Wildlife And Aircraft Operation: Assessment Of Impacts, Mitigation And Recommendations For Best Management Practices in the Peace Region

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1. Introduction

Northeastern British Columbia has the highest diversity and overall abundance of wildlife in the province. The region also has the largest extent of industrial activity and land alienation disturbance of any region in the Province. The large land area and widely dispersed nature of the oil and gas industry and other human activities has resulted in the large amount of land disturbance for roads and seismic lines in the Boreal and Taiga Plains Ecoprovinces (Demarchi 1995), as illustrated in the red areas in the figure below.

Aircraft have traditionally been used to pioneer access and cope with the large travel distances, and severe environmental conditions in this polar influenced area.

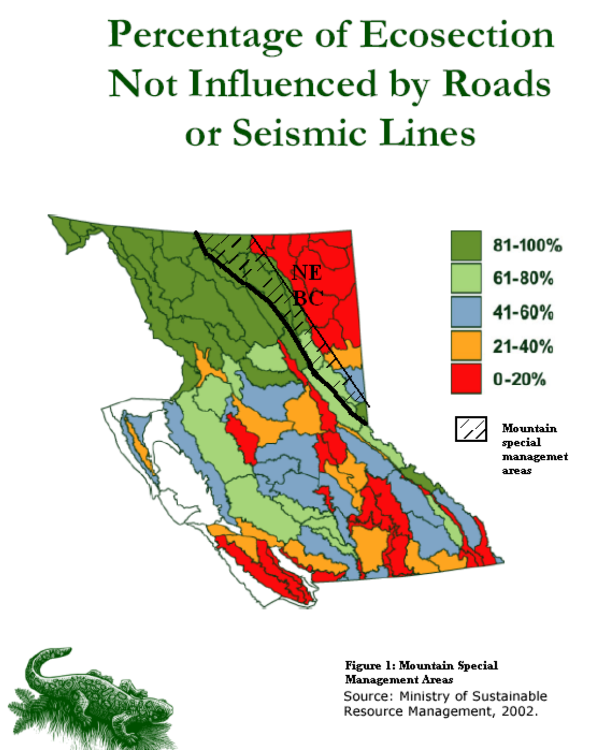

FIGURE 1: ROAD AND SEISMIC LINE DISTURBANCE (AFTER MSRM 2002)

As industrial development pushes into the Northern Canadian and Central Canadian Rocky Mountains Ecoregions (crosshatched in Figure 1) the ruggedness of the terrain restricts ground access options and increases their environmental impacts. This has lead to more utilization of aircraft, particularly rotary wing to support human activities. The increased availability, reliability and cost effectiveness of aircraft and the lack of ground disturbance have also contributed to their increased use for industrial access, commercial and personal recreation.

Aircraft can have a variety of impacts on wildlife and their utilization of habitats. The increasing numbers of aircraft and flights individually, and cumulatively are of concern to effective management of wildlife. This report was commissioned to provide background information, assessment of impacts and recommendations for best management practices to provide for the long-term viability of Northeastern British Columbia's diverse and abundant wildlife.

Along the east slope of the Rockies in Northeastern British Columbia ungulates (mountain sheep, mountain goats, caribou, moose, elk, bison and deer) and carnivores (grizzly bear, black bear, wolves, lynx and wolverine) are found in a diversity and abundance of numbers highest in the province, and comparable to the highest numbers found anywhere in the world. The wildlife resource has been recognised in land use planning, both in the creation of a number of Parks, and in the formation of the Muskwa-Kechika Management Area and other special Resource Management Zones (RMZ) including; Major River Corridors, Wildlife Recreation, Wildlife Coalfield and Cultural Heritage. These zones have been given legal recognition in the Dawson Creek, Fort St. John, Fort Nelson and Mackenzie Land and Resource Management Plans (LRMP's).

The vast majority of low-level aircraft use (below 3050 meters or 10,000 ft above sea level (ASL)) is in the exploration and development of Oil and Gas areas. However, localized use for commercial and personal recreation as well as inventory and research can possibly be as or more intense in localized areas, and may have as much impact as the often more widespread industrial use. Most important of all, these various uses of aircraft can have a cumulative impact on wildlife. This report is intended to generally cover all low-level aircraft use.

The purpose of this report is to provide information and assessment on aircraft uses that most affect the viability of wildlife in Northeastern British Columbia. As well as to provide a best management practices guideline section to describe preferred management practices of aircraft operation, to mitigate impacts on wildlife use and to protect populations and individuals.

Specific objectives were:

1. To provide a targeted literature review to identify issues, current knowledge and practices;

2. To document and assess aircraft operational practices of concern for wildlife;

3. To assess best management practices to reduce environmental impacts of aircraft use in industrial developments and commercial operational activities;

4. To specify acceptable parameters for protection of mammals in the special management and protected areas including the Muskwa-Kechika; and

5. To identify monitoring and threshold criteria for assessing impacts of aircraft activity on key mammal species.

The Best Management Practices section has two objectives:

1. To provide best management practices for regulators, industry, construction contractors and service firms to reduce environmental impacts of aircraft use in industrial development and commercial operational activities; and

2. To specify acceptable parameters for protection of mammals in special management and protected areas, especially the Muskwa-Kechika Management Area.

1.1. Issue

Aircraft, especially helicopters, are extensively used for supporting oil and gas exploration and development. As oil and gas exploration reaches into sensitive mountain habitats helicopters are commonly used for seismic exploration, surveying, scouting and support for drilling operations. This is in addition to the use of helicopters and other aircraft for forest inventory and management, commercial and public recreation and wildlife inventory and management. The amount of aircraft traffic in total is increasing and there is concern for the impact of the cumulative amount of aircraft traffic on wildlife.

