PEACE REGION
LEAST-RISK TIMING WINDOWS: BIOLOGICAL RATIONALE



October 2009

BRITISH COLUMBIA
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EXECUTIVE SUMMARY

Because of the potential impacts of disturbance on a wide range of species, the Ministry of Environment (MoE) has established least-risk timing windows for the Peace Region. Least-risk windows divide a calendar year into critical, cautionary, and low risk windows based on the ecology of specific species groups. Critical and cautionary timing windows cover the time when a species is most susceptible to disturbance, and development should be avoided. Low risk timing windows are defined when species are least susceptible to disturbance; development activities should be planned for low risk windows whenever possible.

Disturbance impacts populations at both the individual and regional levels, from shifts in physiology and behaviour to alterations of range use and recruitment. Excessive, prolonged, or unfamiliar disturbance during key times can result in:

- Increased vigilance and flight responses (behavioural responses)
- Reduced foraging efficiency, body condition, and growth rates
- Interference with territory defence and mate choice (specifically songbirds)
- Increased mortality from predation, injury, disease, or climate extremes
- Physiological responses (increased heart rates, higher cortisone levels)
- Habitat shifts, including increased use of suboptimal habitat
- Delayed neonate development and abandoned nests
- Lower survival rates and life expectancies
- Reduced reproductive success and population productivity (often across years)

Critical timing windows cover breeding and rearing seasons for birds, and late winter, parturition, and early rearing for ungulates. Cautionary windows cover late rearing for some sensitive birds (sandhill cranes, trumpeter swans, and raptors) and the early winter rut period for caribou, mountain sheep, and mountain goats. Population viability is based on successful recruitment of new individuals into the breeding population, which in turn relies on the successful production of young. Reproductive success is based on a number of factors, including environment, climate, and nutrition, most of which are difficult to manage. Disturbance can also influence the reproductive success, and human disturbance can be minimized during key periods. This includes late parturition, birth, and the post-parturition period for ungulates, as well as late winter, when energetic demands of pregnant females are high and food is scarce. In birds, this period covers nest establishment, incubation, and chick development.

This document provides a biological rationale to support the temporal delineation of these least risk timing windows in the Peace Region. Note that timing windows are not legally applicable to any industrial activity unless specified on a permit; they are suggested actions to minimize adverse impacts to wildlife of management concern.

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1 MOOSE - ELK - DEER - BISON

1.1 Introduction

Moose, mule deer, white-tailed deer, and Rocky Mountain elk are relatively abundant across the Peace River Region, and are not currently listed on either Federal or Provincial Species at Risk schedules. Two subspecies of bison, plains bison and wood bison, are also found in isolated areas in the Peace Region. A population of plains bison was reintroduced approximately 30-40 years ago to the Halfway River drainage, whereas wood bison populations were reintroduced to the Nordquist Lake area in 1995 and to the Chinchaga area of north eastern BC in the late 1990s (Rowe 2006). Both subspecies of bison are currently red-listed in BC (BC CDC 2008), and the wood bison subspecies are considered threatened under the Federal Species at Risk Act Schedule 1. Wood bison were once naturally occurring in the Peace Region (Gates et al. 2001).

Ungulates occurring in the Peace River region have been identified on the Category of Ungulate Species under Section 11(3) of the *Government Actions Regulation* of the *Forest and Range Practices Act*, which allows the Ministry of Environment to designate areas critical to the winter survival of ungulates and identify General Wildlife Measures. Across the Peace Region, areas that provide the habitats and attributes required by moose, deer, elk and bison during the winter season have been identified and spatially defined. In addition, general wildlife measures associated with these areas provide the legal direction to forest and range tenure holders in order to protect the integrity of these winter habitats.

Ungulate Winter Range (UWR) areas serve to protect the most critical winter range areas, but do not provide habitat protection for other seasons or important periods such as during parturition and rearing. Moose, deer, elk and bison are currently considered stable across the region; and therefore, areas specifically used during the calving/fawning period cannot be identified under the Identified Wildlife Management Strategy under the *Forest and Range Practices Act*, which designates areas critical for the survival of Species at Risk, such as for northern and boreal ecotype woodland caribou. Least risk timing windows, including the temporal delineation of three risk categories (low, caution, and critical) associated with non-physical or sensory disturbance to moose, deer, elk and bison across the Peace Region, have been identified to ensure disturbances during critical periods are minimized and avoided where possible. The calving/fawning period, occurring approximately from early May to mid July, for moose, deer, elk and bison has been identified as ‘critical’ by the Peace Region MoE in the least risk timing window (TABLE 1).

The following information provides a biology-based rationale to support the Ministry of Environment’s (MoE) temporal delineation of these least risk timing windows in the Peace Region. Note: non-physical or sensory disturbance stimuli associated with ground/aerial mechanized activity hereafter referred to as “disturbance”.

TABLE 1. Timing windows for moose, mule deer, white-tailed deer, elk, and bison for the calendar year (January 1st to December 31st).

Species	Season	Risk Category	Timing	Management Direction
All Species	*Late Winter*	Caution	January 15 to May 14	Operation should avoid development activities during these timeframes.
Moose Mule Deer White-tailed Deer Elk	*Calving and/or Fawning*	Critical	May 15 to July 15	Development activities are not appropriate during this timeframe. Aerial activities should adhere to guidelines. In the event that working within a critical window is unavoidable, proponent should contact the Ministry of Environment, to discuss alternatives, and potential mitigation and monitoring plans.
Bison	*Calving*	Critical	April 15 to July 15	
All Species	*Summer & Early Winter*	Low	July 16 to January 14	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.

1.2 Biological Rationale - Critical Timing Window

The critical window begins in mid-May and captures the sensitive calving or fawning period for moose, deer, elk and bison (April 15 to July 15) in the Peace Region, which includes the range of possible parturition dates as well as includes the critical first month of life for offspring. Based on the scientific literature, mean calving and fawning dates for moose, elk, mule deer, and white-tailed deer, can range from mid-May to mid-June and support the designation of this critical timing window (TABLE 2). The critical timing window for bison begins one month earlier (April 15) to incorporate the earlier calving period for bison (McHugh 1958; Rutberg 1984). The critical timing window also captures the first month of life for offspring to minimize disturbance during this sensitive period when offspring are most susceptible to predation, disturbance, displacement and separation from the mother. In ungulates, birth synchrony is an important biological process that attempts to minimize environmental or energetic stress on both the female and offspring and to reduce predation to newborns (Sadleir 1973; Bunnell 1980).

Populations of ungulates are most influenced by the survival of young, and as such, most ungulates invoke certain strategies during the calving and fawning periods to minimize risk of predation and to ensure forage and other resources are available to both mother and young (Bergerud et al. 1984; Bergerud 1992; Singer et al. 1997; Bowyer et al. 1999; Phillips and Alldredge 2000; Raithel et al. 2007). For most ungulates, mortality of newborn young and survival of young to recruitment age is a greater contributor to declines in ungulate populations than is adult mortality (Allee et al. 1949; Pimlott 1967; Gaillard et al. 2000; Fuller et al. 2007; Barber-Meyer et al. 2008). In addition, for most ungulates, the highest calf/fawn mortality rates occur in the first month of life (Ballard 1992; Keech et al. 2000; Ballard et al. 2001; Pojar and Bowden 2004; Culling et al. 2006; Carstensen et al. 2009).

TABLE 2. Median and range of calving or fawning dates for moose, mule deer, white-tailed deer, elk and bison as reported in the scientific literature.

	Parturition Date		
Species	**Mean**	**Range**	**Reference**
Moose	-	May 18-June 10	Ballard et al. 1991
	-	May 19-June 8	Sigouin et al. 1997
	May 28	May 14-June 9	Poole et al. 2007
	May 19	May 12-27	Keech et al. 2000
Elk	May 28	May 16-June 10	Barber-Meyer et al. 2008
	Early: May 26	Early: May 12-June 10	Cook et al. 2004
	Late: June 19	Late: June 11-29	Cook et al. 2004
White-tailed Deer	May 30	May 26-June 2	McGinnes and Downing 1977
	May 26	May 5-June 19	Carstensen et al. 2009
Mule Deer	June 19	June 9-July 6	Pojar and Bowden 2004[a]
	July 3-14	-	Lomas and Bender 2007[b]
Bison	May 6	April 15-May 31	McHugh 1958
		March 25-September 24	Gogan et al. 2005
		May 7-June 10	Haugen 1974
		April 20-June 2	Rutberg 1984

[a] Mean capture date during fawning season (Pojar and Bowden 2004).
[b] Later birth dates likely related to poor habitat quality (Lomas and Bender 2007).

It is important that direct and indirect disturbance to calving/fawning animals be minimized during the critical reproductive period. It has been documented for most ungulates that offspring born during the preferred period (height of calving/fawning) experience lower mortality; therefore, disturbance occurring during the peak calving/fawning period can impact timing of parturition, and may decrease offspring survival (Begerud 1974; Estes 1976; Rutberg 1984; Pojar and Bowden 2004; Lomas and Bender 2007). By decreasing disturbance during the critical timing window, direct predation events as well as the factors that may indirectly increase susceptibility of reproductive females to predation during parturition can be minimized.

Although most healthy ungulate populations do not suffer from low pregnancy rates, in many ungulate species, reproductive success, which can be defined as the rate of pregnancy, rate of parturition, offspring survival, and offspring recruitment, is influenced by a combination of factors including climate, environment, and nutrition (Cook et al. 2001; Wilson et al. 2002). Climatic conditions, such as poor snow conditions and cold temperatures, which may negatively impact populations, cannot be directly managed; however, impacts to the species' environment and associated disturbance can be minimized to ensure the highest possible reproductive success. Disturbance can adversely affect ungulate behaviour and energetic balance (Murphy et al. 1987; Bradshaw et al. 1997, 1998; Simpson 2000; Dzus 2001; Frid et al. 2002; Seip et al. 2006), and increased energetic demands can be cumulative, reduce animal growth, and decrease reproduction the following spring (Dyer 1999; Cook et al. 2001; Wilson et al. 2002; Lomas and Bender 2007).

In northern climates, female ungulates entering the parturition period are usually in decreased physical condition from harsh winter conditions, which is further compounded by the lack of available and palatable forage during late winter and early spring (Schwartz 1998; Weixelman et al. 1998). In addition, pregnant females incur additional costs of a growing fetus during this physically-taxing period

(Schwartz and Hundertmark 1993). After parturition, due to high lactation demands, ungulates attain their lowest body condition during the 3 weeks post-calving (White and Luick 1984; Green and Rothstein 1991; Gustine 2005). In addition to the physiological impacts of calving/fawning, studies have shown that the physical condition of the female prior to calving can both directly and indirectly affect the survivorship of young (Sams et al. 1996; Keech et al. 2000). Females in poor physical condition can have smaller young and later birthing dates, both of which can directly result in reduced survivorship of young (Keech et al. 2000; Wilson et al. 2002). In addition to normal parturition stresses, animal response to disturbance can further decrease body condition by increased energetic costs associated with movement and reduced food intake (Bradshaw et al. 1987; Murphy et al. 1987; Simpson et al. 2000; Dzus 2001).

