general, disturbed area is on a trajectory to meet the ten-year disturbance target, which was established based on 50% of the median reported fire cycle for each natural subregion. Forested area in the Upper Foothills and vegetated non-forested area in the Subalpine will require directed efforts to meet the targets. However, a single moderate sized prescribed burn or natural wildfire would contribute significantly.

Table 42. Disturbed area from 2007 to 2012 for the forested and vegetated non-forest (i.e., herbaceous and shrubby meadow) landbase within each natural subregion in the R11 FMU. The percentage of the target ten-year disturbance rate is shown in parentheses.

Natural Subregion	Forested Area	Vegetated Non-forest Area	Non-vegetated Area*
Alpine	815 ha (216%)	64 ha (38%)	191 ha
Subalpine	3718 ha (47%)	158 ha (21%)	89 ha
Montane	1809 ha (130%)	92 ha (52%)	59 ha
Upper Foothills	644 ha (18%)	146 ha (220%)	6 ha

* Most of the non-vegetated treatment area was within prescribed burn boundaries or quite small and the result of inventory inaccuracy. No disturbance target for non-vegetated area was outlined in the original FMP.

2012 Revision: To reflect information derived from the R11 Fire Regime Analyses (Rogeanu 2010b), this target will be changed to state ‘periodic disturbance rate of 100% of the median reported fire cycle for each fire regime region’. The average fire cycle for each fire regime region, the average annual disturbed area required to meet these fire cycles, as well as the associated natural ranges in variation are shown in Table 6. Within this disturbance rate, 75% will come from harvest, prescribed burn, and Natural Fire Use (i.e., natural-cause fires which are allowed to burn) and 25% will come from wildfire (i.e., fires which receive suppression action but cannot be contained, including human-caused fires).

Indicator 2.1.2

Value: Ecosystem Integrity and Productivity

Objective: Maintain natural disturbance patterns at the landscape level.

Indicator: Disturbance via natural processes where appropriate.

Target: Identification of natural fire zones for different Head Fire Intensities.

Baseline Status: Much of the R11 FMU is in Prime Protection Zone as delineated by the *Eastern Slopes Policy* where landscape management activities are largely limited to wildlife habitat improvement and fire suppression. Timber harvest can only occur for the purposes of protecting merchantable timber in other zones or protecting other values at risk. Accordingly, prescribed fire will be used to achieve several of the landscape and ecosystem objectives outlined in this FMP. However, the use of prescribed fire requires fuel management activities such as the establishment of strategic fuel breaks and fire doors (i.e., as with fire doors in a building that block spread of fire to other areas, landscape treatments can decrease spread of wildfires). Specifically, this could include creating large cutblocks, conversion of conifer stands to less flammable deciduous and mixedwood stands, and thinning of conifer stands. The establishment of fuel breaks and fire doors may also allow the delineation of natural fire zones where natural fire processes are permitted and suppression activities are limited.

The current policy of the Forestry Division of Alberta Sustainable Resource Development is aggressive initial attack of all wildfires before they reach 2 ha in size. If a wildfire escapes initial attack, an Escaped Fire Analysis Strategy is completed describing values at risk, potential for fire spread under current and forecast conditions, acceptable limits of spread, control objectives, required resources, and estimated costs. Wildfires may occur in areas planned for prescribed burns or in areas where FMP objectives could be met if limited suppression was exercised (i.e., natural fire zones). Natural fire zones containing more options for acceptable limits of spread and acceptable range Head Fire Intensities (HFI; numerical ranking of difficulty of control for specific fuel types) will be identified within the R11 landscape as fire doors and fuel breaks are created. Escaped Fire Analysis Strategies can then take into account these natural fire zones.



Washout Creek prescribed burn

Forecast: The identification of natural fire zones will depend upon the successful establishment of fire doors and fuel breaks on the landscape.

Monitoring: Fire reports will identify the resources committed to a given fire, area burned, etc. Summary statistics on number of fires and area burned each year will be reported in the five-year Stewardship Report.

Response: If natural fire zones are not delineated and all wildfires are actively suppressed, FMP targets for area disturbed (Indicator 2.1.1) may not be met. Additional prescribed burns would then be required.

2012 Status: A summary of prescribed fires and wildfires occurring within the R11 FMU since 2007 is presented in Table 43.

Table 43. Wildfires and prescribed fires occurring within the R11 FMU between 2007 and 2011. Wildfires less than 1 ha in size are not included.

Year	Type of Fire	Number of Fires	Area Burned (ha)
2007	PB	1	127.5
2009	PB	2	4926.6*
2009	WF	1	1773.2
2010	WF	1	9.4
2010	PB	1	102.2
2011	PB	1	398.3

*amount burned on provincial land, additional hectares were burned in Banff National Park as part of the Upper Saskatchewan Unit 1 prescribed burn

The 2009 Parks Canada excursion fire, known to ASRD as RWF-072-09, was allowed to continue burning because it escaped into the Hat Mountain prescribed burn area and also the Hat Mountain prescribed burn containment area. The fire did not escape the containment area and remained within the bounds of the prescribed burn plan.

Natural fire zones have not yet been delineated in the R11 landscape; however the Blackstone Capping Unit prescribed fire was the first in a series of capping units to be installed on the R11 landscape. The current objective for the prescribed fire program for R11 is to complete eight more capping unit burns. From north to south, these proposed burns are Chungo, Blackstone (more units in same area), Wapiabi, Mount Michener, Upper Saskatchewan Unit 2, Hummingbird, Upper Clearwater, and Eagle Pass (Map 5).



Blackstone Capping Unit burn in 2007

Once these capping units are completed, the focus in fire management will shift in two ways. First, the imperative of rapid fire suppression will be lessened as most of the R11 landbase will be contained by a combination of mountain ranges and previous prescribed fire. Increasing limitations on staff resources will support this reduction in suppression action. Secondly, the completion of capping units will allow more flexibility in fire management decision making, allowing such options as the use of natural wildfires and more aggressive prescribed fires to

achieve specific objectives like habitat enhancement burns or mountain pine beetle reduction burns (i.e., move towards natural fire zones).

One outcome from the R11 Fire Regime Analysis is the identification of several areas within the R11 FMU that have a severe fire deficit (Rogean 2010b). These are in order: North Saskatchewan, Red Deer – Clearwater, followed to a lesser extent by the Ram compartment. Increasing presence of managed wildfires and prescribed fires will furthermore help improve this fire deficit.

Indicator 2.1.3

Value: Ecosystem Integrity and Productivity

Objective: Maintain natural disturbance patterns at the landscape level.

Indicator: Fire intensity.

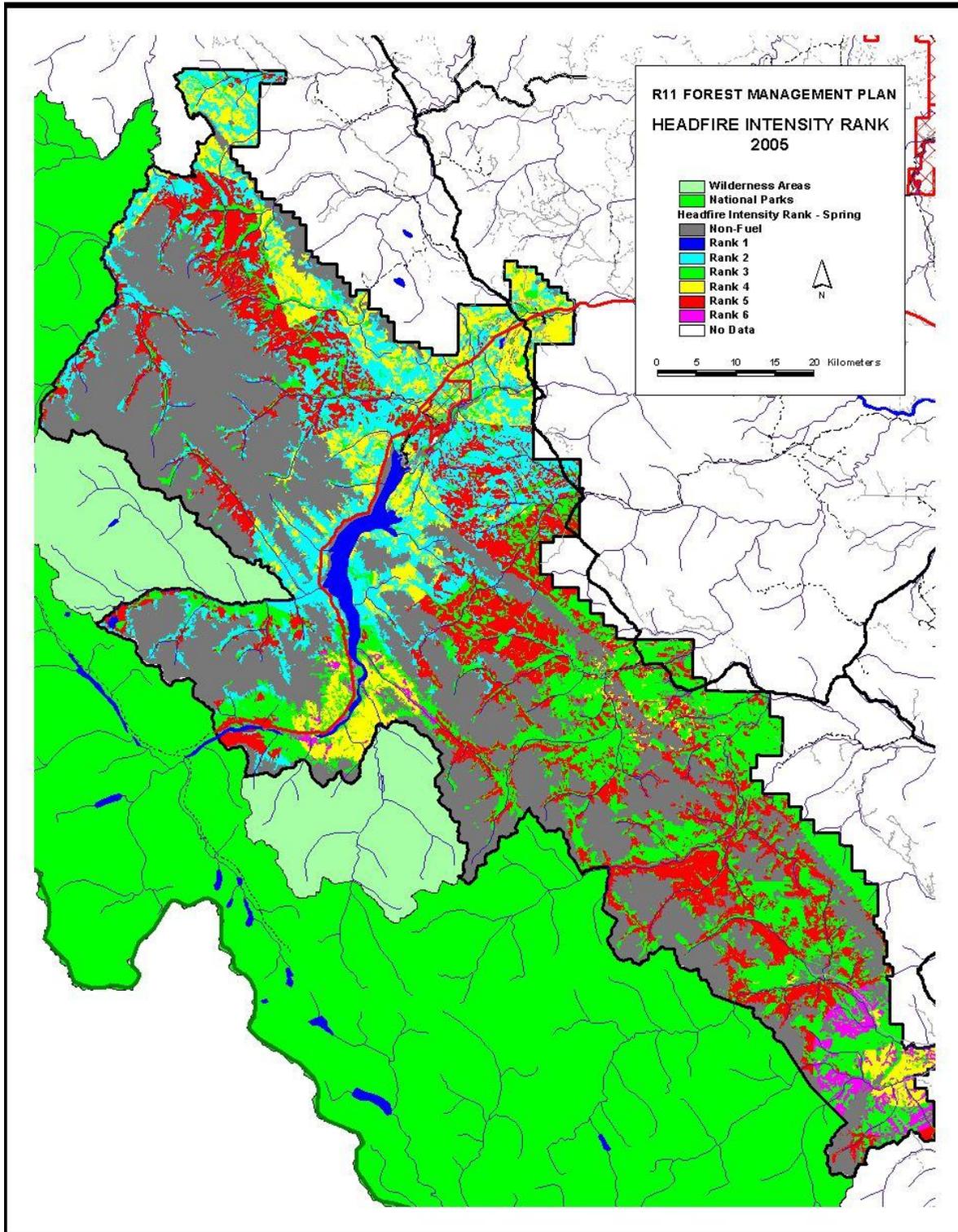
Target: Distribution of Head Fire Intensity ranks across the landscape.

Baseline Status: Head Fire Intensity (HFI) is the predicted intensity, or energy output, of the fire at the front or head of the fire and is one of the primary methods by which fire managers estimate the difficulty of controlling a fire. Areas with high fuel buildup will be susceptible to high intensity fires under the appropriate weather conditions. Fire suppression activities within R11 over the past several decades have produced an older forest age class structure containing a fuel buildup in many areas and thus a prevalence of high HFI ranks (Map 18 to Map 20). High and extreme Head Fire Intensity ranks can have an adverse impact on water and soils if entire watersheds burn under these conditions. Prescribed burn and harvest activities within R11 will lessen such impacts by creating a distribution of lesser HFI potential on the landscape during spring, summer, and fall periods.

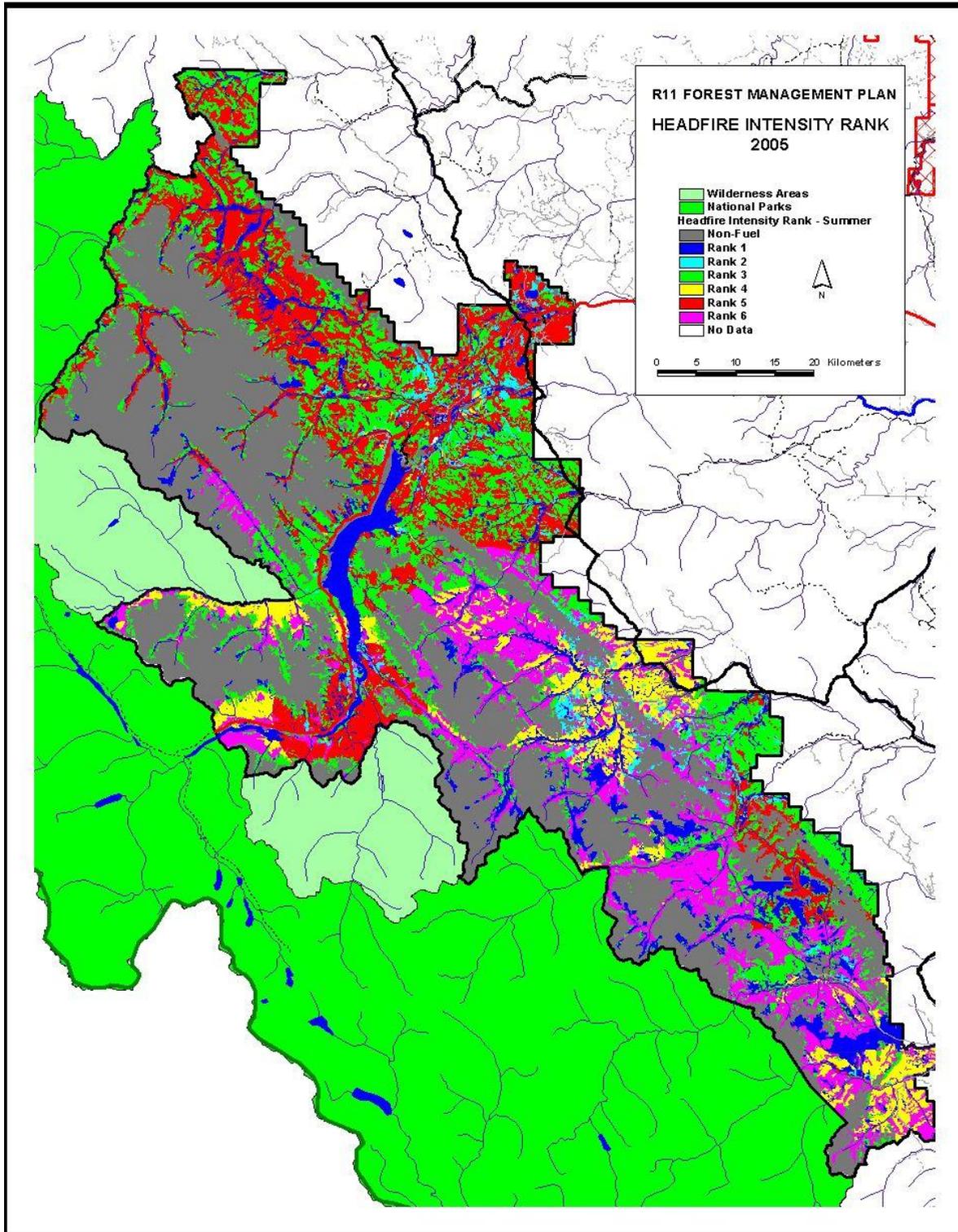
Forecast: Harvesting and burning (both prescribed fires and wildfires) will reduce the forest age structure and fuel loads. This should contribute to a subsequent reduction in the number of high HFI ranks on the landscape.

Monitoring: The 90th percentile Head Fire Intensity ranks will be recalculated at 5, 10, 20, and 50-year intervals to ensure that proposed harvesting and prescribed fire activities are resulting in an even distribution of the full range of HFI ranks on the landscape during spring, summer, and fall periods. As prescribed burn and harvest activities are completed, HFI ranks can be recalculated on a more frequent basis. Maps and charts will be used to display spatial and class distribution changes over time, with 2005 as the baseline for comparison. The Spatial Fire Management System and its associated models will be the primary GIS-based tools used to calculate HFI ranks and produce maps for the R11 landscape. Results will be presented in the Stewardship Report.

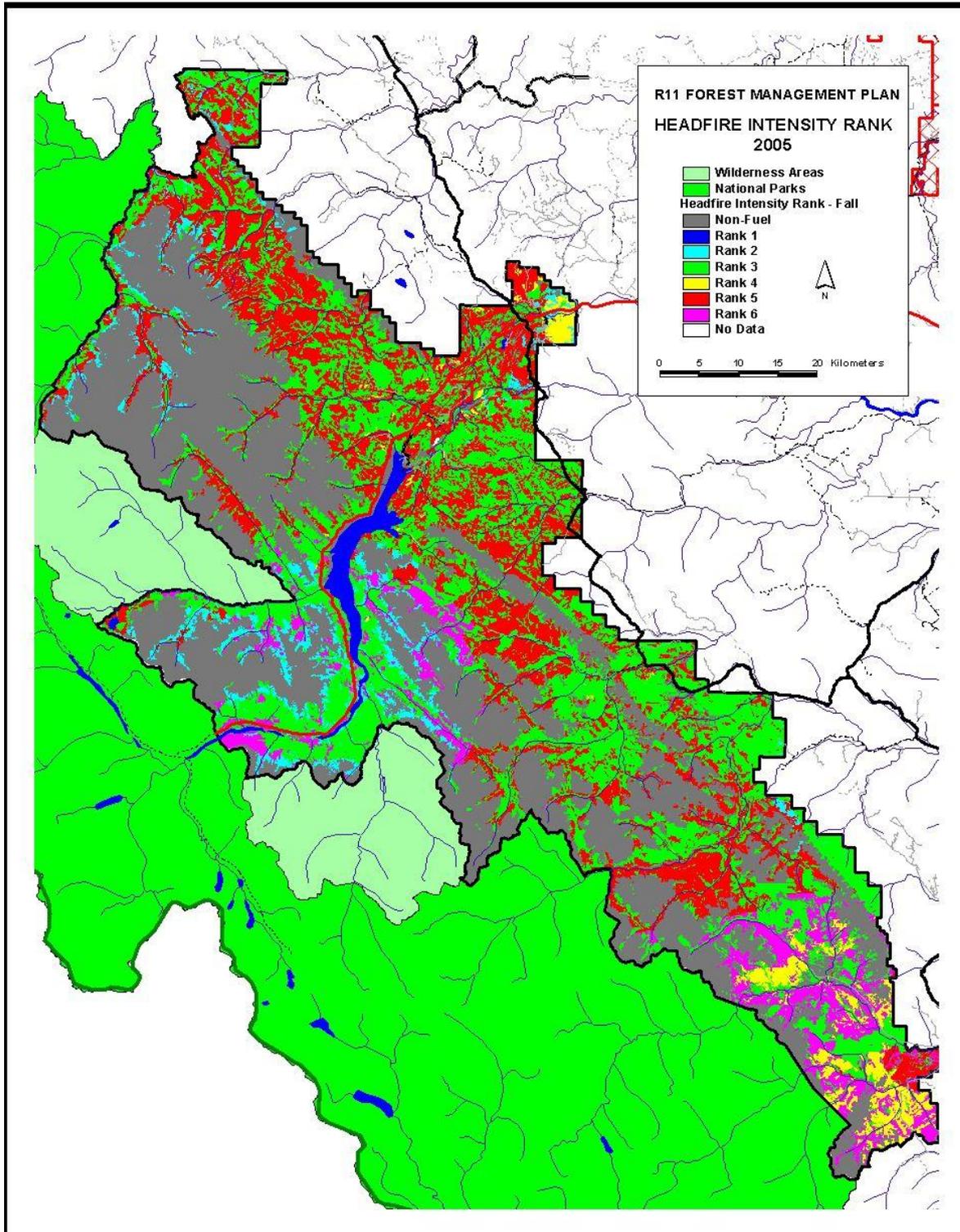
Response: If the desired distribution of HFI ranks is not achieved, prescribed burn or harvest plans will be adjusted.



Map 18. Head Fire Intensity ranks for the R11 FMU in spring 2005. Ranks range from a smouldering, creeping ground fire (Rank 1) to a conflagration with extreme fire behaviour (Rank 6).



Map 19. Head Fire Intensity ranks for the R11 FMU in summer 2005. Ranks range from a smouldering, creeping ground fire (Rank 1) to a conflagration with extreme fire behaviour (Rank 6).



Map 20. Head Fire Intensity ranks for the R11 FMU in fall 2005. Ranks range from a smouldering, creeping ground fire (Rank 1) to a conflagration with extreme fire behaviour (Rank 6).

2012 Status: 90th percentile HFI ranks were calculated for the R11 FMU and the percent of the landscape in each category was summarized (Table 44). Most notable is the slight to moderate decreases in Rank 3 HFIs on the landscape across all seasons coupled with an increase in percent of Rank 5 HFIs on the landscape across all seasons. This likely reflects the fact that the stand age distribution showed increases in the mature age class (101-180 yrs) across all natural subregions (see Indicator 1.1.2). These changes were in the opposite direction required to meet the target of an equal distribution of HFI ranks across the landscape: further efforts are required to ensure future prescribed burns are planned in areas of Rank 5 HFI.

Table 44. Percent of the R11 FMU in each HFI rank category in spring, summer, and fall of 2005 (baseline) and 2012 (current) (ASRD, *unpubl. data*). Ranks range from a smouldering, creeping ground fire (Rank 1) to a conflagration with extreme fire behaviour (Rank 6).

	Spring		Summer		Fall	
	2005	2012	2005	2012	2005	2012
Rank 1	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%
Rank 2	13.4%	9.3%	2.7%	2.0%	2.0%	2.2%
Rank 3	19.4%	17.1%	17.1%	13.0%	30.9%	24.2%
Rank 4	8.2%	12.3%	6.6%	4.6%	2.2%	2.0%
Rank 5	18.0%	23.6%	15.2%	20.6%	19.9%	29.1%
Rank 6	2.9%	2.8%	12.6%	17.0%	7.0%	7.7%

Indicator 2.2.1

Value: Ecosystem Integrity and Productivity

Objective: Allow natural reforestation processes in disturbed areas.

Indicator: Area burned or harvested and left for natural regeneration.

Target: 90% of burned or harvested areas will be left for natural regeneration.

Baseline Status: Commercial timber harvest in Alberta normally requires reforestation under the authority of the Timber Management Regulation. However, the forested landbase in R11 is not committed to nor contributes to the Annual Allowable Cut of any operator, and the reforestation requirement can be waived with proper justification. Several benefits may accrue by leaving disturbances to go through natural reforestation processes including fewer financial costs, regeneration of trees and other plant species carrying genes specifically adapted to that area, less potential for introduction of non-native weed species, and longer duration before crown closure providing enhanced forage for ungulates. Accordingly, natural reforestation processes will be permitted in disturbed areas within R11: the Director of Forest Management Branch, through approval of this plan, has waived the regulatory reforestation requirement. Additional



Eight year old Thompson Creek burn undergoing natural regeneration

reforestation may be desirable to protect social values in select areas, and thus a target of 90% accounts for limited artificial reforestation in such cases.

Forecast: not applicable

Monitoring: The total area of prescribed burn, natural burn, or harvest will be compared to the area in leave-for-natural condition using GIS analyses. Results will be summarized in the Stewardship Reports.

Response: If >10% of the burned or harvested areas are artificially reforested, investigations will determine the reason. Reforestation targets may need to be adjusted in subsequent FMPs to protect social values.

2012 Status: All areas disturbed through prescribed burning (6,362 ha), natural wildfires (1,782 ha), or harvesting (458 ha) were left for natural regeneration. As 100% of the disturbed area was left for natural regeneration, no GIS analyses were conducted to compare the total burned or harvested area to the area of artificial reforestation or the area in leave-for-natural condition.

Indicator 2.3.1

Value: Ecosystem Integrity and Productivity

Objective: Track loss of forest landbase to other uses.

Indicator: Amount of change in forest landbase, including oil and gas, seismic, mining, roads, commercial, urban, acreages.

Target: Minimal loss of forest landbase.

Baseline Status: Landbase losses to resource sectors, public infrastructure development, or private development are usually outside the control of ASRD. Under the Public Lands Act, however, ASRD can encourage the integrated management of public lands through the use of operating and development conditions on dispositions. The use of conditions can regulate certain aspects of the activity to ensure environmental sensitivities of the site are protected. Special operating conditions may be applied to the sale of public land parcels by registering caveats on the land title that protect riparian buffers adjacent to Crown-owned watercourses. Although ASRD cannot control all losses to the forested landbase, tracking conversions will monitor long-term trends. In the short term, the department will also ensure all disposition applications use the existing footprint of roads and clearings wherever possible and include conditions to reclaim the forested landbase upon their abandonment.

Forecast: not applicable

Monitoring: Areas coming in and out of forest landbase are usually tracked by using inventory cover labels. Traditional tracking may be difficult as the existing AVI in the R11 FMU is only current to 1994 and 1997, and the management unit is low priority for inventory updates. ASRD will attempt to track all removals through applications, but has no means of tracking land coming back into forest production. Forest cover and landuse inventories will be updated as resources permit. Stewardship Reports will summarize any data on landbase conversions.

Response: not applicable

2012 Status: A total of 4.2 ha were removed from the forested land in the R11 FMU between 2007 and 2012. The amount of forested land in each age class disturbed by industrial dispositions is shown in Table 45. As mentioned above, there is still no method to track area returning to a forested condition, nor the landbase converted by private development.

Table 45. Forested landbase removed by industrial dispositions in the R11 FMU between 2007 and 2012. EZE = Easement, LOC = License of Occupation, MSL = Mineral Surface Lease, PLA = Pipeline Agreement.

AgeClass	Disposition Type	Area (ha)
Young	EZE	0.55
Pole	EZE	0.39
Mature	EZE	1.30
Mature	LOC	0.21
Mature	MSL	0.66
Mature	PLA	0.13
Old	PLA	0.92

Indicator 2.4.1

Value: Ecosystem Integrity and Productivity

Objective: Maintain soil productivity by preventing soil compaction.

Indicator: Compliance with Sundre Forest Products Operating Ground Rules.

Target: Complete compliance with Sundre Forest Products Operating Ground Rules, with 90% of harvesting conducted under winter conditions.

Baseline Status: Maintenance of soil productivity is a key factor in maintaining a resilient forest condition. Research conducted by the Alberta Research Council has shown the impacts of heavy machinery traffic on soil physical properties include compaction, reduction in pore space, reduction in water infiltration rates, and shifts in drainage class. These impacts can directly hinder root development of seedlings in the short term and are particularly pronounced when harvesting is conducted during moist soil conditions. See Appendix 4.1 in Westbrook and Devito (2002) for complete summary of harvesting impacts on soil properties.

To protect soil productivity, the R11 Forest Management Plan will adopt Sundre Forest Products Operating Ground Rules as the standard: soil and water protection practices are very comparable to the existing Provincial Operating Ground Rules. The Operating Ground Rules do not require harvest in winter conditions; however, ASRD will attempt to conduct all harvest operations in winter conditions when soils are most likely to be dry or frozen.

Forecast: Most harvesting in R11 will be conducted under competitive permits, where ASRD can specify time of harvest. Thus, winter harvest can likely be achieved most of the time; exceptions may arise if coordination of activities with adjacent timber operators dictates adjustment of harvest schedules to achieve joint roading and reclamation.

Monitoring: Field inspection reports and audits will be used to monitor timing of harvest and compliance with the OGR.

Response: Immediate remedial action will be taken to correct harvesting operations that do not comply with the OGR.

2012 Status: Forty-six field inspections conducted during the past five years revealed that harvesting operations were conducted in complete compliance with the OGR, and 100% of harvesting was conducted in the winter. Despite the winter harvest timing, the annual window of frozen ground conditions was found to be narrower than expected (i.e., often only about six weeks of frozen conditions), and in one year the ground did not freeze throughout the entire winter. During that winter, FireSmart harvesting was conducted around Nordegg under non-frozen conditions.

Indicator 3.1.1

Value: Forest Health

Objective: Recognize role of all native forest health agents and climate change.

Indicator: Current inventory and distribution of native forest health agents.

Target: Accurate reporting and mapping of native forest health agents.

Baseline Status: Native forest health agents include insects and diseases that are natural residents of forest ecosystems. When populations are at endemic levels, the effects of these agents are neutral or even beneficial in forest renewal by removing weakened or old trees. Management strategies are usually only required when population outbreaks occur or when other values such as merchantable timber are threatened.

ASRD surveys the R11 Forest Management Unit annually for the presence of insects, disease, and natural disturbance events. The type, cause, and extent of all disturbance agents are mapped and tabulated annually. Table 11 in the original R11 FMP lists the native forest health agents currently present in the R11 FMU. Over the last five years, there has been no significant tree mortality caused by native insects or disease within the R11 FMU. See Indicators 3.3.1 and 3.3.2 for objectives and management directly related to mountain pine beetle.

Forecast: species-specific

Monitoring: Annual aerial surveys are typically conducted from late June to early September to assess location, area disturbed, severity, possible causal agent, and host tree species for insect and disease disturbances. Any significant disturbances are mapped and the disturbance agent ground truthed and verified. These data are compiled and maintained at the Forest Health Section in Edmonton and are available on the ASRD website (<http://srd.alberta.ca/LandsForests/ForestHealth/Default.aspx>). In addition, an inventory of forest health agents will be maintained by the Forest Health Section to ensure all native forest health agents are represented. Summaries will be completed for the Stewardship Report at the end of the five-year reporting period. GIS data coverages that track insect and disease events will be updated regularly.

