EFFECTS OF DELAYED SPRING GREENUP ON BIGHORN SHEEP OF THE LUSCAR AND GREGG RIVER MINES, ALBERTA

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Abstract: In 2011, spring greenup was delayed 3 weeks by unusual deep and persistent snow on the Luscar and Gregg River reclaimed mines in Alberta, resulting in higher than usual ungulate mortality. These mines are located on the east slopes of the Northern Rocky Mountains where Chinook winds typically clear winter ranges of snow throughout the winter providing excellent winter range for bighorn sheep (*Ovis canadensis*) and other ungulates. Sheep using these areas are under high predation pressure from numerous large carnivores. Records of bighorn sheep mortality for the spring of 2011 were obtained from systematic ground surveys conducted by mines personnel and from incident records provided by Alberta Environment and Sustainable Resource Development. Known mortality and causes are summarized, and compared to fall survey results. As expected, winter mortality was highest in the oldest ram classes, and the 2011 lamb crop did poorly (30 lambs:100 ewes in fall 2011). Ewe numbers in the fall of 2011 were similar to those in 2010 and annual survival of lambs born in 2010 was good (55% measured in the fall of 2011).

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Key words: Alberta, bighorn sheep, greenup, Gregg River Mine, Luscar Mine, mortality, *Ovis canadensis*.

In west-central Alberta, the spring of 2011 was characterized by a more than usual persistent snow pack which delayed spring greenup by 3 weeks into the end of April. This is an area where the Chinook wind normally ablates the snow pack and makes forage easily available to grazing ungulates throughout the winter; greenup usually begins on south-facing slopes and valley bottoms in early April. The effect of this delayed greenup on mortality of various age classes of bighorn sheep was examined. A similar but less intense event occurred in the spring of 2002 which resulted in high mortality of older bighorn (*Ovis canadensis*) rams, and in poor survival of lambs born in 2002.

Weather is often cited as contributing to ungulate mortality, especially affecting juvenile survival in dense populations (Portier et al. 1998) and adult survival in exceptional circumstances (Rughetti et al. 2011). Bighorn sheep are not well adapted to deep and crusted snow and are found on south-facing or windblown slopes next to escape terrain in winter. Bighorn sheep exhibit strong sexual dimorphism. Males have higher energy requirements and adopt riskier reproductive strategies than females to achieve high dominance rank to achieve reproductive success. Rams enter the winter period in a weakened state due to the rut as compared to ewes. It is therefore expected that harsh winter and spring weather would affect mature or older rams more than females. Rughetti et al. (2011) documented elevated mortality in adult chamois of both sexes in response to harsh winter conditions. Higher ewe mortality was not expected for the Luscar and Gregg River mine population of bighorn sheep. It is thought that ewes experiencing nutritional stress at critical times of year will redirect resources from the lamb therefore a low survival of lambs born in the spring of 2011 was expected through incomplete gestation or high neonatal mortality.

STUDY AREA

Climate and Physical Characteristics

Bighorn sheep have colonized reclaimed lands associated with two open pit coal mines in west-central Alberta in an area known as the Coalbranch. The reclaimed mines (Teck Coal Corporation, Cardinal River Operations, Luscar Mine and Coal Valley Resources Ltd. Gregg River Mine) are located in the Subalpine Natural SubRegion in the Front Ranges of the Canadian Rocky Mountains. Climate is characterized by