Further to decreasing female condition, young calves and fawns have high metabolic costs for movement and are more susceptible to energetic stress that may result from increased disturbance (Murphy 1987; Phillips and Alldredge 2000). Cows with young calves have a greater sensitivity to disturbance as young calves are more vulnerable to predation (Murphy et al. 1987; Maier et al. 1998; Dyer 1999; Mech and Peterson 2003). Disturbance during the calving/fawning period can induce fleeing, increased movement of young, increased nutritional demands, and separation from the female, which can further increase susceptibility to predation (Kuck et al. 1985; Dyer 1999; Phillips and Alldredge 2000; Frid et al. 2002). When exposed to disturbance, ungulates can evoke antipredator behaviour including habitat shifts and be forced to spend more time in suboptimal habitats that could increase mortality risk from predators (Bradshaw et al. 1997, Frid et al. 2002). A potential long-term impact of disturbance is the avoidance or abandonment of optimal habitat (Bradshaw et al 1997, Maier 1998, Seip et al 2006) and the potential decrease of population productivity (Phillips and Alldredge 2000; Gustine 2005).

In a study of human-induced disturbances on an elk population in Colorado, population modelling showed that elk populations with relatively little disturbance during the calving period exhibited population growth, whereas increasing the number of human-induced disturbances during the calving season to approximately 10 instances, resulted in zero population growth, and further disturbance (>10 disturbance instances) resulted in population decline (Phillips and Alldredge 2000). Results of the disturbance reduced productivity of the study population by approximately 26%, comparable to overwinter mortality for elk (Shively et al. 2005). A follow-up study conducted by Shively et al. (2005) found that removal of human-induced disturbances for 2 years resulted in recovery of calf:cow ratios, and an increase in the reproductive success of elk in the study area (Shively et al. 2005).

Based on the above information, Ministry of Environment Peace Region has suggested that critical timing windows be identified to minimize human-induced disturbances during the calving/fawning season to prevent low reproductive success and therefore potential population declines for ungulate species. Shively et al. (2005) state the US Forest Service installed closures during the elk calving period between May 1 and June 30 in Colorado to protect elk populations and minimize disturbance. This type of management has been recommended across North America for the conservation of ungulates (Towry 1987; Phillips and Alldredge 2000; Shively et al. 2005), and is in alignment with the biological sensitivity during the parturition and early rearing period.

2 WOODLAND CARIBOU – NORTHERN AND BOREAL ECOTYPES

2.1 Introduction

The following information provides a biological rationale to support the temporal delineation of the least risk timing windows for the Peace Region associated with sensory disturbance caused by resource access and development to the northern and boreal ecotypes of the woodland caribou subspecies. The late winter and calving periods, occurring approximately from mid January to mid July, have been identified as critical for caribou by the Peace Region MoE in the least risk timing windows (TABLE 3).

TABLE 3. Timing windows for caribou for the calendar year (January 1st to December 31st).

Caribou Ecotype	Season	Risk Category	Timing	Management Direction
Northern	*Late Winter and Calving/lambing*	Critical	January 15 to July 15	Development activities are not appropriate during this timeframe. Aerial activities should adhere to guidelines. In the event that working within a critical window is unavoidable, proponent should contact the Ministry of Environment, to discuss alternatives, and potential mitigation and monitoring plans.
Boreal	*Late Winter and Calving/lambing*	Critical	March 15 to July 15	
Northern	*Rut/Early winter*	Caution	September 15 to January 14	Proponents should minimize development activities during these timeframes.
Boreal	*Rut/winter*	Caution	September 15 to March 14	
Both	*Summer*	Low	July 16 to September 14	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.

All caribou in British Columbia (BC) are the woodland subspecies and consist of three ecotypes – mountain, northern and boreal (Cichowski et al. 2004). Ecotype is determined primarily by seasonal habitat use and migratory behaviour (Heard and Vagt 1998).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has determined the federal ranking category of these caribou ecotypes based on population trends and threats. Within BC, the boreal and mountain caribou ecotypes are listed as *threatened* on Schedule 1 of the *Species at Risk Act***,** and the northern ecotype is listed as both *special concern* and *threatened* on Schedule 1 of said act (COSEWIC 2002).

The two northern ecotype federal listings are spatially represented by the COSEWIC delineated Southern and Northern Mountain National Ecological Areas (S&NMNEA). Populations of the northern caribou ecotype which reside in the Southern Mountain National Ecological Area are federally listed as *threatened* and the others in the Northern Mountain National Ecological Area are listed as *special concern*. Provincially, the Conservation Data Center (CDC) has listed the mountain and boreal caribou ecotypes as *red* and the northern ecotype as *blue* (BC CDC 2007). Of the three caribou ecotypes in BC, the northern and boreal ecotypes are present in the Peace Region.

Recent research on boreal caribou east of Fort Nelson and northern caribou west of Fort St. John indicate juvenile recruitment below the threshold necessary to maintain a stable population (Culling and Culling 2005/2006). Additionally, similar research on northern caribou populations in the southern

portion of the region indicates several declining populations as well as stable or increasing populations (Seip and Jones 2008).

Due to provincial and federal listings of northern and boreal caribou and their potential susceptibility to adverse impacts associated with various human activities (Murphy and Curatolo 1987; Bradshaw et al. 1998; Dyer et al. 2001; Sorenson et al. 2008), these caribou ecotypes are of particular concern to the MoE. A study conducted by Thiessen (2009) indicates the amount of current anthropogenic disturbance via wellsites, roads, etc. in boreal caribou core habitat (FIGURE 1). Through a combination of field work (eg. habitat analysis, radio telemetry) and computer modeling, the MoE has identified important habitats throughout much of the region for both northern and boreal caribou. A number of these spatially defined habitats are approved Ungulate Winter Ranges (UWRs; overwintering habitat) and/or Wildlife Habitat Areas (WHAs; calving, rearing, rutting and connectivity habitat defined under the Identified Wildlife Management Strategy) while other identified habitats are presently proposed as such. These spatial designations, and the associated General Wildlife Measures (GWMs), specify outcomes to avoid/minimize impacts to caribou and their habitat.

Caribou can be impacted by human development activities such as pipeline development and road construction (Murphy and Curatolo 1987; Bradshaw et al. 1998; Simpson and Terry 2000; Gustine 2005; Seip et al. 2006) and limiting activities to the period(s) of least risk can minimize impacts. The Peace Region MoE has developed least risk timing windows for northern and boreal caribou based on biologically sensitive periods for caribou (late winter, calving periods, and post-parturition).

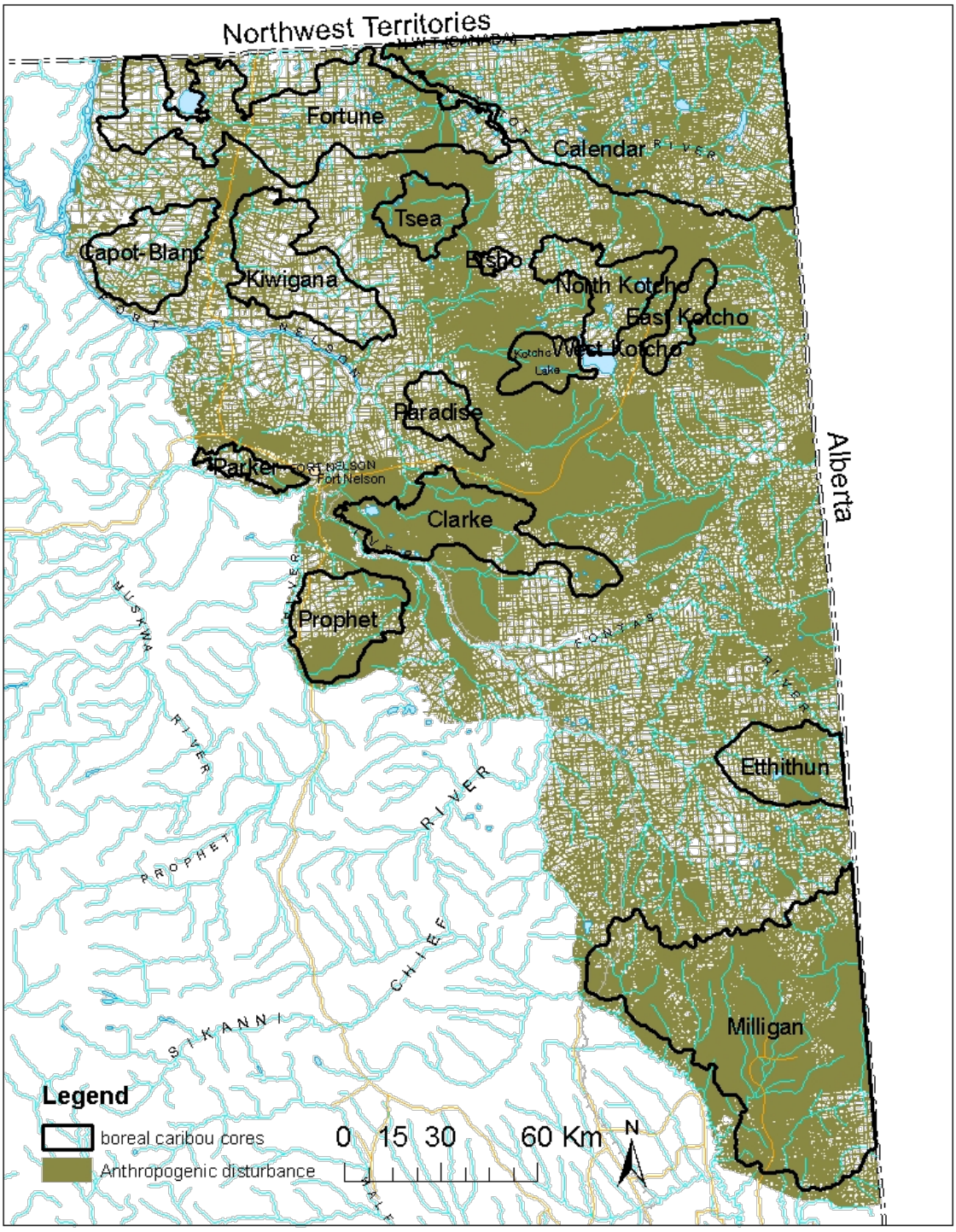

FIGURE 1. Anthropogenic disturbance in British Columbia boreal caribou cores. Disturbance layer consists of all known seismic lines, roads, cut blocks, well sites, and pipelines buffered by 250 metres. Taken from Thiessen (2009).

2.2 Biological Rationale - Critical Timing Window

2.2.1 Late winter

For caribou, winter is the most critical season for obtaining forage, and thus forage availability largely determines physiological stress and individual survival (Skoog, 1968). For the northern ecotype, the critical window begins mid-January, and for the boreal ecotype the critical window begins mid-March, as regional weather conditions become severe (e.g. declining temperatures, increased snow load). Both northern and boreal caribou begin decreasing movements that increase energetic costs and decrease foraging time (Gustine 2005; Culling and Culling 2006) and by late winter switch from maximizing nutrient intake to minimizing energetic costs associated with movement (Gustine and Parker 2008). Interrupting foraging could prevent caribou achieving daily energy requirements (Murphy and Curatolo 1987; Bradshaw et al. 1997; Bradshaw et al. 1998; Frid and Dill 2002).