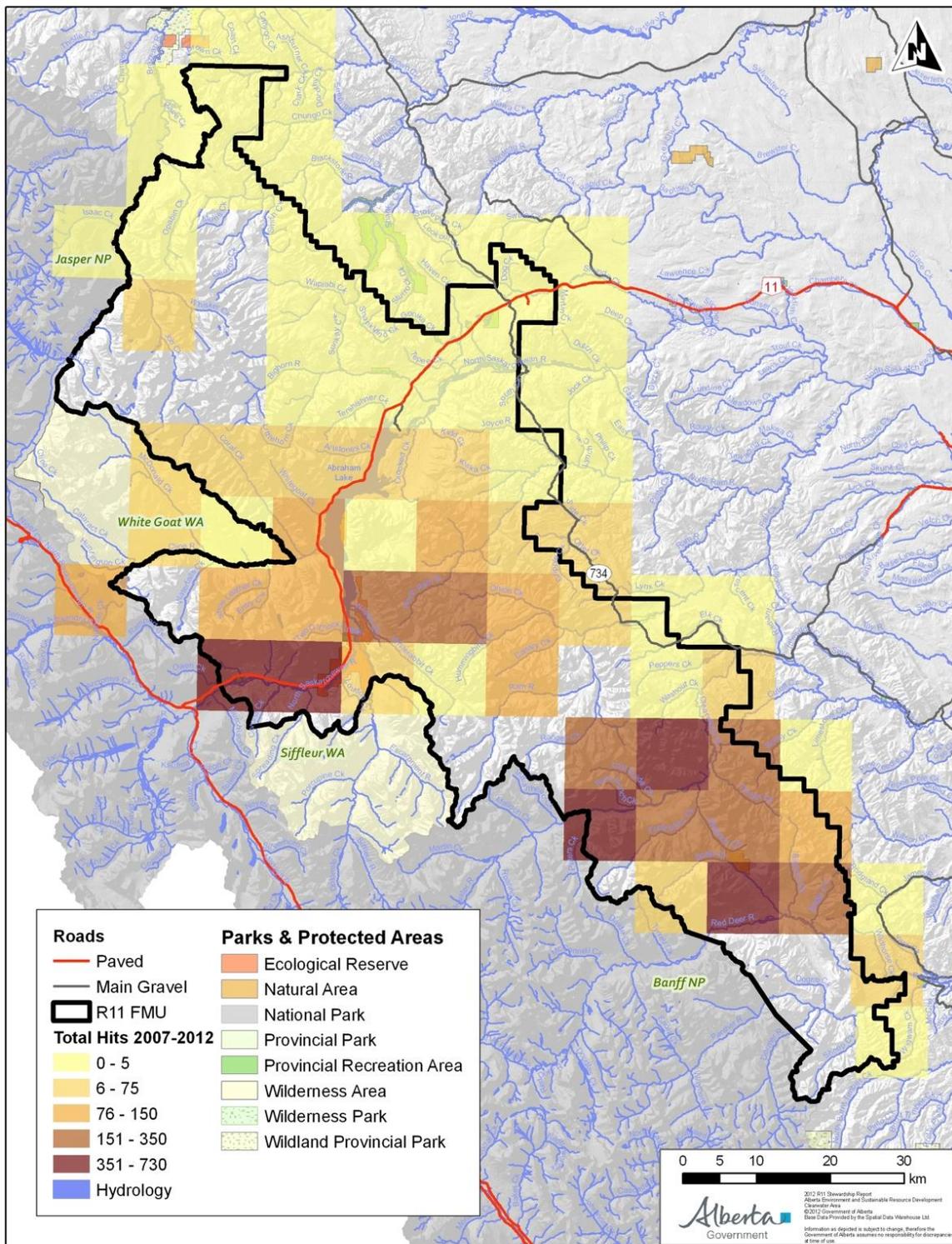


Mountain pine beetle

Response: Any significant increase in insect and disease activity will trigger further evaluation as to the cause, including the relative role of climate change and treatment activities in insect or disease distribution changes. Prescribed burn and harvest plans can be adjusted if determined to be contributing to the increase in insect or disease populations or if necessary to control an agent.

2012 Status: Monitoring and mapping of forest health agents occurred as described (mainly via aerial survey) in the R11 Forest Management Unit. No major findings have occurred in the past five years, and the forest health agents listed in Table 11 of the original R11 FMP are still relevant. An increase in red-belt was noted in 2011. In addition, MPB was identified in the R11 FMU via dispersal bait monitoring and ground surveys, most notably in the Upper Saskatchewan Unit 1 prescribed burn in 2009. Map 21 shows cumulative hits at dispersal bait stations between 2007 and 2012.

Mountain Pine Beetle Dispersal Baits



Map 21. Total hits at mountain pine beetle dispersal bait stations from 2007 to 2012.

Indicator 3.1.2

Value: Forest Health

Objective: Recognize role of all native forest health agents and climate change.

Indicator: Current inventory and distribution of non-native forest health agents.

Target: No increase in incidence of non-native forest health agents.

Baseline Status: Non-native forest health agents are insects or diseases that are introduced into an area that is beyond their natural range of occurrence and become pests in the new environment. Non-native species may have few natural controls within these new ecosystems, which can often lead to outbreak populations and can decimate native species. For example, white pine blister rust is a European pathogen that was introduced to both the east and west coasts of North America in the early 1900's and has subsequently had significant impacts on native white pine populations.

ASRD surveys the R11 Forest Management Unit annually for the presence of insects, disease, and natural disturbances. The type, cause, and extent of all disturbance agents are mapped and tabulated annually. Currently, no non-native forest insects or diseases have been found within the R11 FMU (but see Indicator 3.2.1 for non-native, invasive plants); however, annual monitoring will continue to ensure any occurrences are identified.

Forecast: not applicable

Monitoring: Annual aerial surveys are typically conducted from late June to early September to assess location, area disturbed, severity, possible causal agent, and host tree species for insect and disease disturbances. Any significant disturbances are mapped and the disturbance agent ground truthed and verified. These data are maintained at the Forest Health Section in Edmonton and are available on the ASRD website (<http://srd.alberta.ca/LandsForests/ForestHealth/Default.aspx>). At each five-year monitoring period, the inventory and maps of all forest health surveys will be compiled and analyzed to identify any occurrence of non-native forest health agents. Summaries will be completed for the Stewardship Report. GIS data coverages that track insect and disease events will be updated regularly.

Response: Any occurrence of a non-native forest health agent will trigger immediate development of a management plan to include surveys, control, and monitoring under the responsibility of ASRD Forest Health Section or Alberta Agriculture & Rural Development.

2012 Status: No non-native forest insects or diseases have been identified within the R11 FMU over the past five years.

Indicator 3.2.1

Value: Forest Health

Objective: Prevent introduction of non-native, invasive plant species.

Indicator: Current inventory and distribution of non-native, invasive plant species (i.e., noxious and restricted weeds).

Target: No increase in incidence of non-native, invasive plant species (i.e., noxious and restricted weeds).

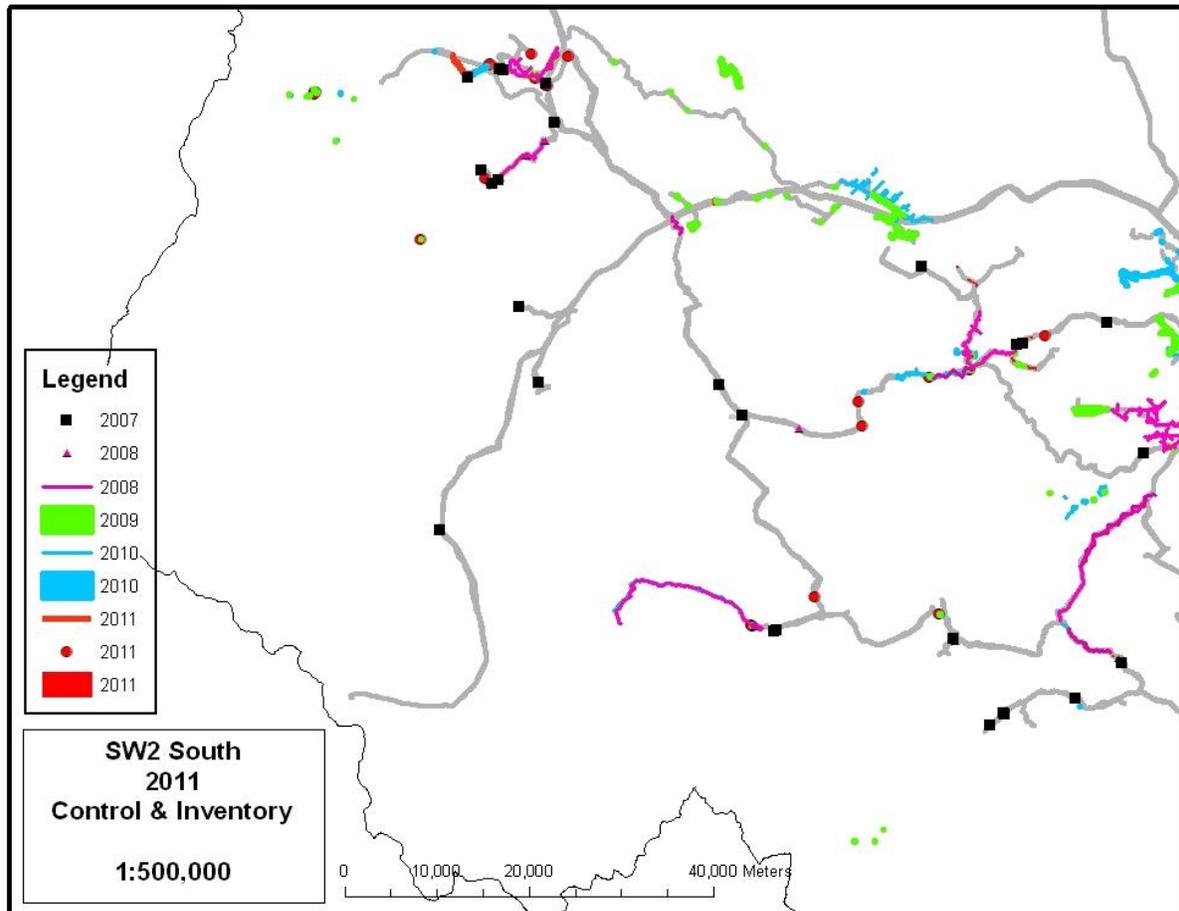
Baseline Status: Non-native, invasive plants (i.e., provincially designated noxious and prohibited noxious) have the potential to pose undesirable or detrimental impacts on humans, animals or ecosystems. Invasive plants typically have no natural enemies, proliferate in novel habitats, have the ability to monopolize resources, and have high reproductive capacities. Impacts of noxious and prohibited noxious weeds on ecosystems can include displacing native, threatened, and endangered plant species, impeding the successful reclamation of disturbed sites, decreasing soil stabilization, delaying forest succession, and altering wildlife habitat. The control or eradication of noxious and prohibited noxious weeds within forested areas is regulated by the *Weed Control Act* and *Directive 2001-06: Weed Management in Forestry Operations*.

ASRD surveys the R11 FMU annually for the presence non-native, invasive plants. As of 2007, oxeye daisy, scentless chamomile, tall buttercup, wild caraway, and white cockle have been identified within or immediately adjacent to R11. Management plans are in place to survey, control, and monitor these populations, under the responsibility of the Forest Health Officer for ASRD. The final component of non-native, invasive plant management in R11 is prevention. Specific practices include use of native seed for any required reclamation work, public education, and participation in co-operative programs.

Monitoring: ASRD conducts annual forest health surveys of the R11 forests from which the location, extent, and type of all non-native, invasive plants are mapped and tabulated. These data are maintained in the Forest Health Section in Edmonton. At each five-year monitoring period, the inventory and maps of all non-native, invasive plants will be compiled and analyzed to identify the extent of the infestations. Results will be summarized in the Stewardship Report. GIS data coverages that track non-native, invasive plant infestations will be updated regularly. The effectiveness of control or eradication measures will also be monitored through field inventories and inspections.

Response: Any increase in the extent of non-native, invasive plants will trigger a new, more aggressive management plan to include surveys, control, and monitoring under the responsibility of ASRD Forest Health Section or Alberta Agriculture & Rural Development.

2012 Status: The target of no increase in incidence of noxious and restricted weeds was met. Invasive plant infestations that have been receiving control treatments are decreasing or have been eliminated. Some new infestations have been detected, but the overall incidence of invasive plants has not increased (Map 22).



Map 22. Recent control (points) and inventory (transects, shaded areas) sites for non-native, invasive plants within the R11 FMU.

Indicator 3.3.1

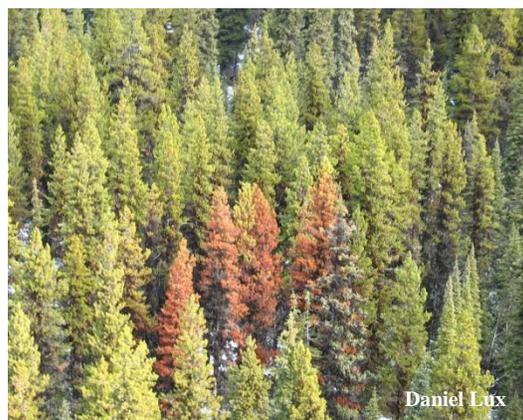
Value: Forest Health

Objective: Reduce the impact of mountain pine beetle.

Indicator: Stand Susceptibility Index.

Target: 75% reduction in the area of highly susceptible stands currently projected in 20 years.

Baseline Status: Although mountain pine beetle (MPB) has not yet been detected within R11, this species is spreading eastward into Alberta through most of the major mountain passes. The mature and old growth lodgepole pine stands in the FMU are at risk of infestation if measures are not taken to reduce their susceptibility. Three major factors define a stand's likelihood of mountain pine beetle attack and subsequent mortality: (1) Mountain Pine Beetle Stand Susceptibility Index, (2) climate suitability, and (3) proximity to existing beetle populations (risk).



**Pine trees under attack by
mountain pine beetle**

1. The Stand Susceptibility Index is one tool used by ASRD to identify stands that are most susceptible and/or would incur the most significant damage given a mountain pine beetle infestation. The index is based on the Shore/Safranyik Susceptibility Rating System (Shore and Safranyik 1992) that measures a stand's capacity to produce beetles in the event it is attacked. One component in this analysis is the pine rating, a factor of the percentage of susceptible pine basal area, stand age, and stand density. This relative measure ranges from 0 to 100 where stands rated as 100 have conditions most conducive to MPB production.
2. The climate suitability is a relative measure of the likelihood of MPB undergoing a one-generation per year life cycle. Higher ranked stands are those where MPB populations will grow rapidly if not controlled.
3. Risk is an assessment of the probability that an area will be attacked based on existing MPB populations. The general criteria for risk assessment are as follows:
 - i. **High:** areas adjacent to existing MPB populations or in the direct pathway of logical MPB corridors.
 - ii. **Moderate:** areas that are not in the direct path of current MPB flight patterns, but are likely to experience MPB populations in the next 5-7 years.
 - iii. **Low:** areas not expected to experience significant MPB pressure for the next 7 years or areas that have already experienced a MPB outbreak and there is limited opportunity for prevention.

For ease and planning purposes, all areas within the R11 will be ranked as moderate.

The *Mountain Pine Beetle Action Plan for Alberta* (Government of Alberta 2006b; online at <http://www.srd.gov.ab.ca/forests/pdf/MPB%20Action%20Plan.pdf>) describes targets as well as control and prevention strategies to reduce the amount of susceptible stands across the landscape. Specifically, the target is to reduce the number of Rank 1 and Rank 2 stands to 25% of their currently projected level in 20 years. Rank 1 stands provide the best habitat for MPB to reproduce and spread to other stands, and are typically comprised of large, old pine, are close to existing MPB populations, and/or are in areas that are climatically suitable for beetle development (Government of Alberta 2006c). Rank 2 stands have a lower pine component, lower climate suitability, and/or greater distance from existing MPB populations, and thus are lower priority. The ranking system for pine stands is shown in Table 46.

Table 46. Pine stand ranking system for Prevention (Pine) Strategy FMP planning and implementation (taken from Government of Alberta 2006c).

Climate Factor (per stand)	Pine Rating				Risk
	0 to 30	31to 50	51to 80	81to 100	
Very Suitable 1.0	Rank 1	Rank 1	Rank 1	Rank 1	High
	Rank 2	Rank 1	Rank 1	Rank 1	Moderate
	Rank 2	Rank 2	Rank 1	Rank 1	Low
Highly Suitable 0.8	Rank 1	Rank 1	Rank 1	Rank 1	High
	Rank 2	Rank 2	Rank 1	Rank 1	Moderate
	Rank 2	Rank 2	Rank 2	Rank 1	Low
Moderately Suitable 0.5	Rank 2	Rank 1	Rank 1	Rank 1	High
	Rank 2	Rank 2	Rank 2	Rank 1	Moderate
	Rank 3	Rank 2	Rank 2	Rank 2	Low
Low Suitability 0.2	Rank 2	Rank 1	Rank 1	Rank 1	High
	Rank 3	Rank 2	Rank 2	Rank 2	Moderate
	Rank 3	Rank 2	Rank 2	Rank 2	Low
Very Low Suitability 0.1	Rank 3	Rank 2	Rank 2	Rank 2	High
	Rank 3	Rank 3	Rank 2	Rank 2	Moderate
	Rank 3	Rank 3	Rank 3	Rank 3	Low

In 2007, there are 54,341 ha of Rank 1 and Rank 2 stands within the R11 FMU (see Map 29 in original FMP). Prescribed burning and harvesting will target these stands.

Forecast: Mountain pine beetles will not attack burned or downed wood or young regenerating stands. Thus, if all proposed prescribed burns and harvest blocks are carried out to completion, 18,607 ha of Rank 1 and Rank 2 stands will be removed, representing a 66% reduction in the area of highly susceptible stands.

Monitoring: Completed burn and harvest area boundaries will be overlaid on the mountain pine beetle susceptibility rating map and the results summarized in the Stewardship Report.

Response: If the number of highly susceptible stands is not reduced at the five-year reporting period, a new schedule and timeframe for the prescribed burn and harvest activities will be implemented to target the highly susceptible stands.

2012 Status: Harvest block, prescribed burn, and wildfire boundaries occurring over the five-year reporting period, as well as proposed prescribed burn boundaries, were overlaid onto the mountain pine beetle susceptibility ratings used in the original R11 FMP. This analysis showed a projected 40,153 ha of Rank 1 and 2 stands in 2030, representing a 26% reduction in the area of highly susceptible stands relative to the baseline status in 2007. The Upper Saskatchewan Unit 1 prescribed burn, the Parks Canada Ya Ha Tinda multi-year burn and subsequent wildfire RWF-072-09, and the Hat Mountain prescribed burn all were situated in highly susceptible MPB stands.

Since completion of the 2007 R11 FMP, ASRD Forest Health has modified the pine ranking system, eliminating the climate suitability factor and the risk component based on proximity to known beetle populations. This leaves only the Stand Susceptibility Index and renders the Rank 1/2/3 categorizations no longer valid. A revised definition of highly susceptible stands for the Indicator 3.3.1 target is thus necessary.

2012 Revision: The range of Mountain Pine Beetle Stand Susceptibility Indices on the current R11 landscape were examined to determine objective cut-off values for high, moderate, and low rankings. The following rankings were chosen based on a quantile method of classification in GIS, with approximately equivalent stand areas in each category:

- High: SSI greater than 42,
- Moderate: SSI between 25 and 42,
- Low: SSI less than 25.

Under this revised ranking system for the R11 FMP, approximately 64,000 ha falls into the High susceptibility category and will be targeted for future treatments. The target will remain the same: ‘75% reduction in the area of highly susceptible stands currently projected in 20 years’.

Indicator 3.3.2

Value: Forest Health

Objective: Reduce the impact of mountain pine beetle.

Indicator: Stand age distribution.

Target: Current stand age distribution within the natural range of variation. See Indicator 1.1.2.

Baseline Status: Although mountain pine beetle has not yet been detected within R11, this species is spreading eastward into Alberta through most of the major mountain passes. The mature and old growth lodgepole pine stands in the FMU are at greatest risk of infestation as the beetle preferentially attacks these age classes. Fire suppression activities have shifted the distribution of forest stand ages outside the natural range of variation, specifically there are fewer younger stands and more mature and old growth stands than historically present in the FMU. Specific treatment actions planned in this FMP will be directed at creating a stand age distribution within the natural range of variation. For further details, see Indicator 1.1.2.

2012 Revision: Note in the associated text for Indicator 1.1.2 that in future Stewardship Reports, the target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation. That change will be mirrored in this target, under the assumption that restoring the specific fire regime characteristic to a particular portion of the landscape will create a diversity of stand ages.

Indicator 4.1.1

Value: Watershed Integrity

Objective: Maintain flow quantity.

Indicator: Annual flow.

Target: No increase in annual flow projections greater than 15% on third-order streams.

Baseline Status: As a forested landscape recovers from disturbance, the regeneration of forest vegetation decreases the disturbance impact on the surrounding watershed and hydrologic regime. ECA stands for 'Equivalent Clearcut Area' and describes the hydrologic recovery of a disturbed area relative to the water use of a similar-sized mature area. For example, the water use of a 100 ha juvenile stand recovering on the site of a stand that was harvested in 1973 might be 75% of the water use of a mature stand and thus is equivalent to an area with 75 ha mature forest and 25 ha new clearcut (Silins 2003). The ECA-Alberta model, based on this concept, provides a framework for evaluating the cumulative disturbance condition of landscapes or watersheds using specific data related to hydrologic recovery of provincially common forest stand and site types as well as regional streamflow and precipitation data (Silins 2003). The model also incorporates procedures for simulating annual water yield and stream flows.

Stream order is a measure of the relative size of streams within a watershed or landscape, ranging in Alberta from small first-order perennial streams with no tributaries up to the eighth-order Slave River. First-order streams are non-branching headwater channel segments, second-order streams are formed by the union of two first-order streams, third-order streams by the union of second-order streams and so on. Watershed classification can follow a similar hierarchical pattern with first-order watersheds delineating the area drained by a given first-order stream, second-order watersheds delineating the area drained by a given second-order stream, etc.

For this R11 Forest Management Plan, ASRD delineated the FMU into third-order watersheds, but did not yet analyze the impacts of proposed treatments on those watersheds. Preliminary watershed analyses on the larger watersheds in R11 using ECA-Alberta indicated that if all treatments were done in a single year, the impact to those watersheds would be an increase of less than 3% in the annual flow. As the analyses of smaller watersheds occur, the increase will get larger; however, the treatments will be spread out over a period of years, so the flow increases will not accumulate as rapidly. Analyses of annual flow in third-order watersheds will be completed in future iterations of the plan.

Forecast: Historical watershed analyses from other FMAs rarely show annual flows above the 15% threshold due to forestry activities. Annual flow increase in R11 as a result of treatment activities will be addressed in the next iteration of this plan with a more detailed analysis.

Monitoring: Models will be re-run after treatment activities, particularly prescribed burn treatments that are larger than planned. Results will be presented in Stewardship Reports.

Response: The chosen response to increases in annual flow projections greater than 15% will be detailed in the next version of the plan after the analyses of third-order watersheds are completed. However, the response will likely entail a reduction in the number or magnitude of treatment activities within a given watershed.

2012 Status: As discussed above, analyses of annual flow in third-order watersheds will be completed in future iterations of the plan and thus not in this Stewardship Report.

Indicator 4.2.1

Value: Watershed Integrity

Objective: Maintain flow quality.

Indicator: Roads and watercourse crossings.

Target: All roads and watercourse crossings meet or exceed Sundre Forest Products OGR standards.

Baseline Status: Forest management activities such as road construction, harvesting, and site preparation have been shown to alter water quality, primarily through elevated sediment inputs, elevated water temperatures, decreased dissolved oxygen, and elevated dissolved nutrient levels. Accordingly, various management practices have been developed to minimize the impacts of forest management activities on watercourses and associated riparian areas. Protection of watercourses and water quality is required by the provincial *Timber Harvest Planning and Operating Ground Rules* (AEP 1994), the *Code of Practice for Watercourse Crossings* under the provincial *Water Act*, and the federal *Fisheries Act*. This R11 Forest Management Plan will adopt Sundre Forest Products Operating Ground Rules as the standard.

Road and watercourse crossing construction practices in the Sundre Forest Products Operating Ground Rules are very comparable to existing Provincial OGR. Examples of road and crossing practices in the OGR that conserve water quality include avoiding known springs or seepage areas during road design, constructing watercourse crossings at right angles to watercourses, and reducing water and sediment movement along ditches using vegetated buffers, rock and log obstructions, or sediment control structures. The indicator regarding soil protection (2.4.1) also directs road construction to the lower class roads and frozen conditions.

Forecast: Most harvesting in R11 will be conducted under competitive permits, where ASRD can specify time of harvest, access routes, and crossing types if desired. Winter harvest can likely be achieved most of the time; however, coordination of activities with adjacent timber operators may dictate adjustment of harvest schedules to achieve joint roading and reclamation. In these cases, the Operating Ground Rules will be followed.

Monitoring: Field inspections and audits will be used to monitor compliance with the OGR and timing of harvest. Existing water quality monitoring within the North Saskatchewan watershed is summarized in North Saskatchewan Watershed Alliance (2005), though Alberta Environment focuses its efforts on major rivers especially near communities. Additional watershed quality monitoring may be requested from Alberta Environment if deemed necessary.

Response: Immediate remedial action will be taken to correct road and crossing construction, maintenance, or reclamation operations that do not comply with the OGR or that are creating impacts on water quality.

2012 Status: All roads and crossings constructed for harvest activities were constructed as per the Sundre Forest Products Operating Ground Rules. All constructed roads were reclaimed, and all watercourse crossings were removed. In general, lower grade roads were built as these are easier to reclaim. Of 46 field inspections conducted during this reporting period, only one issue pertaining to roads or watercourse crossings required corrective action: one Commercial Timber Permit operator created some rutting on his road. The operator was subsequently required to hire a specialist to advise on appropriate decompaction techniques.

Indicator 4.2.2

Value: Watershed Integrity

Objective: Maintain flow quality.

Indicator: Maintenance of stream buffers.

Target: Sundre Forest Products OGR for stream buffers met or exceeded in harvest areas.

Baseline Status: Riparian vegetation adjacent to watercourses fulfills several key ecological functions, including stabilizing stream banks and channels, regulating temperature and light effects in the watercourse, regulating water flow regimes, filtering runoff before it enters the watercourse, providing riparian habitat and linkage corridors between other habitats for terrestrial wildlife, and providing long-term recruitment of coarse woody debris and nutrient inputs for aquatic biota. Thus, maintenance of stream buffers is an accepted practice to moderate the impacts of forest management activities on water quantity and quality as well as riparian values. Sundre Forest Products Operating Ground Rules buffers based on stream classification will be followed in all harvested areas within the R11 FMU. The OGR also include other protection measures such as locating log decks outside riparian or water source areas.

Forecast: Achievement of buffer retention is anticipated on 100% of harvest areas.

Monitoring: The inspecting Forest Officer will conduct regular reviews, and any deviation from the approved Annual Operating Plan will be documented.

Response: Immediate remedial action will be taken to correct, where possible, harvesting operations that are not adhering to the OGR.

2012 Status: Forty-six field inspections conducted by Forest Officers during the past five years revealed that all Sundre Forest Products Operating Ground Rules pertaining to stream buffers were met or exceeded during harvest activities.

Indicator 4.2.3

Value: Watershed Integrity

Objective: Maintain flow quality.

Indicator: Bared soil surfaces.

Target: No bared soil surfaces created by harvest operations.

Baseline Status: Similar to the potential water quality impacts of roads and watercourse crossings, bared soil surfaces resulting from forest management activities can also release sediment into nearby streams thereby degrading water quality and aquatic habitat. The indicators regarding soil protection (2.4.1) and roads and watercourse crossings (4.2.1) direct road construction to the lower class roads and frozen conditions. This will minimize the bared areas created by construction activities. Conducting harvesting activities under dry or frozen conditions as well as retaining some downed woody debris and stand structure will further protect the duff layer, maintain the snowpack, and encourage runoff infiltration rather than overland flow.

Forecast: Most harvesting in R11 will be conducted under competitive permits, where ASRD can specify time of harvest. Winter harvest can likely be achieved most of the time; however, coordination of activities with adjacent timber operators may dictate adjustment of harvest schedules to achieve joint roading and reclamation. In these cases, the Operating Ground Rules will be followed.

Monitoring: The inspecting Forest Officer will conduct regular reviews, and any deviation from the approved Annual Operating Plan will be documented.

Response: Immediate remedial action will be taken to correct, where possible, harvesting operations that are creating bared soil surfaces.