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cool, wet and short summers and long, cold winters with heavy snows. Precipitation tends to be greater and winter temperatures more moderate in the Central Ranges than along the eastern slopes of the Front Ranges where the Luscar and Gregg River mines are located (Natural Regions Committee 2006:57). Elevation varies from 1680 m to 1860 m (5512–6102 ft). Topography is rugged, with slopes of varying aspect and angles. Benched high walls, an artifact of open pit mining, have been maintained in strategic areas to provide escape terrain for bighorn sheep in proximity to reclaimed grasslands (MacCallum and Geist 1992). Other design features have been incorporated into the landscape to achieve the end land use goal of providing wildlife habitat. In most years, snow cover is present from November through to April. This study area is located in a major wind corridor (Natural Regions Committee 2006:20) and is characterized by the Chinook; a dry warming wind descending on the east side of the Rocky Mountains primarily in Alberta and Montana. The Chinook can occur year round but its effects are most pronounced in winter when temperature increases of 25^0 C or more within a few hours are possible. The Chinook winds frequently remove snow cover thus ameliorating winter's effects by providing easy access to forage throughout the winter for grazing animals. Spring greenup normally begins in April on south-facing slopes and valley bottoms.

Population

Bighorn sheep on the Luscar and Gregg River mines have been monitored since 1985 and 1989 respectively (MacCallum 2006). These sheep are characterized by large body size, good lamb:ewe ratios, and high density (MacCallum 2006). The maximum fall count on the two mines for the 10 years between 1992 and 2001 varied between 390 and 808 bighorn sheep. Between 2002 and 2011 maximum fall count varied between 798 and 1,065 bighorn sheep (Teck Coal Ltd., Cardinal River Operations annual reports). In the last 20 years, annual population growth rates have varied from a 6.6%–9.7% gain per year for the 10 year period from 1992 to 2001, and a 5.8%–7.3% gain per year in the 10 years between 2002 and 2011. Variable rates of reclamation, an increasing elk (*Cervus elaphus*) population, continuing predation pressure, stochastic weather events, and other factors influence population growth rates on the two mines.

METHODS

Weather Data

Weather data were obtained from Alberta Agriculture and Rural Development long-term climate records available on the web. Maps of snow pack accumulation in stubble fields relative to long term normals were obtained from: agriculture.alberta.ca/acis/Alberta-climate-maps.jsp). Long-term and accumulated precipitation (mm) and long-term and average temperature (at 2m ^{0}C) were obtained from 4 stations located nearest the eastern slope of the Rocky Mountains (http://agriculture.alberta.ca/acis/alberta-weather-data-viewer.jsp). Stations were Hendrickson Creek, Jasper Warden Station, Southesk and Job Creek.

Mortality

Population parameters for the bighorn populations on the Luscar and Gregg River mines were generated annually by means of systematic visual ground surveys carried out throughout the year. Mortality records were used to correct the fall count to generate demographic statistics. Fall was used rather than spring as bighorns were more dispersed in the spring and the highest counts occurred in the fall. Mortality records were collected by mine staff, contractors, and Alberta Justice and Solicitor General officers for various purposes. Alberta Justice and Solicitor General collected the heads of the larger rams and registered them. Mortality records included information on species, age, location, date of death, and cause of death: (unknown; natural - including winter kill; predation by grizzly (*Ursus arctos*), wolf (*Canis lupus*), coyote (*C. latrans*), cougar (*Puma concolor*); unknown predation; vehicle collision with train; vehicle collision with heavy or light vehicle; capture for export; capture for Fish and Wildlife purposes – research and collection; accident – miscellaneous human caused death; and illegal). Mortality records were as complete as observation and collection allowed but represented only known mortality; mortality

was underestimated, particularly for smaller bodied sheep.

RESULTS

Snow Pack

Snow pack accumulations in stubble fields relative to long term normals indicated that very high to extremely high snow pack conditions begin late January 2011 in Yellowhead County where the mines are located (Fig. 1). This condition persisted locally in Alberta through February and March but in April 2011 (Fig. 2) expanded to include the whole of the eastern slope from the Montana border to the northern extent of the Rockies in Alberta. By April 20, 2011 when the rest of the province showed near normal snow pack accumulation, the east slope was characterized by very high and extremely high snow conditions.

Precipitation

Accumulated precipitation for the four weather stations indicated that precipitation between November 2010 and April 2011 was near normal when compared to long term normals for the Hendickson Creek and Job Creek stations (Fig. 3).