The critical window differs for the two ecotypes based on the spatial confines of their winter habitat, as northern ecotype are generally spatially restricted to high-elevation, windswept alpine areas in fairly large groups, whereas boreal caribou are more dispersed across their winter range and exist in much lower densities. For this reason, the risk of disturbance to large numbers of boreal caribou during mid-winter is likely reduced, compared to northern ecotype caribou, and the critical window for the late-winter period is shortened.

Boreal caribou research in northern Alberta revealed that in winter, to conserve energy resources, caribou cease all growth (Dyer 1999) and may even begin reducing body mass (Bradshaw et al. 1998). In addition to normal winter stresses, animal response to disturbance can further decrease body condition by increased energetic costs associated with movement and reduced food intake (Bradshaw et al. 1987; Murphy and Curatolo 1987; Simpson and Terry 2000; Dzus 2001). Both boreal and northern caribou have 90+% pregnancy rates (Culling et al. 2006; McLoughlin et al. 2003; Rettie and Messier 1998) and calf survival to parturition can be enhanced by avoiding/minimizing energetic stress to the cow, especially during late gestation in late winter/early spring.

By late winter and dependant on snow conditions, subpopulations of northern caribou often move from sub-alpine forests/krummholz habitats to occupy higher elevation windswept alpine ridges to forage on relatively accessible arboreal lichens and segregate themselves from predators and ungulates that inhabit early seral habitats (TERA, 1995b; Jones et al. 2004; Culling and Culling 2005). Telemetry locations from the Graham River northern caribou herd indicated that the caribou spent a significant portion of at least late winter in the alpine tundra or subalpine forest. Hence, in late winter, these subpopulations can be at their greatest annual concentration (Culling and Culling 2005).

Caribou may also exhibit an alternate wintering strategy which includes overwintering in low elevation pine-lichen forests that provide abundant foraging habitat (Seip and Cichowski, 1994; Cichowski et al., 2004). Northern caribou telemetry research in the Besa Prophet area revealed that movement is lowest in late winter to minimize energetic costs (Gustine 2005; Gustine and Parker 2008). Comparatively, boreal caribou UWRs have minimal topographic relief/variability and habitat is relatively homogenous (Culling and Culling 2006); therefore, within proposed boreal caribou UWRs, late winter animal distribution is likely more widespread. However, boreal caribou also tend to minimize movement in late winter (Culling and Culling 2006; Rowe 2007) in order to reduce energetic costs.

Disturbance can adversely affect both caribou behaviour and energetic balance (Murphy and Curatolo 1987; Bradshaw et al. 1997/1998; Simpson and Terry 2000; Dzus 2001; Frid and Dill 2002; Seip et al. 2006). When exposed to disturbance caribou can evoke anti-predator behaviour including habitat shifts and be forced to spend more time in suboptimal habitats possibly increasing predation risks and decreasing foraging opportunities (Bradshaw et al. 1997; Frid and Dill 2002). In a number of BC mountain caribou studies habitat displacement from preferred late winter foraging areas into inferior habitats to avoid disturbance was a primary concern (Simpson and Terry 2000; Seip et al. 2006). Potential long-term impacts of disturbance include the avoidance or abandonment of optimal habitat (Bradshaw et al. 1997; Maier et al. 1998; Seip et al. 2006), reduced animal growth and reproduction the following spring (Geist 1971a) and the potential decrease of population productivity via increased competition for forage and risk of predation in suboptimal habitats (Nelleman and Cameron 1998; Gustine 2005).

2.2.2 Calving

Most calving occurs during late May through mid-June with the peak of calving around the first week of June for northern caribou (Hatler 1986; Wood 1996) and mid-May for boreal caribou (Gustine 2005; Culling and Culling 2006) (TABLE 4). During the calving season, northern caribou move to areas that minimise risks from predation. Thus they either use escape terrain with good visibility such as steep, isolated rock outcrops higher than the usual areas travelled by terrestrial predators, or they disperse widely over shrubby vegetation that affords concealment and lowered probability of detection (Fenger et al. 1986; Tripp et al. 2006). High elevations also afford some protection from wolves, which generally use valleys as travel routes (Bergerud and Elliot 1986).

Female caribou exhibit high levels of fidelity to calving sites (Hatler 1986; Farnell and McDonald 1989; Farnell et al. 1991). In the Muskwa-Kechika Management Area (M-KMA), Tripp et al. (2006) observed the majority of females calving within 0-5 kms of the previous year's location, and in only three cases did collared females travel >31kms between years to calve (n=40). This use of high-elevation traditional calving grounds and the highly dispersed pattern employed by woodland caribou is thought to be an anti-predator tactic of female caribou to reduce the vulnerability of calves and to make use of previously successful sites (Bergerud et al. 1984; Seip, 1992).

Caloric costs of pregnancy increase during gestation and are highest immediately prior to parturition, and calf survival is dependent on maternal nutrient uptake and body condition during late pregnancy (Dyer 1999; Gustine and Parker 2008). Disturbance induced energetic stress and decreased foraging behaviour can impact cow nutrition and reduce calf birth weight resulting in higher calf mortality (Bradshaw et al.1998). Poor winter nutrition can delay parturition (Bradshaw et al. 1998) reducing the opportunity for adequate calf growth prior to the onset of the following winter therefore increasing the likelihood of calf mortality due to poor nutrition and/or predation (Dyer 1999). Examining two northern BC herds, both in decline, Bergerud and Elliott (1986) report a low calf survival, with a mean of 55% calves dying in the first two weeks of life. In addition, caribou do not twin, therefore potential population growth is slow (Rock 1992).

TABLE 4. Mean and range of calving dates for northern and boreal subspecies of woodland caribou as reported in the scientific literature.

	Parturition Date		
Ecotype	**Mean**	**Range**	**Reference**
Northern	June 7	May 16-June 30	Culling et al. 2005; Gustine 2005; Hatler 1986; Wood 1996,
Boreal	May 15	May 1-June 30	Culling et al. 2006; Gustine 2005

2.2.3 Post-parturition

Due to high lactation demands, cows attain their worst body condition during the 3 week period post calving (Gustine 2005). Lactating cows have high energetic demands and calves have high metabolic costs for movement; therefore, both are susceptible to energetic stress (Murphy and Curatolo 1987) and disturbance-induced calf movement can be detrimental to their growth (Dyer 1999). Cows with young calves have a greater sensitivity to disturbance as young calves are more vulnerable to predation (Murphy and Curatolo 1987; Maier et al. 1998; Dyer 1999). Disturbance can also cause parent-offspring separation, potentially causing increased predation of the young (Frid and Dill 2002).

Although adult survival is quite high for boreal caribou (84-95%) and not a limiting factor for population growth (Stuart-Smith et al. 1997; Rettie and Messier 1998; Culling et al. 2006), research indicates that predation may be the most important limiting factor for caribou herd sustainability (Dzus 2001; Bentham 2005; Culling and Culling 2005; Goddard 2009) via low calf survival and recruitment into the breeding population (Rettie and Messier 1998). Many studies have linked predation to low calf survival (Stuart-Smith et al. 1997; Rettie and Messier 1998; McLoughlin et al. 2003; Culling et al. 2006) with the majority of calves being lost within the first month post-parturition (Stuart-Smith et al. 1997; Rettie and Messier 1998; Culling et al. 2006). In the Snake-Sahtaneh range of northeastern BC Culling et al. (2006) reported calf survival at one month of age to range from 20-29%, and only 12-14% of calves survived to 10 months of age. Bergerud (1996) suggests that the minimum calf recruitment required to maintain population stability is 15% calf survival or approximately 25 calves:100 cows. Several boreal caribou herds in northeastern BC are below this threshold, suggesting that populations are declining (Goddard 2009).

2.3 Biological Rationale - Cautionary Timing Window

Caribou rut between mid September and mid October (Fenger et al. 1986; Culling et al. 2006), with the peak occurring in the first week of October for boreal caribou and early to mid-October for northern caribou (Radcliffe 2000, Culling et al. 2006). As northern and boreal caribou ruts can occur over a 4 week period, rut activity continues into mid and late October for northern and boreal ecotypes respectively. In the M-KMA, caribou may remain congregated for a month after the rut (Radcliffe 2000).

Northern and mountain caribou typically select alpine rut ranges, including rolling tundra, hilltops, and plateaux (Fenger et al. 1986, Farnell and McDonald 1990, Terry and Wood 1998, Tripp et al. 2006). Although they do not select specific rutting ranges like their high-elevation kin, boreal caribou spend the

rut in mixed-sex groups (Thiessen 2009). In the M-KMA, caribou dramatically increase mineral licking along roads between September and November during the rutting period (Tripp et al. 2006).

3 MOUNTAIN SHEEP AND MOUNTAIN GOAT

3.1 Introduction

Two species of wild sheep are located in British Columbia, bighorns and thinhorns (Pacquet and Demarchi 1999). Wild sheep within the Peace Region are the Rocky Mountain bighorn sheep (hereafter referred to as "bighorn sheep") and Stone's sheep, a subspecies of thinhorn sheep. The mountain goat is a unique species, classified as rupinicaprid with its closest relatives (the goral, the serow, and the chamois) inhabiting similar niches in Europe and Asia (Chadwick 1983). All of BC's wild sheep and goat species typically use steep alpine and subalpine habitats in the summer and lower elevations or wind-swept ridges in the winter.

Bighorn sheep are provincially blue-listed (special concern) and included in the *Identified Wildlife Management Strategy* as requiring special management to address the impacts of forest and range activities on Crown Land. Bighorn sheep are only present in the southeast corner of the Peace Region. Stone's sheep and mountain goats are not listed as at risk provincially or nationally. They are closely associated with mountainous areas throughout the region, although canyon dwelling populations of both species occur in the lower reaches of the Buckinghorse and Sikanni Chief Rivers (Poole et al. 1998). Sheep and goats are managed under the *BC Wildlife Act*.

In BC, wild sheep and goats are listed on Schedule 1 under the Government Actions Regulations section 11(3) of the *Forest and Range Practices Act* as a category of ungulate species that may be impacted by forest and/or range practices and may require UWRs for winter survival (BC MWLAP 2004a). UWR U-9-002 was established in the Dawson Creek Timber Supply Area (TSA) in November 2006 for caribou, bighorn sheep, and mountain goats (BC MWLAP 2006). GWMs include retention of forest cover, no permanent roads, and no development of recreation sites or trails (BC MWLAP 2006). UWR U-9-004 was established in 2008 to manage winter habitat for Stone's sheep and northern caribou in the Fort St. John and Mackenzie TSAs (BC MWLAP 2008). There are also 11 WHAs established under the former Forest Practices Code for mountain goats in the Peace region.

The following information provides a biological rationale to support the temporal delineation of the least risk timing windows for the Peace Region. The late winter and birthing (or lambing/kidding) period, occurring approximately from mid January to mid July, has been identified as critical by the Peace Region MoE in the least risk timing windows for wild sheep and goats (TABLE 5). The early winter rut period has been identified as a cautionary timing window.

TABLE 5. Timing windows for mountain sheep and mountain goats for the calendar year (January 1st to December 31st).

