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Anthropogenic and Fire Disturbances in Woodland Caribou Herd Ranges in the Lower Athabasca Regional Plan Area, Alberta

Woodland caribou are listed as "threatened" under both Alberta's *Wildlife Act* and the Federal *Species at Risk Act*, due to broad-scale range recession and population declines, in large part associated with human settlement and fire and anthropogenic disturbances, including destruction and fragmentation of habitat.[1]

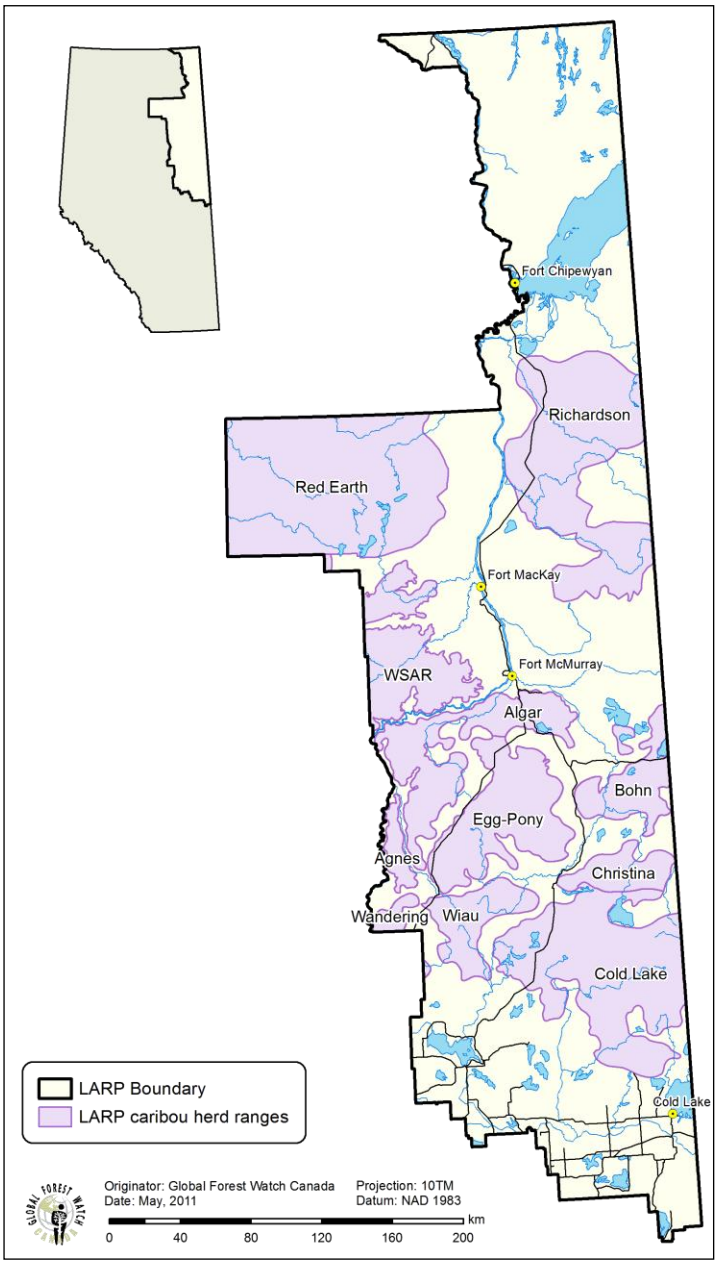
Global Forest Watch Canada undertook this project to map and analyze anthropogenic and fire disturbances in the caribou herd ranges within the area of the Lower Athabasca Regional Plan (LARP) because the Government of Alberta is nearing final decisions regarding land uses in this area. Knowing the level of disturbances in caribou herd ranges would perhaps encourage appropriate decisions in favour of conserving these populations of woodland caribou. Global Forest Watch Canada has extensive experience at mapping anthropogenic disturbances within caribou ranges throughout Canada, using satellite imagery.

What is the state of woodland caribou in Alberta?

The Government of Alberta's 2010 status report of woodland caribou in Alberta states: *"Woodland caribou in Alberta have experienced significant declines in both number and distribution since 1900. Sixteen woodland caribou populations now remain in the province; adequate population monitoring data are available for 13 of these populations. Of the 13 populations with sufficient monitoring data, 10 are demonstrating population decline. The 10 caribou populations documented to be in decline occupy 83% of the total*

area of current caribou range in Alberta, and constitute the majority of caribou occurring in the province. Considering current estimates of caribou population sizes, approximately 70% of all caribou in Alberta occur in populations that are known to be declining. More provincial caribou populations are now in sustained population decline than was the case when the first edition of this status document was prepared in 2001. In addition, the Banff caribou population is believed to have been extirpated in 2009."[2]

Where are the caribou herd ranges that are in LARP?



Map 1. Woodland caribou herds within the area of the area of the Lower Athabasca Regional Plan.

Map 1 shows the locations of the 11 woodland caribou herds that have ranges within the area of the LARP.

38,556 km^2, or 41.4%, of the 93,212 km^2 LARP area is comprised of caribou herd ranges, according to the most recent boundaries by the Alberta Caribou Committee.

The herds with the largest range areas within LARP are:

1. Red Earth (9,197 km^2)
2. Richardson (7,074 km^2)
3. Cold Lake (6,726 km^2)
4. Egg-Pony (3,748 km^2)
5. Algar (3,309 km^2)
6. WSAR (3,158 km^2)
7. Bohn (1,741 km^2)
8. Wiau (1,662 km^2)
9. Christina (1,133 km^2)
10. Agnes (471 km^2)
11. Wandering (338 km^2)

How much of the caribou herd ranges in the LARP area is presently protected and might be protected under the Government of Alberta's LARP decision?