Air Temperature

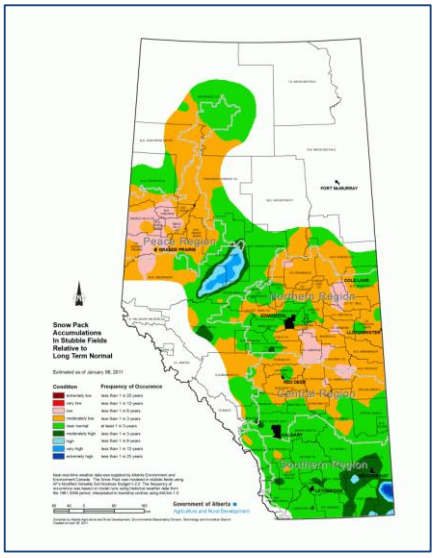
Air temperatures in the early part of winter 2010–2011 were normal for the four weather stations but plunged below normal in mid February 2011 and stayed low throughout March and April, 2011 (Fig. 4). The Chinook winds, which are accompanied by a rise in temperature, did not occur and the accumulated snow pack persisted through most of April delaying greenup until the very end of April and early May.

Mortality

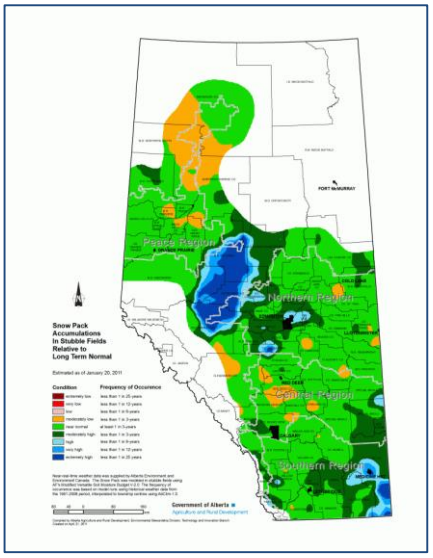
Twenty-seven mortality records were collected for bighorn sheep on the Luscar and Gregg River mines between January 1, 2011 and April 30, 2011 (Fig. 5). Cause of death in 2011 was cougar (44%), natural (22%) unknown (15%), wolf (11%), unknown predation (4%), and train (4%). Seventy-8% of these mortalities were older rams (Class III and IV), 7% Class II rams, 7% unclassified rams, 4% ewes and 4% lambs. Highest mortality occurred in the first two weeks of February and again in the first two weeks of April (Fig. 6 - two mortalities occurred in January, eight in February, six in March and eleven in April). Total mortality from January to April 2011 represented 2.5% of the 2010 total fall population, older ram mortality represented 7.9% of the Class II-IV fall count, and nursery herd mortality represented 0.32% of the fall nursery herd (Table 1). Annual survival of lambs (measured from fall 2010 to fall of 2011) was 55% indicating good survival through the winter of 2011. The number of ewes in the fall of 2011 (384) was similar to the fall of 2010 (391). The lamb:ewe ratio in the fall of 2011 representing those lambs born immediately after the prolonged spring of 2011 was 30:100. This was the lowest lamb:ewe ratio reported since surveys began in 1985; the fall lamb:100 ewe ratio for the 10 years previous to 2011 (2001–2010) was 49:100. The severe winter of 2010–2011 was not confined to the Alberta east slopes. Populations of pronghorn (*Antilocapra americana*) and deer in southeastern Alberta (*Odocoileus hemionus* and *O. virginianus*) were also affected by cold temperatures and persistent snow pack (Figs. 1 and 2). As a result, harvest goals for pronghorn and deer in most prairie Wildlife Management Units were adjusted downward for fall 2011 (D. Eslinger, Alberta Fish and Wildlife, personal communication). High levels of mortality were also reported for pronghorn, elk, and deer in pockets of Montana, Wyoming and Idaho during the winter of 2010–2011 (Long 2011, Zuckerman 2011).