Species	Season	Risk Category	Timing	Management Direction
All Species	*Late Winter and Lambing/Kidding*	Critical	January 15th to July 15th	Development activities are not appropriate during this timeframe. Aerial activities should adhere to guidelines. In the event that working within a critical window is unavoidable, proponent should contact the Ministry of Environment, to discuss alternatives, and potential mitigation and monitoring plans.
Sheep & Goat	*Early winter*	Caution	November 1st to January 14th	Proponents should minimize development activities during these timeframes.
Sheep	*Summer*	Low	July 16th to November 14th	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.
Sheep	*Summer*	Low	July 16th to October 31st	

3.2 Biological Rationale – Critical Timing Window

3.2.1 Disturbance

Mountain sheep and goats are sensitive to disturbances and may respond negatively to a variety of disturbance stimuli such as helicopters, fixed-wing aircraft, road construction, exploration and development for oil, gas, coal and minerals, transmission line corridors, independent power projects, wind power projects, and forestry development among others. Responses include increased vigilance, lower foraging efficiency and habitat abandonment (Côté 1996; Gordon and Wilson 2004; Goldstein et al. 2005). Predation, energetic costs and susceptibility to disease may increase due to the aforementioned responses (Stemp 1983; Bleich et al. 1994; Demarchi and Hartwig 2000; Demarchi and Hartwig 2004; Goldstein et al. 2005; Keller and Bender 2007). Physiological and population-level responses to disturbance are much more difficult to quantify than behavioural responses, but are ultimately critical to the persistence of the population (Poole and Hebert 2000).

A telemetred heart rate bighorn sheep study undertaken in southern Alberta exposed three unrestrained female bighorn sheep to a variety of disturbance stimuli at a range of distances. Aerial disturbance dramatically affected sheep heart rates (3.5 fold rise) when rotary aircraft approached within 150-200 metres, but elicited no behavioural response when 500-1500 metres distant; however, the cumulative effects of continuous exposure to humans may have been energetically significant (MacArthur et al. 1979). Stemp (1982) supports that disturbed bighorn sheep may exhibit prolonged heart rate increases even if they do not demonstrate behavioural responses. Further studies by Stemp (1983) measured the heart rate responses of bighorn sheep to sensory disturbance associated with helicopters and discovered the potential for adverse impacts including increased energy expenditure, decreased foraging activity and displacement to less suitable habitat. Furthermore, he notes that real-time observation will not accurately reflect disturbance impacts to the sheep. The consequences of disturbance-related stress can be delayed and "probably not be expressed until other stressors or disease vectors are present and may be latent for one or two generations" (p267). In addition, disturbance can also contribute to increased mortality when associated with poor weather conditions, disease, predation, hunting and malnutrition during severe winters (Keller and Bender 2007; Paquet and Demarchi 1999; Demarchi et al. 2000).

A study conducted in late spring/early summer in the Yukon subjected Dall's sheep to intentional rotary and fixed wing overflights including opportunistic observation of aerial activities related to industrial activities to observe sheep behavioural response (Frid 2003). The study concluded that direct aircraft approaches (as determined by the aircraft's elevation and horizontal distance) are more likely to elicit fleeing and disrupt resting/rumination time. The study also notes that disturbance during rumination could have higher energetic consequences than foraging or locomotion costs.

Mountain goats appear to be particularly sensitive to helicopter disturbances (Côté 1996, Gordon and Wilson 2004, Goldstein et al. 2005), which appear to be more disruptive than fixed-wing overflights for mountain ungulates (Wilson and Shackleton 2001, Frid 2003). Behavioural response of mountain goats to helicopter disturbance ranges from no observed disruption to severe flight response and temporary abandonment of range, and is inversely related to the distance of the helicopter from the group. Côté (1996) observed a strong reaction in mountain goats 85% of the time when flights were <500 m, and 37% of flights at <1,500 m caused at least a moderate reaction; one female broke a leg while fleeing a helicopter. Goldstein et al. (2005) found less reaction in four areas studied in Alaska, with >90% of disturbances not causing a response if distance to a group was >990 m, >1,320 m, >1,480 m, and >1,730 m. Reaction to helicopters varies among areas, and may be related to the degree of prior exposure to helicopters (habituation) and topography (Goldstein et al. 2005).

In northern British Columbia, mountain goats abandoned an area subject to drilling disturbances (helicopters, drilling, noise), but returned after the disturbance was removed (Foster and Rahs 1983). Studies in Montana suggested that while mountain goats did not abandon home ranges because of seismic activities, declines in adult female numbers, kid numbers and productivity occurred, which were postulated to be a result of cumulative stress (Joslin 1986).

Whether or not a population has been exposed to the disturbance before can potentially impact the response of the individuals. Irregular loud noises, especially by low-flying aircraft, helicopters, and snowmobiles are most likely to disturb goats (Côté 1996; Poole and Hebert 2000; Wilkinson 2000). For all areas of British Columbia, a 2,000 m horizontal distance setback and 300 m vertical separation are recommended from all mountain goat habitat (Foster and Rahs 1983, Côté 1996, Frid 1997, Wilson and Shackleton 2001, Festa-Bianchet and Côté 2008) are to be applied year round (BC MoE in prep).

3.2.2 Late winter

Sheep and goats favour slopes where forage is easily obtained, usually convex curvatures and steep, south-facing slopes where increased solar radiation reduced snow depths (Walker 2005). Vegetation type is also an important factor in late winter habitat selection. Walker (2005) observed Stone's sheep primarily selecting shrubs, burn-grass and dry-alpine vegetation. Mountain goats select winter ranges with lower snow accumulations, usually <50 cm, by either moving to lower elevations where forests provide low snow depths or to high wind-swept ridges (BC MoF 2004). Wilkinson (2000) found goats in the Peace region chose Engelmann spruce/subalpine fir stands during 68% winter of occurrences.

Late winter can regulate populations by high snow fall, lack of nutritional forage, risk of predation and intra-specific competition (Paquet and Demarchi 1999). Winter habitat is the range used for the longest duration over the year and is the most important habitat given the difficulty of obtaining adequate forage

(AXYS 2005). Blood (2000) suggested that persistent late-winter snow packs, which result in high energy demands while preventing access to forage, are a leading cause of goat mortality. Deep snow years also prevent animals from moving between different parts of less-exploited winter range, further limiting forage availability (Geist 1964).

High quality forage is important for females in late gestation because the fetus displaces the rumen and reduces the amount of space for forage being ingested (Reid 1961; Graham 1965 in Stemp 1983), as well as the additional energetic costs of carrying the fetus to full term. Displacement from birthing areas or optimal foraging areas can cause nutritional impacts and result in newborns and mothers in situations of higher susceptibility of predation (Bleich et al. 1994; AXYS 2005). Sheep and goats select inaccessible ledges for parturition to reduce the risk of predation on neonates (Demarchi et al. 2000; Demarchi and Hartwig 2004).

Survival of mountain goat kids to one year of age is around 65% for both sexes (Côté and Festa-Bianchett 2001); between 40% and 60% of kids die in their first winter, and the yearling mortality is also disproportionately high during this time (Blood 2000; Chadwick 1983). Yearling mortality may be higher than kid mortality in some populations. Nannies continue to care for kids into their first winter, but yearlings, at the bottom of the social hierarchy and without a dominant nanny protecting them, are easily displaced from foraging and resting areas (Chadwick 1983). The age of first reproduction in sheep may be postponed during periods of nutritional stress (Demarchi et al. 2000 and references therein).

3.2.3 Lambing/Kidding

Stone's sheep will typically begin birthing in the earliest favourable month of spring, typically May, and continue into June and occasionally July (Paquet and Demarchi 1999) while bighorn sheep begin and end birthing slightly later (Cowan and Guiget 1965; Shackelton et al. 1999) (TABLE 6). In Alberta, 80% of kids were born within 2 weeks after the first kid was recorded (mean birth date May 28; Côté and Festa-Bianchett 2001).

Although pregnancy rates are high for bighorn sheep (90%) (Hass 1989; Jorgenson 1992), females do not usually reproduce until their second or third year (Geist 1971; Wishart 1975) and males in their third or fourth (Smith 1954). Reproductive rates are low (K-selected) for Stone's sheep, with ewes first lambing usually in the third or fourth year and males entering the rut in their fifth (Paquet and Demarchi 1999). Mountain goats are physiologically capable of breeding at 2.5 years old, although males of this age are typically displaced by dominant billies (Geist 1964). Mountain goats rarely twin, and up to 40% of the nannies may not have kids in a given year (Blood 2000). Habitat condition the preceding year also appears to have a considerable impact on body condition, and subsequently, offspring survival (Festa-Bianchet et al. 1997). Access to nutritional forage is essential during the last stages of pregnancy, the natal period, and during lactation as females provide for young and regain their physical condition.

TABLE 6. Mean and range of lambing/kidding dates for sheep and goats as reported in the scientific literature.

Species	Parturition Date	Reference
Bighorn Sheep	Early June-1st week in July	Cowan and Guiget 1965; Shackelton et al. 1999
Stone's Sheep	May 14-June 17	Bunnell 1982; Paquet and Demarchi 1999
Mountain Goat	Late May- Early June	Blood 2000

Lactation is the most energetically demanding time of the annual cycle for females and timing for parturition is critical for maximum neonate survival (Stemp 1983) as birth weight and survival are often correlated (Festa-Bianchet et al. 1997). Lambs born too late miss peak foraging and do not grow to a size sufficient to survive the winter; lambs born too early are often small and unable to properly thermoregulate during early spring storms (Geist 1971a, 1981; Bunnell 1980; and Horesji 1976a in Stemp 1983) and are susceptible to predation.

Nannies are particularly sensitive to disturbance when they are accompanied by kids (Ballard 1975 cited in Goldstein et al. 2005). Stemp (1983) states that frequent disturbance in the first few days of life is likely to severely reduce the life expectancy of bighorn sheep. In a study by Moore (1958), domestic lambs were subjected to a mildly upsetting stimulus and appeared competent; however, few survived beyond a few months demonstrating their extreme susceptibility to stress. Furthermore, Stemp (1983) reports that lambing is the most critical time in the lifecycle of bighorns - a time when they are extremely susceptible to inclement weather and predation. He recommends disturbance to bighorn sheep be minimized particularly during lambing and other key periods of the reproductive cycle such as rutting and late gestation.

3.2.4 Post-parturition

Lamb mortality is highest in the first month of life, reaching 50-60% by the end of the first year (Paquet and Demarchi 1999; Nicols and Bunnell 1999). This figure may be caused in part by the ewe's ability to carry a fetus to full term even when extremely malnourished, and consequently give birth to a lamb in poor condition and potentially immunocompromised (Demarchi et al. 2000). In addition, mortality caused by malnutrition, predation or disease can be exacerbated by stress and disturbance (Stemp 1983; Paquet and Demarchi 1999; Demarchi et al. 2000).

The post-parturition period is also particularly difficult for reproductive females. Not only is lactation energetically costly, females may lose some resistance to parasites and pathogens during this time (Festa-Bianchet 1989a).

Based on the information above, mountain sheep and goats in the Peace Region require minimal disturbance during late winter, birthing and post-parturition in order for adult survival and successful lambing and recruitment. The least-risk timing windows for the Peace Region are based on the scientific literature provided and suggest minimizing all sensory disturbances during these critical periods.