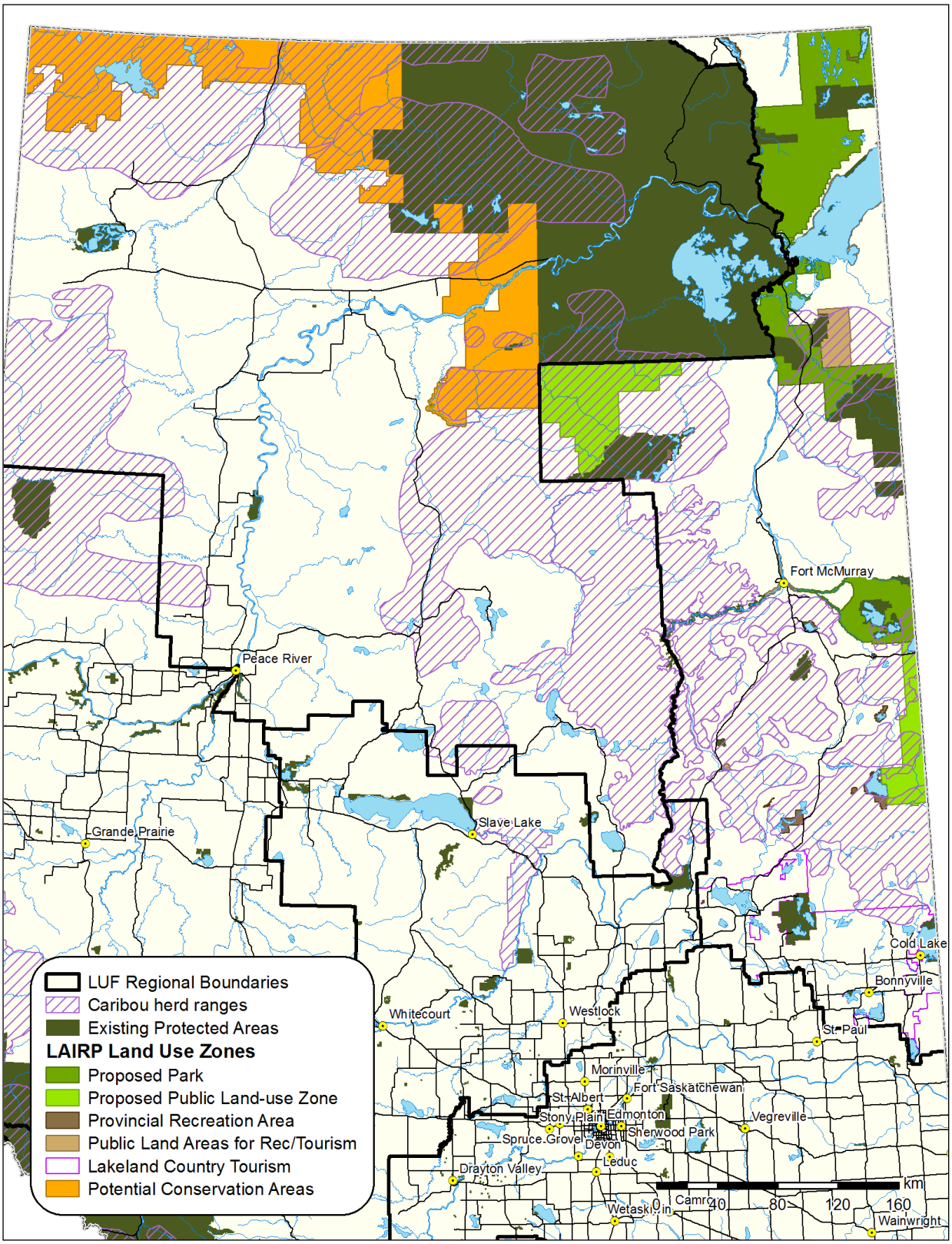
Map 2 shows the caribou herd ranges in northern Alberta, the LARP boundary, existing protected areas and Government of Alberta proposed Land Use Zones, including Proposed Parks, Proposed Public Land-use Zones, Public Land Areas for Recreation and Tourism and Lakeland County Tourism (the Potential Conservation Areas on the map are outside LARP).

Existing protected areas within LARP total 5,875 km^2, or 6.3% of the LARP area. Of these protected areas, 2,650 km^2 of these occur within caribou ranges and occupy 2.8% of the caribou ranges in LARP.

It is not known which of the proposed Land Use Zones will have sufficient legal and policy protections to enable the conservation of caribou within their boundaries as such details were not included in the Government's announcement. Assuming that Proposed Parks alone may have sufficient legal and policy protection to enable the conservation of caribou within their boundaries, this zone totals 9,902 km^2, which is 10.6% of the LARP area or 3.9% of the caribou ranges within LARP (Table 1). 87,071km^2 of the caribou ranges within LARP will remain unprotected (93.3% of all the caribou ranges in LARP).

Table 1. Area (ha) of proposed Land Use Zones in LARP and woodland caribou herds and ranges.