DISCUSSION

The absence of the Chinook and persistent cool temperatures in the winter and spring of 2011 resulted in limited access to forage for bighorn sheep on the Luscar and Gregg River mines at this critical time of the year. Even though the timing of mortality through the winter of 2011 was similar to that through the winters of 1992–2010, a higher proportion of older rams relative to the numbers of rams present in the fall died during the winter and spring of 2011 than in previous years. Ewe numbers in the fall of 2011 were similar to those in the fall of 2010. Lambs born in the spring of2010 survived the winter reasonably well as indicated by an annual survival rate of 55% measured in the fall of 2011. The lamb:ewe ratio in the fall of 2011 was the lowest in 20 years



January 6



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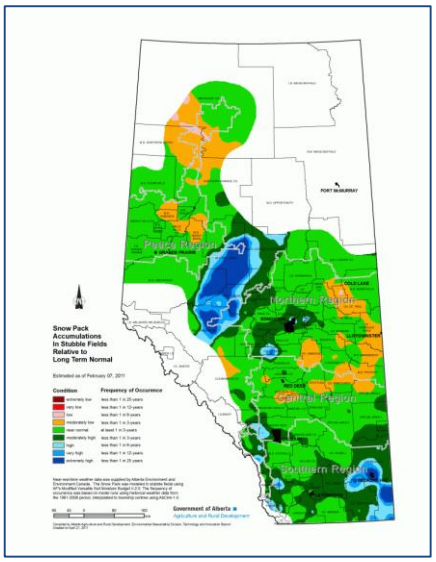

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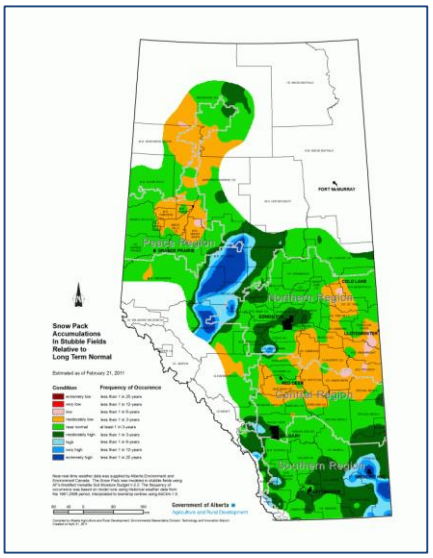

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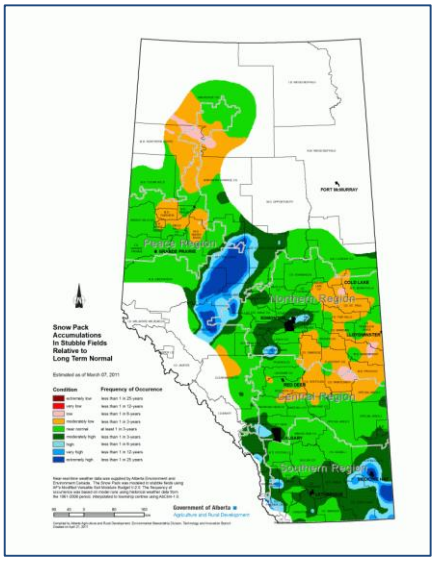