3.3 Biological Rationale - Cautionary Timing Window

Early winter has been designated as a cautionary timing window for mountain sheep and goats in the Peace Region to account for the energetically-costly rut season; therefore, the cautionary window for mountain sheep and goats is Nov. 1 to Jan 14. As previously stated, mountain sheep and goats are sensitive to disturbance, and any additional stress from disturbance during the already stressful rut period should be avoided. Sheep and goats time the rut to optimize nutritious foraging opportunities during parturition (Hebert 1973; Bunnell 1982; Thompson and Turner 1982). The timing of vegetation green-up varies considerably between low and high elevations and across the ranges of these species, so

the peak of the rut can occur over the span of a month for all populations in the province (Demarchi et al. 2000).

The mating systems of bighorn sheep, thinhorn sheep, and mountain goats are similar. Throughout most of the year, animals are segregated into bachelor groups and 'nursery' bands, made up of females, young-of-the-year, and young males. Prior to the rut, males begin to approach and integrate into nursery bands. The constant male-female association, with courtship by males repulsed by female agonistic behaviour, marks the prerut (Geist 1964; Geist 1971b; Chadwick 1983). The rut begins when females enter estrous ('heat') and accept male courtship. Dominant males defend estrous ewes, while subordinate animals attempt to force matings by evading the defending male or by 'blocking' a female away from other males (Geist 1964; Pelletier et al. 2006) After the peak rut in early winter, males start to resume normal foraging behaviour, females become less tolerant of males, and the sexes may segregate again (Geist 1964; Geist 1971b). Although there can be significant year-to-year variation in rut activity, typical rutting dates for BC are reported in TABLE 7.

TABLE 7. Range of rutting dates for sheep and goats as reported in the scientific literature.

Species	Rut Date	Reference
Rocky Mountain Bighorn Sheep	Nov 21 $\pm$ 4 days until mid-late Dec	Pelletier et al. 2006
	Early Nov - early Dec (may be up to a month earlier in northern populations)	Demarchi et al. 2000
Stone's Sheep	Mid Nov - mid Dec	Paquet and Demarchi 1999
Mountain Goat	Late Oct – early Jan (entire rut) Late Nov – early Dec (peak)	Geist 1964 Blood 2000, Mainguy et al. 2008

Rams and billies undergo hypophagia during the rut, drastically reducing their foraging time in favour of reproductive activities (Pelletier et al. 2009). Combined with the energetic demands of dominance and courtship, this leaves rams and billies in relatively poor condition just as winter sets in. Young males, which store less fat and put less energy into their immune system (Festa-Bianchet 1989), may be particularly susceptible, although they their rut participation varies. Geist (1971b) found that where hunters removed most older males >5 years of age, the natural mortality for 3-5 year olds increased, possibly due to stress of rutting earlier than in a population with large males.

The energetic costs of the rut take a heavy toll on most northern ungulates, including sheep and goats, leaving them in reduced condition to face the winter. Considering the stresses on animals during the rut, additional disturbance should be minimized. For these reasons, early winter cautionary windows have been established for sheep and goats.

4 AVIFAUNA

4.1 Introduction

The Peace Region encompasses a diverse variety of habitats, including a large area of western boreal forest, the most bird-rich habitat north of Mexico (Smith 1992). For many eastern/central boreal species, this is the western edge of their range, and the only place these species are found in BC. The Peace Region is comprised of portions of Bird Conservation Regions 4 (BCR4; Northwestern Interior Forest)

and 6 (Boreal Taiga Plateau), which correspond to the Northern Boreal Mountains, Boreal Plains, and Taiga Plains ecoprovinces (FIGURE 2). The regional avifauna is comprised of permanent resident species, long-distance migrants (breed in the Peace, winter in the tropics) and short-distance migrants (breed in the Peace, winter in south western or coastal Canada and the continental US) (Smith 1992). The diverse life history strategies complicate bird management, but mitigation measures applied during the fairly synchronous breeding season can be effective for many species across a broad spectrum of niches.

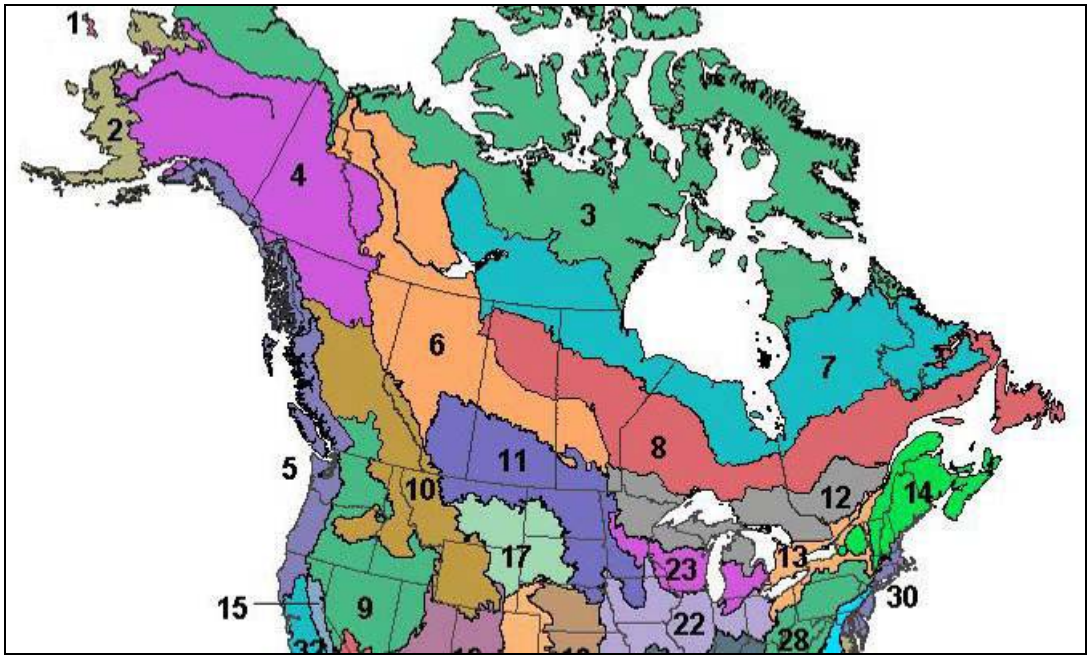

FIGURE 2. Bird Conservation Regions of Canada (NABCI 2009).

Boreal avifauna have adapted to the suite of disturbances that naturally occur in the boreal forest (Schmiegelow et al. 1997; Jones et al. 2001; Penteriani et al. 2002; Machtans 2006), but the impacts of sensory disturbance, which critical and cautionary timing windows seek to reduce, are not well-known for boreal birds. While disturbance occasionally produces readily detectable results (e.g. nest abandonment), other effects are indirect and cumulative, and therefore difficult to quantify (Boyle and Samson 1985; Pomerantz et al. 1988; Fernandez and Azkona 1993).

The Ministry of Environment has developed least risk timing windows for bird species in the Peace Region (TABLE 8). Wherever possible, development activity should be scheduled outside the critical timing window, which encompasses breeding season for most species. The timing windows are not legally applicable to any industrial activity; they are suggested actions to minimize adverse impacts to wildlife of management concern.

TABLE 8. Timing windows for birds for the calendar year (January 1st to December 31st).

Species & Season	Risk Category	Timing	Management Direction
Songbirds *(Breeding season)*	Critical	May 1 to July 31	Development activities are not appropriate during this timeframe. In the event that working within a critical window is unavoidable, proponent should contact the Ministry of Environment, to discuss alternatives, and
Trumpeter Swan/ Sandhill Crane	Critical	April 1 to July 31	

(Breeding season)			potential mitigation and monitoring plans.
Raptors *(Breeding season)*	Critical	March 1 to July 31	
Trumpeter Swan/ Sandhill Crane *(Breeding season)*	Caution	August 1 to September 30	Operations should avoid development activities during these timeframes.
Raptors *(Breeding season)*	Caution	August 1 to September 30	
Songbirds *(Late summer to early spring)*	Low	August 1 to April 30	
Trumpeter Swan/ Sandhill Crane *(Late summer to early spring)*	Low	October 1 to March 31	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.
Raptors *(Late summer to early spring)*	Low	October 1 to March 31	

4.2 Legislation

In Canada, birds are protected under the federal *Migratory Birds Convention Act* (MBCA) of 1994, which governs the 1916 *Migratory Birds Convention* between the United States and Canada. The Federal *Migratory Birds Regulations* (MBR), section 6 contains general prohibitions against the disturbance and destruction of nests; section 5.1(1) (2) of the MBCA prohibits the deposit of harmful substances into areas frequented by migratory birds. The MBCA also prohibits the incidental take of migratory bird nests through destruction and disturbance through otherwise legal human activities. Proponents and planners are advised to exhibit due diligence in regards to their responsibilities under the MBCA and MBR. Though not limited to the following, some of the considerations in planning that can contribute to the maintenance of sustainable populations of migratory birds are:

- protection of key habitats;
- scheduling of activities to avoid the breeding season;
- conducting pre-clearing surveys for migratory bird use; and,
- identification of priority species.

Additional protection is granted to COSEWIC species at risk that become listed under the 2003 Federal *Species at Risk Act* (SARA). Species listed by COSEWIC are not granted protection under SARA until reviewed and added to SARA. Three bird species that occur in the Peace area are currently listed under SARA: two are ranked as Special Concern (Rusty Blackbird, Yellow Rail), and one is ranked as Threatened (Peregrine Falcon Olive-sided Flycatcher and Canada Warbler). While COSEWIC has listed Olive-sided Flycatcher and Canada Warbler as Threatened, and Common Nighthawk, Short-eared Owl and Horned Grebe as Special Concern, but they are not yet listed under SARA. Additionally, COSEWIC has downgraded Peregrine Falcon to Special Concern, but since the public review period is not yet complete, it remains listed as Threatened under SARA. Protection for species listed under SARA as Special Concern is limited to a requirement to prepare a Management Plan and review the species' status every 10 years. Greater protection is afforded SARA-listed species with higher at-risk rankings. Section 32(1) states that "no person shall kill, harm, harass, capture or take an individual of a wildlife

species that is listed as an extirpated species, an endangered species or a threatened species." Under Section 33:

> No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.

In British Columbia, birds are also protected under the provincial *Wildlife Act*. The *Wildlife Act* protects all native North American birds (as defined by the American Ornithologists Union Checklist, 6th edition and supplements). Some introduced species (raptors, some upland gamebirds) are also protected. Some native and introduced species (American Crow, Black-billed Magpie, Rock Pigeon, Brown-headed Cowbird, House Sparrow, European Starling) are exempted from most protection under the act for management reasons. Of primary importance is section 34, which reads as follows:

> A person commits an offence if the person, except as provided by regulation, possesses, takes, injures, molests or destroys
> (a) a bird or its egg,
> (b) the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl, or
> (c) the nest of a bird not referred to in paragraph (b) when the nest is occupied by a bird or its egg.

Additional management guidelines are available for provincially designated species at risk and regionally important species in the Identified Wildlife Management Strategy, under the *Forest and Range Practices Act*. Identified wildlife are managed with WHAs (sections 9 and 10 of the *Government Actions Regulation*) and GWMs, which often include no harvesting, no access development, and limited grazing.