2012 Status: Bared soil surfaces were created during the construction of temporary roads to access harvest blocks as the period of frozen ground conditions was shorter than originally anticipated (see Indicator 2.4.1). Furthermore, the target was based on the expectations that logs could be skidded to an existing road for loading with no additional clearing required or that trucks could operate within the block with minimal roading. These expectations were unrealistic, and some roads with bared soil surfaces were necessary (note that the general rule of <5% road coverage per block area was not assessed). Any lower grade roads were completely reclaimed during the same season of operation, and no bared soil surfaces remained following harvesting activities. Of 46 field inspections conducted during this five-year reporting period, one corrective action was required with respect to bared soil surfaces: the operator was required to spread additional harvest debris following his operations and to hire a specialist to advise on appropriate decompaction techniques after creating rutting on a road.

Indicator 4.2.4

Value: Watershed Integrity

Objective: Maintain flow quality.

Indicator: Area of unsalvaged blowdown.

Target: No salvage of merchantable blowdown in riparian areas.

Baseline Status: Long-term recruitment of coarse woody debris into streams from adjacent riparian vegetation creates pool and complex cover habitats for fish and other aquatic organisms, provides nutrient inputs into the system, stabilizes stream banks and channels, and traps sediment and organic matter (Harmon et al. 1986). Coarse woody debris within watercourses also helps discourage motorized traffic and associated sedimentation. Accordingly, merchantable blowdown occurring in riparian areas within R11 will not be salvaged (note that there may be limited salvage of merchantable burn or blowdown in non-riparian areas as per Indicator 1.3.1).



Robert Anderson

Recruitment of coarse woody debris from a burn along Corona Creek

Localized variance may be required if blowdown contributes to excessive fuel hazard or safety concerns.

Forecast: not applicable

Monitoring: Stream buffer widths will be identified from air photos or GPS boundaries of harvest blocks and burns and compared to the boundaries of salvage areas. Results will be reported in the five-year Stewardship Reports.

Response: Immediate remedial action will be taken to correct, where possible, harvest operations that are salvaging blowdown from riparian areas.

2012 Status: No salvage of blowdown from riparian areas occurred in the R11 FMU during the past five years. Accordingly, no GIS analysis was conducted to compare the boundaries of salvage areas to stream buffer widths or harvest block boundaries.

Indicator 4.3.1

Value: Watershed Integrity

Objective: Support Watershed Alliances.

Indicator: Communications with Watershed Alliances.

Target: Referral of plan to Red Deer and North Saskatchewan Watershed Alliances.

Baseline Status: The North Saskatchewan and Red Deer River Watershed Alliances are non-profit partnerships of interested stakeholders working together to protect the ecological integrity of their respective watersheds. These alliances provide a forum for information exchange among those working toward sustainable use and management of water supplies; support public education and communication-related initiatives on issues impacting the watersheds; and promote a watershed approach to environmental, cultural, social, and economic decision-making and actions within their respective communities. Membership is diverse and includes representatives from government, agriculture, industry, environmental groups, local stewardship groups, municipalities, educational institutions, interested citizens, etc.

The North Saskatchewan Watershed Alliance participated in the initial stakeholder meetings during the development of the R11 Forest Management Plan. As well, an Alberta Environment employee who also represents the Alliance attended the public Charrette planning session to help draft the plan. The R11 FMP was made available for public review prior to approval, and the approved copy will be made available to the public, including the Watershed Alliances.

Forecast: not applicable

Monitoring: Correspondence with Watershed Alliances will be documented and reported in the Stewardship Report.

Response: not applicable

2012 Status: Since approval, the R11 FMP has been available on ASRD's website at: <http://www.srd.alberta.ca/LandsForests/ForestManagement/ForestManagementPlans/ForestManagementUnitR11.aspx> for viewing by the public or other relevant organizations such as Watershed Alliances. Kevin Gagne, Senior Area Forester for the Clearwater Area, gave a presentation on February 11, 2009 about the R11 Forest Management Plan at the North Saskatchewan Watershed Alliance "We Are All Upstream 2: Making Connections" conference. Kevin Gagne has also been a member of the Red Deer River Watershed Alliance Technical Advisory Committee since March 2010. This Alliance has a much smaller area within the R11 boundaries, and no formal presentation has been given to the Alliance. The R11 FMP has been mentioned briefly at the Technical Advisory Committee meetings.

Indicator 5.1.1

Value: Science-based Decision Making

Objective: Ensure stakeholders and managers are informed by science so they can understand trade-offs and make defensible decisions; employ scientific thresholds and checkpoints; make ecosystem-based decisions; and adhere to planning standards.

Indicator: Implementation of current research findings in R11.

Targets: Continual monitoring and implementation of research findings relevant to R11; Current communications systems in place to monitor research initiatives.

Baseline Status: ASRD has a specialist who reviews and guides research initiatives related to forest and land management. All related research is scrutinized for relevancy, applicability, and scientific procedures. Furthermore, ASRD is a partner and key financial supporter of two particularly relevant bodies, the Foothills Model Forest (<http://www.fmf.ca/index.html>) and the Sustainable Forest Management Network (<http://www.sfmnetwork.ca/>), and also provides significant funding to many Canadian universities when their research may be applicable in Alberta. FMF grizzly bear research products have already been utilized, and this work will continue as models are refined. Similarly, statistics from the FMF Highway 40 North project have been calculated in the ecosystem biodiversity Indicator 1.1.1, as this project is recognized as being closely aligned with the objectives of the R11 FMP. Recently completed and ongoing research will be discussed at regular stakeholder meetings (e.g., after the completion of five-year Stewardship Reports) to ensure all parties remain informed of research initiatives and findings and their implications in the management of R11.



Radio-collared bighorn sheep along Hwy 11

Forecast: The R11 FMU has the potential to adopt new research strategies relatively easily. Results from the Foothills Model Forest research will likely continue to be a major driver in planning and treatment activities conducted in R11.

Monitoring: ASRD will continue to monitor findings from all research, most notably research to which the Alberta government is a significant contributor.

Response: Current research findings that result in small-scale changes to treatment activities will be implemented immediately and reported in the five-year Stewardship Report. Research findings that would require a significant change in management direction will be considered in the subsequent FMP.

2012 Status: Several research projects have been completed or initiated within the R11 FMU during the five-year reporting period, most notably a fire regime analysis, Wet Areas Mapping Initiative, additional grizzly bear work, cougar predation and human-cougar coexistence projects, and a wolf population dynamics and management project. A brief summary and references for additional information for each project are presented below. The results of this work will be communicated to stakeholders to ensure they are aware of the research initiatives and their implications on the R11 FMP. For example, the Fire Regime Analysis research has led to a revision of indicators related to stand age distribution to targets associated with fire cycle instead (e.g., Indicators 1.1.2, 1.12.2, 3.3.2), and results from the cougar and wolf research were used to revise the predator-prey target in Indicator 1.8.1.

Fire Regime Analysis

As noted in the original R11 FMP, a detailed fire regime analysis did not exist at the natural subregion level for the majority of the R11 FMU. Rogeau (1999) studied historical fire regimes between 1470 and 1998 for the area west of the Cline River as well as White Goat and Siffleur Wilderness Areas, while Tymstra et al. (2005) analyzed natural subregion fire regimes primarily between 1961 and 2002 at the provincial level. Accordingly, natural range of variation targets were established in the original FMP based on studies conducted within the same natural subregions in other areas of the province.

ASRD subsequently attempted to fill this critical knowledge gap by contracting M.P. Rogeau of Wildland Disturbance Consulting to conduct a fire regime analysis of the R11 FMU.

Specifically, the analysis would

- identify and describe the recent and historical fire regime(s) within the FMU,
- assess the spatial distribution of young, mature and old growth forests using fire regime simulations,
- assess the natural variation in fire sizes and fire cycle (i.e., annual disturbance rate), and
- calculate the departure from historical fire regime conditions.

This body of work as well as a supporting fire history field study is described in a three-part report series (Rogeau 1999, Rogeau 2010a, Rogeau 2010b). A brief summary is provided elsewhere in the current Stewardship Report (Section 2). Results of the Rogeau work have been used to refine targets from Indicators 1.1.1, 1.1.2, 2.1.1, 2.1.2, and associated indicators that defer to one of these.

Wet Areas Mapping Initiative

In collaboration with researchers from University of New Brunswick, ASRD has developed a GIS-based mapping tool that predicts flow channels, wet areas, and depth-to-water under the soil surface. Using previously mapped streams, rivers, and lakes in combination with LiDAR-derived digital elevation data, the modelling tool predicts topographic connectivity among adjacent wetlands as well as many previous unmapped ephemerals and small wet areas that are sensitive to development nonetheless.

The approach has been used successfully by governments and industry in eastern Canada and Maine to enhance stewardship of the forested landscape and reduce operational costs; and ASRD is using LiDAR-derived digital elevation data to produce high quality wet areas maps for 15 million hectares of forested landscape in the boreal and foothills regions. In addition to numerous applications within the Land-Use Framework, specific applications relevant to the R11 include identification of potential watercourse crossings, placement of wood landing sites and in-block harvest trails, and identification of areas where water or wet areas may limit regeneration.

Grizzly Bear Research

Population estimates for several grizzly bear population units in the province were conducted between 2004 and 2008 using a DNA-based Capture-Mark-Recapture analysis (Festa-Bianchet 2010). Two of these population units overlap the R11 FMU: the portion of the FMU north of Hwy 11 is overlapped by the Yellowhead unit, while the portion of the FMU south of Hwy 11 is overlapped by the Clearwater unit. Several parameters related to population estimates, density, and mortality are summarized in Table 30. See Indicator 1.10.1 for additional discussion of grizzly bear populations, recovery, and habitat mapping as it applies to the R11 FMU and Indicator 1.8.1 for inclusion of grizzly bears in the predator-prey targets.

Cougar Predation and Human-Cougar Coexistence Research

Kyle Knopff and Dr. Mark Boyce from the University of Alberta completed a study of cougar predation in the multi-prey ecosystem of west-central Alberta, specifically the Rocky-Clearwater Forest, between 2005 and 2008 (Knopff 2010, Knopff et al. 2010). Using GPS telemetry data from 44 GPS-collared cougars combined with occasional snow-tracking, Knopff was able to locate over 1,500 predation events and examine several fundamental aspects of predation, such as kill rate, the influence of season, the influence of cougar population structure (i.e., age, sex, reproductive status), and the influence of prey vulnerability (e.g., female ungulates during pre-birthing/birthing period, juveniles, males during rutting) on prey composition. Information stemming from this study has been used in establishing the predator-prey targets outlined in Indicator 1.8.1.

In a complementary study from the same landscape and using the same telemetry data, Aliah Adams Knopff and Dr. Colleen Cassidy-St.Clair examined behaviour flexibility in cougar habitat selection along a gradient of anthropogenic development (Adams Knopff 2011). They also used a survey to identify residents' tolerance for cougars as it related to value for cougars, risk perception, socio-economic factors, social associations, experience with cougars, and proximity.

Wolf Population Dynamics and Management Research

Nathan Webb and Dr. Evelyn Merrill from the University of Alberta, in collaboration with Jim Allen, ASRD local area biologist, conducted an intensive telemetry-based investigation of wolf population dynamics and predation rates in the Clearwater Area from 2003 to 2007. A total of 84 wolves from 19 packs were radio-collared and monitored approximately bi-weekly using aerial telemetry or occasionally from the ground.

This research program was intended to address several questions important for the management and conservation of both wolves and their prey in the Clearwater Area, including estimating current wolf densities, exploring new techniques to monitor wolf populations, determining wolf predation rates and prey selection, estimating wolf harvest rates, and determining the sustainability of current wolf management regimes. A summary of the research findings and management implications is available in Webb, Merrill, and Allen (2009), while a complete description of the project, methods, analysis, and results is presented in Webb (2009).

Indicator 6.1.1

Value: Domestic Grazing

Objective: Maintain trails open to manage livestock and consider cow locations during seasonal use.

Indicator: Location of cow trails and season of use.

Targets: No increased use of riparian areas as a result of prescribed burn or harvest treatments; Consultation with affected disposition holders prior to treatments.

Baseline Status: ASRD Land Division and Forestry Division policy directive 2006-1 on Integration of Grazing and Timber Activities and the Grazing and Timber Integration Manual (ASRD 2006b) outline procedures to promote the successful integration of grazing with timber harvest and reforestation on public lands. In particular, grazing interests should be considered in the development of a forest management plan and resulting harvest sequence for a given FMA or FMU. Domestic grazing in R11 is limited with the FMU containing portions of only six grazing dispositions, concentrated primarily along the southeastern boundary (see Map 34 in original R11 FMP). Few prescribed burns are scheduled for this area although harvest activities are planned. Operating Ground Rule stream buffers will be retained, and expanded if required, to discourage cattle from entering riparian areas. Consultation with the affected disposition holders will occur prior to treatment activities to address issues such as the timing of operations and associated movement of cattle, location of high-use cattle trails, maintenance of access to forage and water resources, damage to existing fences, introduction of weeds, damage to riparian areas, and overgrazing or damage to regenerating cutblocks.

Forecast:

Monitoring: All communications with affected disposition holders will be documented, and a summary of activities addressing range management concerns will be prepared for the Stewardship Report.

Response:

2012 Status: No harvest treatments were conducted in any grazing leases over the five-year reporting period. The R11 portion of prescribed burn occurred proximate to the South Idlewilde Distribution Unit of the Clearwater Grazing Allotment, although the actual prescribed burn area in R11 was not part of the grazing disposition and therefore no consultation was required. Of note, anecdotal signs of cattle use did appear to increase (as noted by change in grass loading) following the 2008 South Idlewilde prescribed fire in an adjacent meadow portion of the R10 FMU.

Indicator 7.1.1

Value: Economic Opportunities

Objective: Maintain or increase the economic potential of the R11 area without damaging the overall appeal for users.

Indicator: Number of tourism-related operators in the R11 area.

Target: Number of tourism-related operators in the R11 area is maintained or increased.

Baseline Status: In addition to personal recreation and enjoyment, the stunning natural beauty of the R11 FMU attracts visitors from afar, resulting in the potential for local economic returns from tourism. Development applications by tourism-related operators desiring to operate on public lands and requiring long-term tenure, permanent structures, public review, or integration with existing land uses may be subject to ASRD's Alberta Tourism Recreational Leasing Program process. Furthermore, operators based in county-administered sub-divisions, hamlets, and development nodes must comply with municipal requirements for development permits. However, tourism-related operators without facilities do not require any type of permitting. ASRD recognizes there are many such operators, but no agency tracks their activities. Comprehensive assessment of this indicator is thus difficult using existing provincial or municipal government data (e.g., limit on the number of Alberta Tourism Recreation Leasing permits, no geographical identifier on municipal development permits). The R11 plan has addressed tourism generally in Indicator 10.2.1, and until there is a method to track and report all tourist-related operators, monitoring through other indicators must suffice. Planned treatment activities may result in aesthetic impacts (Indicator 9.3.1) or temporary closure of some recreational areas when hazard trees create a public safety concern (Indicator 15.1.1), but a public education program will help communicate the ecological rationale behind the treatments (Indicator 13.1.1).

2012 Status: As there have been no changes to the application or data collection processes discussed above, it remains a challenge to track the number of operators in the R11 area, particularly those without any facilities. ASRD staff are not aware of any operators ceasing to conduct business in the R11 FMU over the past five years.

Indicator 7.1.2

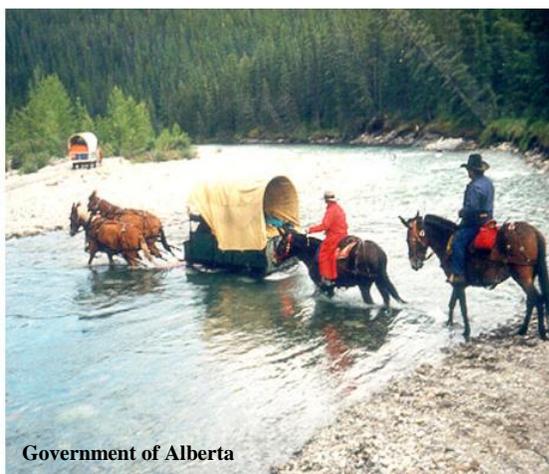
Value: Economic Opportunities

Objective: Maintain or increase the economic potential of the R11 area without damaging the overall appeal for users.

Indicator: Client impact, financial impact for operators, and economic impact on local economy.

Target: Positive client feedback.

Baseline Status: Many tourism-related operators rely on the access, fish and wildlife, and aesthetic resources within the R11 FMU when providing accommodation, guiding and outfitting services, or other recreational experiences for clients. The economic returns that operators and other local businesses receive can support the local economy. The success of tourism-based businesses, however, require positive client experiences, which are often influenced by factors outside the operators' control such as weather, scenery, frequency of encounters with wildlife or other tourists, forest management activities occurring on the landscape, etc.



Government of Alberta

Wagon train crossing the Panther River

Planned harvest and prescribed burn treatment activities may result in aesthetic impacts (Indicator 9.3.1) or temporary closure of some recreational areas when hazard trees create a public safety concern (Indicator 15.1.1): this has the potential to result in temporary impacts on clients and operators. A public education program will help communicate the ecological rationale behind the treatments (Indicator 13.1.1), and operators will be encouraged to help educate clients on the benefits of the management activities (e.g., increased ungulate forage, reduced risk of mountain pine beetle infestation).

The impact of R11 treatment activities on tourism-based operators and their clients will be difficult to assess using existing government-maintained datasets, though many operators may individually record client feedback and maintain financial records. Thus monitoring the impacts of treatment activities on tourism clients, operators, and the local economy will require further investigation into targets that both reflect the indicator and are measurable. In the interim, general visitor numbers and feedback will be monitored as outlined in Indicator 10.2.1.

2012 Status: Quantitative assessment of the impacts of R11 treatment activities on tourism clients, operators, and the local economy remains a challenge as a standardized, repeatable

visitor survey has not been developed and operators are not required to make financial records available to the public.

To qualitatively assess the impact of treatment activities, Rebecca Heemeryck, Area Forester, for the Clearwater Area, conducted interviews with three tourism operators in the Nordegg area: McKenzies' Trails West, Aurum Lodge, and Icefield Heli Tours. Generally, all three businesses felt that the smoke during and two to three months following the Upper Saskatchewan Unit 1 prescribed burn had the greatest impact on their businesses. They all felt that once the smoke subsided the burns did not impact the number of visitors to the area. The Icefield Heli Tours operator did hear several comments about 'how terrible the burn looks', and felt additional information would help increase public education about why the fires were done. None of the businesses had received any negative comments from tourists about the FireSmart harvesting conducted in the area.

One anecdotal positive impact on the local economy was also noted. The Bighorn FireSmart program generated building logs for the Stoney Nakoda Log Home Building Program and provided 325 man days of employment processing firewood for Stoney Nakoda First Nations members.

Indicator 8.1.1

Value: Wildfire Threat

Objective: Integrate fire management objectives with overall landscape management objectives (i.e., balance the level of risk of wildfire with the responsibility of other parties, such as developers and adjacent forest companies, to participate in their own risk reduction).

Indicator: Vegetation management zone map.

Target: Appropriate vegetation management zone map developed.

Baseline Status: The R11 Forest Management Plan is based upon the natural disturbance paradigm: management activities that emulate natural disturbances will create a landscape similar to one that would have existed without human intervention thereby conserving biotic resources contained therein. Furthermore, the *Eastern Slopes Policy* directs that much of the R11 FMU is in the Prime Protection Zone where resource extraction activities are prohibited and preservation of environmentally sensitive terrain and valuable ecological and aesthetic resources is the foremost concern. Management activities are limited to those that protect or improve watershed, fisheries, or wildlife resources. Given these underlying conditions, participants in the public Charrette planning session outlined a vegetation management zone map that identifies zones within the R11 FMU designated for a given management treatment. The four management zones are as follows:

- Fire Only – prescribed fire will be the only management type used
- Fire > Mechanical – prescribed fire is the preferred management type; however, mechanical treatments (e.g., harvesting, brush cutting) may be used in some circumstances including preparatory work in advance of prescribed fire treatments
- Mechanical > Fire – mechanical treatment is the preferred management type for logistical or social reasons; however, prescribed fire may be used given the appropriate conditions
- Mechanical Only – mechanical treatment will be the only management type used

These zones are compatible with both the natural disturbance paradigm and the *Eastern Slopes Policy* and represent the integration of fire management objectives with landscape management objectives. Specifically, prescribed fire will be the primary tool used over much of the FMU to reduce wildfire threat by returning the stand age distribution to within its natural range of variation. In areas where the risk associated with the use of prescribed fire is deemed too high (i.e., near infrastructure or adjacent FMAs), mechanical treatments will be used, recognizing that harvesting will be the most common mechanical treatment used on the landscape.

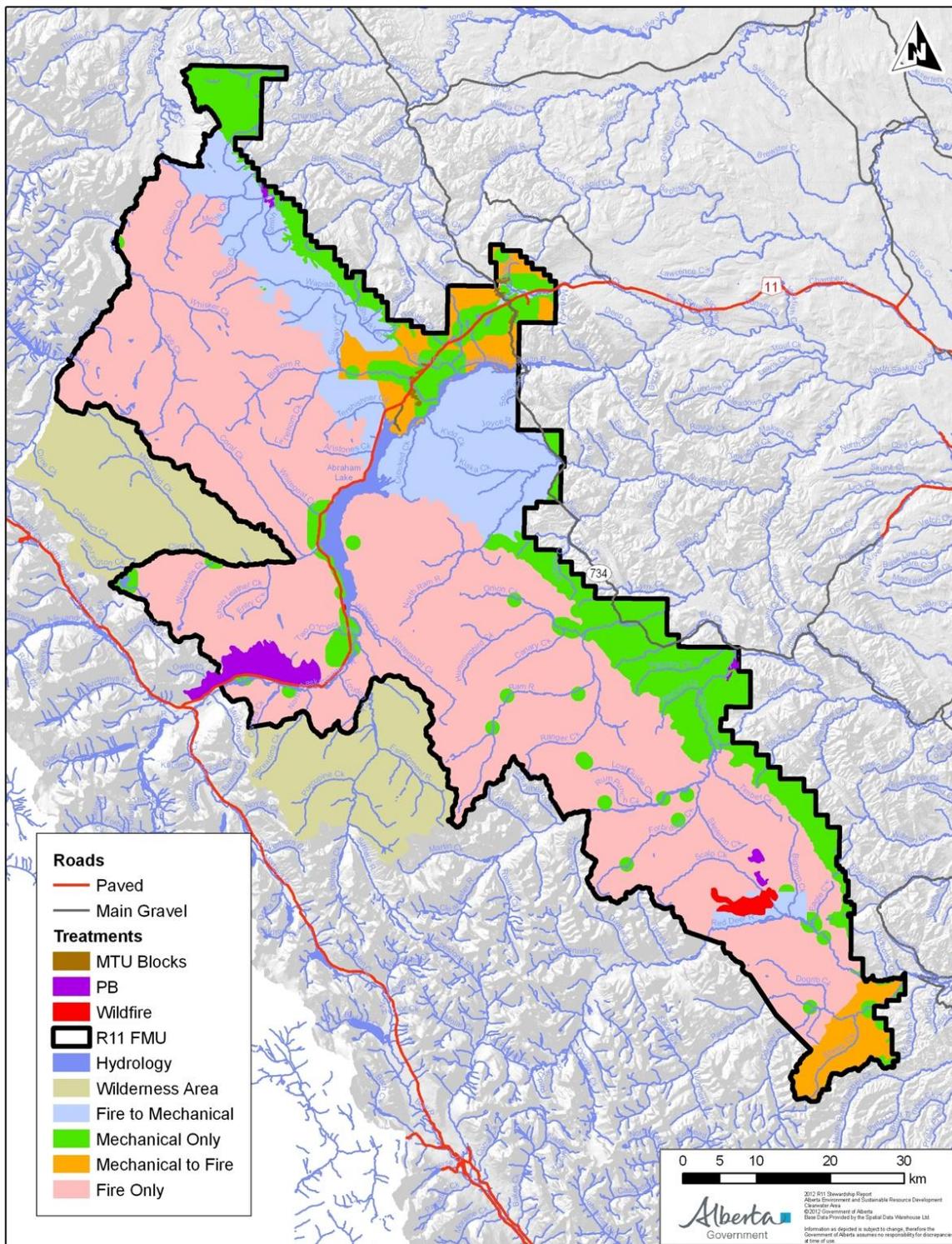
Forecast: not applicable

Monitoring: GIS analysis will be used to overlay prescribed burn and mechanical treatment boundaries on the vegetation management zone map to ensure the proper treatment type is used in each zone. Results of the mapping exercise will be reported in the five-year Stewardship Report.

Response: Planned treatment types will be adjusted if they are not compatible with the vegetation management zone map.

2012 Status: Prescribed fire and harvest treatments, as well as wildfires, were overlaid on vegetation management zone map described above (Map 23). The treatment type applied corresponded with the identified management zone, with the exception of a prescribed fire in a mechanical harvest zone along the Clearwater River.

Vegetation Management Zones



Map 23. Vegetation Management Zones identifying the particular management treatments to be used within the R11 FMU as well as the treatments applied in those zones from 2007 to 2012.

Indicator 8.1.2

Value: Wildfire Threat

Objective: Integrate fire management objectives with overall landscape management objectives (i.e., balance the level of risk of wildfire with the responsibility of other parties, such as developers and adjacent forest companies, to participate in their own risk reduction).

Indicator: Number of FireSmart initiatives.

Targets: FireSmart Program in place for all communities and infrastructure in the R11 Forest Management Unit; FireSmart Landscape in place for the R11 Forest Management Unit.

Baseline Status: As one component of ASRD Forestry Division’s wildfire prevention strategy, FireSmart programs encourage proactive planning to reduce negative impacts of wildfire. Three zones have been delineated to assist planning at different scales:

1. FireSmart Wildland Urban Interface Zone – comprises the area where infrastructure and human developments meet or are interspersed with combustible vegetation.
2. FireSmart Community Zone – usually encompasses a 10-kilometer radius around the community extending from the FireSmart Wildland Urban Interface Zone.
3. FireSmart Landscape Zone – extends beyond the FireSmart Community Zone overlapping multiple jurisdictions at a broad landscape level. This zone focuses on mitigating the likelihood of large, high intensity, high severity fires.

Initial FireSmart planning often begins with the Wildland Urban Interface Zone and proceeds to the increasingly broader levels.

The Nordegg FireSmart Wildland Urban Interface Plan was approved in spring 1998. A fuel reduction project has occurred: existing initiatives for vegetation control will be continued. The Nordegg FireSmart Community Zone Plan, covering the Nordegg Townsite, Shunda-Goldeye and Bighorn Canyon Development Nodes, and the Bighorn Reserve, was approved in September 2005, and a detailed project plan was approved for the area immediately west of the Nordegg townsite as identified in the Community Zone Plan. Commercial fuel reduction harvesting is ongoing in this area. A FireSmart program will be prepared for the Whitegoat Lakes Development Node in 2006 and ultimately for all communities and infrastructure in the R11 FMU. Furthermore, a FireSmart Landscape will be implemented in R11 (see results of the Landscape Fire Assessment in the Landscape Description chapter).

Forecast: not applicable

Monitoring: The number of new and ongoing FireSmart initiatives will be tallied annually and recorded in the Stewardship Report.

Response: not applicable

2012 Status: FireSmart work has been ongoing in the R11 FMU over the five-year reporting period. Completed plans, vegetation management work, and imminent projects are summarized below for several areas.