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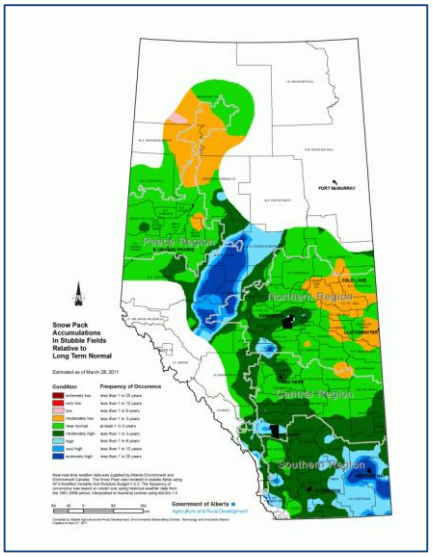
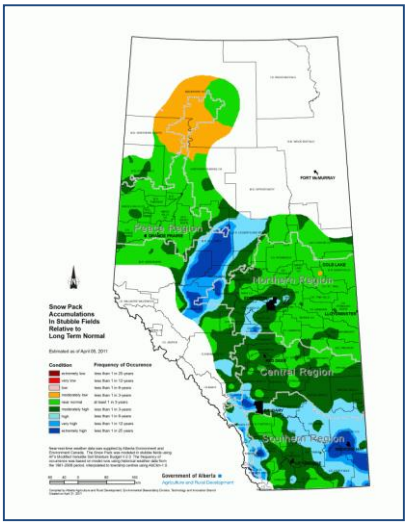
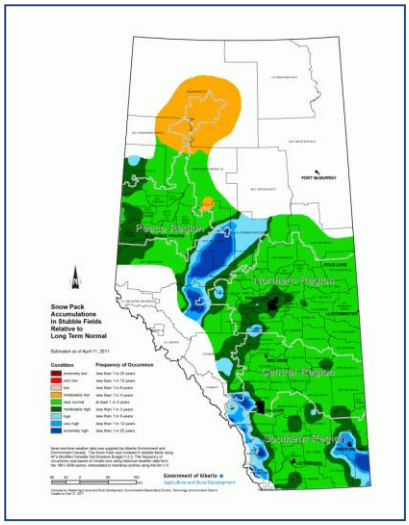


March 28

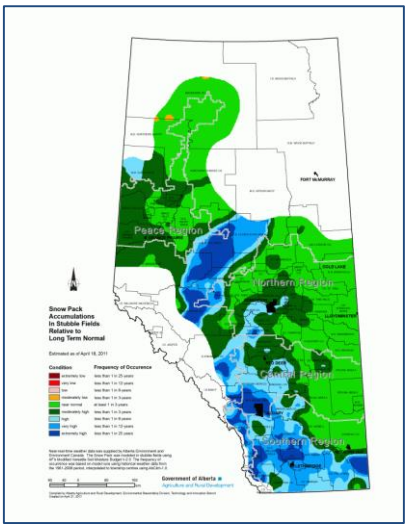
Fig. 1. Snow pack accumulations in stubble fields relative to long-term normals (low – red to high – blue) in Alberta, January through March 2011.



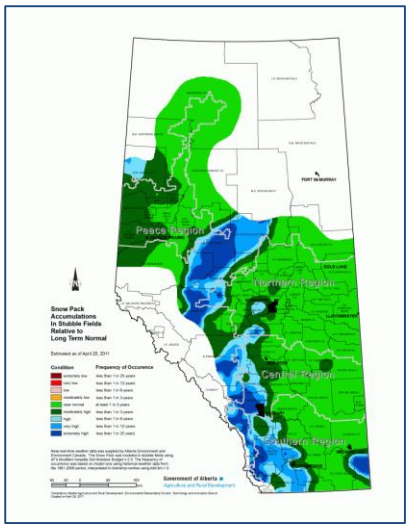
April 5



April 11



April 18



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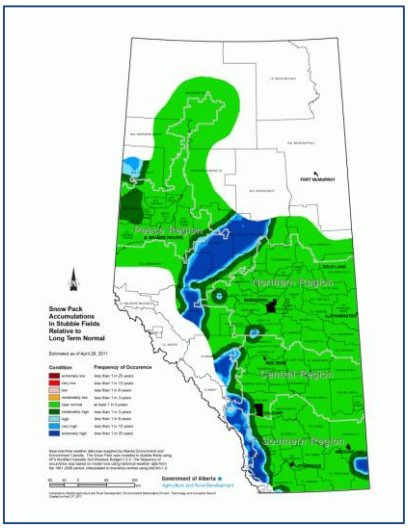

April 26

Fig. 2. Snow pack accumulations in stubble fields relative to long-term normals (low – red to high – blue) in Alberta, April 2011.