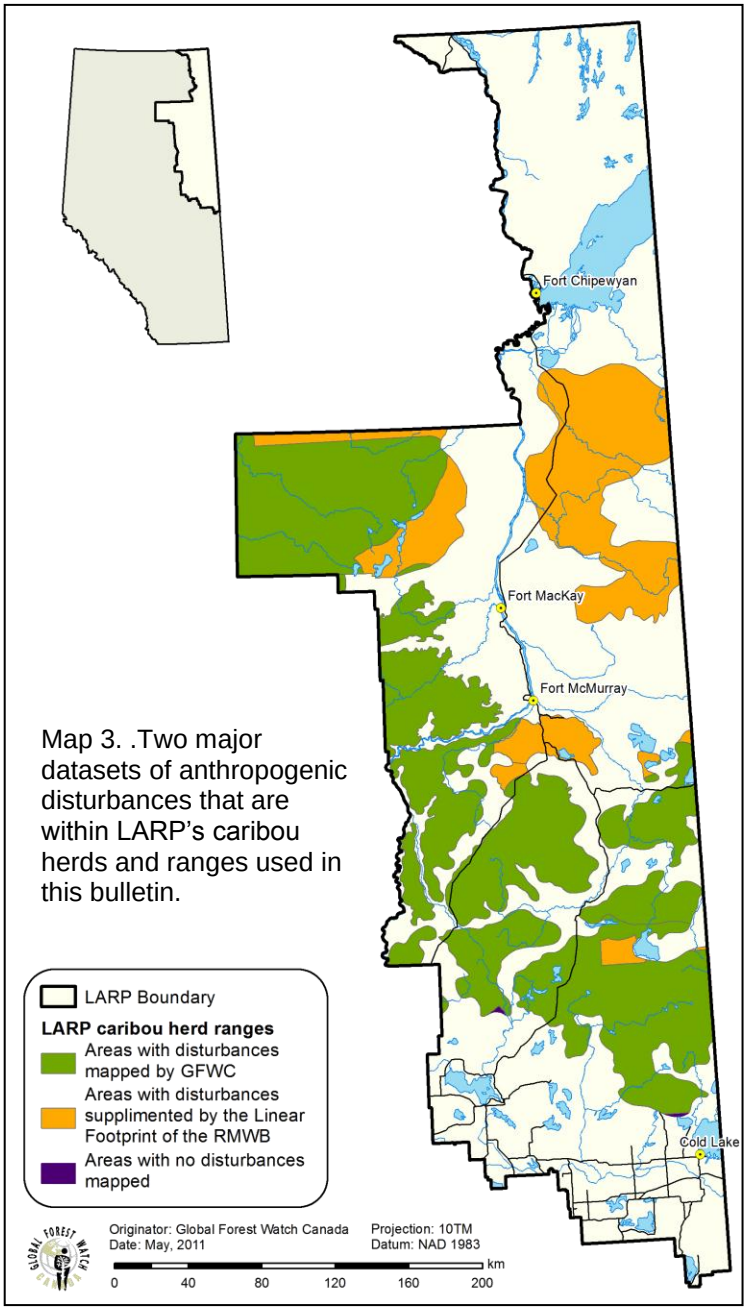
HERD RANGE	HERD	Total Area within LARP (ha)	Provincial Recreation Area	%	Proposed Park	%	Proposed Public Land-use Zone	%	Public Land Areas for Recreation/Tourism	%	Lakeland County Tourism	%
Cold Lake	Cold Lake	672,422	19,927	3.0	0	0.0	31,886	4.7	0	0.0	29,613	4.4
ESAR	Agnes	47,098	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Algar	331,072	3,802	1.1	9	0.0	0	0.0	0	0.0	0	0.0
	Bohn	174,047	0	0.0	25,184	14.5	29,259	16.8	0	0.0	0	0.0
	Christina	113,278	0	0.0	0	0.0	24,073	21.3	0	0.0	0	0.0
	Egg-Pony	374,996	420	0.1	0	0.0	0	0.0	896	0.2	0	0.0
	Wandering	33,797	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Wiau	166,203	0	0.0	0	0.0	0	0.0	48	0.0	0	0.0
Red Earth	Red Earth	920,876	2,691	0.3	0	0.0	351,952	38.2	0	0.0	0	0.0
Richardson	Richardson	707,349	0	0.0	125,581	17.8	0	0.0	64,328	9.1	0	0.0
WSAR	WSAR	316,127	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total Caribou Range		3,857,264	26,840	0.7	150,774	3.9	437,170	11.3	65,272	1.7	29,613	0.8
Non-Caribou Range		5,466,577	27,987	0.5	839,414	15.4	80,033	1.5	21,082	0.4	944,545	17.3
		9,323,842	**54,827**	**0.6**	**990,189**	**10.6**	**517,204**	**5.5**	**86,353**	**0.9**	**974,157**	**10.4**



Map 2. Land Use Zones Proposed by the Government of Alberta in their LARP announcement.

What is the state of woodland caribou within LARP?

Methodology to determine amount of industrial and fire disturbances within woodland caribou ranges within LARP



Map 3. .Two major datasets of anthropogenic disturbances that are within LARP's caribou herds and ranges used in this bulletin.