4.3 Biological Rationale - Critical Timing Window

The critical window for most bird species in the Peace Region begins May 1 and extends to the end of July to encompass most breeding activity (from pre-laying to fledgling use of nest areas, TABLE 8). Breeding dates in the Peace tend to correspond more closely with breeding dates in boreal Alberta, Yukon, and Northwest Territories than with other parts of British Columbia. As FIGURE 3 shows, the breeding season starts significantly later (late May or early June) in the Peace than elsewhere farther south in the Northern Rockies and throughout BCR 10 (early May). Species at risk and Identified Wildlife are of particular importance, and fall within this window (

TABLE 10), except those addressed under the raptor and Trumpeter Swan/Sandhill Crane windows. Sandhill Cranes, while not listed by either COSEWIC or the CDC, are considered Identified Wildlife under the Forest and Range Practices Act.

TABLE 9. Quantile values of dates for pre-laying (27 species of passerines, waterfowl, shorebirds), nesting (19 species of passerines and waterfowl), and brood-rearing (12 species of passerines) periods in the boreal Northwest Territories and Nunavut. Adapted from Coulton and Robertson 2009.

Quantile	Pre-laying	Nesting	Brood-rearing
Min	April 21	May 7	May 28
5%	April 24	May 12	June 4
10%	May 5	May 17	June 11
25%	May 13	May 27	June 20
50%	May 23	June 14	July 2
75%	June 1	June 25	July 16
90%	June 21	July 8	July 22
95%	June 27	July 13	July 27
Max	July 13	July 21	August 10

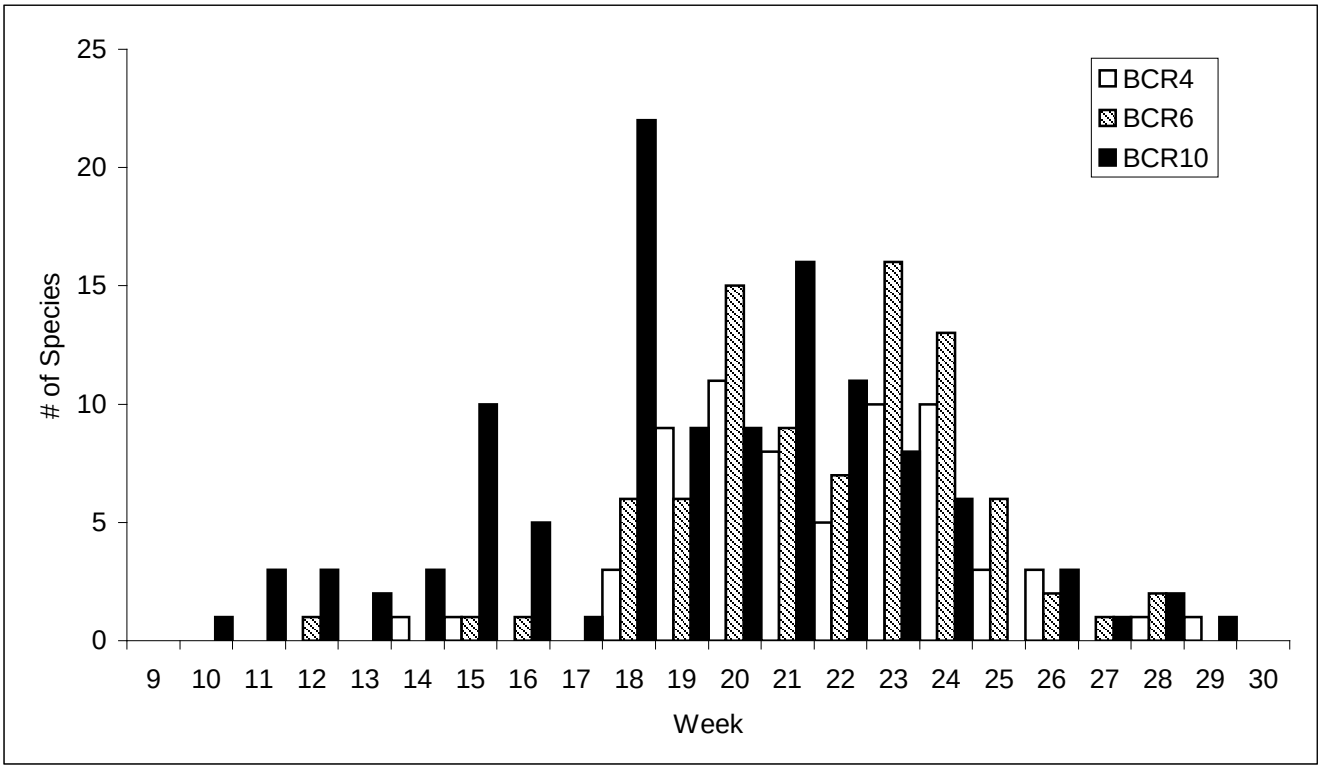

FIGURE 3. Start dates for breeding season for all birds in the Peace (BCR4 and BCR6) compared to BCR10 (the Central Interior and Kootenay regions of British Columbia). Data from Campbell et al. 1990a,1990b, 1997, and 2001.

TABLE 10. Breeding season dates for bird species at risk and those listed under the Identified Wildlife Management Strategy in the Peace Region (BCR4 and BCR6). Breeding dates for other parts of the range are indicated if none are available specifically for the Peace.

Species	COSEWIC Status	SARA Status	Provincial Status	Identified Wildlife	Breeding Dates	Reference
American Bittern	Not Assessed	Not Assessed	**Blue**	No	May or June to August	BC CDC 2009a
Barn Swallow	Not Assessed	Not Assessed	**Blue**	No	March 30 to September 17	Campbell et al. 1997
Bay-breasted Warbler	Not Assessed	Not Assessed	**Red**	**Yes**	June 16 to July 30	Campbell et al. 2001
Black-throated Green Warbler	Not Assessed	Not Assessed	**Blue**	**Yes**	June 3 to July 2	Campbell et al. 2001
Broad-winged Hawk	Not Assessed	Not Assessed	**Blue**	No	Early June to early September (Alberta)	Rusch and Doerr 1972; Fraser et al. 1999
Canada Warbler	**Threatened**	Not Assessed	**Blue**	No	June 23 to July 21	Campbell et al. 2001
Cape May Warbler	Not Assessed	Not Assessed	**Red**	**Yes**	June 16 to July 8	Campbell et al. 2001
Common Nighthawk	**Special Concern**	Not Assessed	Yellow	No	May 24 to August 20	Campbell et al. 1990
Connecticut Warbler	Not Assessed	Not Assessed	**Red**	**Yes**	July 1 to August 5	Campbell et al. 2001
Gyrfalcon	Not at Risk	Not at Risk	**Blue**	No	April 3 to July 19	Campbell et al. 1990
Horned Grebe	**Special Concern**	Not Assessed	Yellow	No	May 9 to September 5	Campbell et al. 1990
LeConte's Sparrow	Not Assessed	Not Assessed	**Blue**	No	June 15 to June 21	Campbell et al. 2001
Nelson's Sharp-tailed Sparrow	Not at Risk	Not at Risk	**Red**	**Yes**	Mid-June to late July (BC)	Fraser et al. 1999
Olive-sided Flycatcher	**Threatened**	Not Assessed	**Blue**	No	May 22 to June 25	Campbell et al. 2001
Peregrine Falcon (*anatum* subspecies)	**Special Concern**	**Threatened**	**Red**	No	March 30 to July 22 (BC, all subspecies)	Campbell et al. 1990
Rusty Blackbird	**Special Concern**	**Special Concern**	**Blue**	No	May 18 to July 9	Campbell et al. 2001
Sandhill Crane	Not at Risk	Not at Risk	Yellow	**Yes**	April 8 to August 30	Campbell et al. 1990
Short-eared Owl	**Special Concern**	Not Assessed	**Blue**	**Yes**	March 30 to September 15 (BC)	Campbell et al. 1990
Surf Scoter	Not Assessed	Not Assessed	**Blue**	No	Mid-June to August (elsewhere in range)	BC CDC 2009b
Upland Sandpiper	Not Assessed	Not Assessed	**Red**	No	Mid-May to August (elsewhere in range)	Van den Driessche et al. 1994; Hooper 1997; Fraser et al. 1999
Yellow Rail	**Special Concern**	**Special Concern**	**Red**	No	Late May or early June to mid July (elsewhere in range)	BC CDC 2009c; Saraloja 1981

4.3.1 Pre-laying Period

Boreal songbirds rely to a great extent on auditory cues for mate choice and territory defence (Brenowitz 1982; Nowicki and Searcy 2005). Disturbances that produce noise, especially loud noise for long durations, can disrupt assessment of mate quality, breeding status, and territory (Bayne et al 2001). Song functions as a form of passive territory defence, without which the frequency of territorial fights increases. Increased frequency of physical encounters with aggressive conspecifics stresses birds, raising corticosterone levels (Mazerolle and Hobson 2002). This is especially pronounced during the breeding season, when territoriality peaks (Dickens et al. 2006). Chronically elevated corticosterone can lead to immunosuppression, muscle wasting, decreased growth rates, and eventually death (Walker et al. 2005a). More aggressive territorial defence is also energetically costly, and birds that are fighting are unable to spend that time feeding, courting, or tending to eggs or young (Yalden 1992).

The impacts of industrial noise on individual songbirds apparently extend to the population level. Bayne et al. (2008) examined density of 26 passerines around loud industrial development (compressor stations) and quiet development (well pads) in boreal Alberta. They found bird densities 1.5 times greater at well pads than at compressor stations. Other studies have examined the impact of road noise on bird densities, finding significantly lower bird densities near roads (Reijnen and Foppen 1994; Forman and Deblinger 2000; Bayne et al. 2008).

Increased disturbance effectively lowers habitat quality for many species. Where habitat quality is lower, territorial species must move or expand their territories (Yalden 1992; Jones et al. 2001; Burke 2003). The result is fewer, larger territories of lower quality, defended by the dominant individuals in the population (Reijnen and Foppen 1994; Fort and Otter 2004). In this instance, breeding success may be the same as in undisturbed populations, but the total number of pairs breeding is lower, producing a net decline in recruitment (Yalden 1992; Holm and Laursen 2009). This phenomenon has been documented in habitat generalists (Black-capped Chickadee, Fort and Otter 2004), and should not be discounted even for abundant generalist species. Disturbance therefore plays a key role in determining population viability of songbirds (Klaus et al. 2005), and likely affects viability of other bird groups as well.

4.3.2 Incubation

Birds vary extensively in their sensitivity to disturbance. The incubation period can be the most sensitive time for birds, when most nests are likely to be deserted, or birds may be less likely to display alarm behaviour if they are sitting on the nest. Generally speaking, the more a bird has invested in the year's breeding effort, the less likely it will abandon it. A bird is less likely to abandon nestlings than eggs, and less likely to abandon eggs over a recently constructed nest, and most likely to cease use of an area if no nest has been established yet. Golden-plovers were least likely to display alarm behaviour and abandon nests during incubation compared to pre-laying and post-hatching periods (Yalden and Yalden 1990). However, incubating Ferruginous Hawks that were briefly disturbed by investigators abandoned their nests 33% of the time (White and Thurow 1985).

Incubation constancy, or the time spent incubating the eggs, is directly correlated with breeding success (Henson and Cooper 1993). Less nest-attentiveness results in delayed embryo development and greater opportunity for predation (Rodway et al. 1996). Northern Harriers reacting to disturbance spent less

time on the nest or gathering food for nestlings than harriers that were not disturbed (Fernandez and Azkona 1993).