Nordegg (see Figure 10)

- 2009 – 6.4 ha treated through vegetation management work within the Nordegg municipal boundaries funded through the FireSmart Community Grant Program
- 2010 – 27.4 ha treated through vegetation management work within the Nordegg municipal boundaries funded through the Community Development Trust Fund
- 2010 – blowdown from summer 2009 wind event cleaned up in the FireSmart blocks to the west of Nordegg along the Forestry Trunk Road
- 2012 (proposed) – review of existing FireSmart Community Zone Plan and all work completed to date

Bighorn Reserve (see Figure 11)

- 2008 – FireSmart planning commenced for the Bighorn Reserve Community Zone
- 2010 – 197 ha treated through vegetation management work on the reserve

Goldeye/Frontier Lodge

- 2011 – FireSmart planning commenced for the Goldeye/Frontier Lodge Community Zone
- 2012 (proposed) – Complete the Goldeye/Frontier Lodge Community Zone Plan with the intention of commencing vegetation management work during the winter of 2012-2013

ASRD Clearwater Facilities

- 2011 – FireSmart plans completed for Shunda Base and Cline Lookout
- 2012 (proposed) – Continue preparing FireSmart plans and implementing vegetation management work for ASRD facilities (i.e., towers, back-country cabins, and bases)

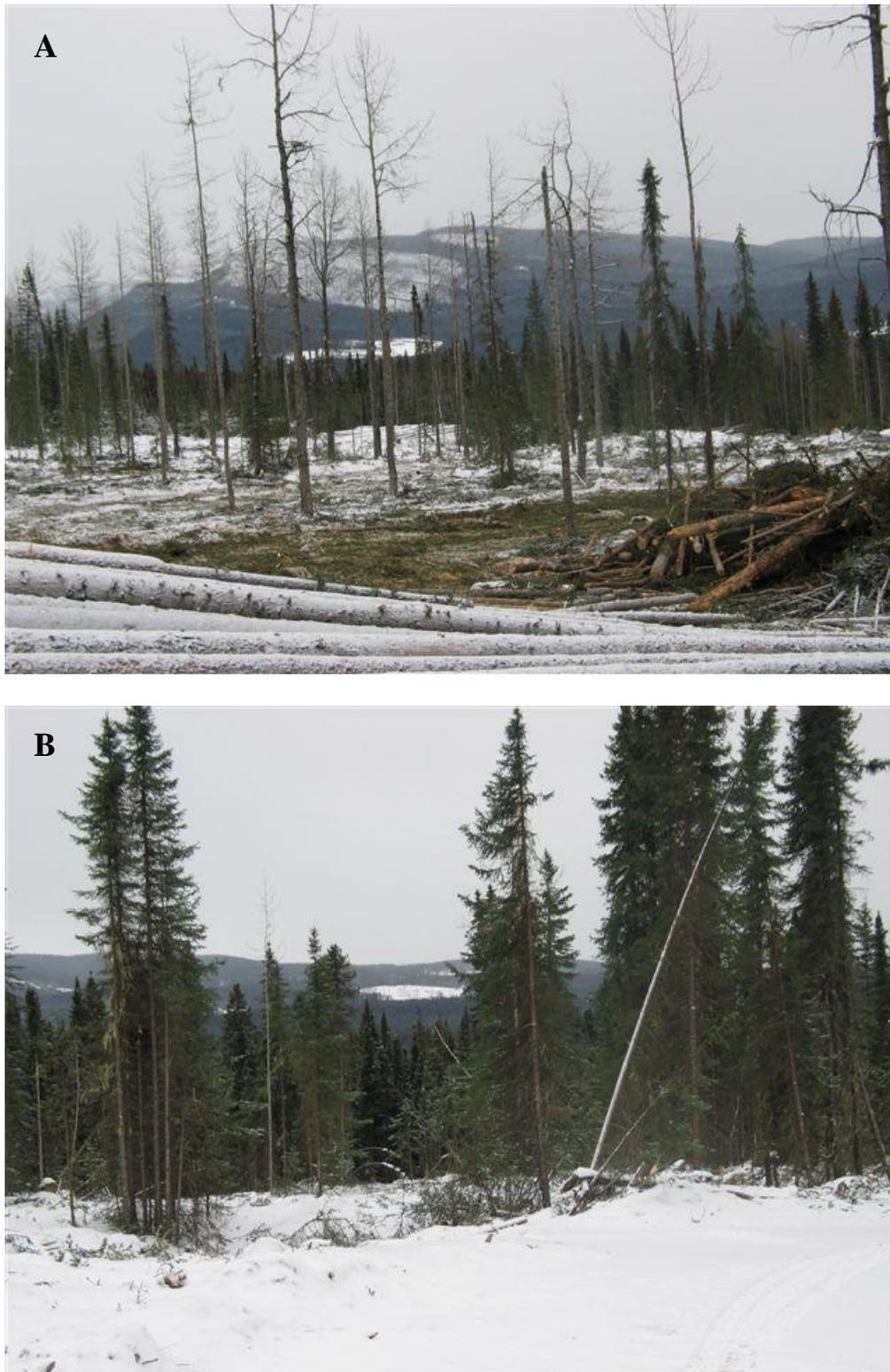


Figure 10 (A & B). Vegetation management work conducted near Nordegg in February 2008 as part of the Nordegg Community Zone FireSmart Plan.





Figure 11 (A,B,C,D). Aerial views of vegetation management work conducted around the Bighorn Reserve as part of the Bighorn Community Zone FireSmart Plan.

Indicator 8.2.1

Value: Wildfire Threat

Objective: Reduce the threat of large, high intensity, catastrophic wildfires.

Indicator: Fire behaviour potential.

Target: 5% reduction of high and extreme fire behaviour classes over a 20-year period.

Baseline Status: Fire behaviour is defined as the manner in which fuel ignites, flame develops, and fire spreads and exhibits other related phenomena as determined by the interaction of fuel, weather, and topography (Merrill and Alexander 1987). Wildfire threat assessments examine fire behaviour potential, in combination with fire occurrence risk, values at risk, and suppression capability, to ascertain which component is dominant in the wildfire threat. Current fire behavior potential classes in R11 have been analyzed for spring, summer, and fall periods using Alberta's Wildfire Threat Assessment Rating Model, based on 90th percentile historic weather, fuels, and topography. The baseline status is displayed spatially on Map 18 to Map 20 and graphically in Figure 9 to Figure 11 of the original R11 FMP. Prescribed burn and harvest treatments will be used to reduce the amount of area falling within the high and extreme fire behaviour classes.

Forecast: Fire behavior potential classes have also been analyzed over 10, 20, and 50 year periods based on fuel type changes resulting from the identification and sequencing of proposed prescribed burn and harvest treatment units.

Monitoring: Fire behaviour potential classes will be reanalyzed at 10-year intervals based on actual burns and other treatments completed. Results will be summarized and presented in Stewardship Reports.

Response: The sequence and number of harvest or prescribed burn plans will be adjusted if the target is not met.

2012 Status: As noted above, the target for this indicator will be re-analyzed at 10-year intervals (i.e., in the 2017 Stewardship Report).

Indicator 8.2.2

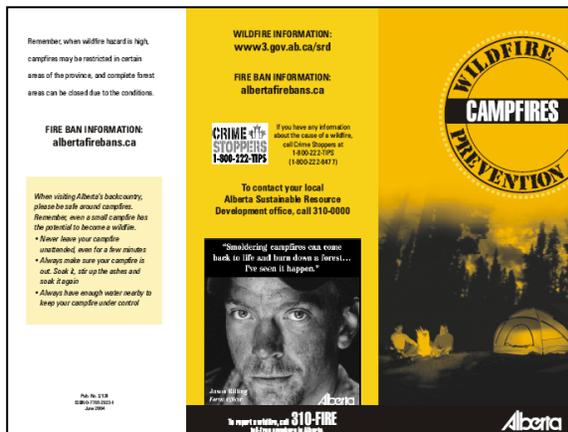
Value: Wildfire Threat

Objective: Reduce the threat of large, high intensity, catastrophic wildfires.

Indicator: Number of human-caused wildfires.

Target: Number of human-caused wildfires at or below levels indicated in ASRD Forestry Division Standard Operating Procedures performance measures.

Baseline Status: Human-caused wildfires account for almost 50% of the wildfires and 30% of the area burned in Alberta over the past ten years. Within the R11 Forest Management Unit, there were on average 21 human-caused wildfires between 2001 and 2005 (Figure 12, Map 24).



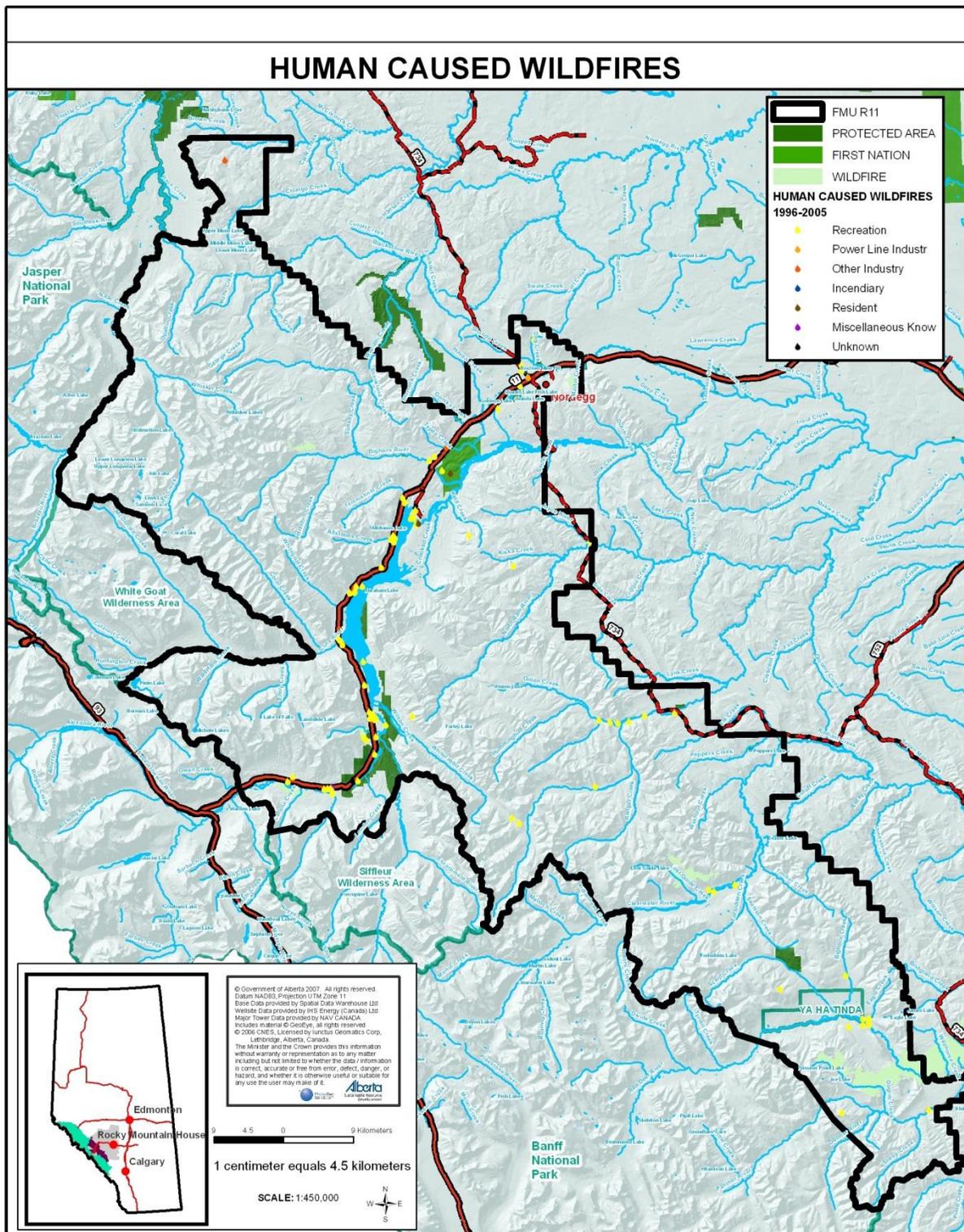
Ignition sources for such wildfires commonly include abandoned campfires, discarded cigarette butts, off-highway vehicles, debris burning, and power lines. Alberta Sustainable Resource Development, Forestry Division's Standard Operating Procedures describe performance measures for each Wildfire Management Area. The 2005 performance measure target for the Clearwater Wildfire Management Area, of which R11 represents 25% of the area, is 110 human-caused fires per year. Accordingly, the target assigned to the R11 FMU based on proportion of total area is 27

human-caused fires per year. Education, engineering (e.g., fuel modification, prescribed fire), and enforcement represent the three approaches used by Forestry Division to prevent human-caused wildfires, and these approaches will be supported within the R11 FMU. For example, utility companies have Fire Control Agreements with ASRD that require annual submission of maintenance plans and reporting of work completed to ensure lines are safe from hazard trees. Furthermore, the use of FireSmart techniques will be promoted to utility companies operating within R11, and a newly developed power line hazard assessment will be included in applications starting in 2006.

Forecast: not applicable

Monitoring: The number of human-caused wildfires will be compared annually to Forestry Division Standard Operating Procedures performance measures and reported at five year intervals in the Stewardship Report.

Response: Additional strategies to reduce the number of human-caused wildfires will be developed in subsequent FMPs.



Map 24. Distribution of human-caused wildfires in the R11 FMU between 1996 and 2005.

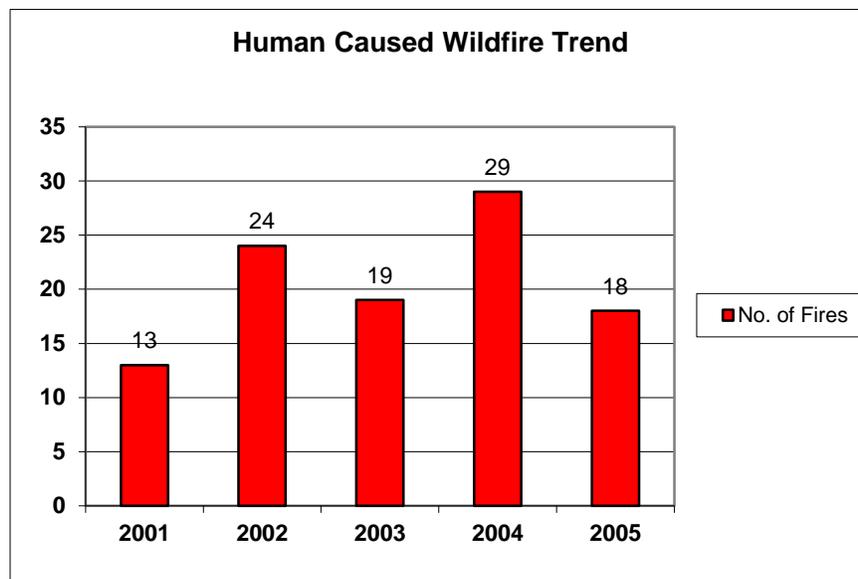
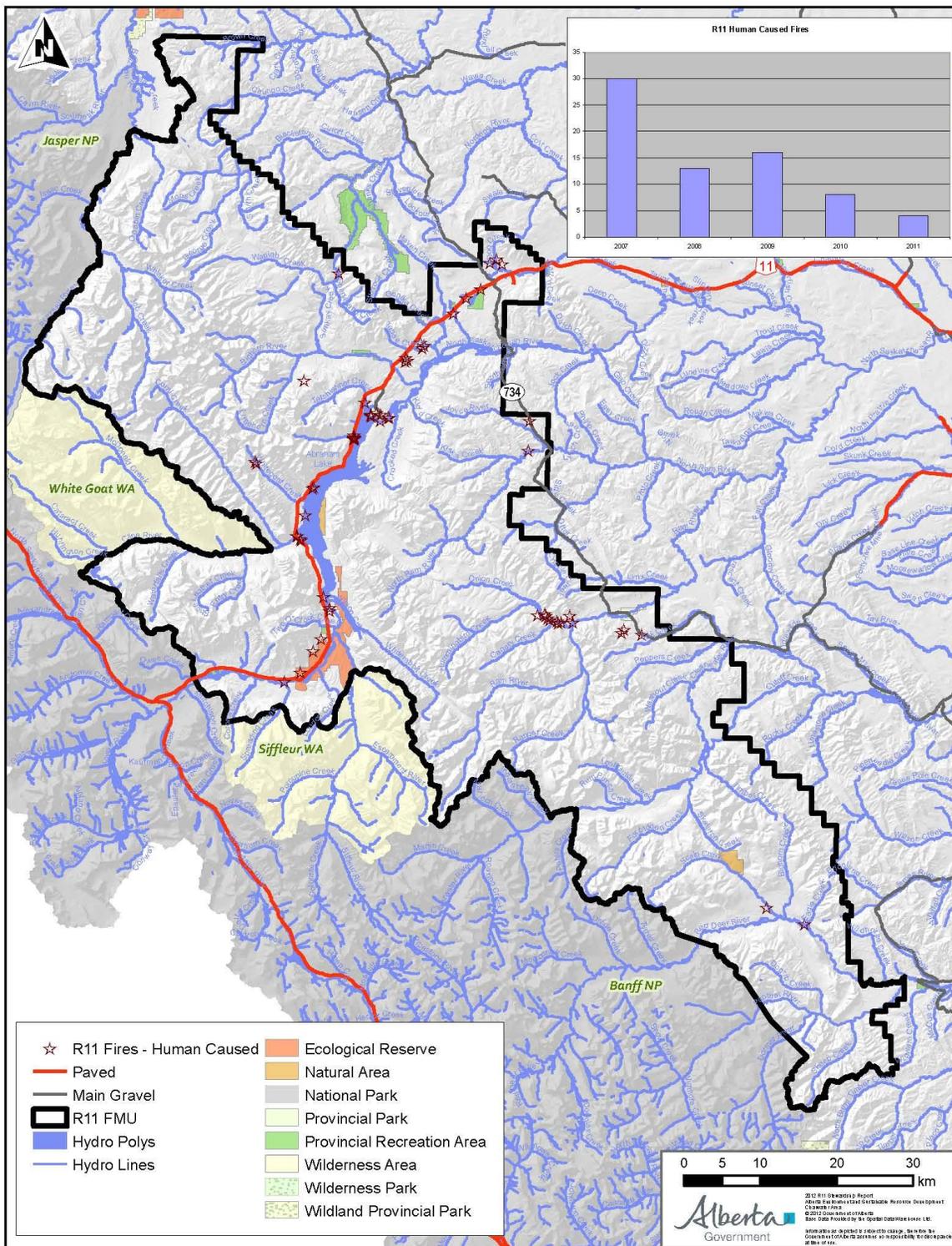


Figure 12. Annual number of human-caused wildfires in the R11 FMU. Prior to 2001, abandoned, smouldering campfires were not recorded as wildfires and thus such data are not presented here.

2012 Status: Data on wildfires from 2007 to 2011 in the R11 FMU show that the target of 27 or fewer human-caused wildfires was met in 4 of the 5 years (see insert in Map 25). A total of 30 human-caused wildfires was recorded in the FMU in 2007, but the number has decreased since then with only 4 human-caused wildfires noted in 2011. The North Saskatchewan River valley (especially areas around Bighorn Dam and the mouth of Allstones Creek), as well as areas around the junction of Hummingbird and Canary Creeks, shows the highest density of human-caused wildfires (Map 25). Recreation, popular in these areas, continues to represent the greatest source of fire ignitions.

R11 Human Caused Fires 2007 - 2012



Map 25. Human-caused wildfires in the R11 FMU from 2007 to 2011. The figure insert shows the number of human-caused wildfires each year.

Indicator 8.2.3

Value: Wildfire Threat

Objective: Reduce the threat of large, high intensity, catastrophic wildfires.

Indicator: Area burned outside of containment areas.

Target: No hectares burned outside of containment areas.

Baseline Status: Fuel management activities, such as the establishment of strategic fuel breaks and fire doors to block the spread of fire, will help reduce the threat of large, high intensity wildfires. Fuel breaks and fire doors will be established in the R11 Forest Management Unit through prescribed fire and mechanical treatments and could include creating large cutblocks, converting conifer stands to less flammable deciduous stands, thinning stands, and clearing understory. Specific containment areas within the R11 FMU will be outlined once fuel breaks and fire doors are established. In the event of wildfires escaping initial attack, containment areas and limits of acceptable fire spread will be identified through the Escaped Fire Analysis Strategy process for each individual fire. Prometheus, the Canadian Wildland Fire Growth Model, will be used to help determine landscape features that could function as barriers to fire spread or where additional containment lines should be developed.

Forecast: The identification of containment areas will depend upon the successful creation of fire doors and fuel breaks on the landscape.

Monitoring: GIS analysis will be used to determine the area burned outside of established containment areas, and results will be reported in the Stewardship Report. Wildfire growth modeling will be conducted periodically after harvest, prescribed burn, or natural wildfires to reconfirm optimal arrangement of containment areas. Maps of wildfire growth models after disturbances will also be produced.

Response: Harvest or prescribed burn timing and sequence may be adjusted based on the results of the wildfire growth modeling.

2012 Status: ASRD Forestry Division is still in the process of establishing capping units within the R11 Forest Management Unit. Accordingly, landscape-level containment areas have not yet been delineated (see Indicator 2.1.2).

2012 Revision: To clarify that the indicator and target refer to containment areas across the landscape rather than for specific prescribed burns, the wording will be modified to state 'landscape-level containment areas'.

Indicator 8.3.1

Value: Wildfire Threat

Objective: Protect values at risk within and adjacent to the R11 area.

Indicator: Presuppression Plans developed for communities, Development Nodes, and high-use areas.

Targets: Completion of Nordegg Presuppression Plan by 2007 fire season; Completion of Development Node Presuppression Plans as development occurs.

Baseline Status: Values at risk are natural resources and man-made improvements or developments that have measurable or intrinsic worth, and which could potentially be destroyed or otherwise altered by fire in any given area. Examples of values at risk include human lives; communities; transportation, telecommunication, and building infrastructure; sensitive watersheds and soils; and natural resources, such as terrestrial and aquatic biota, recreation areas, and cultural or historical areas. ASRD Forestry Division uses Presuppression Plans to identify



Government of Alberta

2006 Eastbush Mountain fire near Nordegg

five-year Stewardship Report.

Forecast: not applicable

Response: not applicable

2012 Status: Presuppression Plans were completed for Nordegg in 2007 and Bighorn Reserve in 2009. Work in 2012 will look at incorporating the operational maps from these plans into an ArcPad format that is easily accessed by Response Officers on their laptops in the field.

Indicator 8.3.2

Value: Wildfire Threat

Objective: Protect values at risk within and adjacent to the R11 area.

Indicator: Disposition referral process.

Target: Referral process implemented by fall 2007.

Baseline Status: Dispositions to use the public lands are issued by ASRD Lands Division under the Public Lands Act and include leases, licenses, or permits for surface access for oil and gas, recreation, livestock grazing, sand and gravel extraction, and industrial development. Applications may be referred to staff in other divisions that may have an interest in the parcel of land under question (e.g., referred to wildlife biologist if the area contains colonial nesting birds, species at risk, etc.), and conditions may be placed on the disposition to ensure protection of specific features or resources. ASRD is currently developing a process for referral of industrial, commercial, and recreational lease applications on public lands within FireSmart Community Zones to the Forestry Division. Consultative Notations are being placed on Community Zones to ensure approvals contain FireSmart-related operating conditions.

Forecast: not applicable

Monitoring: not applicable

Response: not applicable

2012 Status: Consultative Notations were placed on Community Zones, ensuring any new industrial, commercial, and recreational lease applications are referred to ASRD Forestry Division for the inclusion of FireSmart operating conditions. The *FireSmart Guidebook for the Oil and Gas Industry* (ASRD and Partners in Protection 2008) as well as a FireSmart for Industry webpage (<http://srd.alberta.ca/Wildfire/FireSmartIndustry/Default.aspx>) provide resources to help industrial users assess wildfire risk and develop FireSmart mitigation options for their activities.

Below is a sample list of the type of activities and dispositions that may occur within the 40,737 ha Nordegg FireSmart Community Zone, thus requiring referral. The Consultative Notation came into effect on May 6, 2009 and will be in place for 25 years.

- Recreation Lease (REC)
- Disposition Reservation (DRS)
- Easement (EZE)
- Vegetation Control Easement (VCE)
- License of Occupation (LOC) – high grade roads or access roads 20+ m wide

Mineral Surface Lease (MSL) – well sites > 5 ha

Miscellaneous Lease (MLL)

Miscellaneous Permit (MLP)

Pipeline Agreement (PLA) – if 20+ m wide

Pipeline Installation Lease (PIL) – if > 5 ha

Rural Electric Association Easement (REA)

Surface Material Lease (SML) – only if peat moss

All Agricultural Dispositions requiring fence line or field clearing and debris removal

Regional Grazing/Timber Integration Plans

Indicator 9.1.1

Value: Inherent Value

Objective: Maintain cultural values and treaty rights.

Indicator: Integrity of traditional sites, burial grounds, ceremonial locations, etc.

Target: Complete protection of all traditional sites, burial grounds, ceremonial locations, etc.

Baseline Status: The Government of Alberta has a duty to consult with First Nations where land management and resource development have the potential to adversely impact First Nations treaty rights and traditional uses of Crown lands. ASRD consultations regarding forest management activities are therefore guided by the *Government of Alberta's First Nations Consultation Guidelines on Land Management and Resource Development* (Government of Alberta 2006a), and protection of archaeological, paleontological, and historical resources is provided under the *Historical Resources Act*.

Many traditional sites within R11 requiring protection are already identified; however, the consultation process continues to identify additional sites. Some identified sites are not used by local First Nations: efforts will be made to identify the users, and protect the sites accordingly. The location of identified traditional sites will be compared to planned treatment boundaries. If the planned treatment boundaries encompass a site, additional consultation efforts will engage the individual First Nations or Aboriginal bands associated with each site to determine if prescribed fire or timber harvest will compromise those sites. Not all cultural features will be impacted by prescribed burning or harvesting, in which case the site-specific level of protection will be evaluated in operational plans.

Forecast: The number of identified traditional sites receiving protection and the degree of protection required will depend upon the results of consultations with affected First Nations. Identified sites not associated with a particular band will be protected from harvest, but may be burned over if no loss of historic value will result.

Monitoring: Communications and consultations with affected First Nations will be documented. Management activities will be reviewed with consulted parties to ensure adequate protection was achieved. The five-year Stewardship Report will summarize consultative and protective activities; however, no specific site locations will be reported in public documents.

Response: If a review of treatment activities and the impacts on associated traditional sites reveals that protection levels were inadequate, additional consultations will be conducted to determine alternative protection methods for future treatments.

2012 Status: Note that this indicator deals with the success of protective measures employed during operations to ensure the integrity of identified traditional sites: please refer to Indicator

9.1.2 for information on identifying traditional sites through associated consultations during operational planning activities.

One traditional ceremonial site was identified within the Upper Saskatchewan Unit 1 prescribed burn boundary. Onsite consultations with Stoney Nakoda First Nations elders resulted in the understanding that fire would not be intentionally introduced to the site or to a narrow strip of vegetation along the highway, but should one occur, a low intensity surface fire through the area would not compromise the nature of the site. During the prescribed burn, the ignition teams successfully avoided the area, though spot fires subsequently resulted in a low intensity surface fire that burned grass, dry matter, and a few low hanging ceremonial cloths. By mid-summer the site had greened up and was receiving use by First Nations.

A historic grave site known to ASRD for several years (Figure 13) was also avoided during treatment activities conducted during this five-year reporting period. The location of this burial site is not reported here due to the sensitive nature of the site. Also of note, Darryl Bereziuk, Northern Archaeologist with the Historical Resources Management Branch of Alberta Culture and Community Services found stone chips from tool making along Hummingbird Creek when conducting an archaeological survey in the area. Although this find is not within any existing treatment boundaries, the location will be noted in the appropriate databases and considered when planning future treatments.



Figure 13. Grave site within the R11 FMU identified by ASRD Forestry Officers several years ago and subsequently avoided during treatment activities.

Indicator 9.1.2

Value: Inherent Value

Objective: Maintain cultural values and treaty rights.

Indicator: Number and diversity of cultural stakeholders involved in R11 planning.

Target: Representatives from local First Nations participating in stakeholder meetings.

Baseline Status: The Government of Alberta has a duty to consult with First Nations where land management and resource development have the potential to adversely impact First Nations treaty rights and traditional uses of Crown lands. ASRD consultations regarding forest management activities are therefore guided by the *Government of Alberta's First Nations Consultation Guidelines on Land Management and Resource Development* (Government of Alberta 2006a), and protection of archaeological, paleontological, and historical resources is provided under the *Historical Resources Act*.

Invitations to attend the preliminary R11 planning meetings were extended to 61 stakeholder groups, based on the list of stakeholders derived from the *Bighorn Backcountry Access Management Plan* process. O'Chiese First Nations, Sunchild First Nations, and Stoney First Nations were among those invited. O'Chiese First Nations were the only group to attend the initial meetings, and none of the invitees chose to attend the Charrette planning session. First Nations are kept informed of the process through regular discussions with ASRD. The consultation process is most valuable at the operational level in identifying sites of importance and how those sites should be respected. ASRD is aware of some sites not used by local First Nations: efforts will be made to identify the users and include them in consultations.

Forecast: Regular consultation efforts with local First Nations stakeholders will continue to help identify historical sites and resources. The engagement of additional representatives will depend on individual or band interest in the process.

Monitoring: Consultation efforts with those First Nations potentially affected by R11 management activities will be documented. The five-year Stewardship Report will summarize consultative and protective activities.

Response: ASRD will attempt to engage additional cultural stakeholders if sufficient representation is not achieved. Additionally, the adequacy of consultations and activities directed at protecting traditional sites will be reviewed with First Nations.

2012 Status: ASRD adopted new consultation procedures in 2011 entitled *SRD Lands and Forestry First Nations Consultation – Operating Procedure*. Following this and previous guiding documents, local First Nations stakeholders were consulted during operational planning

activities to identify particular traditional sites of importance and determine how treatment activities might impact those sites.

For the Upper Saskatchewan Unit 1 prescribed burn, a Historical Resource Impact Assessment was completed in 2007. Notices were provided to and consultation requested from Paul First Nations, Sunchild First Nations, O’Chiese First Nations, and Stoney Nakoda First Nations (ASRD and Parks Canada 2010). A total of six meetings, one field day, and three phone calls were documented with First Nations between June 2007 and April 2009. Onsite consultation was held with Stoney Nakoda First Nations elders, and a ceremonial smoke (i.e., a blessing) was held with an elder from the Stoney Nakoda First Nations on September 12, 2007. Representatives from the Stoney Nakoda First Nations approved plans and protective measures to be implemented at the ceremonial site identified within the Upper Saskatchewan Unit 1 prescribed burn boundary. Representatives from the O’Chiese Reserve were also consulted prior to the Upper Saskatchewan Unit 1 prescribed burn, but subsequently expressed displeasure after the burn was conducted. A summary of protective measures employed during the prescribed burn and the burn impacts on the traditional site is provided in Indicator 9.1.1.