The tool that this bulletin is based on is the approach that has been identified by the recent Federal Science Advisory Group (SAG) in their 2008 report to Environment Canada, the "*Scientific Review for the Identification of Critical Habitat for Woodland Caribou, Boreal Population in Canada*,"[3] which established the strong negative relationship between range disturbance and calf recruitment and undertook the meta-analysis of studied populations across the Boreal Forest in Canada. This work demonstrated that populations that experience more disturbance, due to forest fires and industry, show lower calf recruitment. Recruitment (the ratio of calves per female) is a known indicator of growth or decline of caribou populations.[4]

The SAG approach followed Sorensen et al. (2008),[5] where the relationship between calf recruitment and range condition was evaluated by comparing three candidate models: (a) fire disturbance, (b) anthropogenic disturbance (including, for example: roads, reservoirs, railroads, croplands, settlement areas, and cutblocks), and (c) both fire and anthropogenic disturbance. The third candidate model of fire plus anthropogenic disturbance, or "Total Disturbance" proved to be the most predictive indicator of population viability. This relationship between total disturbance and calf recruitment can serve as a reasonable

surrogate for understanding the pressures on a local range by combining recent (<50 years) disturbances from fire, together with buffered anthropogenic disturbances[1] to obtain a total disturbance footprint within the range. From this can be estimated the probability of persistence of populations of woodland caribou. It should be recognized that there is some uncertainty in forecasting caribou impacts based on landscape condition.[6]

This bulletin used two primary datasets of anthropogenic disturbances: 1) The steps and process involved in mapping of anthropogenic disturbances by Global Forest Watch Canada, using Landsat satellite imagery was the base data source, accompanied by ancillary datasets, and is outlined in detail in: **Process Documentation: Anthropogenic Disturbance Mapping in Woodland Caribou (Rangifer tarandus caribou) Boreal Herd Ranges in the Lower Athabasca Regional Plan area**, available on request from info@globalforestwatch.ca. (Figure 1 shows an example of mapping of industrial disturbances.) 2) The steps and process involved in mapping anthropogenic disturbances by the Cumulative Environmental Management Association, using SPOT satellite imagery as the base data source, is outlined in detail in the document "*Mapping the Linear Footprint in the Regional Municipality of Wood Buffalo*."

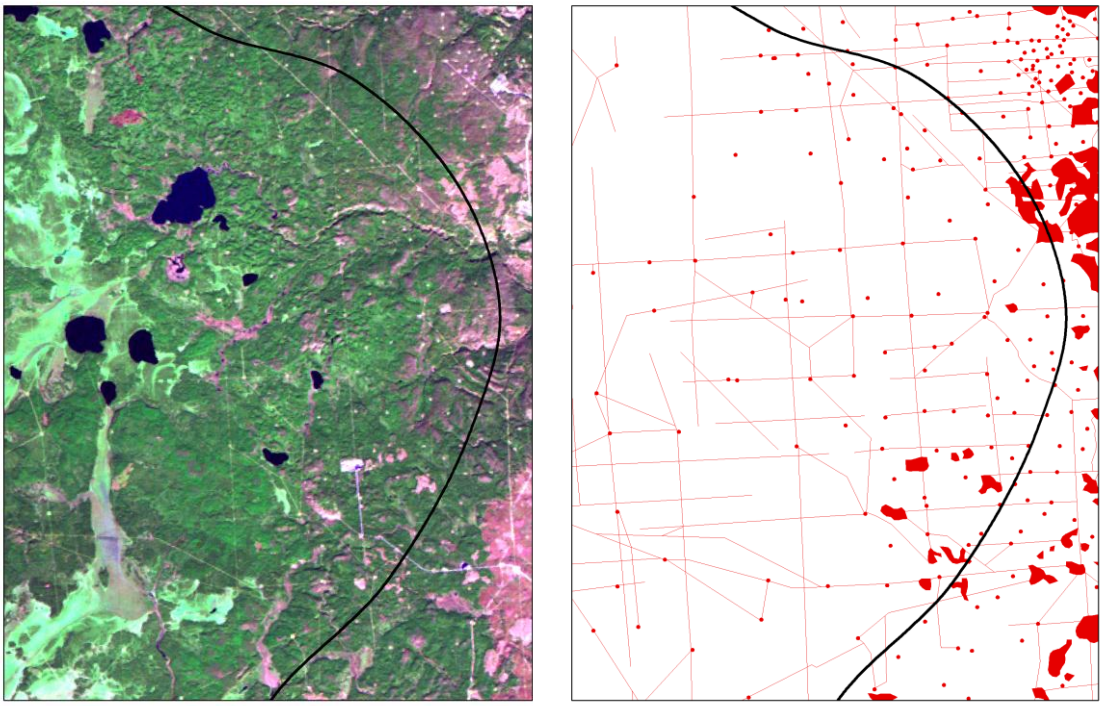
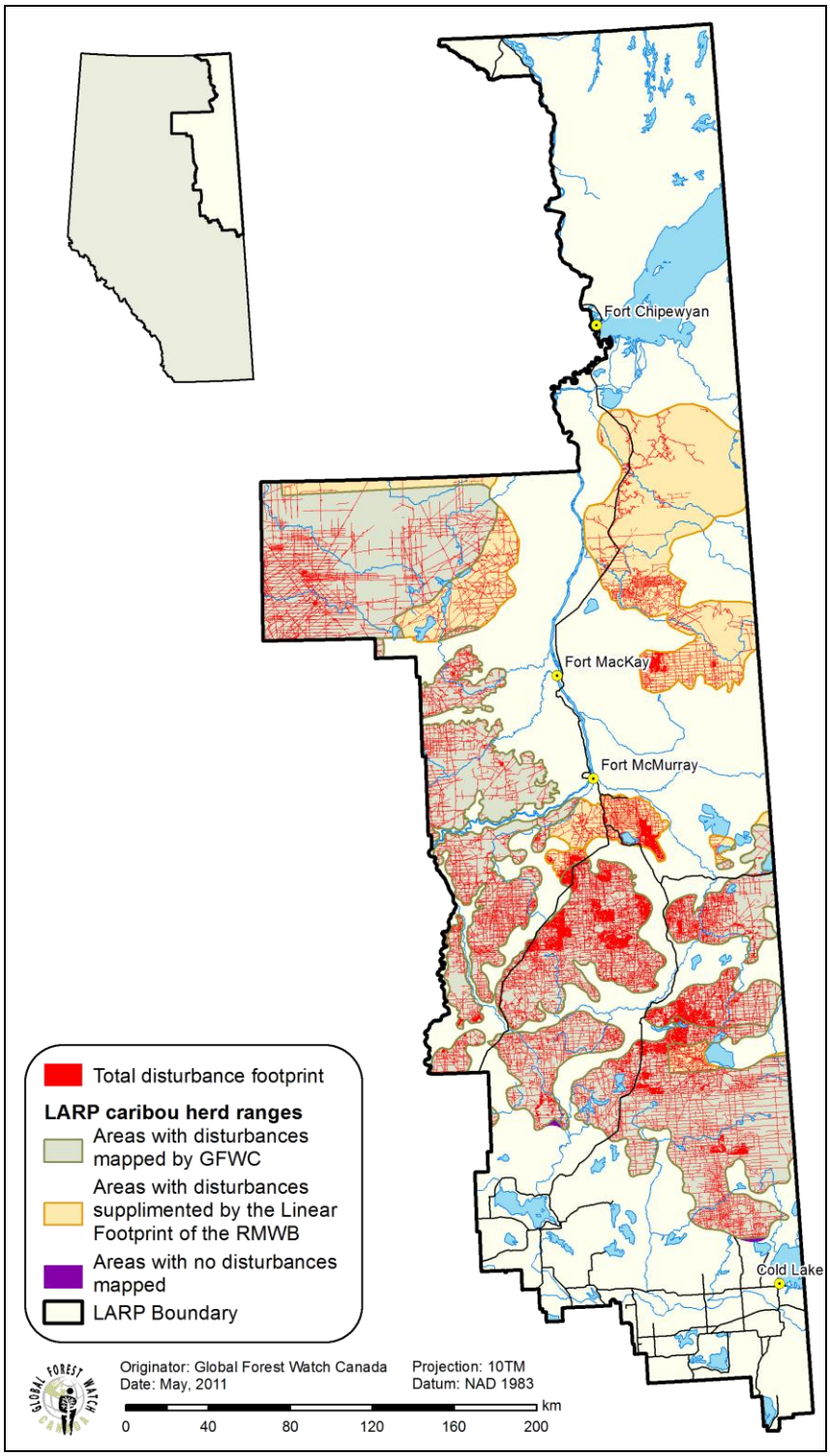