In the Peace, the incubation period for most species likely falls between May 7 and July 21, as it does in the boreal Northwest Territories (
TABLE 9). The MoE critical timing window of May 1 to July 31 effectively covers the incubation period for songbirds (raptors, Trumpeter Swans, and Sandhill Cranes have different critical windows).

4.3.3 Chick Development

Once the eggs have hatched, disturbance can continue to impact the parent birds, but now it can also impact the chicks. Young raised in a stressful environment will react differently to stress, even as adults (Walker et al. 2005b), and may be more susceptible to stressors, including disease (Liu et al. 2000; Shanks 2002; Walker et al. 2005b).

Chicks in disturbed environments suffer higher rates of predation and siblicide, higher mortality due to weather, slower growth rates, and smaller size at fledging (Harris and Wanless 1984; White and Thurow 1985; Pierce and Simmons 1986; Piatt et al. 1990; Fernandez and Azkona 1993; Rodway et al 1996; Holm and Laursen 2009). Birds may fledge at smaller body size if there is pressure to prematurely leave the nest (White and Thurow 1985) or if hatching was delayed or growth slowed (Harris and Wanless 1984; Pierce and Simmons 1986). Disturbed nests may experience survival rates as low as 60% that of their undisturbed neighbours (White and Thurow 1985; Piatt et al.1990; Rodway et al. 1996). Conversely, other investigators have found no effect of disturbance on individual breeding success (Yalden 1992), or have found impacts on nest success but not fledgling success (Skagen et al. 2001). Fernandez and Azkona (1993) found no difference in nest success between disturbed and undisturbed sites, but chicks on disturbed sites were in poorer condition than those on undisturbed sites.

Adults defending chicks will be more sensitive to disturbance than when no chicks are present (Yalden 1992). Increased alarm behaviour is energetically costly, and also distracts adults from brooding or feeding chicks (Fernandez and Azkona 1993). Constant stress, physical fatigue, and increased predation risk from these behaviours combine to decrease life expectancy of the parents (Fernandez and Azkona 1993). Females may be differentially affected, especially in species where the female is the primary caregiver (Altenburg et al. 1982; Fernandez and Azkona 1993).

In the Peace, the brood-rearing period likely falls between May 28 and August 10 for most species, as it does in the boreal Northwest Territories (
TABLE 9). The MoE songbird critical timing window of May 1 to July 31 does not cover this entire period, but most brood-rearing activity will be covered by the timing window.

4.4 Exceptions to Songbird Timing Windows

4.4.1 Trumpeter Swans and Sandhill Cranes

The breeding population of Trumpeter Swans in BC is slowly increasing, and they have been delisted by the province (yellow-listed, or not at risk). However, there are different timing windows for Trumpeter Swans: April 1st to July 31st is the critical timing window, when most of the breeding activity takes place, and August 1st to September 30st is the cautionary timing window. Trumpeter Swans are

extremely sensitive to loud disturbances, pedestrian traffic, and boat/floatplane traffic (Henson and Grant 1991; James 2000). Disturbance can disrupt feeding and keep females away from the nest, resulting in nest loss or cygnet loss (Henson and Grant 1991; James 2000). Swan pairs will not attempt a second clutch if the first clutch is lost (James 2000). In some cases, pairs have abandoned breeding lakes due to human disturbance (Brechtel 1982). Wider critical and cautionary windows have been developed for Trumpeter Swans because of their sensitivity to disturbance.

Sandhill Cranes fall under the Identified Wildlife Management Strategy. Guidelines include minimizing disturbance between April 1st and September 21st, and not harvesting timber between April 15th and August 15th (BC MWLAP 2004b).

In both cases, young are dependent on parents well into August, even September. Negative impacts of disturbance are less likely later in the breeding season, so the critical timing window is downgraded to cautionary. Development should still be avoided in a cautionary window if possible, but if it must proceed, it is better to schedule activities in a cautionary window (when the risks are lower) than in a critical window (when the risks are very high).

4.4.2 Raptors

Raptors, which are afforded additional protection under the provincial *Wildlife Act*, tend to breed earlier than other birds. Breeding dates for most raptors in the Peace Region have not been established. Disturbance has been noted as a limiting factor for many raptor species (Peregrine Falcon, Rowell and Stepnisky 1997; Broad-winged Hawks, Fraser et al. 1999; Prairie Falcon, Paton 2002; Ferruginous Hawk, ASRD and ACA 2006), so a critical window better reflecting their breeding season is essential. A critical window of March 1 to July 31, with an extended cautionary window until September 30, would cover the majority of the breeding season for most raptors known (or suspected) to breed in the Peace (

TABLE 11). Note that nests of Peregrine and Prairie Falcons, Ospreys, and Bald Eagles, regardless of whether or not they are occupied, are protected under the *BC Wildlife Act*.

4.4.3 Crossbills and Corvids

Red and White-winged crossbills occur in the Peace Region. In the Northern Rockies (BCR10), Red Crossbills have started breeding as early as January (Campbell et al. 2001). Since they are not a species of concern, separate timing windows have not been proposed for crossbills. As wild birds, they do still fall under MBCA and the *Wildlife Act*.

Corvids in the area are generally nesting in April and early May, although Gray Jays may be much earlier. Since they are highly adaptable and generally tolerant of disturbance (and some considered as pests in certain areas), separate timing windows have not been proposed for corvids. Corvids fall solely under the *Wildlife Act* and any stipulations under this Act must be followed, although some species are exempted from protection (American Crow, Black-billed Magpie).

TABLE 11. Breeding season dates for raptors in British Columbia recorded breeding in BCR4, BCR6, and BCR10. Data is province-wide from Campbell et al. 1990b.

Species	Breeding Dates	Covered by Apr 1-Sep 30 Windows?
American Kestrel	April 2 to August 30	Yes
Bald Eagle	February 3 to August 30	Probably - early nest records likely southern/coastal birds
Barred Owl	March 18 to August 15	Yes
Boreal Owl	April 1 to June 13	Yes
Cooper's Hawk	April 30 to August 30	Yes
Golden Eagle	April 1 to August 30	Yes
Great Grey Owl	March 28 to August 14	Yes
Great Horned Owl	February 10 to September 6	No – nesting earlier (southern birds) than critical and cautionary windows
Gyrfalcon	April 3 to July 19	Yes
Long-eared Owl	March 10 to August 2	Yes
Merlin	April 15 to August 13	Yes
Northern Goshawk	April 2 to August 22	Yes
Northern Harrier	April 15 to August 7	Yes
Northern Hawk Owl	April 20 to August 6	Yes
Northern Pygmy Owl	April 15 to August 30	Yes
Northern Saw-whet Owl	March 1 to August 15	Yes
Osprey	April 20 to September 6	Yes
Peregrine Falcon	March 30 to July 22	Yes
Red-tailed Hawk	February 25 to August 5	Probably – early nest records likely southern birds
Short-eared Owl	March 30 to September 15	Yes
Sharp-shinned Hawk	March 28 to August 14	Yes
Swainson's Hawk	May 2 to August 14	Yes

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APPENDIX 1. SCIENTIFIC NAMES OF SPECIES MENTIONED IN TEXT

TABLE 1. Common and scientific names of wildlife species mentioned in this document.

Common Name	Scientific Name
Alaskan Moose	*Alces alces gigas*
American Bittern	*Botaurus lentiginosis*
American Buffalo	*Bison bison bison*
American Crow	*Corvus brachyrhynchos*
American Kestrel	*Falco sparverius*
Atlantic Puffin	*Fratercula arctica*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Swallow	*Hirundo rustica*
Bay-breasted Warbler	*Dendroica castanea*
Bear	*Ursus sp.*
Bighorn Sheep	*Ovis canadensis*
Black-billed Magpie	*Pica pica*
Black-capped Chickadee	*Poecile atricapillus*
Black-tailed Deer	*Odocoileus hemionus columbianus*
Black-tailed Godwit	*Limosa limosa*
Black-throated Green Warbler	*Dendroica virens*
Boreal Caribou	*Rangifer tarandus caribou*
Boreal Owl	*Aegolius funereus*
Broad-winged Hawk	*Buteo platypterus*
Brown-headed Cowbird	*Molothrus ater*
Burrowing Owl	*Athene cunicularia*
Canada Warbler	*Wilsonia canadensis*
Cape May Warbler	*Dendroica tigrina*
Caribou	*Rangifer tarandus*
Chamois	*Rupicapra sp.*
Common Guillemot	*Uria aalge*
Common Sandpiper	*Actitis hypoleucas*
Connecticut Warbler	*Oporornis agilis*
Crested Auklet	*Aethia cristatella*
Crested Myna	*Acridotheres cristatellus*
Dall Sheep	*Ovis dalli dalli*
Domestic Sheep	*Ovis aries*
Elk	*Cervus canadensis*
Eurasian Skylark	*Alauda arvensis*
European Starling	*Sturnus vulgaris*
Ferruginous Hawk	*Buteo regalis*
Golden Eagle	*Aquila chrysaetos*
Golden Plover	*Pluvialis apricarius*
Goral	*Naemorhedus sp.*
Great Grey Owl	*Strix nebulosa*
Great Horned Owl	*Bubo virginianus*
Grizzly Bear	*Ursus arctos*

Common Name	Scientific Name
Gyrfalcon	*Falco rusticolus*
House Sparrow	*Passer domesticus*
Least Auklet	*Aethia pusillia*
LeConte's Sparrow	*Ammodramus leconteii*
Magellanic Penguin	*Spheniscus magellanicus*
Marsh Harrier	*Circus aeruginosis*
Merlin	*Falco columbarius*
Moose	*Alces alces*
Mountain Caribou	*Rangifer tarandus caribou*
Mountain Goat	*Oreamnos americanus*
Mule Deer	*Odocoileus hemionus*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Northern Caribou	*Rangifer tarandus caribou*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Northern Hawk Owl	*Surnia ulula*
Northern Saw-whet Owl	*Aegolius acadicus*
Olive-sided Flycatcher	*Contopus cooperi*
Osprey	*Pandion haliaeetus*
Peregrine Falcon	*Falco peregrinus*
Plains Bison	*Bison bison bison*
Red Crossbill	*Loxia curvirostra*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Reindeer	*Rangifer tarandus*
Rock Pigeon	*Columba livia*
Rocky Mountain Bighorn Sheep	*Ovis canadensis canadensis*
Rusty Blackbird	*Euphagus carolinus*
Sandhill Crane	*Grus canadensis*
Serow	*Capricornis sp.*
Sharp-shinned Hawk	*Accipiter striatus*
Short-eared Owl	*Asio flammeus*
Surf Scoter	*Melanitta perspicillata*
Thinhorn Sheep	*Ovis dalli*
Trumpeter Swan	*Cygnus buccinator*
Tufted Puffin	*Fratercula cirrhata*
Upland Sandpiper	*Bartramia longicauda*
White-tailed Deer	*Odocoileus virginianus*
White-winged Crossbill	*Loxia leucoptera*
Wildebeest	*Connochaetes sp.*
Willow Warbler	*Phylloscopus trochilus*
Wolf	*Canis lupus*
Wood Bison	*Bison bison athabascae*
Woodland Caribou	*Rangifer tarandus caribou*
Yellow Rail	*Coturnicops noveboracensis*

APPENDIX 2: GLOSSARY

Behavioural response –the immediately observable reaction of an animal to any environmental stimulus.