Bighorn FireSmart harvesting included consultation with the Stoney Nakoda First Nations. Consultation records show seven emails, three letters, four meetings, and one open house from November 2008 to January 2010. Finally, Nordegg blowdown salvage harvesting included consultation with the Stoney Nakoda First Nations in September 2010.

Indicator 9.2.1

Value: Inherent Value

Objective: Allow continued use of forest for non-timber products such as mushrooms, medicinal plants, berries, etc.

Indicator: Known incidences of non-timber product use.

Target: Continued and enhanced use of non-timber products in the R11 FMU.

Baseline Status: Non-timber forest products are items of biological origin other than wood derived from forests and can include such products as mushrooms, berries, medicinal plants, floral greenery, cones, moss, and maple syrup. The suite and extent of non-timber product use in the R11 FMU is currently unknown. Consultation processes during detailed planning of harvest or prescribed burns are extensive, and should identify areas of non-timber resource use. As these areas are identified, their location will be housed in a GIS. Protection of such areas will depend on the nature of the resource, as many are likely disturbance-dependent. No restrictions on the use of these non-timber products are expected.



Morel mushroom

Forecast: Restoring disturbances to the landscape will result in a continued and renewed availability of non-timber products that are disturbance-dependent (e.g., mushrooms).

Monitoring: Feedback from stakeholders will be important in evaluating the ongoing availability of non-timber resources. A summary of information collected on the suite of products originating from the R11 FMU will be presented in the five-year Stewardship Report.

Response: Future harvest and prescribed burn plans will be adjusted if the use of the R11 forest for non-timber products is significantly impaired.

2012 Status: The spring following the 2009 Upper Saskatchewan Unit 1 prescribed burn, many people were observed picking fire-associated morel mushrooms. No estimated of the mass of mushrooms harvested is available. Likewise, there is no new or detailed information to report on the extent of other non-timber product use originating from the R11 FMU, as no areas of non-timber resource use were identified during consultations or stakeholder meetings.

Indicator 9.3.1

Value: Inherent Value

Objective: Maintain aesthetic qualities of the landscape where possible.

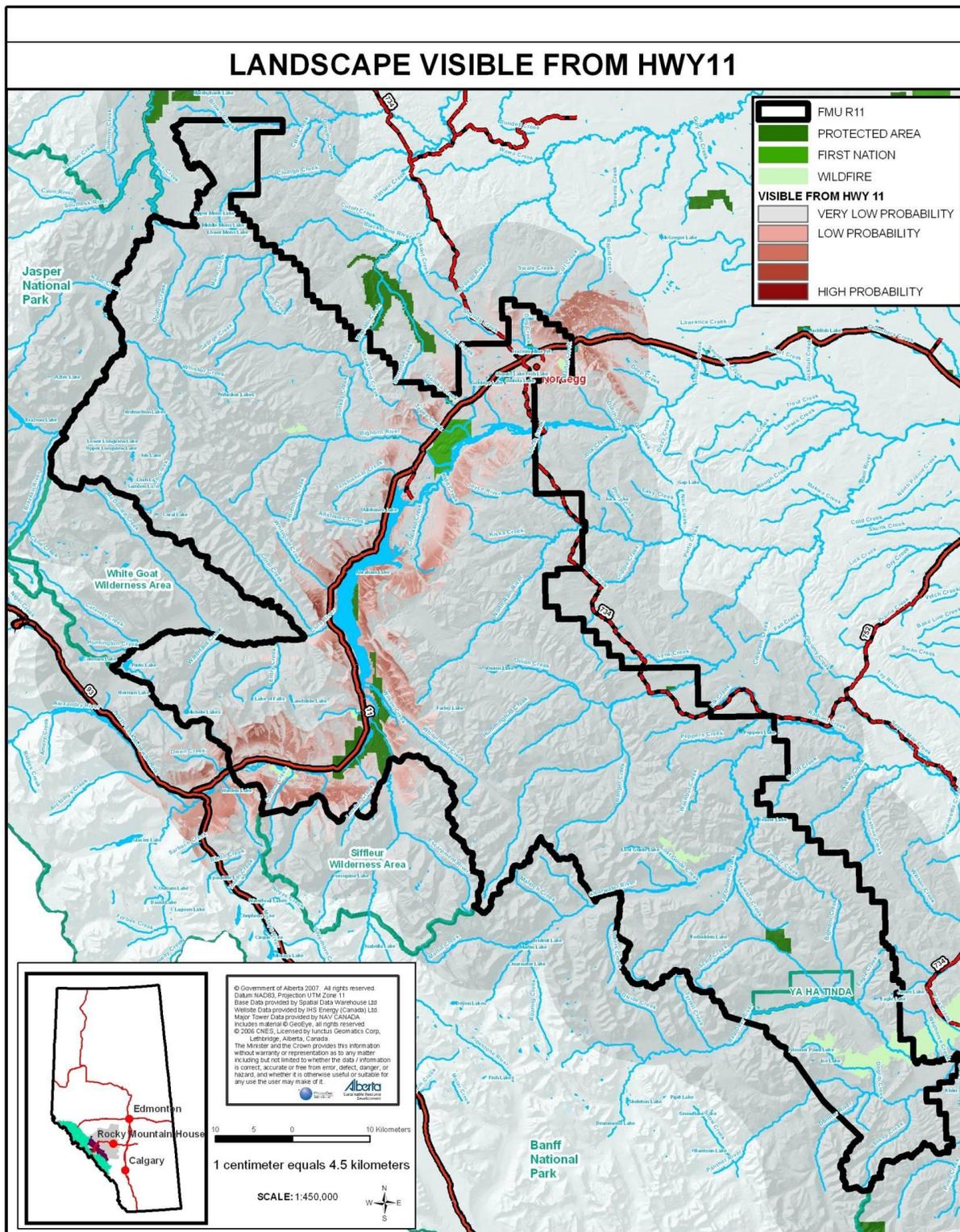
Indicator: Visual impact and buffer width.

Target: No increase in proportion of negative comments about aesthetic appeal of changed viewscape.

Baseline Status: Diverse topography and stunning scenery draw visitors from both near and afar to the R11 FMU. Aesthetic qualities of the landscape, however, are difficult to quantify due to the wide variety of personal preferences. For example, comments received by ASRD on one cutblock ranged from “it’s nice the trees are gone so we can see the mountains” to “visual buffers should have been left to screen the view of the cutblock”. Nonetheless, visibility of landscape features from particular viewpoints can be depicted: Map 26 shows the result of an analysis conducted to assess visibility from Highway 11.

An altered visual landscape is a necessary side effect resulting from the use of prescribed burns and harvesting to emulate natural disturbance patterns and processes. Although not every treatment area in R11 will require aesthetic consideration, several high-use viewpoints and travel corridors must be assessed for visual impacts. A treatment area that is determined to be highly visual will not be removed from the scheduled treatment. Rather, planning will strive to include design features that minimize visual impacts and extended views. Harvest blocks will be designed using retention patches, visual screening, or topography to prevent prolonged views, while travelling on a highway for example. Block edges will also be irregular in design to simulate natural disturbance event boundaries. Prescribed burns, usually viewed as more natural and thus preferred over harvesting, will also be assessed for visual impacts, and if required, the burn plan will address screening requirements. Public education will play a key role in fostering acceptance and appreciation for the ecological benefits arising from the changed viewscape. Communication activities may range from presentations that show a computer simulation of visual impact from key viewpoints to pamphlets explaining fire and harvest ecology. See Indicator 13.1.1 for more details.

Forecast: ASRD has done some initial modelling to assess the visual impacts of burns from several Highway 11 vantage points, namely Banff east boundary, Siffleur Falls parking lot, Whitegoat Lake, and Baldy Lookout. The following graphics simulate the view of a burn and its regeneration from the Siffleur Falls parking lot (Figure 14 to Figure 17). For this exercise, the following worst-case visual situations were incorporated: snow on the ground, removal of foreground screening, and a complete burn.



Map 26. Visibility rankings of landscape near Highway 11.



Figure 14. Photograph of actual view from Siffleur Falls parking lot before a proposed prescribed burn treatment.



Figure 15. Simulated view from Siffleur Falls parking lot before the prescribed burn treatment.

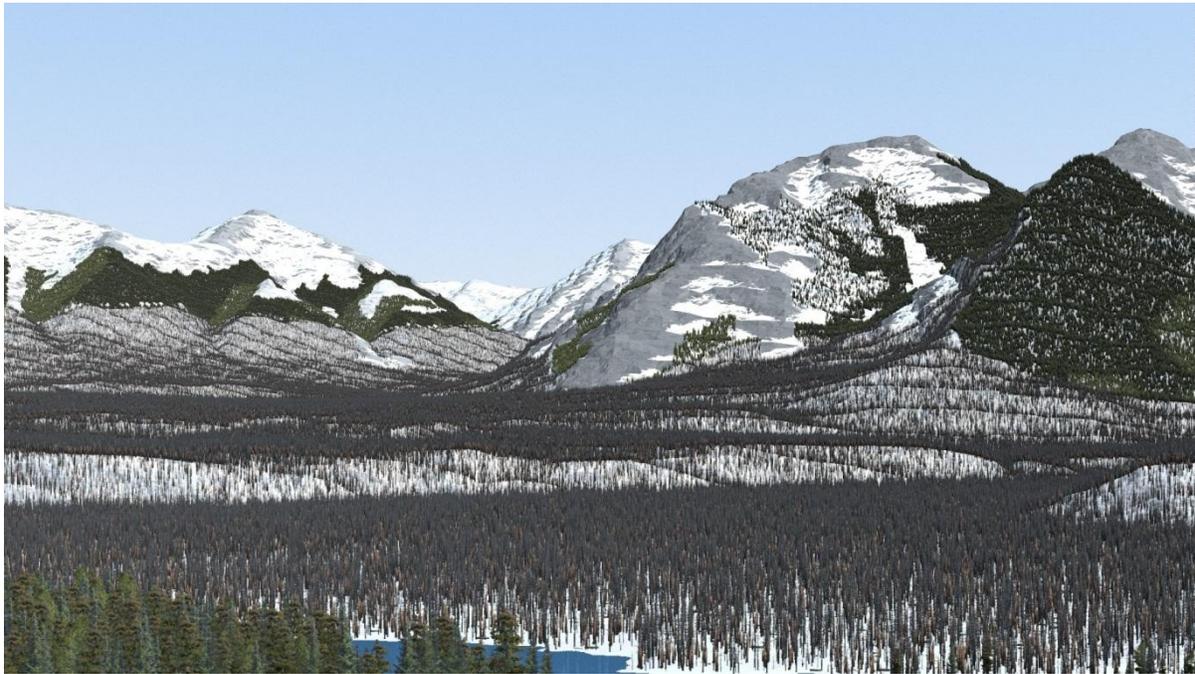


Figure 16. Simulated view from Siffleur Falls parking lot immediately post burn.

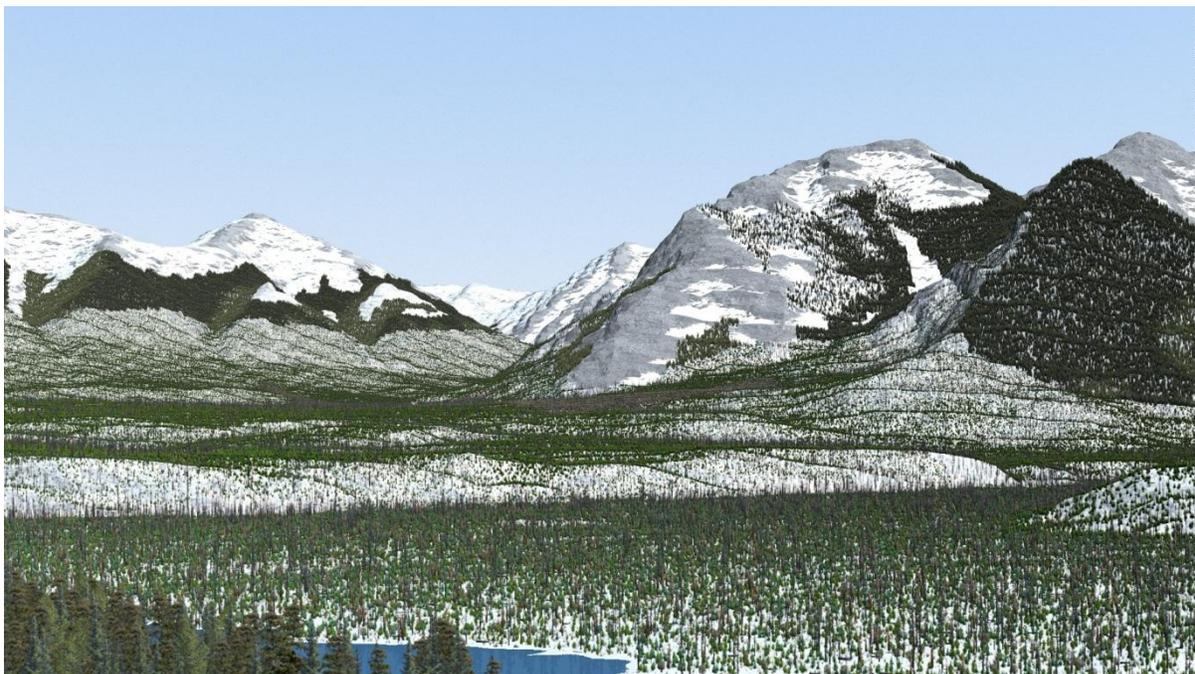


Figure 17. Simulated view from the Siffleur Falls parking lot 20 years post burn.

Monitoring: Visual quality will be included on the visitor survey questionnaire distributed by Guardians, and annual responses monitored. A summary will be included in the Stewardship Report.

Response: If the proportion of negative comments regarding visual quality rise, ASRD will revisit the visual needs.

2012 Status: A survey to objectively measure aesthetic appeal, as well as general enjoyment and opportunities to promote personal wellness for R11 users, could not be developed and distributed during this reporting period. Guardians reported comments regarding smoke during and immediately following the Upper Saskatchewan Unit 1 prescribed burn; however, they felt there was no lasting impact on visitor use of the area as evidenced by the number of vehicles at trailheads in subsequent seasons. During interviews with tourism operators in the area (see Indicator 7.1.2), the Icefield Heli Tours operator reported he heard several comments about ‘how terrible the burn looks’, and felt additional information would help increase public education about why the fires were done. None of the businesses had received any negative comments from tourists about the FireSmart harvesting conducted in the area.

Of note, Alberta Tourism, Parks, and Recreation (ATPR) is currently developing spatially explicit inventories to support ATPR planning within the Land-use Framework. Their Recreation & Tourism Resources Inventory is composed of four components:

- Recreation & Tourism Features Inventory (e.g., human-modified sites such as ski hills, museums, or accommodations, biophysical sites such as hoodoos, lakes, or prime grizzly bear habitat, cultural/historic sites such as homesteader home, bison kill site, or historical town site);
- Detailed Site Inventories (campgrounds, trails, etc.),
- Recreation and Tourism Opportunity Spectrums, and
- Scenic Resource Assessments (regionally significant scenic resources, scenic corridors, or byways).

A Scenic Resource Assessment has been completed for North Saskatchewan Planning Region, and tourism planning initiatives would benefit from the maintenance of visual buffers.

Indicator 9.4.1

Value: Inherent Value

Objective: Minimize changes to air quality as a result of prescribed burn treatments.

Indicator: Number of smoke-filled days in high use areas.

Target: Less than five consecutive smoke-filled days per year in high-use areas as a result of prescribed burn treatments.

Baseline Status: Reduction in air quality is one concern the public may voice in opposition to prescribed burning activities. Smoke emission and dispersion is influenced by several factors including the amount and type of fuel available, fire behaviour, topography, and current atmospheric conditions. For instance, the intense heat of a large canopy fire can produce a convection column that lifts the smoke and disperses it in the upper atmosphere, while an understory burn may produce less but low-lying smoke. Fire managers typically only initiate prescribed burns in high-use areas under conditions conducive to good vertical venting. Smoke plume and emission models exist that can be used to assist prescribed burn planners in determining the optimal conditions for smoke dispersion. For example, the Canadian Wildland Fire Information System uses the Atmospheric Dispersion Index, a numeric rating of the atmosphere's capability of transporting pollutants away from their sources. Factors such as the height of the cloud ceiling, stability of the atmosphere (i.e., amount of mixing that occurs between layers), height to which smoke will rise, and wind speed and direction are used to calculate this index. Within the R11 Forest Management Unit, Forestry Division staff will consider smoke dispersion when conducting prescribed burns in high-use areas and will attempt to have less than five consecutive smoke-filled days each year.

Forecast: Models and indices are important tools in predicting factors such as fire behaviour and smoke dispersion, yet a level of uncertainty always remains. Ignitions can occur when the proper scenarios arise; however, large prescribed fires may burn for multiple days or weeks and thus experience various wind and atmospheric conditions in the ensuing days. These conditions and their influence on smoke dispersion cannot be anticipated in all situations.

Monitoring: The visibility distance from the nearest fire tower will be recorded each day during all prescribed burn activities, and data will be summarized in the Stewardship Report. The number of smoke-related complaints received by the Forestry Division will be monitored for each prescribed burn occurring in a high-use area.

Response: Adjust subsequent prescribed burn plans to reduce the size of proposed burn units such that the unit can be burned over fewer days (i.e., smoke produced on less days). This requires an increase in the number of proposed units to ensure the total treatment area remains the same.

2012 Status: Smoke observations during the two highest profile and longest duration prescribed burns, Upper Saskatchewan Unit 1 and Hat Mountain, were collected from 15 fire towers throughout the Clearwater Area. For the purposes of this report, a smoke-filled day was subjectively defined as any day when smoke from a forest fire is obviously noticeable. The number of towers reporting visible smoke at 06:00 and 12:00 each day during the ignition period and the days immediately following were determined. Ignition on the main unit of the 2009 Upper Saskatchewan Unit 1 prescribed burn began on May 30 and continued until June 3 (ASRD and Parks Canada 2010). Some large unburned patches remaining after the spring burn were ignited between September 23 and 25, 2009. Ignitions on the main unit of the 2011 Hat Mountain prescribed burn were conducted on September 15 and September 24-25 (Dave Finn, *pers. comm.*). Towers located throughout the R11 FMU reported smoke on up to four consecutive days during the primary ignition periods for both the Upper Saskatchewan Unit 1 and Hat Mountain prescribed burns (Figure 18, Figure 20), though smoke lingered for longer after the fall burning on the Upper Saskatchewan Unit 1 burn (Figure 19). In other words, a combination of proper planning and fire ignition patterns generally resulted in successful smoke column management, thus meeting the target of less than five consecutive smoke-filled days in high-use areas.

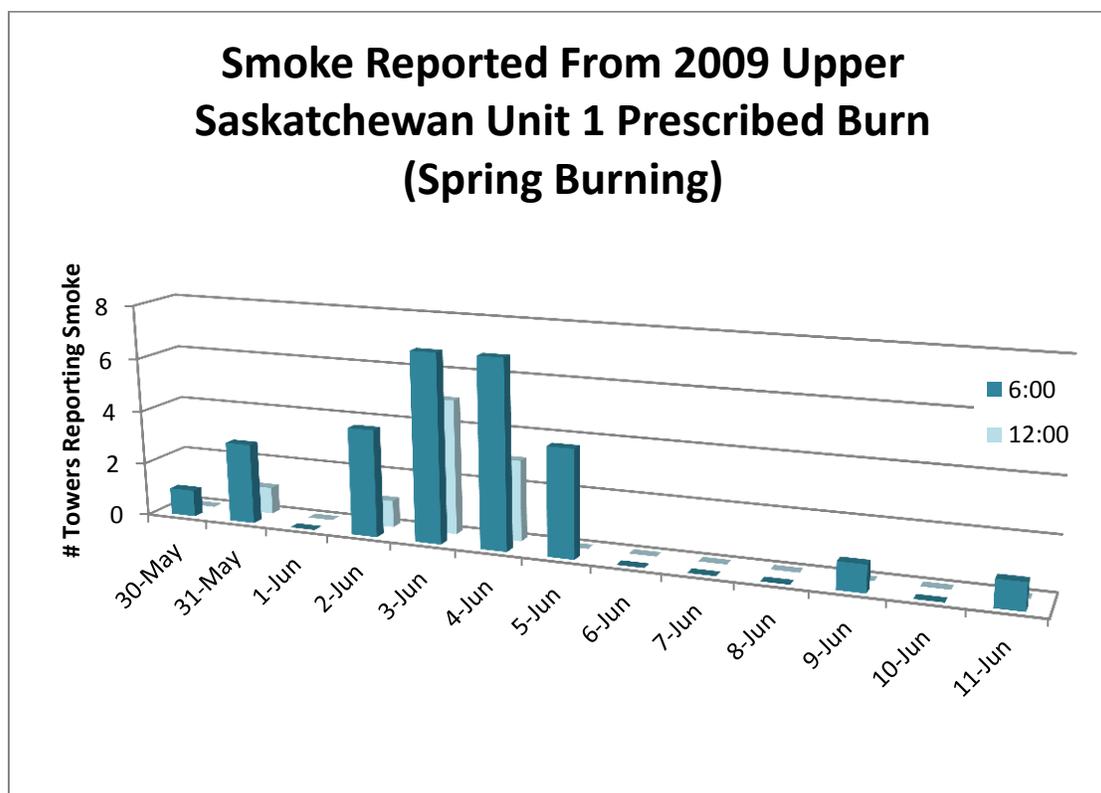


Figure 18. Smoke observations from fire towers during spring burning on the 2009 Upper Saskatchewan Unit 1 prescribed burn.

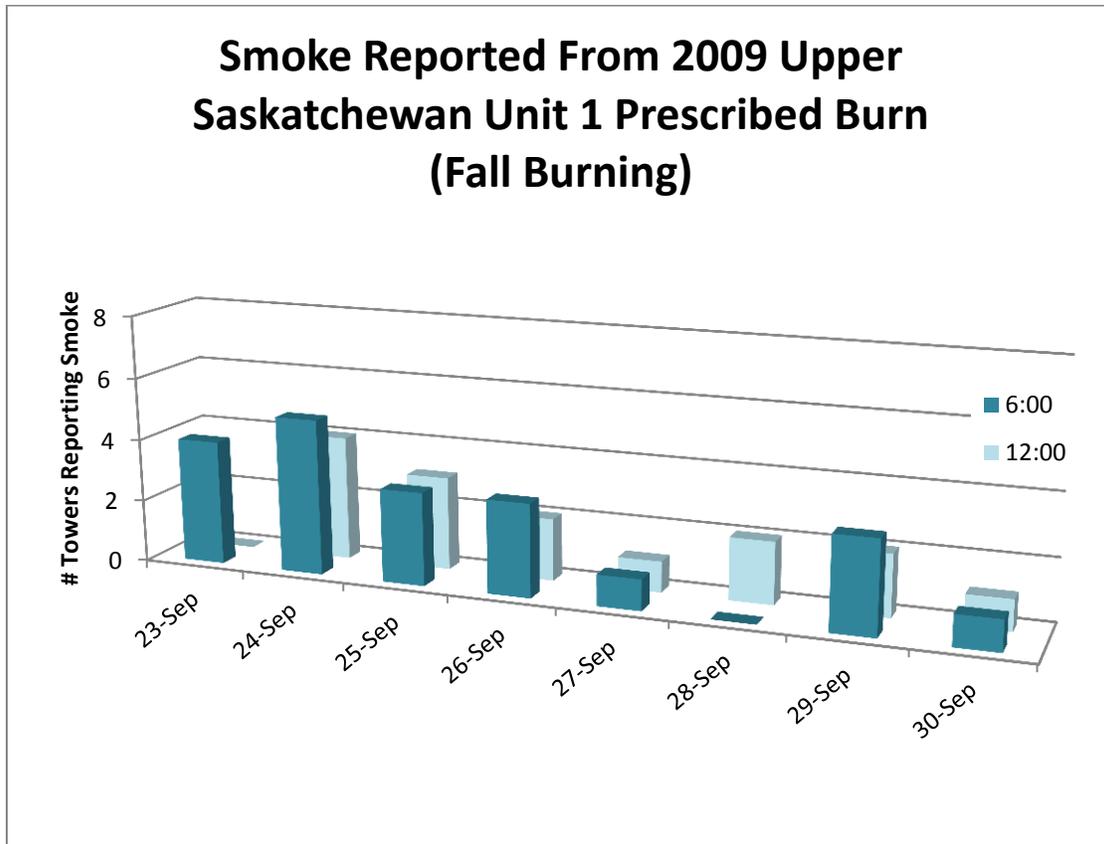


Figure 19. Smoke observations from fire towers during fall burning on the 2009 Upper Saskatchewan Unit 1 prescribed burn.

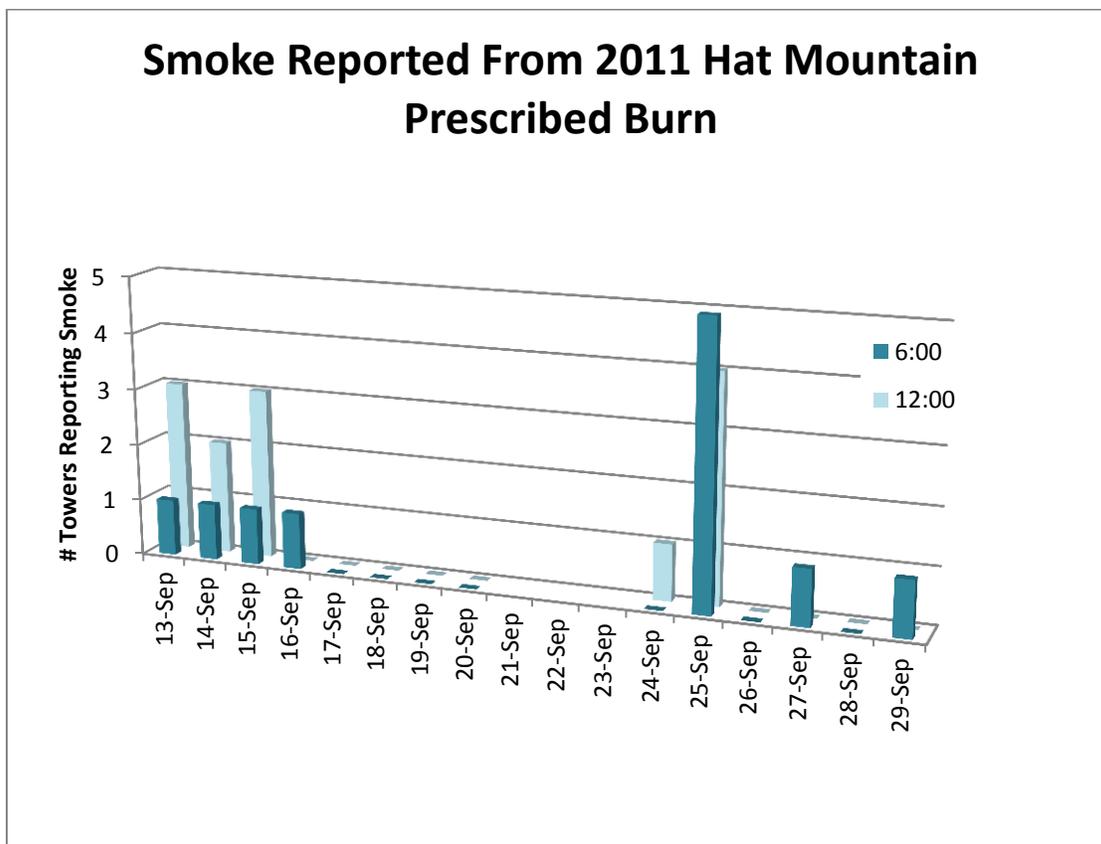


Figure 20. Smoke observations from fire towers during the 2011 Hat Mountain prescribed burn.

Extensive modelling of both predicted and actual smoke dispersion trajectories during the Upper Saskatchewan Unit 1 prescribed burn was conducted by Parks Canada (ASRD and Parks Canada 2010). Results support the more general fire tower observations summarized above in that the models showed consecutive days of prescribed burn smoke were uncommon outside the local burn area due to shifts in the wind patterns.