Figure 1. Industrial disturbances 2010 (left) from Landsat 5 (Path 41, Row 21; colour infrared bands 5,4,3) and extracted in right for site at eastern edge of Egg-Pony caribou herd range (black line).

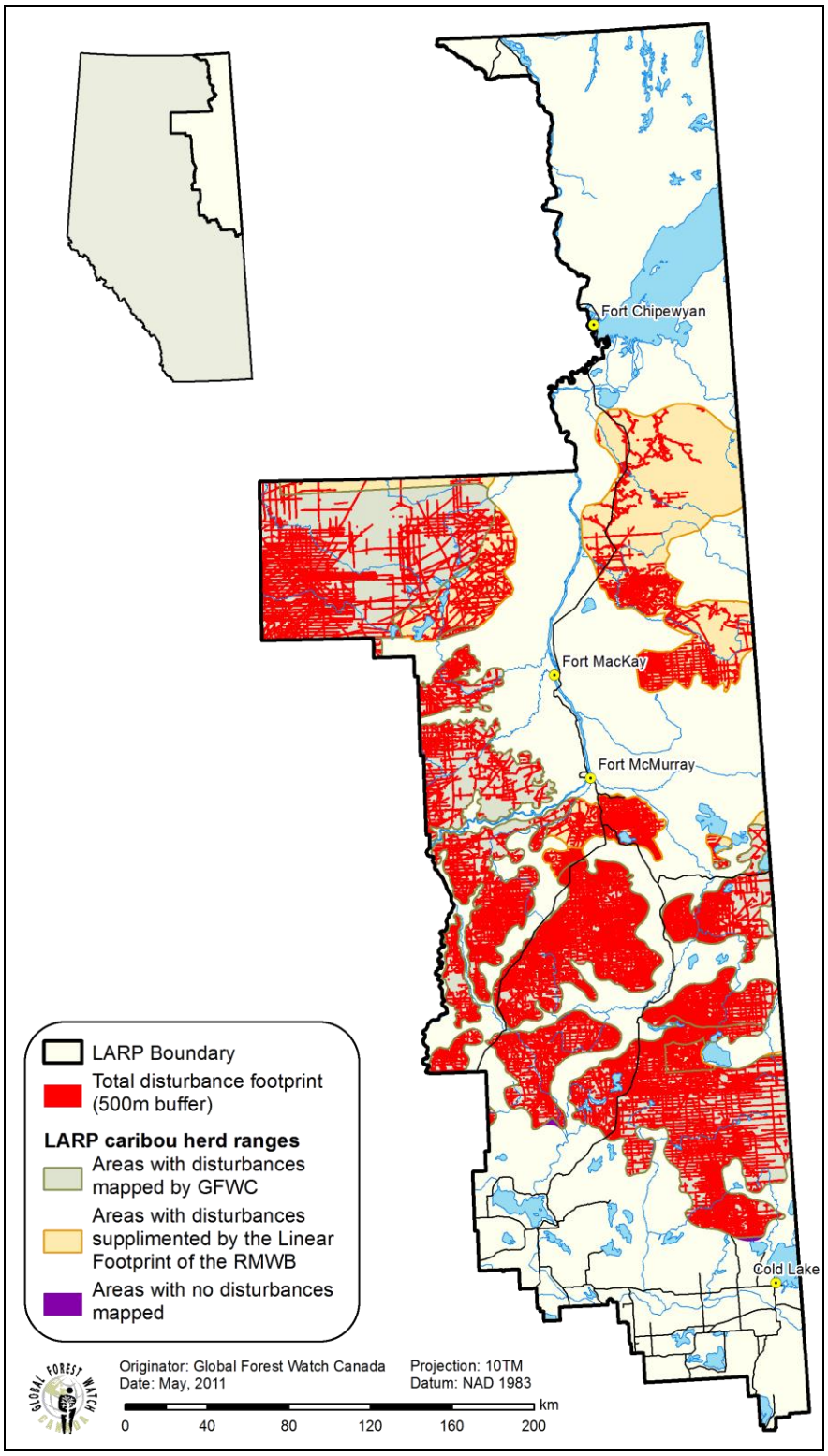
[1] Anthropogenic disturbances were buffered 500 m as consistent with *Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada. August 2008. Ottawa: Environment Canada. 72 pp. plus 180 pp Appendices*