Bird – any animal of the class Aves including all life stages of that animal.

Blue list –. list of ecological communities and indigenous species and subspecies of special concern (formerly 'vulnerable') in British Columbia, compiled by the Conservation Data Centre.

Boreal- a term referring to the northern regions of the Northern Hemisphere, especially those areas dominated by coniferous forest (Burton and Burton 2002).

Breeding season – in birds, the time period between courtship/ nest establishment to the end of chick dependence on adults or the end of the chicks' first summer, whichever comes first.

Breeding success – defines the recruitment for the year in birds and incorporates success at the end of the breeding season, i.e. nest is established, eggs are laid, eggs hatch, hatchlings fledge.

Brood-rearing – The period after eggs have hatched and before chicks are independent of parents.

Calf – the young-of-the-year of several mammal species of mammals, in this document referring to elk, moose, bison, and caribou.

Corvid – any member of the family Corvidae.

Cow – the female of several species of mammals, in this document referring to elk, moose, bison, and caribou.

Critical habitat – The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species (SARA 2003).

Development – human activity at any stage where a permanent or semipermanent impact on the landscape occurs.

Disease vectors – Plants or animals that transmit disease organisms without showing evidence of the disease themselves.

Disturbance – A natural or human action that results in a sustained disruption of ecological structure and function.

Doe – the female of several species of mammal, in this document referring to white-tailed deer and mule deer.

Ecotype – A subdivision (eg. a population or group of populations) within a species or subspecies that has adapted to specific landscapes or environments as expressed primarily by its movements and feeding behaviour (Heard and Vagt 1998).

Endangered – Refers to a species facing imminent extinction or extirpation (SARA 2003).

Estrous – the physiological state when a female is receptive to impregnation ('in heat').

Ewe – a female mountain sheep.

Extirpated – species that no longer exists in the wild in Canada, but exists elsewhere in the wild (SARA 2003).

Fawn – a young-of-the-year deer.

Fledging – the process or period of chick development during which the chick learns to fly.

Fledgling – a young bird with flight-ready feathers which is beginning to fly.

Fledgling success - the number of hatchlings that survive to fledging.

Forage – as a verb: the act of searching for, gathering, and consuming food. As a noun: plant species sought by ungulates as food.

Game bird – a bird prescribed as a game bird and includes the eggs of that bird (BC Wildlife Act 1996).

General Wildlife Measures (GWMs) – Measures or management practices that must be implemented and applied to a specified area such as Ungulate Winter Ranges or Wildlife Habitat Areas; they

may prohibit or partially limit activities, and prescribe a level of management appropriate to the conservation status of the Identified Wildlife under the BC Forest and Range Practices Act 2002 (formerly Forest Practices Code).

Generalist – a species with a broad ecological niche (typically able to survive in a variety of habitats and climates using different food sources).

Gestation – the period of active embryonic growth inside a mammal's body between the time the embryo attaches itself to the uterus and the time of birth (Burton and Burton 2002).

Habitat – the area or type of site where an individual or wildlife species naturally occurs or depends on directly or indirectly in order to carry out its life processes or formerly occurred and has the potential to be reintroduced (SARA 2003).

Hypophagia – eating less than required to meet metabolic demands.

Identified wildlife – species in British Columbia that have been designated by the Chief Forester (Ministry of Forests and Range) and Deputy Minister (Ministry of Environment) as requiring special management attention during forest and range operational planning or higher level planning (FRPA 2002).

Incubation – the period during which and egg is kept warm by one or more parents or adults until the embryo develops and hatches (Burton and Burton 2002).

Incubation constancy – amount of time spent brooding (incubating) the eggs.

Industrial activity – any activity associated with renewable or non-renewable industries, including oil and gas exploration, mining, forestry, wind power production, etc.

Juvenile – An individual that has not reached maturity.

Kid – a young-of-the-year goat.

Lactation – The production and secretion of milk by the mammary glands.

Lambs – a young-of-the-year sheep.

Lichen – a fungus and an algae living closely together in a symbiotic association, developing into a unique form of life that is distinct from either partner (Burton and Burton 2002).

Listed – a species that is listed as at risk by the CDC or COSEWIC, or specified under the Identified Wildlife Management Strategy as regionally important.

Long-distance migrant – bird species breeding in the boreal forest and wintering in the tropics (Smith 1992).

Malnutrition – a state of poor nutrition; can result from insufficient or excessive or unbalanced diet or from inability to absorb foods.

Migratory bird - a migratory bird referred to in the Convention, and includes the sperm, eggs, embryos, tissue cultures and parts of the bird (MBCA 1994).

Mineral lick – site with disproportionate mineral distribution compared to surrounding area and which is used by wildlife to supplement their diets, by consuming soil (wet or dry licks) or water (wet licks only). Licks are typically on lower slopes where subsurface downslope water movement deposits minerals (Poole and Hebert 2000).

Mortality – death.

Natal area – part of an animal's range that is specifically selected for giving birth (usually few predators, inaccessible, and abundant available forage and water).

Natal period – in mammals, the period of time from birth to weaning.

Nanny – a female mountain goat.

Nest – a structure, or part of a structure, prepared by or used by an animal of the class Aves to hold its eggs or offspring (Wildlife Act 1996).

Nest success – survival of eggs or nestlings (usually excluding those of brood parasites).

Nesting – to build or occupy a nest.

Parturition – the act or process of giving birth.
Passerine – any member of the order Passeriformes.
Permanent resident – bird species for which breeding and wintering ranges overlap at the landscape or regional scale.
Population – A group of interacting individuals of the same species in a defined area distinguished by a distinct gene pool.
Population productivity – a measure of a population`s rate of growth or decline.
Population recruitment – a measure of the number of young in a population that survive to breeding age.
Population viability – a species' ability to grow, develop or succeed at a population scale.
Predation – a species interaction in which one organism (the predator) kills and consumes another (the prey).
Pre-laying period – part of the breeding season primarily concerned with courtship and nest establishment, before eggs are laid.
Prerut – period immediately preceding the rut, in which males will attempt to court females, but females are unreceptive.
Ram – a male sheep.
Raptor – any member of the order Strigiformes or Falconiformes.
Red list – in BC, a list of species that are endangered at the provincial level, established by the Conservation Data Center.
Residence – a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating (SARA 2003).
Rumination – part of the process of ruminant digestion, whereby the animal swallows food quickly, and then regurgitates and chews it more thoroughly later on.
Rut – the breeding period of certain mammals, especially ungulates, when females are in estrous. During the rut, males exhibit specific behaviours to establish harems, assert dominance, and court females, followed by mating.
Sensory disturbance – any disturbance to wildlife that does not physically harm wildlife or habitat but elicits a behavioural or physiological response, including visual or auditory disturbances from aerial, vehicle or human traffic, construction and industrial development.
Shorebirds – birds of the suborder Charadrii of the order Charadriiformes.
Short-distance migrant – bird species breeding in the boreal forest and wintering in the continental US but not as far south as long-distance migrants (Smith 1992).
Songbird – a member of the suborder Oscines of the order Passeriformes, in which the syrinx (voice-producing organ) is extremely well developed, enabling the production of sophisticated calls and songs (Burton and Burton 2002).
Special Concern - may become a threatened or an endangered species because of a combination of biological characteristics and identified threats (SARA 2003).
Species at risk – extirpated, endangered or threatened species or a species of special concern (SARA 2003).
Species of special concern – a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats (SARA 2003).
Suboptimal habitat – habitat that is less desirable or less suitable for a given species and in which survival and reproduction are lower.

Subpopulation – a breeding group or stock with distinct genetic or life history attributes that interact on a regular basis. May also represent a component of a metapopulation or population found in a discrete or isolated area (Hanski et al. 1996).

Subspecies – a taxonomic subdivision comprising one or more populations of a species, the members of which differ in certain respects from other populations of the same species (Burton and Burton 2002).

Telemetered – to measure a variable and transmit it to a distant receiver.

Terrestrial – a term applied to animals that live in or are adapted for living principally on the ground (Burton and Burton 2002).

Thermoregulation – maintenance of a consistent internal body temperature.

Threatened – likely to become endangered if limiting factors not reversed.

Topographic relief – the elevation difference between two points on the landscape.

Ungulate – a herbivorous mammal with hooves; most ungulates are split into the artiodactyls (even-toed ungulates), and the perissodactyls (odd-toed ungulates). In BC, wild ungulates include mountain goats and sheep, elk, moose, deer, caribou and bison.

Ungulate Winter Range (UWR) – An area that contains habitat that is necessary to meet the winter habitat requirements of an ungulate species.

Waterfowl – any member of the order Anseriformes, Gadiiformes, or Podicipediformes, also including the coots (Rallidae).

Wildlife Habitat Areas (WHAs) – Mapped areas that are necessary to meet the habitat requirements of an Identified Wildlife element. WHAs designate critical habitats in which activities are managed to limit their impact on the Identified Wildlife element for which the area was established. The purpose of WHAs is to conserve those habitats considered most limiting to a given Identified Wildlife element (FRPA 2002).

Yellow list – list of ecological communities and indigenous species that are not at risk in British Columbia, compiled by the Conservation Data Center.

APPENDIX 3: PEACE REGION SELECTED TERRESTRIAL AND AQUATIC WILDLIFE LEAST-RISK WINDOWS – OCTOBER 8 2009

The following table presents the least-risk windows for selected aquatic and terrestrial wildlife of primary management concern in the Peace Region of the BC Ministry of Environment. Before development or exploration is undertaken, proponents should consider the potential for affecting these wildlife, and plan their activities to coincide with the least-risk windows.

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	Jan
Terrestrial													
Bison				15	-	-	15						
Caribou – boreal	-	-	15	-	-	-			15	-	-	-	-
Caribou – northern	15	-	-	-	-	-	15		15	-	-	-	14
Rocky Mt Elk	15	-	-	-	15	-	15						
Moose					15	-	15						
Bighorn/Thinhorn Sheep	15	-	-	-	-	-	15				15	-	14
Mt Goat	15	-	-	-	-	-	15				1	-	14
Songbirds					1		31						
Trumpeter Swan				1	-	-	31	31					
Aquatic (sport fish)													
Spring Spawners			31	-	-	-	15						
Fall Spawners	-	-	-	-	-	15		31	-	-	-	-	-
Both Spring and Fall Spawners	-	-	-	-	-	-	15	15	-	-	-	-	-

Low Risk	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.
Caution	Operators should avoid development activities during these timeframes.
Critical	Development activities are not appropriate during this timeframe. Aerial activities should adhere to guidelines[1]. In the event that working within a critical window is unavoidable, proponent should contact an appropriate qualified professional (e.g., Registered Professional Biologist with BC accreditation) to discuss alternatives, and potential mitigation and monitoring plans.

For further information, please address any enquiries to the Ecosystems Section.

[1] B.C. Ministry of Environment. 2008. *Peace Region Guidelines for Aircraft Operations/Wildlife Interactions*. ftp://ftpfsj.env.gov.bc.ca/pub/outgoing/Peace_Region_Wildlife_Values/Industrial_Sectors/Best_Management_Practices/ (July 15, 2008).