The air quality measure of greatest concern with respect to prescribed burn smoke is particulate matter, specifically particles that are 2.5 micrometres or smaller in diameter ($PM_{2.5}$) because they can lodge deep in the lungs, and cause respiratory and cardiac problems (WHO 2006). These fine particulates are also the emission component that creates haze and limits visual range. The Parkland Airshed Management Zone maintains air quality monitoring stations through much of the area east of the R11 FMU, though not all stations monitor $PM_{2.5}$. Monitoring data from two stations that measured $PM_{2.5}$ are shown in Figure 21 for the immediate pre-burn, operational, and immediate post-burn periods of the Upper Saskatchewan Unit 1 prescribed burn (there are no stations proximate to the Hat Mountain burn area that measure particulate matter). The current Alberta Ambient Air Quality Objectives and Guidelines for particulate matter are not to exceed $30 \mu\text{g}/\text{m}^3$ for the 24-hour average and not to exceed $80 \mu\text{g}/\text{m}^3$ for 1 hour. Although maximum levels reached $30 \mu\text{g}/\text{m}^3$ at each of the stations briefly during the burn period, the 24-hour average was always well below the air quality objective.

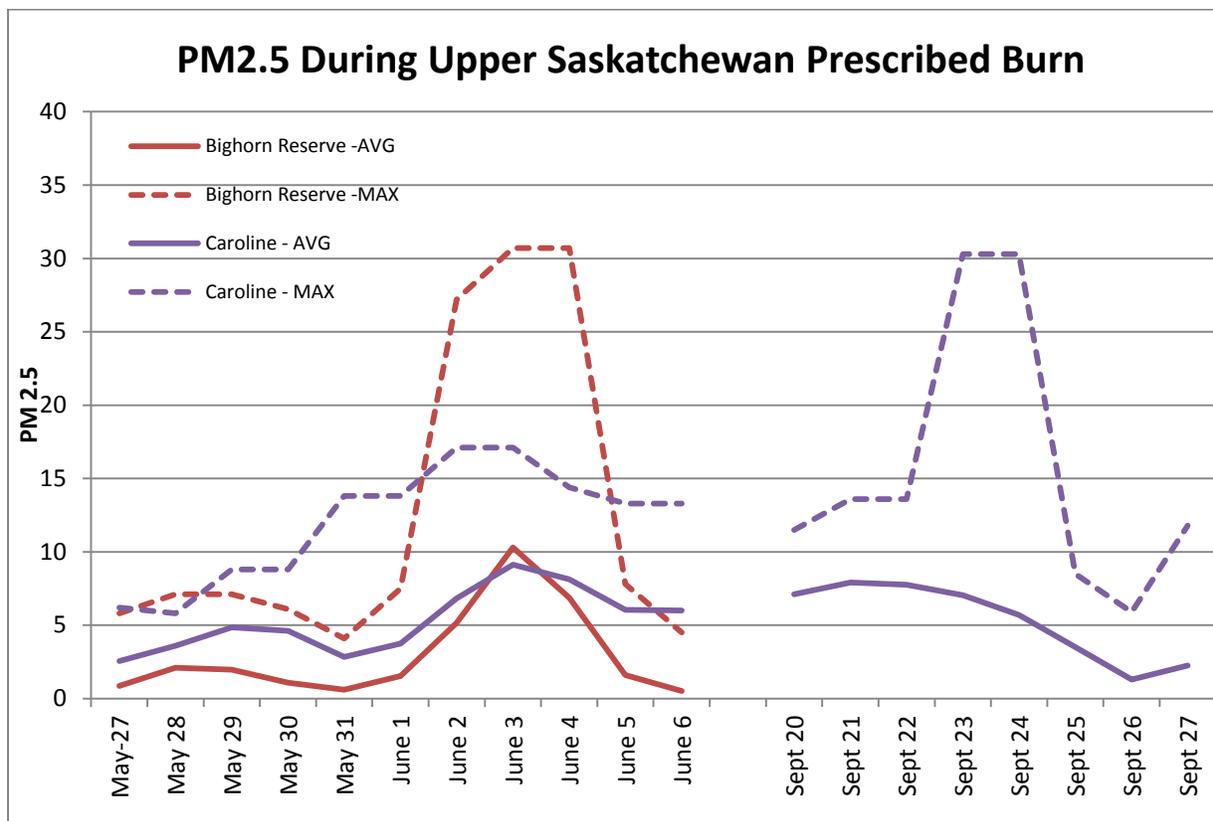


Figure 21. Particulate matter (PM2.5) measurements from the Caroline and Bighorn Reserve air quality monitoring stations during the Upper Saskatchewan Unit 1 prescribed burn period.

Although no formal or written complaints were issued during either of the Upper Saskatchewan Unit 1 or Hat Mountain prescribed burns, Forestry Division, Clearwater Area was aware of verbal smoke complaints/concerns regarding the Upper Saskatchewan Unit 1 burn. Inversion conditions on June 2-3, 2009 caused smoke to settle around the Saskatchewan Crossing Resort and resulted in complaints to motel staff. ASRD staff on-site explained to visitors and staff about the inversion conditions, and smoke lifted by the next day. Smoke concerns were also raised by the family of an elderly Thompson Creek Campground user on supplementary oxygen due to a prior lung condition. The family moved the person out of the area as a precautionary measure and no other action was taken. Smoke concerns in either instance were from those in the immediate area of the burn: no complaints from other high-use areas or population centres were received.

Indicator 10.1.1

Value: Recreational Opportunities

Objective: Maintain infrastructure and recognize volunteer efforts to maintain or replace infrastructure.

Indicator: Location of staging areas, washrooms, bridges, campgrounds, trails, roads.

Target: No impact to infrastructure from treatments.

Baseline Status: With the *Bighorn Backcountry Access Management Plan* in place, significant resources in the form of volunteer hours and funding have been directed to trails and facilities in R11. The locations of recreational infrastructure and trails have been identified, and ASRD staff monitors sites. Prescribed burn and harvest plans will be reviewed with regard for infrastructure and developments. When recreational infrastructure falls within a planned prescribed burn or harvest boundary, damage will be avoided wherever possible during the implementation of the treatment. Those volunteer groups responsible for particular developments (if known) will be consulted prior to prescribed burns or harvest, and synergies for future trail work will be explored.

Forecast: Complete protection of recreational infrastructure is anticipated.

Monitoring: Monitoring of trails and infrastructure is done through a multistakeholder monitoring group established under the *Bighorn Backcountry Access Management Plan*.

Response: In the event infrastructure cannot be protected, volunteer groups will be consulted and options for replacement or upgrading infrastructure will be provided.

2012 Status: No infrastructure was impacted by treatment activities occurring over the past five years. In fact, new washrooms, signage, and a trail were installed at the Landslide Lake Interpretive Fire Trail. This interpretive trail was created in 2010 by ASRD and ACA following the Upper Saskatchewan Unit 1 prescribed burn to educate visitors on the effects of fire on plants and wildlife in a forest ecosystem.

Indicator 10.2.1

Value: Recreational Opportunities

Objective: Maintain tourism appeal (i.e., for snowmobiles, off-highway vehicles, hiking, camping, hunting, fishing, berry picking) and opportunities to enhance personal health and wellness.

Indicator: Annual number of visitors and visitor feedback on quality of experience including aesthetics, general enjoyment, and opportunities to promote personal wellness.

Targets: Visitor trends follow trends in other jurisdictions (e.g., Banff); No decline in proportion of positive visitor feedback.

Baseline Status: The Bighorn Backcountry has long been valued for the recreational opportunities it provides, including snowmobiling, quadding, hiking, mountain biking, skiing, camping, hunting, fishing, berry picking, and photography. However, there is no definitive measure of visitor use within the R11 Forest Management Unit. Several options were explored for use in tourism tracking including traffic and tourist information booth counts, commercial trail riders data, volunteer backcountry travel registration, and trail counter data.

Traffic counts from Banff National Park as well as tourist information booth counts from Nordegg were investigated to determine the level of correlation, anticipating that a strong correlation would be an indicator of tourist numbers. Traffic counts from Banff East Gates on Highways 1 and 11 and visitor counts at the Nordegg Heritage Centre tourist information booth vary from year to year and location to location (Figure 22 to Figure 24), with no apparent correlation among these counts.

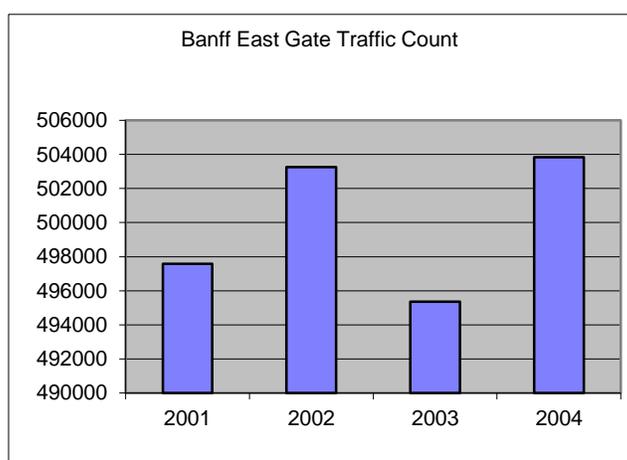


Figure 22. Traffic counts from the Banff National Park East Gate on Highway 1.

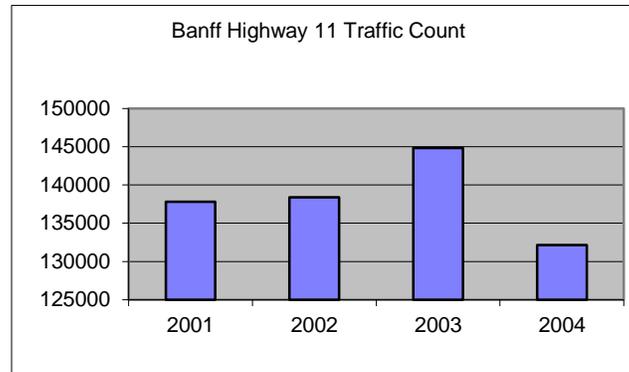


Figure 23. Traffic counts from the Banff National Park East Gate on Highway 11.

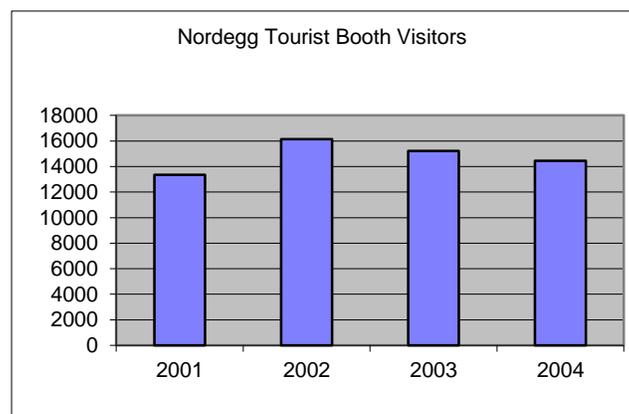


Figure 24. Visitor counts from the Nordegg Heritage Centre tourist information booth.

Data from the commercial trail riders (CTR) in and around the R11 FMU also demonstrates significant year to year variability (Figure 25). Backcountry travellers are asked to voluntarily register at the Nordegg Ranger Station, providing another source of visitor data (Figure 26). As with the CTR data, this information is not exclusive to R11, but can be attributed largely to R11. Trail counter data has also been collected for the *Bighorn Backcountry Access Management Plan*. After review of the data, however, inconsistent counter dates (i.e., not complete years) make establishing year-to-year trends difficult. Nonetheless, trail counters are recognized as an important tool and will be used to assess local impacts on trail usage following treatment activities.

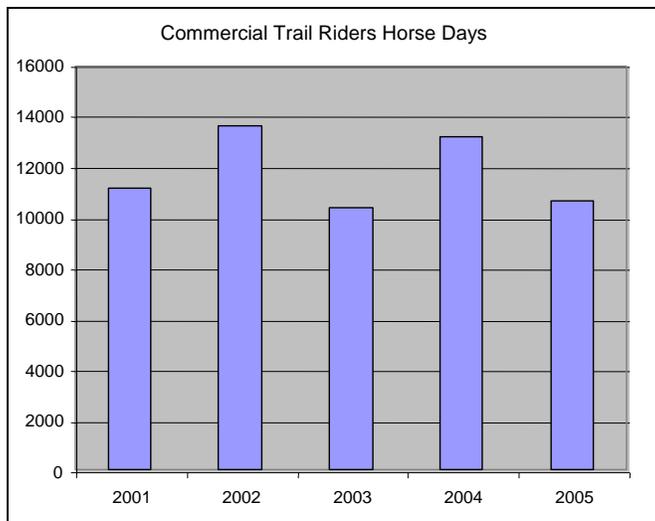


Figure 25. Number of commercial trail riding “horse days” in and near the R11 FMU.

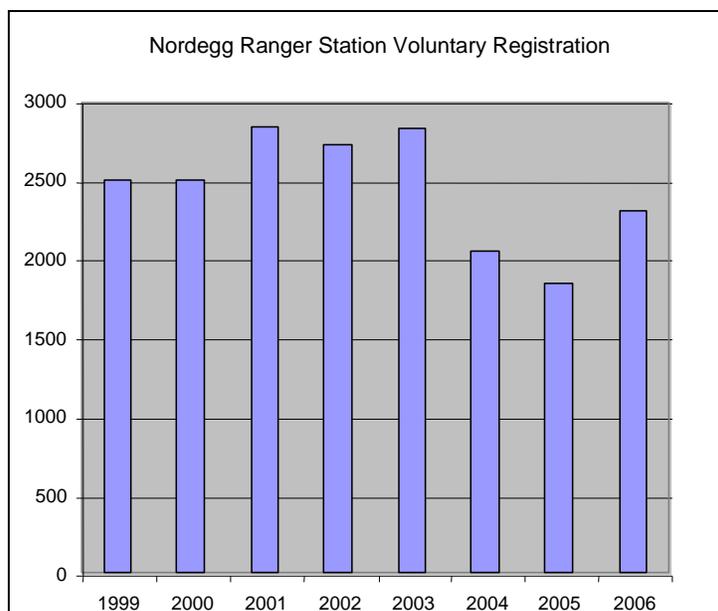


Figure 26. Backcountry travel voluntary registration at the Nordegg Ranger Station.

In addition to tracking the visitor numbers, visitor feedback will be obtained from surveys focusing on the quality of the experience including aesthetics, general enjoyment, and opportunities to promote personal wellness. These surveys will be distributed to visitors by backcountry guardians. Visitor counts and feedback will serve as a proxy measure of tourism appeal; however, it may be necessary to look for an indicator that better reflects the objective of maintaining appeal and opportunities for personal health and wellness.

Forecast: Visitor trends from the data sources examined show high annual variability. While outside forces can have a large influence on visitor trends, perhaps the most valuable tool will be the trail counters, employed both prior to and following burn or harvest treatments to gauge local-level responses.

Monitoring: Data described above are collected by ASRD or other agencies and are readily available. The Stewardship Report will include summaries of these data, as well as trail counter information as it gets refined.

Response: A clear downtrend in visitor numbers or quality of experience will be investigated for causal factors.

2012 Status: Voluntary backcountry traveller registration at the Nordegg Ranger Station is no longer conducted as the station closed during the reporting period, rendering this data source unavailable. Similarly, commercial trail riding “horse days” are no longer compiled through the Nordegg Ranger Station.

The Nordegg Heritage Centre tourist information booth is open from the May long weekend until the second weekend in September. Visitor counts are based on the number of people that sign the guest book. A decrease in visitor numbers was noted between 2007 and 2011 (Figure 27) and was mirrored by a decrease in the number of tours (Joe Baker, *pers. comm.*). However, Joe Baker, West Country Manager for Clearwater County, felt this decrease in visitors could be attributed more to economy and weather than to forest management activities in R11.

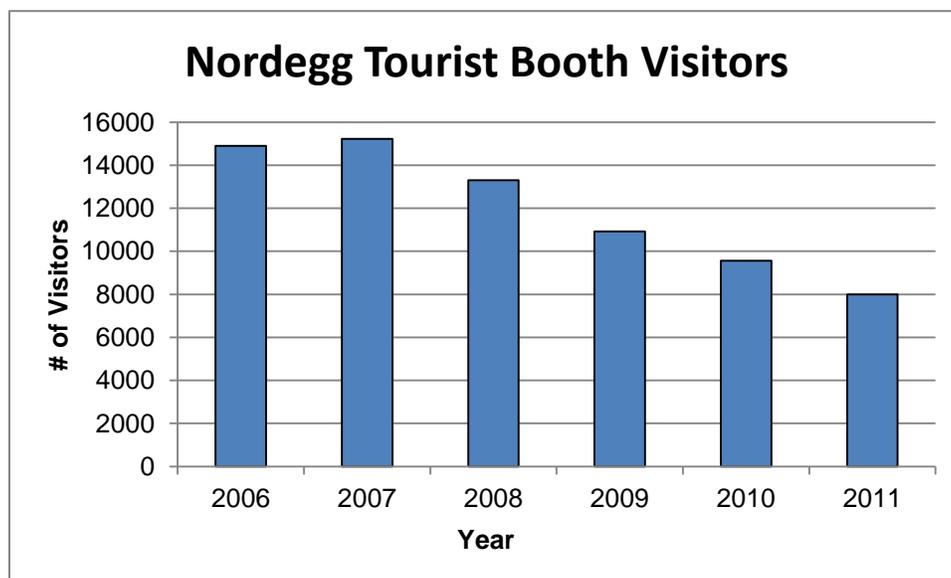


Figure 27. Visitor counts from the Nordegg Heritage Centre tourist information booth from 2006 to 2011.

Alberta Tourism, Parks, and Recreation compiles data from two annual Statistics Canada surveys (i.e., Travel Survey of Residents of Canada and International Travel Survey) to provide

comprehensive information on number of visitors, major non-resident markets, reason for trip, seasonality, and average length of stay for various regions of the province (ATPR 2012). Visitor statistics for the Central Alberta and Canadian Rockies Tourism Destination Regions provide a relevant comparison for the R11 FMU. Between 2007 and 2010 (2011 statistics will be released in spring 2013), overnight and total person-visit numbers for these regions were generally steady to slightly declining, indicating the trends observed at the Nordegg tourist information booth were perhaps reflective of tourism across a broader area.

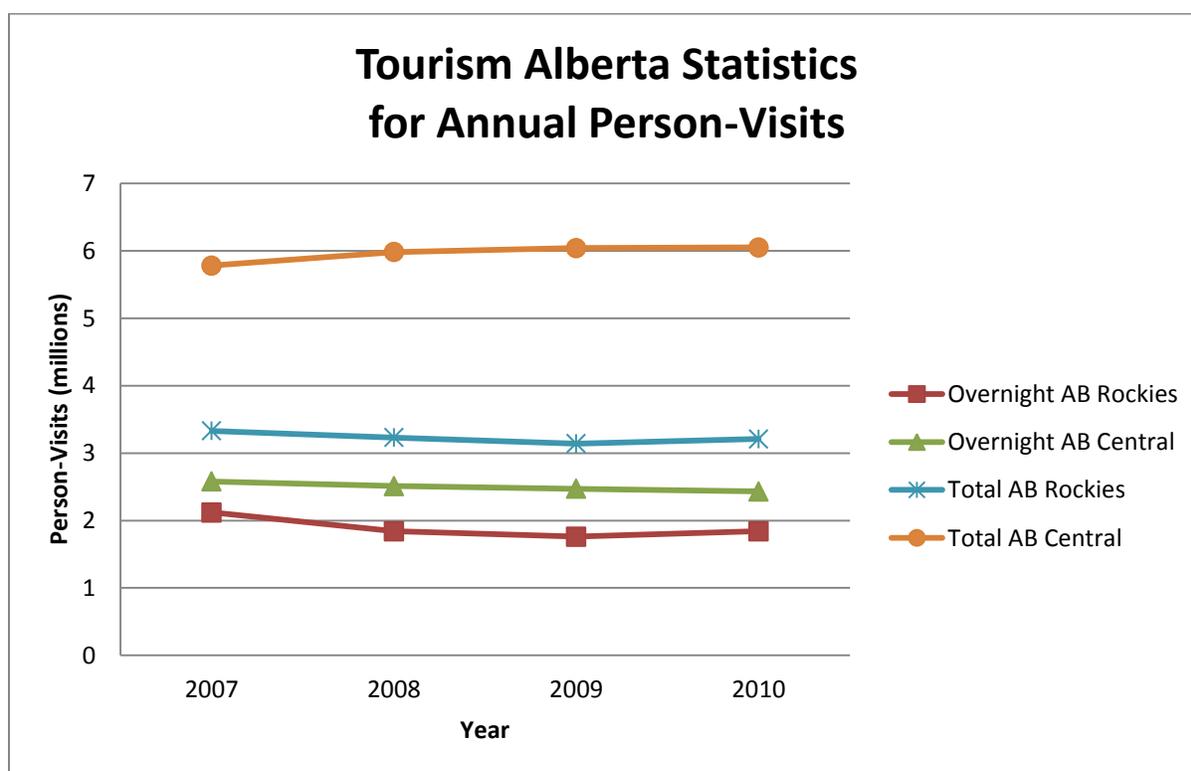


Figure 28. Alberta Tourism, Parks, and Recreation statistics on overnight person-visits and total person-visits to the Central Alberta and Canadian Rockies Tourism Destination Regions from 2007 to 2010 (adapted from ATPR 2012).

A survey to objectively measure user experiences including aesthetics, general enjoyment, and opportunities to promote personal wellness could not be developed and distributed during this reporting period. Informal comments from clients of three tourism operators in the Nordegg area are discussed in Indicator 7.1.2.

2012 Revision: As discussed above, it remains challenging to accurately assess the level of tourism appeal for the R11 FMU, particularly visitor experiences. Accordingly, the indicator will be modified to focus specifically on visitor numbers, until such time as another indicator is developed to better reflect the objective of maintaining appeal and opportunities for personal health and wellness. The modified indicator will state ‘annual number of visitors’, while the target will state ‘visitor trends follow trends in other jurisdictions (e.g., Banff).

Indicator 11.1.1

Value: Access

Objective: Adhere to a “no new access” policy in the R11 area while maintaining existing access.

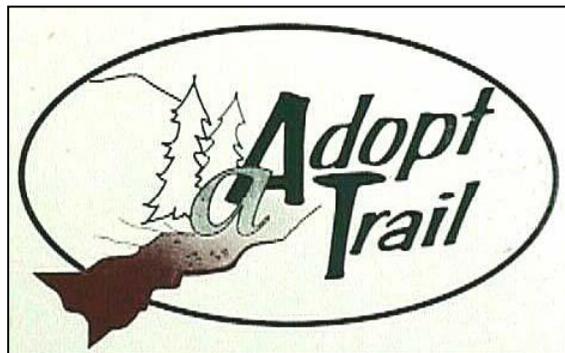
Indicator: Kilometres of permanent trails or roads open to public by use type.

Target: 4190 km of permanent access open to public for the following use types: foot access, equestrian, mountain biking, snowmobiles, off-highway vehicles, on-highway vehicles.

Baseline Status: Access in the R11 FMU is governed by the *Bighorn Backcountry Access Management Plan*, and any proposed changes are agreed upon by a multistakeholder monitoring group. The target was derived from the amount of trails currently in existence in the Bighorn Backcountry. In total, 4190 km of identified trails are on record in the Bighorn Backcountry, with 2059 km of motorized trails and 2131 km of non-motorized trails. Associating the number of kilometres with each type of trail user becomes problematic, however, as non-motorized use is not restricted to trails. The general breakdown is as follows:

- Foot access: no timing restrictions; not limited to identified trails.
- Equestrian: 21 km of timing-restricted trails; not limited to identified trails.
- Mountain biking: no timing restrictions; not limited to identified trails.
- Snowmobiles: 2059 km of trails, including some timing restrictions.
- Off-highway vehicles: 2059 km of trails, including some timing restrictions.
- On-highway vehicles: no identified trails for on-highway vehicles.

ASRD will continue to coordinate the Bighorn Backcountry Recreational Trail Monitoring Program to determine the condition of select trails (i.e., frequency and intensity of erosion and rutting events, extent of trail braiding, adequacy of stream crossings, presence of noxious or restricted weeds). Currently, over two dozen organizations, families, and individuals have adopted trails or sections of trail through the Adopt-A-Trail program, and are thus responsible for inspecting the trail at least once a year and conducting basic trail maintenance (e.g., removal of litter and fallen trees, erosion control). If trail conditions deteriorate despite monitoring and volunteer steward efforts, trail closures may be made from time to time by the Bighorn Steering Committee, in consultation with the Bighorn Standing Committee. Although the kilometres of open trail will fluctuate as per the Steering Committee recommendations and will be monitored accordingly, such closures are not necessarily related to R11 forest management activities.



However, new industrial road access may be necessary to conduct harvesting activities as outlined in this plan. This access will be temporary and restrict users (e.g., via gates) wherever possible and will be reclaimed upon completion of harvest.

Forecast: Any new access created during harvesting activities in R11 will be temporary and restricted wherever possible. Prompt reclamation should minimize the likelihood of new permanent access within the FMU.

Monitoring: The Bighorn Steering Committee will monitor open and closed trails in R11. Any new access, for the purposes of the R11 FMP or otherwise, will be maintained as a GIS data layer. Stewardship reporting will include a summary of industrial access created and reclaimed.

Response: Trails suffering from abuse and lack of maintenance will be closed as per the Bighorn Steering Committee recommendations. Failure to reclaim any new access created for R11 forest management activities will be examined and addressed promptly.

2012 Status: Between 2007 and 2012, the Bighorn Steering and Standing Committees expended considerable effort in ground truthing previously-identified recreational trails in the Bighorn Backcountry, particularly in the Kiska/Willson Public Land Use Zone. Some trails previously identified as open during the Bighorn process were found to be inaccessible and thus were reclassified as closed. This resulted in a significant decrease in the apparent amount of open trails, though in reality very little changed on the ground. Accordingly, 2138 km of recreational trails are now recognized in the Bighorn Backcountry, including 754 km of motorized trails and 1564 km of non-motorized trails. However, non-motorized users including hikers, equestrian riders, and mountain bikers may also travel off-trail. Timing restrictions are in place for snowmobile users on 20 km of the motorized trails and for equestrian users on 24 km of the non-motorized trails.

No new access trails were created with the exception of the Landslide Lake Interpretive Fire Trail in 2010. This short hiking trail (2.4 km in length) provides an opportunity for visitors to experience and learn about the effects of fire on plants and wildlife in a forest ecosystem.

2012 Revision: The target will be revised to reflect the ground-truthing conducted by the Bighorn Steering and Standing Committees. The new target will state ‘2318 km of permanent access open to the public for motorized and non-motorized use, with no new permanent access created by R11 forest management activities unless previously approved by the Bighorn Standing Committee’.

Indicator 12.1.1

Value: Community Integrity

Objective: Protect community appeal for local residents by encouraging economic potential, providing quality recreational opportunities, and protecting private infrastructure and property.

Indicator: Economic growth.

Target: Tax base of Clearwater County for R11 area is maintained or increased.

Current Status: Fish and wildlife populations, stunning viewsapes, and other natural resources contained within the R11 FMU hold economic potential for local residents, particularly those employed within the tourism and recreation sector. Treatment activities implemented through this forest management plan should ensure that this aspect of community integrity is maintained. Furthermore, ASRD will support the completion and implementation of Development Node plans to promote economic growth in R11. Currently however, Clearwater County does not have geographically explicit data available to report on the economic growth indicator or tax base target chosen through the Charrette planning session. Until such time as this information is available, Indicator 10.2.1 will serve as a measure of economic health, recognizing that it only deals with the tourism component of economic growth.

2012 Status: There has been no change to the available data described above, thus tracking this indicator remains a challenge and must default to Indicator 10.2.1. Note that no new development has occurred within the identified Development Nodes over the reporting period.

Indicator 12.1.2

Value: Community Integrity

Objective: Protect community appeal for local residents by encouraging economic potential, providing quality recreational opportunities, and protecting private infrastructure and property.

Indicator: Local user feedback on quality of recreational experiences including aesthetics and general enjoyment.

Target: No decline in proportion of positive user feedback.

Baseline Status: The R11 FMU supports a relatively small permanent population, however the value of the FMU may be greater for local residents who enjoy the landscape and its resources on an ongoing basis than for visitors who use it on a relatively temporary basis. Quality recreational opportunities were identified in the Charrette process as a particular concern to residents. Incorporating aesthetic concerns into treatment planning (Indicator 9.3.1), maintaining existing recreational infrastructure (Indicator 10.1.1), and limiting the amount of linear access available to recreational users (Indicator 11.1.1) should help ensure the landscape features and developments local users hold in high regard are not degraded and contribute to community appeal in perpetuity.

Currently, ASRD does not have baseline data on recreational user feedback, positive or negative, from either residents or visitors. User surveys will be created and distributed annually by backcountry guardians and businesses to R11 users as a method of establishing a benchmark and monitoring trends. These surveys will address the quality of R11 experiences including aesthetics, general enjoyment, and opportunities to promote personal wellness, and will ask users to identify themselves as either visitor or local resident.



View over the Blackstone/Wapiabi FLUZ

Forecast: Temporary displeasure is to be expected from some users of the R11 FMU as treatments are initiated and viewscapes change. However, regeneration of treatment areas as well as ongoing communication and public education efforts should help mitigate any long-term negative impacts on recreational experiences.