Results

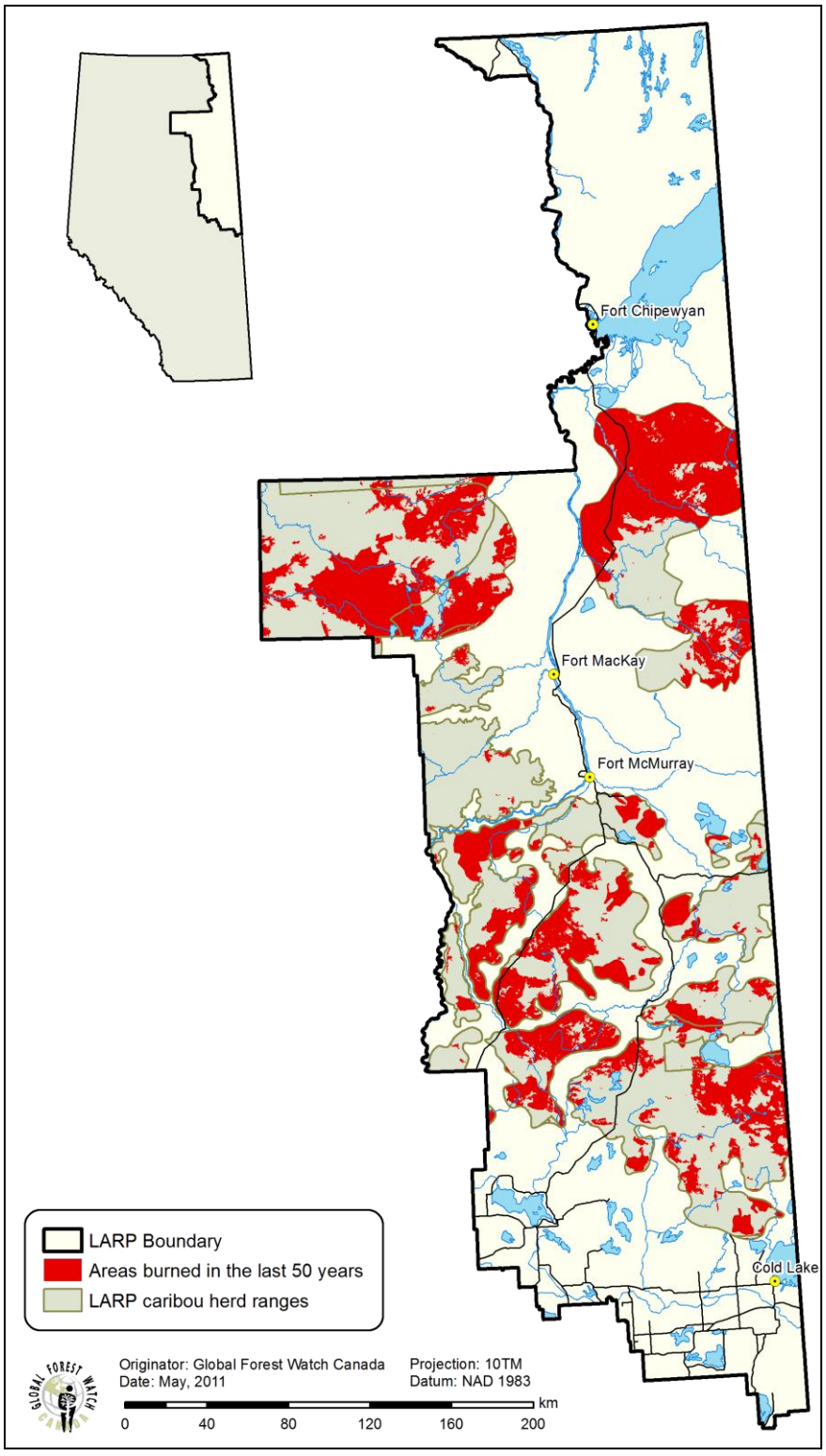
Maps 4 to 7 below and next pages show the anthropogenic and fire disturbances in the ranges of the 11caribou herds that are within the LARP area.