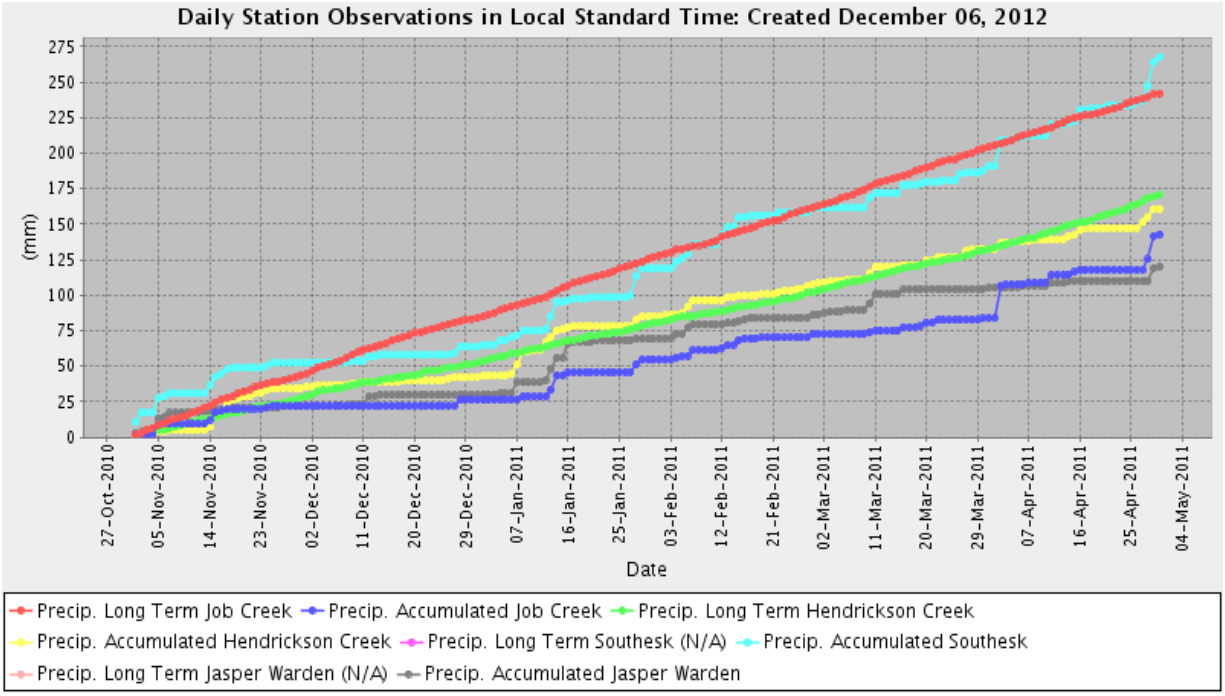

Fig. 3. Long term and accumulated precipitation for 4 stations in the northern Alberta Rocky Mountains, October 27, 2010 to May 4, 2011.