Monitoring: Feedback from user surveys will be summarized and reported in the Stewardship Report.

Response: A downtrend in positive comments will be reviewed for the root cause.

2012 Status: A survey to objectively measure user experiences including aesthetics, general enjoyment, and opportunities to promote personal wellness could not be developed and distributed during this reporting period. Although no ‘Letters to the Editor’ commenting on the treatment impacts were submitted by local residents to the Nordegg community newsletter, some residents did feel there were significant impacts on their viewscape resulting from FireSmart logging in and around the Nordegg area (Arin McFarlane-Dyer, *pers. comm.*). Greater communication efforts were dedicated to explaining the rationale for and impacts from planned prescribed burn treatments than communication efforts to explain details of proposed FireSmart harvesting to local residents (Arin McFarlane-Dyer, *pers. comm.*).

Indicator 12.1.3

Value: Community Integrity

Objective: Protect community appeal for local residents by encouraging economic potential, providing quality recreational opportunities, and protecting private infrastructure and property.

Indicator: Integrity of personal property in or near treatment areas.

Target: Complete protection of private property during treatment activities.

Baseline Status: Although the use of prescribed fire was supported as a primary forest management tool in R11, residents and business owners alike naturally desire protection of their private infrastructure and property during treatment activities. Landscape-level FireSmart planning for the protection of personal property was incorporated as an important objective of this forest management plan (see Objectives 8.1, 8.2, and 8.3). FireSmart Community Zone Plans have been or will be developed and implemented for communities and development nodes within R11 (Indicator 8.1.2). Trappers will also be encouraged to implement fuel management precautions around their cabins (e.g., thinning, pruning, and removal of dead and downed fuels).

Individuals with private property near treatment areas will be consulted during operational planning of prescribed burn or harvest activities. There are instances of private property, primarily trappers' cabins, on Crown lands that are not in the formal record. The location of most structures or property not previously identified through local knowledge will be discovered during fieldwork phase of operational planning. Locations of all property will be incorporated into a GIS system for use during planning exercises.

Forecast: Identification of all infrastructure is critical to achieving complete protection during treatment activities. Prescribed fires will only be conducted under the conditions outlined in the burn plan when the likelihood of achieving associated objectives, including infrastructure protection, is the greatest. Complete protection of infrastructure during harvesting will be possible.

Monitoring:

Response:

2012 Status: As anticipated, complete protection of infrastructure during harvesting activities was achieved. Infrastructure protection was required during two prescribed burns. Due to the proximity of the Ya Ha Tinda – Hat Mountain prescribed burn to buildings, sprinkler sets were placed on the buildings at the Ya Ha Tinda Ranch and on an abandoned, but locally significant, old log trappers cabin about 1.5 km north of the Ya Ha Tinda Ranch (Dave Finn, *pers. comm.*). These buildings were successfully protected during the prescribed burn. Similarly, all personal

property and infrastructure were successfully protected during the Upper Saskatchewan Unit 1 prescribed burn as summarized below (ASRD and Parks Canada 2010):

- Thompson Creek Firewood Stockpile and Log Deck – contained two year supply of firewood for the Thompson Creek Campground including full length tree decks, logs, and split firewood piles. All machinery and equipment had been removed prior to ignition, and all piles were also limited to the center of a cleared area, sitting on mineral soil. A combination of prior soaking, sprinklers operating during ignition, canvas coverings, and plastic sheeting were used to protect the wood piles during the ignition and passing of the crown fire.
- Beechwood Water Treatment Site and Gathering System – contained a storage tank pumping system, an underground power generator and fuel supply, as well as an underground black plastic 3 inch pipe leading down from the gathering system at the top of the drainage where natural spring water was collected. A sprinkler system was employed as well as soaking the ground around the underground pipe and successfully protected the infrastructure despite high intensity Rank 5-6 crown fire that passed through the area.
- Thompson Creek Campground and Infrastructure – was situated directly across the highway from the burn unit and thus was protected in the case of a potential excursion. Protective measures (sprinklers, pumps, canvas tarps) were established on all buildings of significance within the campground, specifically the log caretaker’s cabin, one 1000 gal propane tank, a tool shed, and two woodsheds. No excursion occurred and thus none of the protective measures were employed.



Canvas covering wood piles at the Thompson Creek firewood stockpile site (taken from ASRD and Parks Canada 2010)

Indicator 13.1.1

Value: Information and Education

Objective: Communicate the rationale behind and benefits resulting from burn and harvest treatments in R11.

Indicator: Activities demonstrating communication and education.

Target: Ongoing and timely multi-pronged communication and public education program.

Baseline Status: Given the high profile of the Bighorn Backcountry, public education and information dissemination will play key roles in garnering public support for this FMP by communicating to R11 users the rationale behind and benefits resulting from burn and harvest treatments. Communication with the public is an ongoing process within ASRD and typically takes the form of personal communication, presentations, websites, signage, newspaper articles, and pamphlets. Examples of related program areas where ASRD has been increasing public awareness include the mountain pine beetle awareness, FireSmart planning, and responsible recreational use of public lands (e.g., Shifting Gears, Respect the Land).

R11 presentations were made, often in conjunction with Mountain Pine Beetle Management Strategy presentations, to counties, towns, trappers, fish and game associations, outfitters, rotary clubs, National Parks staff, and internal staff prior to approval of the R11 plan. Additional future presentations may be given to school programs, community organizations, field tours, or at public meetings and open houses. The ASRD website will house a page specifically for the R11 FMU where the approved forest management plan and Stewardship Reports will be available. Background information on concepts integral to this plan including natural range of variation, fire ecology, and harvest ecology may also be available on the R11 website as will links to related websites such as the *Bighorn Backcountry Access Management Plan* site. Static displays may be created adjacent to main routes highlighting the potential increase in wildlife encounters resulting from treatment activities. Finally, an R11 information pamphlet will be made available at area accommodations and campgrounds. In addition to communication of the complete plan, most burns or harvest treatments will require individual communication strategies. High profile burns will have extensive consultation processes, and will be well advertised and promoted.

Forecast: not applicable

Monitoring: All communication activities will be documented, including presentations, distribution of printed materials, and use of electronic media. Feedback from participants in programs and presentations will also be recorded on an ad hoc basis. Activities and feedback will be summarized in the five-year Stewardship Report.

Response:

2012 Status:***Presentations and Outreach***

Presentations and outreach activities conducted during plan development and over the five-year reporting period are listed below:

Feb 2005	ASRD Fire Conference in Hinton
Apr 2005	Bighorn Reserve / Stoney First Nation
Oct 2005	Bighorn Standing Committee
Jan 2007	ASRD Southern Rockies Area staff
Jan 2007	Banff National Park Science Council
Feb 2007	Alberta Outfitters Association / Foundation for North American Wild Sheep
May 2007	ASRD Deputy Minister and Executive Team
May 2007	Bighorn Standing Committee
Jun 2007	Natural Disturbance Approaches to Forest Land Management Short Course
Oct 2007	ASRD Clearwater Area Staff
May 2008	Canadian Parks For Tomorrow: Parks and Protected Areas Conference
Aug 2008	ASRD Deputy Minister and Assistant Deputy Minister
Sep 2008	Fire Ecology Tour for Media, Town, and County Councillors (Figure 29)
Nov 2008	David Andison, Bandaloo Landscape-Ecosystem Services
Feb 2009	North Saskatchewan Watershed Alliance - We Are All Upstream 2 Conference
Feb 2009	ASRD Woodlands Area Staff
Oct 2009	ASRD Forest Management Branch
Sept 2010	Grand Opening Landslide Lake Interpretive Fire Trail
Feb 2011	Prescribed Burn Workshop
Mar 2011	Sundre Forest Products Woodlands Staff
Oct 2012	Wildland Fire Canada Conference



Figure 29. Participants in the September 2008 Fire Ecology Tour in the R11 FMU.

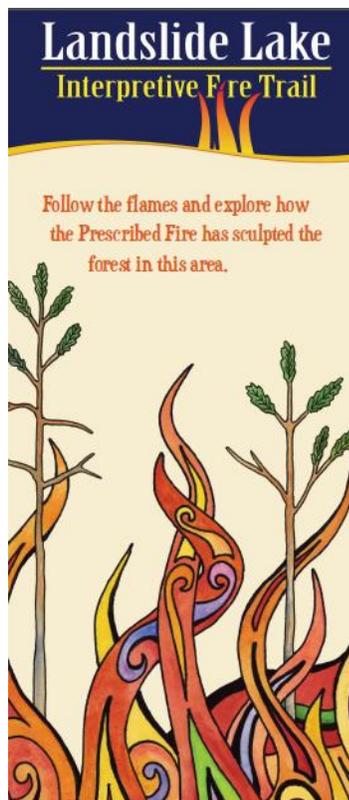
Websites

The R11 Forest Management Plan has been available since approval on ASRD's website at: <http://www.srd.alberta.ca/LandsForests/ForestManagement/ForestManagementPlans/ForestManagementUnitR11.aspx>. Information about upcoming or ongoing prescribed fires within the R11 FMU is also available on ASRD's website at <http://www.srd.alberta.ca/Wildfire/PrescribedFires/Default.aspx>.

Signage

The Landslide Lake Interpretive Fire Trail was created in 2010 by ASRD and ACA following the Upper Saskatchewan Unit 1 prescribed burn to educate visitors on the effects of fire on plants and wildlife in a forest ecosystem. The 2.4 km interpretive trail is a great resource to which many local businesses direct tourists when they have questions about the prescribed burn.

Interviews conducted by Rebecca Heemeryck, Area Forester in the Clearwater Area, with three tourism operators in the Nordegg area (McKenzies' Trails West, Aurum Lodge, and Icefield Heli Tours) indicated that all three businesses had a good understanding of why the burns were conducted and why particular areas were selected for treatment. Icefield Heli Tours requested additional signs about the prescribed burns at their location due to the high volume of tourists that stop, especially on tour buses. The owner felt more signage both along Highway 11 at the burn site stating the year and name of the prescribed burn, as well as informational signs at rest stops would increase public awareness as many tourists think the burn was conducted primarily to combat MPB.



Printed Materials

A brochure highlighting the Landslide Lake Interpretive Fire Trail was produced as well as a fact sheet answering common questions on the effects of forest fires. Both the brochure and fact sheet are available online at

<http://www.srd.alberta.ca/Wildfire/PrescribedFires/Default.aspx>.

A general informational brochure on the R11 Forest Management Plan was not produced for local accommodations, campgrounds, and tourism operators during this reporting period, though is still under consideration for subsequent reporting periods.

Communications for Individual Treatment Events

Prescribed burns, and some harvest treatments, develop individual communication strategies. High profile burns, such as the Upper Saskatchewan Unit 1 burn, require timely, accurate, and coordinated communications to staff and stakeholders through all stages of burn planning and implementation. The specific modes of communications, key messages, issues of concern, and relevant stakeholders vary with each treatment event. Individual prescribed burn plans/post-burn reports should be consulted for additional information on communication activities conducted over the past five

years, as the activities are too varied and burn-specific to summarize here. For example, communication activities conducted before and during the Upper Saskatchewan Unit 1 burn included a Faces of Fire theatrical presentation in the local community, Fire Ecology tour, area closure signs, information kiosk, posters in local businesses, presentations to school groups observing the burn operations, and on-site information officers (ASRD and Parks Canada 2010).

Indicator 14.1.1

Value: Multi-Agency Cooperation

Objective: Employ a multi-jurisdictional approach to managing fire and pests at both the planning and operational levels.

Indicator: Harmonized plan objectives across agency boundaries.

Targets: Timely and meaningful consultation with stakeholder agencies; Refer to targets identified in management plans for embedded or adjacent protected areas.

Baseline Status: Collaboration among resource and land management agencies promotes a more comprehensive approach to landscape-level management issues including wildfire risk and pest invasions (e.g., mountain pine beetle) that transcend jurisdictional boundaries, and allows efficient use of available expertise, finances, and logistical resources. The R11 Planning Team included two representatives from Alberta Tourism, Parks, Recreation, and Culture. The areas under ATPRC management are covered by separate management plans, aspects of which do not align well at this time with the R11 FMP objectives (e.g., use of fire for ecosystem restoration). The Planning Team will continue to work towards a resolution for the next iteration of the R11 plan. Parks Canada representatives also participated in the public Charrette planning session, and were key contributors in the natural disturbance work upon which much of this plan is based. Finally, Sundre Forest Products Inc. (a division of West Fraser Mills Ltd.), the FMA holder sharing the longest boundary with the R11 FMU, has been in regular communication about the FMP. These strong working relationships will continue into plan implementation.

ASRD representatives will also contribute to the North Saskatchewan Watershed Alliance Integrated Watershed Management Plan, adjacent area plans (e.g., coordinating prescribed burn plans along the National Park boundaries with Parks Canada), and emergency response plans (where the presence of a forest protection duty officer and resources on standby often places ASRD in the role of coordinating agency).

Forecast: not applicable

Monitoring: R11 stakeholder agencies will meet regularly to monitor implementation of the R11 Forest Management Plan. Planning consultations with stakeholder agencies and adjacent land managers will be documented and reported upon in the five-year Stewardship Report.

Response:

2012 Status: Stakeholder agencies and adjacent land managers with whom ASRD has consulted and cooperated with during this five-year period of plan implementation are shown below in Table 47.

Table 47. Agencies/land managers and the activity or issue on which they were consulted.

Agency/Land Manager	Activity or Issue
Banff National Park	<ul style="list-style-type: none"> • Partners in Upper Saskatchewan Unit 1 prescribed burn; • Joint operations in Ya Ha Tinda-Hat Mountain prescribed burn and prescribed burn on Ya Ha Tinda Ranch • Presentation to Banff National Park Science Council on R11 FMP
Jasper National Park	<ul style="list-style-type: none"> • Joint planning on Brazeau prescribed burn
Sundre Forest Products	<ul style="list-style-type: none"> • Presentation to staff on R11 FMP • Consultation on South Idlewilde prescribed burns • Consultation on Ram prescribed burn for sheep habitat
Bighorn Standing Committee	<ul style="list-style-type: none"> • Presentation on R11 FMP • Ongoing updates regarding prescribed burn activities
Foundation for North American Wild Sheep	<ul style="list-style-type: none"> • Presentation on R11 Plan • Partners in Ram prescribed burn for sheep habitat
Alberta Conservation Association	<ul style="list-style-type: none"> • Partners on South Idlewilde prescribed burn • Partners on Landslide Lake Interpretive Fire Trail
Alberta Tourism, Parks, and Recreation	<ul style="list-style-type: none"> • Consultation on Upper Saskatchewan Unit 1 prescribed burn
Forest Resource Improvement Association of Alberta	<ul style="list-style-type: none"> • Provided incremental funds for Firesmart harvesting

As discussed above, adjacent or embedded protected areas managed by Alberta Tourism, Parks, and Recreation (e.g., Siffleur Wilderness Area, White Goat Wilderness Area, Kootenay Ecological Reserve, Scalp Creek Natural Area) do not have management plans that recognize the role of historic wildfires as the primary natural disturbance agent. Accordingly, the R11 FMP fire and pest management objectives are still not compatible with management objectives for these protected areas.

Vegetation management goals, objectives, and key actions related to the natural disturbance role of fire in the Banff National Park Management Plan (Environment Canada and Parks Canada 2007) are considered compatible with R11 FMP objectives and are shown below in Table 48. There are no specific objectives or actions related to forest pests noted in the plan, though insect infestations and disease are recognized as a natural disturbance with short-term negative impacts

on forest stands and wildlife but also a factor creating long-term renewal in forested ecosystems. The short-term impacts of insects and disease on fuel accumulation and fire intensity, however, further support the need for vegetation management.

Table 48. Strategic goals, objectives, and key actions related to fire management in the Banff National Park Management Plan (Environment Canada and Parks Canada 2007).

Strategic Goal	Objectives	Key Actions
<i>To maintain and, where feasible, restore native vegetation communities to reflect the long-term ecosystem states and processes.</i>	<p>To restore the role of fire in modifying vegetation communities, except where limited by public safety, public health, major park facilities and neighbouring lands.</p> <p>To improve public awareness of natural disturbances, such as fire, and the management implications of these disturbances.</p> <p>Through prescribed burns and not suppressing fires caused by lightning, achieve a target of 50% of the long-term fire cycle or approximately 14 sq. km burned annually.</p>	<p>Conduct prescribed burns after consultation with affected parties.</p> <p>Work with a variety of stakeholders to encourage understanding of and support for the prescribed burn program.</p>

Similarly, the Jasper National Park Management Plan recognizes fires, forest insects, and diseases as ecological processes working in park ecosystems. Relevant fire and pest management objectives from the 2010 Jasper National Park Management Plan (Parks Canada 2010) are compatible with the R11 FMP and are summarized below in Table 49.

Goal: Allow ecological processes to play their traditional role in shaping park ecosystems; where public safety is a concern, use techniques that emulate ecological processes as closely as possible.

Objectives:

- Use fire to maintain and restore natural vegetation, using the range of natural variability as a guide.
- Monitor forest insects and diseases; develop appropriate responses to fluctuations of native forest insects and diseases; consider the interests of adjacent land managers.

Table 49. Indicators, measures, and targets related to fire and pest management in the Jasper National Park Management Plan (Parks Canada 2010).

Indicator	Measure	Target/Threshold
Terrestrial Ecosystems	Aerial disturbance by fire	The percent area by ecoregion increases
	Forest insect and disease – whitebark pine	Under development
	Forest insect and disease – mountain pine beetle	Under development

Indicator 14.1.2

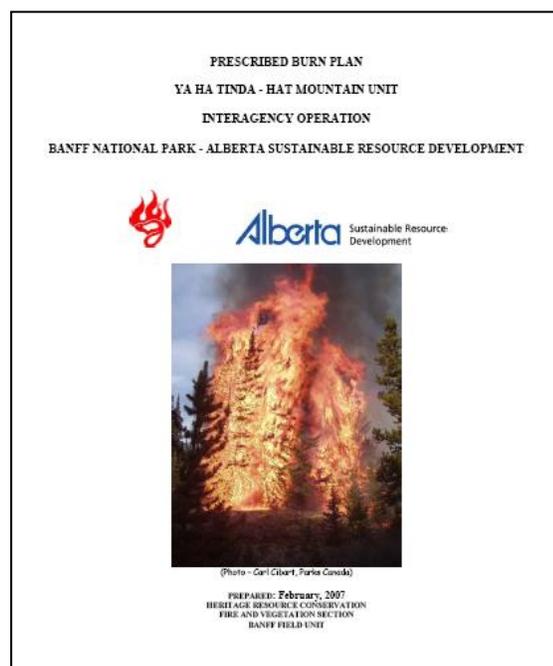
Value: Multi-Agency Cooperation

Objective: Employ a multi-jurisdictional approach to managing fire and pests at both the planning and operational levels.

Indicator: Joint operations among agencies when implementing fire and pest management treatments.

Target: Participation in joint treatments with other agencies.

Baseline Status: Collaboration among resource and land management agencies promotes a more comprehensive approach to landscape-level management issues including wildfire risk and pest invasions (e.g., mountain pine beetle) that transcend jurisdictional boundaries, and allows efficient use of available expertise, finances, and logistical resources. Banff National Park and ASRD have been cooperating on the Upper Saskatchewan prescribed burn planning during the FMP development, and have cooperated in the implementation of a prescribed burn around the Ya Ha Tinda ranch. Sundre Forest Products Inc. (a division of West Fraser Mills Ltd.), the FMA holder sharing the longest boundary with the R11 FMU, has been in regular communication about the plan. R11 harvest operations along the eastern side of the FMU will be coordinated with Sundre Forest Products operations to minimize the amount of open roads. Strong working relationships with these and other adjacent land managers have been established during the plan development, and will continue into implementation.



Forecast: not applicable

Monitoring: Regular meetings will be held with stakeholder agencies and adjacent land managers to coordinate operational plans wherever possible.

Response:

2012 Status: ASRD participated in a joint South Idlewilde prescribed burn with Alberta Conservation Association, and strong working relationships have been developed with Parks Canada through the implementation of two joint prescribed burns: Ya Ha Tinda-Hat Mountain and Upper North Saskatchewan Unit 1. When implementing the Upper North Saskatchewan Unit 1 prescribed burn, for example, ASRD and Parks Canada followed a Unified Command concept that incorporated staff and resources from each agency into one Incident Command Structure. ASRD personnel assumed the Incident Command role and Parks Canada the Deputy Incident Command role while ignition operations were in Alberta, and roles were reversed as ignition operations moved into Banff National Park. Daily Organization Charts indicating the Incident Command Structure position and agency affiliation can be found in Appendix III of the Post-burn Report (ASRD and Parks Canada 2010). Furthermore, Parks Canada, ASRD, and ATPR staff were present during the prescribed fire operations to answer questions from the public along the roadside and at an information kiosk set up at Saskatchewan Crossing.

ASRD continues to stay in communication with adjoining agencies in regards to damaging forest health agents: the main forest health agent of concern is MPB. ASRD staff also participated with Parks Canada on pest management treatments of new MPB trees identified within the Banff National Park boundary by ASRD staff working in an adjacent area. Ongoing communication among Forest Areas within ASRD and with Parks Canada provides information and assessment of the possible threat of a MPB infestation within the R11 FMU. ASRD representatives also attend interprovincial forest health workshops to stay current on what is occurring outside the R11 FMU and Clearwater Forest Area.

Indicator 14.2.1

Value: Multi-Agency Cooperation

Objective: Ensure protection of timber adjacent to the R11 FMU is achieved through complementary fire and pest management plans.

Indicator: Number of adjacent forest companies with a fire and pest management plan.

Target: All adjacent FMA holders with a fire and pest management plan that is compatible and integrated with the R11 FMP.

Baseline Status: All forest companies, including the adjacent FMA holders, include a forest health section in their Detailed Forest Management Plan which addresses their strategies towards various insect and disease issues. ASRD has been meeting regularly with National Parks, Alberta Tourism, Parks, Recreation, and Culture, and the four adjacent FMA holders regarding mountain pine beetle in particular. Each company is responsible for developing a strategy for reducing the amount of susceptible pine, with companies at various stages of strategy development. In addition, all adjacent forest companies are required to submit an annual Forest Protection Plan, primarily dealing with wildfire risk. Companies share location of camps, firefighting resources, road status, and other information to assist with rapid response to wildfires. Strong working relationships with adjacent land managers have been established during the R11 FMP development; ASRD will likewise provide input during the FMP review process for adjacent FMAs.

Forecast: not applicable

Monitoring:

Response:

2012 Status: Sundre Forest Products, West Fraser – Hinton Wood Products, Sundance Forest Products, and Weyerhaeuser Company have all prepared new or amended Pine Strategy FMPs that will target for harvesting stands most susceptible to MPB over the next 5 to 20 years in an attempt to alter the current age-class structure of susceptible pine forests, thereby increasing their long-term resistance to MPB infestations.

Although Sundre Forest Products has participated in some FireSmart planning and harvesting and may attempt to align some objectives in their 2015 Detailed Forest Management Plan with R11 FMP objectives, there has been little coordination of fire management planning to date with other adjacent FMA holders. As future prescribed burn treatments are planned near the other FMUs, the relevant FMA holders will be consulted and joint fire management plans developed.

Indicator 14.3.1

Value: Multi-Agency Cooperation

Objective: Share data, information, and resources among stakeholder agencies.

Indicator: Awareness among stakeholder agencies of other available agencies, resources, or services and initiatives in the R11 area.

Targets: Current and accessible list of all available agencies, resources, or services and initiatives in the R11 area; Regular communication among agencies to discuss new initiatives and opportunities to maximize utility of data and resources.

Baseline Status: Efficient use of expertise, data, finances, and logistical resources requires that stakeholder agencies are aware of resources, services, and initiatives available through other organizations. ASRD takes advantage of opportunities offered by other agencies to stay abreast of research and policies through, for example, participation in information sessions offered by the Foothills Model Forest and Banff National Park to share science-based research findings. A process will be developed to ensure that all R11 stakeholder agencies remain informed and may include a web-accessible list of agencies and initiatives in the R11 area, stakeholder information-sharing meetings, etc. Furthermore, GIS data coverages will be updated regularly and made available to other agencies, subject to data sharing agreements and security of sensitive information.

Forecast: not applicable

Monitoring: Communications with and data requests from stakeholder agencies will be documented. Joint agency projects will also be reported in the Stewardship Report.

Response:

2012 Status: R11 FMP presentations and outreach activities, many with stakeholder agencies or representatives, are summarized in Indicator 13.1.1. Table 47 in Indicator 14.1.1 shows agencies or organizations that were further consulted on particular activities or issues occurring within the R11 FMU. A summary of research conducted during the five-year reporting period is presented in Indicator 5.1.1. GIS data coverages related to treatments and activities occurring within the R11 FMU are kept current and are provided to requesting agencies, following ASRD data sharing agreements and protocols for security of sensitive information. To date, however, limited staff and financial resources have precluded the development of a process or centralized information system whereby stakeholder agencies can receive a compiled list of relevant agencies, initiatives, scientific research, stakeholder information meetings, etc. ongoing within the R11 FMU. The results of this five-year Stewardship Report nevertheless will be communicated to stakeholders in various formats (i.e., presentations, electronic copies, hard copies).

Indicator 15.1.1

Value: Public Safety

Objective: Ensure public safety along existing trails through burned and harvested areas.

Indicator: Identification and mitigation of risk trees in burned and harvested areas.

Target: Mitigation of all risk trees along existing trails running through burned and harvested areas.

Baseline Status: Trees remaining within or adjacent to either burned or harvested areas may be weakened and thus prone to structural failure and uprooting. Growth pattern, habitat, hardness of wood, rate of growth, root type, species, size of affected part (limb, trunk, whole tree, etc.), and presence of structural defects (forks, decay, cankers, leaning, etc.) can contribute to failure potential. When these trees have the potential to impact people, property, or infrastructure in the event of a failure, they are considered risk or hazard trees. Hazard rating systems are a common method to ensure that pertinent, consistent criteria are used to evaluate the relative hazard of a tree. Rating systems typically incorporate some measure of the degree of tree defect (e.g., presence of vertical cracks, >50% of base is charred, etc.) and a measure of risk (i.e., likelihood and value of loss if the tree fails). Mitigation measures can include removal, pruning or selective branch removal, topping, and temporary closure of areas with high risk. Within R11, current fuel management project plans address hazards along existing trails within the project area. Boundaries of completed harvest and burn units can be compared using GIS to the location of all trails receiving heavy foot traffic, and plans to identify and mitigate all risk trees can subsequently be developed.

Forecast: The length of trails affected by prescribed burning or harvesting activities will depend on the spatial location of treatment units, while the ability to mitigate hazard trees will depend on fiscal realities.

Monitoring: The annual number of kilometres of trail undergoing hazard reduction work will be noted in Stewardship Report.

Response:

2012 Status: Specific hazard reduction work was conducted along the 2.4 km long Landslide Lake Interpretive Fire Trail twice over the five-year reporting period: once approximately four weeks post burn in 2009 and again in 2010. No other trails within the R11 FMU received specific hazard reduction work as they were primarily affected by harvesting and did not require additional hazard tree reduction or removal.

4 Summary of Indicator Revisions

A summary of indicators or targets with proposed revisions based on recently available information is provided in Table 50. These updates or revisions are discussed in greater detail in the individual indicators presented previously.

Table 50. Indicators with proposed revisions based on new information or data summarized for the 2012 Stewardship Report.

Indicator	Revision
1.1.1	Target for treatment size will be revised to ‘greater than one half of treatment events will be 500 ha or larger’ to reflect new information.
1.1.2	Original target of stand age distribution within the natural range of variation will change to fire cycle within the natural range of variation, assessed for each fire regime region instead of at the natural subregion level.
1.3.1	Target will be modified to state ‘any salvage of blowdown events will be minimized and will be reported’ and ‘90% of burned areas will remain unsalvaged’.
1.8.1	New predator indicator will focus on three carnivore species: <ul style="list-style-type: none"> • presence of breeding wolf packs distributed across the R11 FMU, • presence of breeding female cougars distributed across the R11 FMU, and • presence of breeding female grizzly bears within each grizzly bear watershed unit in the R11 FMU. Specific targets for this predator indicator will be adopted upon development. The prey component of the indicator has adopted ASRD ungulate population targets at the WMU level.
1.9.1	Indicator will be dropped in subsequent five-year Stewardship Reports, and ungulate habitat tracking will instead focus on Elk Habitat Effectiveness Planning Tool (Indicators 1.9.2 and 1.9.3).
1.10.1	Targets now set at the grizzly bear watershed scale as follows: <ul style="list-style-type: none"> • No net loss of source habitats (i.e., areas with moderate to high habitat value and low mortality risk, Nielsen et al. 2006). • Maintain or enhance landscape connectivity through linkages, particularly between large source habitat patches. • No net increase in mortality risk. • Ensure R11 treatment activities do not affect open route densities, including all forms of motorized access.
1.11.1	Defer to Indicator 1.1.2 where target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation.
1.12.2	Defer to Indicator 1.1.2 where target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation.
1.15.1	Defer to Indicator 1.1.2 where target will shift from current stand age for each

	natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation.
1.17.1	Indicator will be modified to focus on Environmentally Significant Areas alone rather than also including sensitive sites such as licks, den sites, significant fish habitat, etc.
2.1.1	Target will be changed to state ‘periodic disturbance rate of 100% of the median reported fire cycle for each fire regime region’, with 75% of disturbance from harvest, prescribed burn, and Natural Fire Use and 25% of disturbance from wildfire.
3.3.1	Definition of highly susceptible stands in target will be modified in response to changes in the pine ranking system. The new criteria adopted in R11 will be as follows: <ul style="list-style-type: none"> • Highly Susceptible: SSI greater than 42, • Moderately Susceptible: SSI between 25 and 42, • Low Susceptibility: SSI less than 25.
3.3.2	Defer to Indicator 1.1.2 where target will shift from current stand age for each natural subregion within the natural range of variation to fire cycle for each fire regime region within the natural range of variation.
8.2.3	Minor wording clarification in the indicator and target, from ‘containment areas’ to ‘landscape-level containment areas’.
10.2.1	Indicator will be modified to focus specifically on visitor numbers, until such time as another indicator is developed to better reflect the objective of maintaining appeal and opportunities for personal health and wellness.
11.1.1	To reflect results of trail accessibility ground-truthing conducted by the Bighorn Steering and Standing Committees, target will be revised to ‘2318 km of permanent access open to the public for motorized and non-motorized use, with no new permanent access created by R11 forest management activities unless previously approved by the Bighorn Standing Committee’.