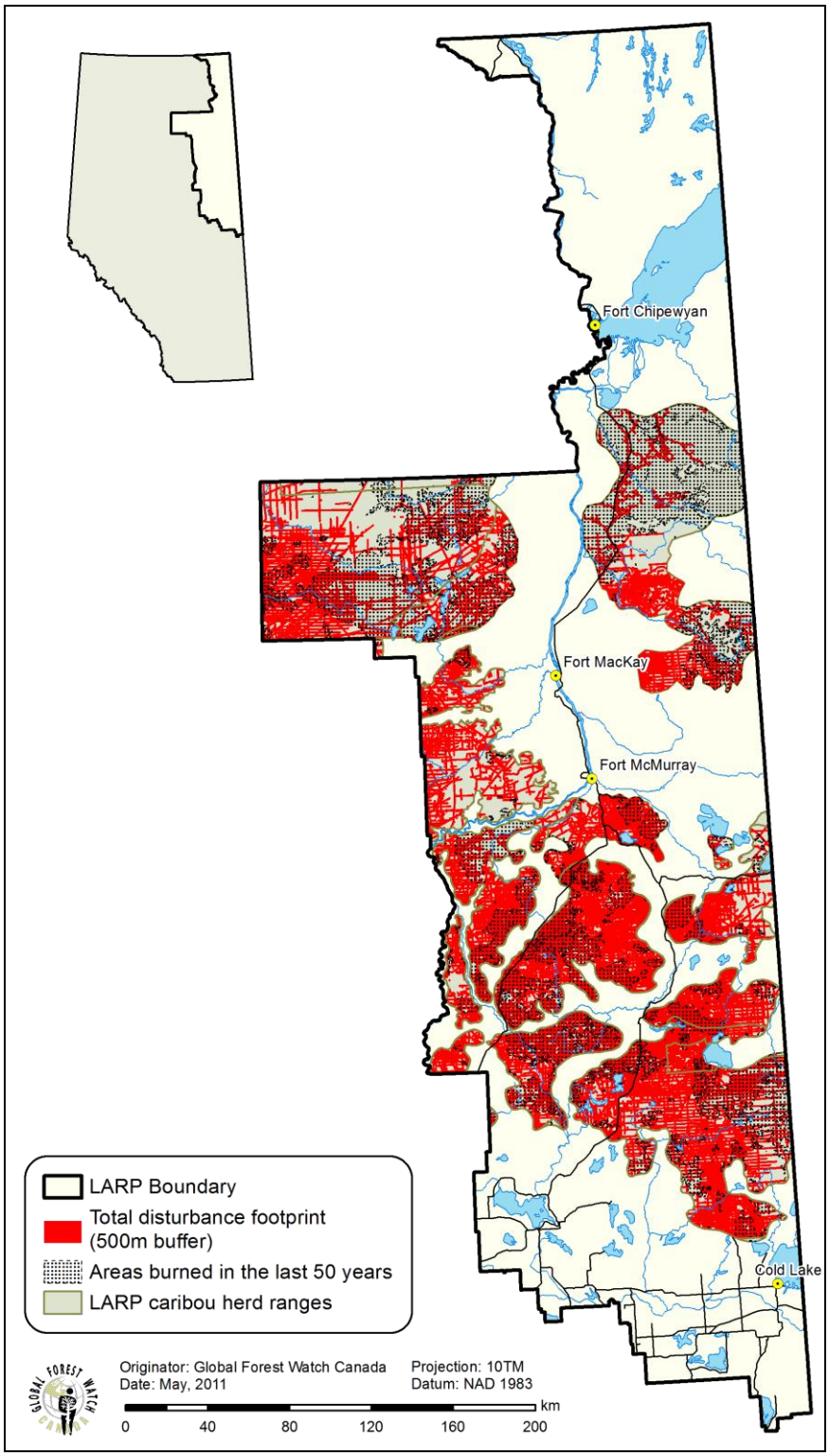
Map 4. Total anthropogenic disturbance footprint in caribou herd ranges that are within LARP.



Map 5. Total anthropogenic disturbance footprint (with 500 m buffer) in caribou herd ranges that are within LARP.



Map 6. Total fire (<50 years) disturbance footprint in the caribou herd ranges that are within LARP.



Map 7. Total anthropogenic (as of 2010) and fire (<50 years) disturbance footprint in the caribou herd ranges that are within LARP.

Table 2 (below) lists the amount of anthropogenic (buffered by 500 m) and fires, plus combined non-overlapping disturbances of each of the ranges of these herds. Two of the 11 herds have more than 90% of their ranges disturbed (Wiau at 93.4% and Egg-Pony at 92.3%); eight of the 11 herds have more than 75% of their ranges disturbed (above plus Wandering at 86.9%, Algar at 85.5%, Christina at 84.6%, Cold Lake at 84.0%, Richardson at 82.8% and Agnes at 77.3%).

The 11 herds have 75.5% of their herd ranges disturbed (anthropogenic buffered by 500 m plus fire).

Table 2. Disturbance area (fire <50 years + anthropogenic as of 2010) in caribou herd ranges that are within LARP.