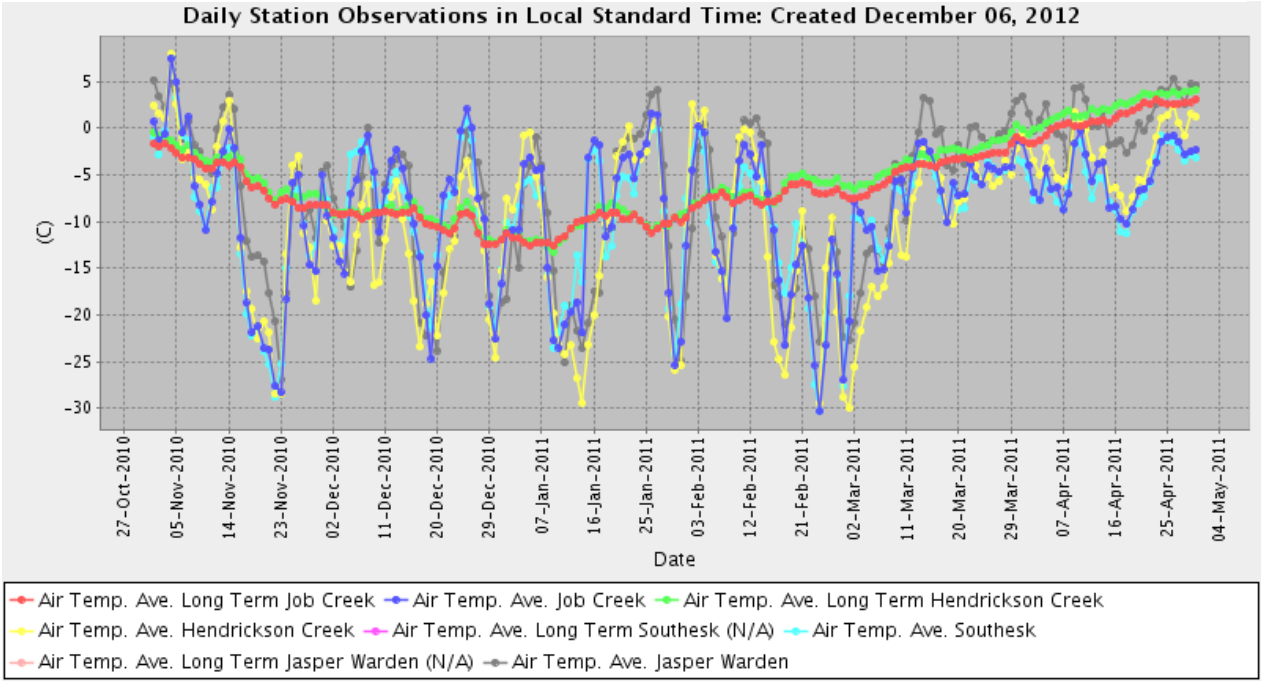

Fig. 4. Long term and average air temperature for 4 stations in the northern Alberta Rocky Mountains, October 27, 2010 to May 4, 2011.

indicating poor survival of lambs born in the spring of 2011 following the hard winter and prolonged spring.

A similar weather event occurred in the winter of 2002 with similar results, i.e., a higher proportion of rams dying than previous years, good lamb survival through the winter but poor lamb:ewe ratios the following fall (Bighorn 2003).

Conditions in 2002 were described as “snow and cool weather continued through March, April,