5 Summary and Recommendations

5.1 Summary

The period from 2007 to 2012 marked the first forest management activities conducted in the R11 Forest Management Unit under the direction of the inaugural R11 Forest Management Plan. Several notable achievements were recorded over this five-year reporting period including

- completion of an R11 FMU fire regime study,
- completion of a large 5700 ha prescribed burn that was generally well received by local residents, business owners, and visiting public,
- completion of pre-suppression plans and FireSmart harvesting/vegetation management around Nordegg and the Bighorn reserve,
- implementation of joint operations and/or ongoing relationship building with other agencies or adjacent land managers,
- identification of several previously unknown whitebark and limber pine trees/stands,

- significant progress towards setting targets for key wildlife indicators including ungulates and grizzly bears, and
- creation of a short interpretive hiking trail as one component of several communication and outreach activities that provided information on R11 FMP activities to stakeholders and the public.

To summarize success in meeting targets during this reporting period for the 72 indicators identified in the R11 FMP, a report card was generated (Table 51). Grades were assigned as follows:

- E = Excellent success in meeting target
- A = Target met adequately or as best possible given knowledge or logistical constraints (i.e., met with room for improvement)
- NY = Target not yet met, though progress may be evident
- NA = Target still under development, will be assessed at longer intervals, or will be assessed once Clearwater Landscape Fire Management Strategy is in place

Overall, 75% of the indicators were assigned adequate or excellent success in meeting the outlined target (i.e., the grade distribution was as follows: 35 E, 19 A, 5 NY, 8 NA, 5 defer to other indicators).

R11 FMP planning guidelines specified that indicators must be derived from currently available government data. Some indicators have not yet been adequately tracked due to the lack of existing data (e.g., breeding habitat/locations of sensitive species such as long-toed salamanders or Harlequin ducks, number of tourism-related operators working within the R11 FMU, harvest of non-timber products). Financial and logistical constraints have prevented the design and implementation of other supplementary data identified in the original R11 FMP (e.g., training of forestry personnel and contractors in rare plant identification, visitor survey to determine experiences).

Table 51. Report card for the first five-year reporting period of the R11 Forest Management Plan. Grade codes are as follows: E = Excellent success in meeting target, A = Target met adequately or as best possible given knowledge or logistical constraints (i.e., met but room for improvement), NY = Target not yet met, though progress is evident, NA = Target still under development, will be assessed at longer intervals, or will be assessed once Clearwater Landscape Fire Management Strategy is in place.

Value	Objective	Indicator	Target	Grade
1. Biodiversity - Ecosystem Diversity	1.1 Conserve ecosystem diversity by emulating natural disturbance patterns and the range of variation therein (i.e., coarse filter approach).	1.1.1 Treatment size and residual pattern.	Treatment size and pattern within the natural range of variation: multiple treatments over a series of years may be clustered to emulate larger natural burns.	NY
		1.1.2 Stand age distribution by area.	Area of young and old forest within the natural range of variation for each natural subregion.	NY
	1.2 Conserve ecosystem diversity by maintaining or restoring uncommon plant communities.	1.2.1 Uncommon plant communities, specifically whitebark pine, limber pine, Douglas-fir, and lowland grassland communities.	All total known area of each community type inside Protected Areas and 80% of the total known area of each community type outside Protected Areas will be maintained, including via burning if the community is identified as fire dependant.	A
	1.3 Conserve ecosystem diversity by maintaining unique habitats provided by burns and blowdown.	1.3.1 Area of unsalvaged burned forest and blowdown.	90% of burned and blowdown areas remaining unsalvaged.	E

Value	Objective	Indicator	Target	Grade
1. Biodiversity - Plant Species Diversity	1.4 Conserve plant species diversity by maintaining viable populations of native species (i.e., fine filter approach).	1.4.1 Location of individual whitebark and limber pine.	80% of identified populations and individual trees maintained (fire dependent).	E
		1.4.2 Location of mountain bladder fern populations.	All identified populations maintained.	A
		1.4.3 Location of wood anemone populations.	All identified populations maintained.	A
		1.4.4 Location of Lapland rose-bay populations.	All identified populations maintained.	A
1. Biodiversity - Fish Species Diversity	1.5 Maintain important habitat for populations of fish species.	1.5.1 Area of disturbed riparian habitat.	Complete protection of all riparian habitats.	A
	1.6 Minimize impact of treatment activities on known bull trout and cutthroat trout streams.	1.6.1 Maintenance of stream buffers.	Sundre Forest Products OGR for stream buffers met or exceeded on all known bull trout and cutthroat trout streams.	NY
		1.6.2 Number of stream crossings.	No permanent crossings wherever possible.	E
		1.6.3 Timing of instream work.	No instream work from September 1 to April 30 (bull trout streams) or May 16 to August 15 (cutthroat trout streams).	E

Value	Objective	Indicator	Target	Grade
	1.7 Maintain the integrity of key instream habitats.	1.7.1 Spawning, rearing, and overwintering habitat condition.	No significant increase in sediment load in spawning, rearing, or overwintering areas.	A
1. Biodiversity - Wildlife Species Diversity	1.8 Ensure treatment activities do not unduly benefit either predator or prey populations.	1.8.1 Predator-prey ratio.	Targets to be determined after completion of ongoing research.	NA
	1.9 Maintain and restore high quality ungulate summer and winter range and associated movement habitat.	1.9.1 Stand age distribution broken down by habitat capability for elk, deer, and moose.	Current stand age distribution within the natural range of variation in areas identified as capable of supporting elk, deer, moose, and bighorn sheep.	NY
		1.9.2 Location and extent of high quality ungulate winter range, and associated movement habitat.	Not yet completed; target needs to be set using the Elk Habitat Effectiveness Planning tool.	NA
		1.9.3 Location and extent of high quality ungulate summer range, and associated movement habitat.	Not yet completed; target needs to be set using the Elk Habitat Effectiveness Planning tool.	NA
	1.10 Maintain important habitat for grizzly bear.	1.10.1 Location and extent of high quality grizzly bear habitat and associated movement habitat.	Targets to be determined after the Grizzly Bear Recovery Plan is approved.	E
	1.11 Maintain important habitat for wolverine.	1.11.1 Location and extent of high quality wolverine habitat.	Current stand age distribution within the natural range of variation. See Indicator 1.1.2.	See Indicator 1.1.2

Value	Objective	Indicator	Target	Grade
	1.12 Maintain habitat for important furbearer populations, specifically pine marten and red squirrel.	1.12.1 Average number of individuals harvested each year on traplines active for a given species.	No decrease in average number of individuals trapped per year over 5 years.	A
		1.12.2 Stand age distribution, specifically mature and old-growth.	Current stand age distribution within the natural range of variation. See Indicator 1.1.2.	See Indicator 1.1.2
	1.13 Maintain important habitat for Harlequin duck.	1.13.1 Quality of nesting, breeding and foraging habitat for Harlequin duck.	No net increase to motorized access (both on- and off-highway vehicles) on streams with historic duck observations.	E
	1.14 Maintain important habitat for Clark's nutcracker.	1.14.1 Location and extent of high quality Clark's nutcracker habitat, including whitebark and limber pine stands.	80% of identified populations and individual whitebark and limber pine trees maintained. See Indicator 1.4.1.	See Indicator 1.4.1
	1.15 Maintain habitat capable of sustaining future woodland caribou range expansion into the R11 area.	1.15.1 Area of mature and old-growth forest.	Area of mature and old-growth forest within the natural range of variation; Target could be further refined once west-central habitat planning targets are developed.	See Indicator 1.1.2
	1.16 Maintain habitat capable of supporting long-toed salamander populations.	1.16.1 Location of potential breeding ponds and lakes.	Information on whether long-toed salamanders exist and breed in the identified ponds and lakes.	A

Value	Objective	Indicator	Target	Grade
1. Biodiversity - Sensitive Sites	1.17 Maintain integrity of sensitive sites.	1.17.1 Identified sensitive sites (e.g., nationally and provincially significant ESAs, selected Special Features, mineral licks, major game trails, rocky outcrops, den sites, fish spawning, rearing, and over-wintering areas).	Complete protection of sites sensitive to burning or harvesting (sites not sensitive to such treatments will not require the same degree of protection).	A
1. Biodiversity - Genetic Diversity	1.18 Conserve genetic diversity by maintaining genetic variation of tree species.	1.18.1 Inventory of whitebark and limber pine stands and stored seed.	80% of identified populations and individual trees maintained (see Indicator 1.4.1) as well as a viable stored seed inventory.	E
2. Ecosystem Integrity and Productivity	2.1 Maintain natural disturbance patterns at the landscape level.	2.1.1 Area disturbed per decade by natural subregion.	Periodic disturbance rate of 50% of the median reported fire cycle for each natural subregion	A
		2.1.2 Disturbance via natural processes where appropriate.	Identification of natural fire zones for different HFIs.	NA
		2.1.3 Fire intensity.	Distribution of HFI ranks across the landscape.	NY
	2.2 Allow natural reforestation processes in disturbed areas.	2.2.1 Area burned or harvested and left for natural regeneration.	90% of burned or harvested areas will be left for natural regeneration.	E
	2.3 Track loss of forest landbase to other uses.	2.3.1 Amount of change in forest landbase, including oil and gas, seismic, mining, roads, commercial, urban, acreages.	Minimal loss of forest landbase.	E

Value	Objective	Indicator	Target	Grade
	2.4 Maintain soil productivity by preventing soil compaction.	2.4.1 Compliance with Sundre Forest Products OGR.	Complete compliance with Sundre Forest Products OGR, with 90% of harvesting conducted under winter conditions.	E
3. Forest Health	3.1 Recognize role of all native forest health agents and climate change.	3.1.1 Current inventory and distribution of native forest health agents.	Accurate reporting and mapping of native forest health agents.	E
		3.1.2 Current inventory and distribution of non-native forest health agents.	No increase in incidence of non-native forest health agents.	E
	3.2 Prevent introduction of non-native, invasive plant species.	3.2.1 Current inventory and distribution of non-native, invasive plant species (i.e., noxious and restricted weeds).	No increase in incidence of non-native, invasive plant species (i.e., noxious and restricted weeds).	E
	3.3 Reduce impact of mountain pine beetle.	3.3.1 Stand Susceptibility Index.	75% reduction in the area of highly susceptible stands currently projected in 20 years.	E
		3.3.2 Stand age distribution.	Current stand age distribution within the natural range of variation. See Indicator 1.1.2.	See Indicator 1.1.2
4. Watershed Integrity	4.1 Maintain flow quantity.	4.1.1 Annual flow.	No increase in annual flow projections greater than 15% on third order streams.	NA
	4.2 Maintain flow quality.	4.2.1 Roads and watercourse crossings.	All roads and watercourse crossings meet or exceed Sundre Forest Products OGR standards.	E

Value	Objective	Indicator	Target	Grade
		4.2.2 Maintenance of stream buffers.	Sundre Forest Products OGR for stream buffers met or exceeded in harvest areas.	E
		4.2.3 Bared soil surfaces.	No bared soil surfaces created by harvest operations.	E
		4.2.4 Area of unsalvaged blowdown.	No salvage of merchantable blowdown in riparian areas.	E
	4.3 Support Watershed Alliances.	4.3.1 Communications with Watershed Alliances.	Referral of plan to Red Deer River and North Saskatchewan Watershed Alliances.	E
5.Science-based Decision Making	5.1 Ensure stakeholders and managers are informed by science so they can understand trade-offs and make defensible decisions; employ scientific thresholds and checkpoints; make ecosystem-based decisions; and adhere to planning standards.	5.1.1 Implementation of current research findings in R11.	Continual monitoring and implementation of research findings relevant to R11; Current communications system in place to monitor research initiatives.	E
6. Domestic Grazing	6.1 Maintain trails open to manage livestock and consider cow locations during seasonal burn plans.	6.1.1 Location of cow trails and season of use.	No increased use of riparian areas as a result of prescribed burn or harvest treatments; Consultation with affected disposition holders prior to treatments.	A
7. Economic Opportunities	7.1 Maintain or increase the economic potential of the R11 area without damaging the overall appeal for users.	7.1.1 Number of tourism-related operators in the R11 area.	Number of tourism-related operators in the R11 area is maintained or increased.	A

Value	Objective	Indicator	Target	Grade
		7.1.2 Client impact, financial impact for operators, and economic impact on local economy.	Positive client feedback.	A
8. Wildfire Threat	8.1 Integrate fire management objectives with overall landscape management objectives (i.e., balance the level of risk of wildfire with the responsibility of other parties, such as developers and adjacent forest companies, to participate in their own risk reduction).	8.1.1 Vegetation management zone map.	Appropriate vegetation management zoning map developed.	E
		8.1.2 Number of FireSmart initiatives.	FireSmart Programs in place for all communities and infrastructure in the R11 area; FireSmart Landscape in place for the R11 area.	E
	8.2 Reduce the threat of large, high intensity, catastrophic wildfire.	8.2.1 Fire behaviour potential.	5% reduction of high and extreme fire behaviour classes over a 20-year period.	NA
		8.2.2 Number of human-caused wildfires.	Number of human-caused wildfires at or below levels indicated in Forestry Division Standard Operating Procedures performance measures (i.e., <27 human-caused fires per year).	E
		8.2.3 Area burned outside containment areas.	No hectares burned outside of containment areas.	NA

Value	Objective	Indicator	Target	Grade
	8.3 Protect values at risk within and adjacent to the R11 area.	8.3.1 Presuppression Plans developed for communities, Development Nodes, and high-use areas.	Completion of Nordegg Presuppression Plan by 2007 fire season; Completion of Development Node Presuppression Plans as development occurs.	E
		8.3.2 Disposition referral process.	Referral process implemented by fall 2007.	E
9. Inherent Value	9.1 Maintain cultural values and treaty rights.	9.1.1 Integrity of traditional sites, burial grounds, ceremonial locations, etc.	Complete protection of all traditional sites, burial grounds, ceremonial locations, etc.	E
		9.1.2 Number and diversity of cultural stakeholders involved in R11 planning.	Representatives from local First Nations participating in stakeholder meetings.	E
	9.2 Allow continued use of forest for non-timber products such as mushrooms, medicinal plants, berries, etc.	9.2.1 Known incidences of non-timber product use.	Continued and enhanced use of non-timber products in the R11 FMU.	A
	9.3 Maintain aesthetic qualities of the landscape where possible.	9.3.1 Visual impact and buffer width.	No increase in proportion of negative comments about aesthetic appeal of changed viewscape; Target for visual buffers yet to be determined.	A
	9.4 Minimize changes to air quality as a result of prescribed burn treatments.	9.4.1 Number of smoke-filled days in high use areas.	Less than five consecutive smoke-filled days per year in high use areas as a result of prescribed burn treatments.	E

Value	Objective	Indicator	Target	Grade
10. Recreational Opportunities	10.1 Maintain infrastructure and recognize volunteer efforts to maintain or replace infrastructure.	10.1.1 Location of staging areas, washrooms, bridges, campgrounds, trails, roads.	No impact to infrastructure from treatments.	E
	10.2 Maintain tourism appeal (i.e., for snowmobiles, off-highway vehicles, hiking, camping, hunting, fishing, berry picking) and opportunities to enhance personal health and wellness.	10.2.1 Annual number of visitors and visitor feedback on quality of experience including aesthetics, general enjoyment, and opportunities to promote personal wellness.	Visitor trends follow trends in other jurisdictions (e.g., Banff); No decline in proportion of positive visitor feedback.	A
11. Access	11.1 Adhere to a "no new permanent access" policy in the R11 area while maintaining existing access.	11.1.1 Kilometers of permanent trails or roads open to public by use type.	4190 km of permanent access open to public for the following use types: foot access, equestrian, mountain biking, snowmobiles, off-highway vehicles, on-highway vehicles.	E
12. Community Integrity	12.1 Protect community appeal for local residents by encouraging economic potential, providing quality recreational opportunities, and protecting private infrastructure and property.	12.1.1 Economic growth.	Tax base of Clearwater County for R11 area is maintained or increased.	NA
		12.1.2 Local user feedback on quality of recreational experiences including aesthetics and general enjoyment.	No decline in the proportion of positive user feedback.	A

Value	Objective	Indicator	Target	Grade
		12.1.3 Integrity of personal property in or near treatment areas.	Complete protection of private property during treatment activities.	E
13. Information and Education	13.1 Communicate the rationale behind and benefits resulting from burn and harvest treatments in R11.	13.1.1 Activities demonstrating communication and education (e.g., presentations, signage, websites, literature, field tours).	Ongoing and timely multi-pronged communication and public education program.	E
14. Multi-Agency Cooperation	14.1 Employ a multi-jurisdictional approach to managing fire and pests at both the planning and operational levels.	14.1.1 Harmonized plan objectives compatible across agency boundaries.	Timely and meaningful consultation with stakeholder agencies; Refer to targets identified in management plans for embedded or adjacent protected areas.	E
		14.1.2 Joint operations among agencies when implementing fire and pest management treatments.	Participation in joint treatments with other agencies.	E
	14.2 Ensure protection of timber adjacent to the R11 FMU is achieved through complementary fire and pest management plans.	14.2.1 Number of adjacent forest companies with a fire and pest management plan.	All adjacent FMA holders with a fire and pest management plan that is compatible and integrated with the R11 FMP.	A

Value	Objective	Indicator	Target	Grade
	14.3 Share data, information, and resources among stakeholder agencies.	14.3.1 Awareness among stakeholder agencies of other available agencies, resources, or services and initiatives in the R11 area.	Current and accessible list of all available agencies, resources or services and initiatives in the R11 area; Regular communication among agencies to discuss new initiatives and opportunities to maximize utility of data and resources (e.g., regular stakeholder meetings).	A
15. Public Safety	15.1 Ensure public safety along existing trails through burned and harvested areas.	15.1.1 Identification and mitigation of risk trees in burned and harvested areas.	Mitigation of all risk trees along existing trails running through burned and harvested areas.	E

5.2 Recommendations

Specific revisions have been recommended previously for several indicators (Table 50). Plan implementation and reporting would also benefit from other additional processes or analyses. The analysis of residual patterns within treatments, particularly prescribed burns or wildfires, would benefit from the adoption of a standardized method of mapping the burn area including remnants within the boundary. One suggested option is the Normalized Burn Ratio from Landsat imagery in combination with the NEPTUNE tool to calculate parameters regarding remnants. The development of checklists based on R11 indicators could help ensure relevant issues have been addressed prior to treatment activities (e.g., *Are there any ESAs within the treatment area? Has ACIMS been queried for rare plants or communities within the treatment area? Are there known bull trout or cutthroat trout streams within the treatment area? Has the appropriate grazing disposition holder been consulted? Have any traditional First Nations sites been identified within the treatment area?*). Furthermore, a spreadsheet detailing information or data required for stewardship reporting, the interval at which this data is summarized (i.e., annually or at five year intervals), and the person responsible for tracking this data (or other source for data acquired outside ASRD) would increase efficiency when preparing future Stewardship Reports.

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7 Appendices

Appendix 1. Rare plants found in the R11 FMU (as identified in ACIMS) and the impacts of harvesting, prescribed fires, and natural wildfires between 2007 and 2011 on their known area (ha; ASRD, unpubl. data).

Scientific Name	Common Name	Rank	Area In R11	Area within Harvest	Area within Prescribed Burns	Area within Natural Wildfire	Percent Disturbed
<i>Agrestia hispida</i>	vagabond lichen	S2S3	2.2				0.0%
<i>Aloina rigida</i>	aloe-like rigid screw moss	S2	83.5				0.0%
<i>Anaptychia crinalis</i>		S2	254.7				0.0%
<i>Anemone quinquefolia</i>	wood anemone	S1	1953.0				0.0%
<i>Antennaria aromatica</i>	scented everlasting	S2	248.9				0.0%
<i>Arnica louiseana</i>	rock arnica	S1S3	656.5				0.0%
<i>Boloria astarte</i>	astarte fritillary	S2	805.2				0.0%
<i>Botrychium ascendens</i>	ascending grape fern	S2	8.0				0.0%
<i>Botrychium spathulatum</i>		S2	8.0				0.0%
<i>Boykinia heucheriformis</i>	telesonix	S2	123.9				0.0%
<i>Braya purpurascens</i>	alpine braya	S1S2	19.9				0.0%
<i>Buellia dispersa</i>	button lichen	S1	17.4				0.0%
<i>Calamagrostis lapponica</i>	Lapland reed grass	S1	29.7				0.0%
<i>Caloplaca sinapisperma</i>	firedot lichen	S2S3	11.8				0.0%
<i>Carex aperta</i>	open sedge	S1	35.2				0.0%
<i>Carex incurviformis</i> var. <i>incurviformis</i>	seaside sedge	S2	261.9				0.0%

Scientific Name	Common Name	Rank	Area In R11	Area within Harvest	Area within Prescribed Burns	Area within Natural Wildfire	Percent Disturbed
<i>Cladonia macrophylla</i>	cladonia lichen	S2	799.9				0.0%
<i>Collema undulatum</i> var. <i>granulosum</i>	jelly flakes	S2S3	25.4				0.0%
<i>Conardia compacta</i>		S2	227.9				0.0%
<i>Dactylina beringica</i>	finger lichen	S2S3	799.9				0.0%
<i>Dicranum spadiceum</i>	cushion moss	S2	117.5				0.0%
<i>Didymodon rigidulus</i>	rigid screw moss	S2	9.2		1.3		14.3%
<i>Didymodon tophaceus</i>	blunt-leaved hair moss	S1S2	17.4				0.0%
<i>Draba porsildii</i>	Porsild's whitlow-grass	S1S2	7.4				0.0%
<i>Epilobium saximontanum</i>	Rocky Mountain willowherb	S1	182.5				0.0%
<i>Erigeron radicans</i>	dwarf fleabane	S2	7.1				0.0%
<i>Fissidens adianthoides</i>	maidenhair moss	S2	284.2				0.0%
<i>Fulgensia fulgens</i>	sulphur lichens	S2S3	32.0				0.0%
<i>Glypholecia scabra</i>	lichen	S1	0.5		0.5		96.9%
<i>Gypsoplaca macrophylla</i>	changing earthscale	S1	0.8		0.5		60.5%
<i>Hypnum procerrimum</i>		S2	32.0				0.0%
<i>Hypogymnia enteromorpha</i>		S2	0.5		0.5		100.0%
<i>Leptogium pseudofurfuraceum</i>	dimpled jellyskin lichen	S2	47.8				0.0%
<i>Lesquerella arctica</i> var. <i>purshii</i>	northern bladderpod	S2	19.5				0.0%

Scientific Name	Common Name	Rank	Area In R11	Area within Harvest	Area within Prescribed Burns	Area within Natural Wildfire	Percent Disturbed
<i>Leucorrhinia glacialis</i>	crimson-ringed whiteface	S1S3	24.8				0.0%
<i>Lomatogonium rotatum</i>	marsh felwort	S2S3	0.8				0.0%
<i>Lophozia gillmanii</i>	liverwort	S1	1.0		1.0		100.0%
<i>Lophozia heterocolpos</i>	liverwort	S2	0.5				0.0%
<i>Mannia fragrans</i>	liverwort	S1	0.6				0.0%
<i>Micarea assimilata</i>	assimilative dot lichen	S2	920.8				0.0%
<i>Orthothecium intricatum</i>		S1	42.1				0.0%
<i>Oxytropis campestris</i> var. <i>davisii</i>		S2?	3.2				0.0%
<i>Pellaea glabella</i>	smooth cliff brake	S2	3.3				0.0%
<i>Pellaea glabella</i> ssp. <i>occidentalis</i>		S1	3.3		0.9		25.8%
<i>Pellaea glabella</i> ssp. <i>simplex</i>		S2	0.04				0.0%
<i>Pellia neesiana</i>	liverwort	S2	5.3				0.0%
<i>Peltigera collina</i>		S2	0.5		0.5		100.0%
<i>Pertusaria sommerfeltii</i>	lichen	S1?	962.4	60.1			6.2%
<i>Phaeophyscia nigricans</i>		S2	12.5				0.0%
<i>Phaeophyscia sciastra</i>		S2S4	1.0		1.0		95.8%
<i>Phascum cuspidatum</i>	cuspidate earth moss	S2	42.1				0.0%
<i>Philonotis marchica</i>		S1	117.1				0.0%

Scientific Name	Common Name	Rank	Area In R11	Area within Harvest	Area within Prescribed Burns	Area within Natural Wildfire	Percent Disturbed
<i>Physcia phaea</i>	black-eyed rosette lichen	S2S3	12.5				0.0%
<i>Physconia perisidiosa</i>	crescent frost lichen	S2	78.2				0.0%
<i>Pinus albicaulis</i>	whitebark pine	S2	6608.2		1.0		0.0%
<i>Pinus flexilis</i>	limber pine	S2	6764.1		6.2		0.1%
<i>Poa stenantha</i>	bluegrass	S1	0.5				0.0%
<i>Potentilla hookeriana</i>	Hooker's cinquefoil	S2	7.5				0.0%
<i>Potentilla villosa</i>	hairy cinquefoil	S2	3.4				0.0%
<i>Primula egaliksensis</i>	primrose	S2	5.7				0.0%
<i>Pseudoleskeella sibirica</i>		S2	170.4				0.0%
<i>Psora cerebriformis</i>	brain scale	S1	0.6				0.0%
<i>Psora globifera</i>	blackberry scale	S1S2	0.3				0.0%
<i>Ramalina intermedia</i>	rock ramalina	S2	1.3		1.3		100.0%
<i>Rhizocarpon superficiale</i>	map lichen	S2	49.4				0.0%
<i>Rhizomnium andrewsianum</i>		S1	0.5		0.5		100.0%
<i>Rhododendron lapponicum</i>	Lapland rose-bay	S2	115.6				0.0%
<i>Salix alaxensis var. alaxensis</i>	Alaska willow	S2S3	26.1				0.0%
<i>Salix commutata</i>	changeable willow	S2	0.0				0.0%
<i>Salix lanata ssp. calcicola</i>	woolly willow	S1	1.8				0.0%

Scientific Name	Common Name	Rank	Area In R11	Area within Harvest	Area within Prescribed Burns	Area within Natural Wildfire	Percent Disturbed
<i>Saxifraga flagellaris ssp. setigera</i>	spiderplant	S2	1049.4				0.0%
<i>Saxifraga nivalis</i>	alpine saxifrage	S2?	29.7				0.0%
<i>Scapania cuspiduligera</i>	liverwort	S2	0.5		0.5		100.0%
<i>Sisyrinchium septentrionale</i>	pale blue-eyed grass	S3	301.0		3.1	0.1	1.1%
<i>Solorinella asteriscus</i>	lichen	S1	52.9			9.4	17.8%
<i>Somatochlora cingulata</i>	Lake Emerald	S2S4	1368.6	46.7			3.4%
<i>Somatochlora whitehousei</i>	Whitehouse's Emerald	S2	46.1	1.6			3.6%
<i>Splachnum vasculosum</i>	large-fruited splachnum	S2	0.0				0.0%
<i>Staurothele areolata</i>	rock pimples	S1	3.3				0.0%
<i>Tortella inclinata</i>	bent screw moss	S2	19.6				0.0%
<i>Verrucaria aethiobola</i>	speck lichen	S1	0.5				0.0%
<i>Xanthomendoza fulva</i>	bare-bottomed sunburst lichen	S1	12.5				0.0%
<i>Xanthomendoza hasseana</i>	polar sunburst lichen	S1S2	0.5		0.5		100.0%