HERD	RANGE	LARP herd area (ha)	OUTSIDE herd area (ha)	Disturbance area buffered by 500 m (ha)	%	Fire disturbance area (ha)	%	Total disturbance area (ha)	%
Agnes	ESAR	47,051	0	34,846	74.1	7,398	15.7	36,357	77.3
Algar	ESAR	330,847	0	243,363	73.6	140,815	42.6	282,926	85.5
Bohn	ESAR	174,123	0	94,293	54.2	36,841	21.2	105,756	60.7
Christina	ESAR	113,321	0	91,597	80.8	32,944	29.1	95,918	84.6
Cold Lake	Cold Lake	672,586	1,579	487,863	72.5	222,452	33.1	563,484	84.0
Egg-Pony	ESAR	374,826	0	318,189	84.9	179,399	47.9	346,021	92.3
Red Earth	Red Earth	919,747	0	296,317	32.2	392,131	42.6	577,565	62.8
Richardson	Richardson	707,390	0	232,318	32.8	459,749	65.0	585,484	82.8
Wandering	ESAR	33,763	0	28,882	85.5	3,231	9.6	29,346	86.9
Wiau	ESAR	166,101	1,538	136,580	82.2	108,629	65.4	153,739	93.4
WSAR	WSAR	315,825	0	132,829	42.1	12,746	4.0	140,247	44.4
TOTAL		**3,855,580**	**3,116**	**2,097,077**	**54.4**	**1,596,334**	**41.4**	**2,916,842**	**75.7**

Potential implications to these woodland caribou of these levels of disturbances

Environment Canada's 2008 Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada provides direction on the habitat required for persistence of boreal caribou local populations through assessment of measurable criteria of population and habitat condition for each local population range. Three measurable criteria related to persistence probability were assessed in Environment Canada's 2008 Scientific Review: 1) *population trend*, an indicator of whether a population is self-sustaining over a relatively short measurement period; 2) *population size*, an indicator of the ability of a population to withstand stochastic events and persist over the long-term; and 3) *range disturbance*, an indicator of the ability of a given range to support a self-sustaining local population.

These three criteria – population trend, population size and range disturbance – represent three lines of evidence used to evaluate local population ranges relative to their potential

to support self-sustaining populations. Of the ranges containing 10 of the 11 herds for which there is population data (all except Richardson), all are demonstrating population declines.

For this bulletin, we assumed that the mapped disturbance data may provide a powerful indication of the probability of each of these caribou herds to support self-sustaining populations, while recognizing that there is some uncertainty in forecasting caribou impacts based on landscape condition.[7] This assumption seems reasonable because Environment Canada's 2008 Scientific Review determined that the percentage of the range disturbed by a non-overlapping measure of total area burned and disturbed by anthropogenic activities explained 61% of the variation in mean recruitment rates across 24 boreal caribou populations (i.e., most of the explained variance in recruitment was attributed to the anthropogenic component of the total disturbance measure).

Based on this level of explanation in variance, we provide the following commentary on the implications to the probability of each of these caribou herds to support self-sustaining populations.

Environment Canada's 2008 Scientific Review predicted persistence probability at varying levels of total range disturbance for individual local populations. Prediction intervals around the threshold recruitment value of 28.9 calves/100 cows were used to derive the disturbance states used in their habitat assessment. The lower and upper bounds of the 50%, 70% and 90% prediction intervals defined 5 states of disturbance: Very Low, Low, Moderate, High, and Very High, corresponding to values of total disturbance associated with varying levels of persistence probability.

Of the eleven caribou herds that have ranges that are within LARP, 10 each have over 60% of their area in LARP disturbed (by fires <50 years + industry as of 2010). Eight of these ten herds each have over 75% of their area disturbed and, if this level of disturbance was consistent throughout their range outside of LARP, would therefore be in the extreme high end of the Very High Disturbance category, with a probability of persistence substantially less than 0.1. Two of these ten herds each have over 90% of their area in LARP disturbed. The 11th herd (West Side Athabasca) has 44.4% of its area disturbed, which would place it in the high end of the Moderate Disturbance category, with a probability of persistence of ~0.5, if this level of disturbance was consistent throughout its range outside of LARP.

At the current level of fire and industrial disturbances and without substantial improved conditions (e.g., halting further industrial intrusions into caribou herd ranges and establishing restoration-protection areas; rapidly restoring disturbed caribou herd ranges; preventing fires), the prospects of ten of these eleven caribou herds supporting self-sustaining local populations in LARP in the near future appear to be very, very low, and the prospect of the 11th herd supporting a self-sustaining local population in LARP in the near future appear to be 50/50. With the accelerating pace of oil, gas and bitumen activities in the region, however, the prospects of these caribou herds supporting self-sustaining populations in the near future appear to be declining rapidly.

[1] Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. August 2008. Ottawa: Environment Canada. 72 pp. plus 180 pp Appendices.
[2] Government of Alberta. 2010. Status of the Woodland Caribou (Rangifer tarandus caribou) in Alberta: Update 2010.
[3] Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. August 2008. Ottawa: Environment Canada. 72 pp. plus 180 pp Appendices.
[4] Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. August 2008. Ottawa: Environment Canada. 72 pp. plus 180 pp Appendices.
[5] Sorensen, T., P.D. McLoughlin, D. Hervieux, E. Dzus, J. Nolan, B. Wynes, and S. Boutin. 2008. Determining sustainable levels of cumulative effects for boreal caribou. Journal of Wildlife Management 72:900-905.
[6] Sleep DJH, and C Loele. 2010. Validation of a Demographic Model for Woodland Caribou. The Journal of Wildlife Management 74(7): 1508-15.12.
[7] Sleep DJH, and C Loele. 2010. Validation of a Demographic Model for Woodland Caribou. The Journal of Wildlife Management 74(7): 1508-15.12.