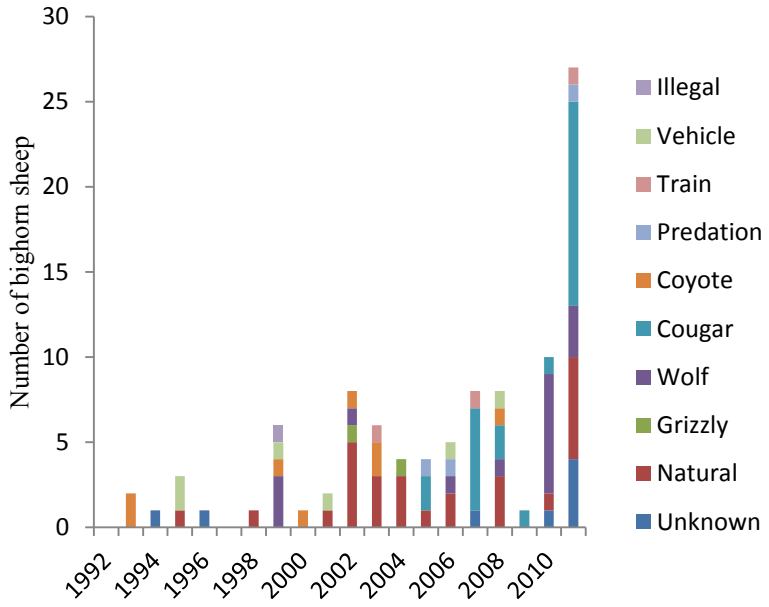

Fig. 5. Total bighorn sheep mortality and causes between January 1 and April 30, 1992–2011, Luscar and Gregg River mines.

and well into May. Both the March 8 and April 12 surveys were conducted in deep snow condition. Sheep appeared to be confined to favoured slopes and were not able to use greenup in the valley bottoms that usually becomes available in April".

These observations support predictions of higher mortality of older age rams in response to a prolonged winter, and highlight the importance of spring weather on the survival of lambs in a northern climate, as has been identified by Portier (1998) and others.

ACKNOWLEDGEMENTS

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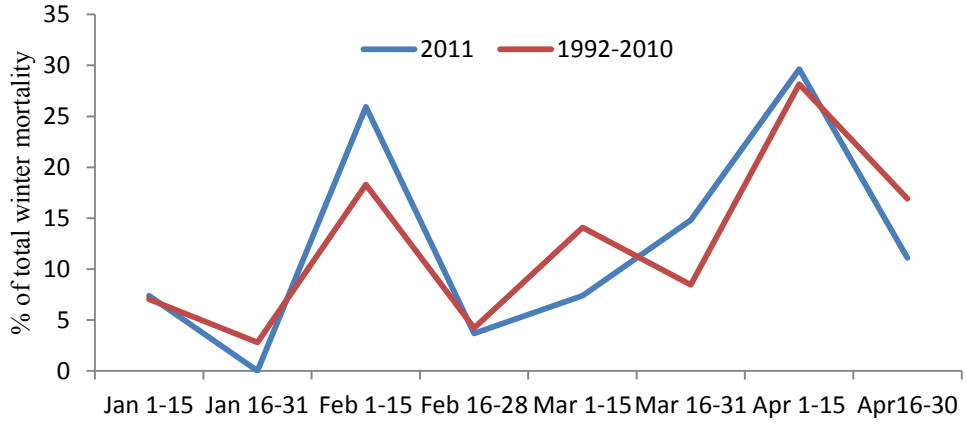

Fig. 6. Bighorn sheep biweekly mortality as a percentage of total winter (January 1 to April 30) mortality, Luscar and Gregg River mines.

Table 3. Percent bighorn sheep winter mortality (January to April) of the previous fall population. Mortality is from all causes except for translocation and collection removals. The category Ram includes Class II, III, and IV sheep; Nursery includes ewe, lamb, yearling, and Class I ram.

Year	% All Mortality: Fall Population	% Ram Mortality: Fall Rams	% Nursery Mortality: Fall Nursery
1992	0.00	0.00	0.00
1993	0.51	0.00	0.56
1994	0.21	0.00	0.27
1995	0.54	1.05	0.25
1996	0.17	0.00	0.29
1997	0.00	0.00	0.00
1998	0.16	0.38	0.00
1999	0.75	1.36	0.41
2000	0.13	0.00	0.22
2001	0.27	0.34	0.19
2002	0.99	2.39	0.20
2003	0.75	0.64	0.68
2004	0.44	0.91	0.20
2005	0.48	1.21	0.00
2006	0.51	1.25	0.13
2007	0.75	2.11	0.16
2008	0.83	1.95	0.14
2009	0.09	0.25	0.00
2010	0.89	2.51	0.14
2011	2.54	7.86	0.32
ALL	0.63	1.38	0.20

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