"In general, wild animals do respond to low-altitude aircraft over flights and landings. The manner in which they do so depends on life-history characteristics of the species, characteristics of the aircraft and flight activities, and a variety of other factors such as habitat type and previous exposure to aircraft. The potential for over flights to disturb wildlife and the resulting consequences have drawn considerable attention from wildlife managers, conservation organizations, the scientific community and to private citizens who feel it is unwise and/or inappropriate to disturb wildlife. Two types of overflight activities have drawn the most attention with regard to their impacts on wildlife: 1) low-altitude overflights by military aircraft in the airspace over national and state wildlife refuges and other wild lands, and 2) light, fixed-wing aircraft and helicopter activities related to tourism and resource extraction in remote areas.

The primary concern expressed is that low-level flights over wild animals may cause physiological and/or behavioral responses that reduce the animals' fitness or ability to survive. It is believed that low-altitude overflights can cause excessive arousal and alertness, or stress (see Fletcher 1980, 1990, Manci et al. 1988 for review). If chronic, stress can compromise the general health of animals. Also, the way in which animals *behave in response to overflights could interfere with raising young, habitat use, physiological energy budgets and predation avoidance. Physiological and behavioral responses have been repeatedly documented, that suggest some of these consequences occur. While the behavioral responses by animals to overflights have been well-documented for several species, few studies have addressed the indirect consequences.*

The scientific community's current understanding of the effects of aircraft overflights on wildlife are found in the literature. Such studies identify: collision with aircraft (Burger 1985, Dolbeer et al. 1993); flushing of birds from nests or feeding areas (Owens 1977, Kushlan 1979, Burger 1981, Anderson and Rongstad 1989, Belanger and Berad 1989, Cook and Anderson 1990); alteration in movement and activity patterns of mountain sheep (Bleich et al. 1990); decreased foraging efficiency of desert big horn sheep (Stockwell and Bateman 1991); panic running by barren ground caribou (Calef et al. 1976); decreased calf survival of woodland caribou (Harrington and Veitch 1992); increased heartrate in elk, antelope, and rocky mountain big horn sheep (Bunch and Workman 1993); and adrenal hypertrophy in feral house mice (Chesser et al. 1975). Over 200 published and unpublished reports can be found on the subject. These reports range in scientific validity from well designed, rigorous studies to professional natural resource manager and pilot reports.

Recent concerns have focused on the significance of impacts as they affect wildlife populations. It is possible to draw the conclusion that impacts to wildlife populations are occurring from low level aircraft overflights. This assertion is supported by numerous studies including the following:

1) Decreased calf survival of woodland caribou (Harrington and Veitch 1992);

2) Disturbance to wintering snow geese documents the effects on staging/wintering subgroup (Belanger and Beard 1989); and

3) Impacts on nesting herring gulls documents effects on a subgroup during production periods (Burger 1991)” [A].

The Wildlife Policy of Canada defines wildlife as all living wild organisms. However, the literature on effects of aircraft operations disturbances on wildlife focuses largely on vertebrates, particularly ungulates and some birds. Very little information exists on other species.

Information on the impacts of aircraft operations on wildlife is extensive and widely dispersed in a variety of refereed journals and proceedings and in reports of consultants and governments. Notwithstanding the large information base (including several reviews), many aspects of the issue are still unstudied and most research is observational

[A] Introduction Chapter 5, Report to Congress on Effects of Aircraft Overflights on the National Park System, National Park Service, Washington DC 1994.

(Wilson and Shackleton 2001). Given the number of wildlife species of concern, the many types of aircraft and usage, the guidelines and criteria proposed in this report are based on general principles and knowledge about wildlife, and use approaches adopted by other management agencies. Research-based findings are appropriately referenced where available. While there is a paucity of definitive literature on aircraft operations impacts, we have assessed potentials based on the Precautionary Principle: *Where there are threats of serious or irreversible impacts to wildlife population viability, lack of full scientific certainty should not prohibit identifying and proposing mitigation measures to protect wildlife.*

Aircraft are used for transportation of humans and materials to remote sites, but also for, research, inventory, sightseeing and wildlife viewing. The primary impact of Aircraft operations is noise and movement disturbance. This disturbance of wildlife is primarily a function of how frequent, how long, how close, how visible and how loud the aircraft is. In general from a proximity/decibel/ time perspective helicopters are more disturbing than fixed-wing aircraft, which are more disturbing than ultralight personal aircraft, hang-gliders, and balloons. Like other impacts, aircraft disturbance of wildlife becomes more serious issue where frequency of aircraft use is high. Helicopters and jet aircraft also cause air movements that can have other impacts.

Wildlife species most affected by aircraft operations include ungulates (in order of susceptibility- mountain goats, mountain sheep, caribou, elk, deer, moose and bison), grizzly bears, waterbirds, raptors and passerine birds at landing/downwash sites

2. Methods

2.1. Literature Review

We have conducted a targeted literature review to identify the impacts of aircraft operations on wildlife and the regulations and proposed mitigations to reduce those impacts. It is not within the scope of this project to review every article relevant to the impacts of aircraft operations on all wildlife. The approach taken has been to draw upon documents pertinent to wildlife and activities predominate in northeastern British Columbia. In particular we have not accessed much of the literature relating to military aircraft, sonic booms and other issues not of known relevance in northeastern BC. We have sourced much of the original literature, but have relied extensively on publications that that have already summarized the significant information. We have extensively used the Discussion Draft of Wildlife and Commercial Backcountry Recreation in British Columbia (Harper and Eastman 2000), as this review included guidelines for aircraft operations. We appreciate the thoroughness of the background and insights in Backcountry Recreation and Mountain Goats: A Proposed Research and Adaptive Management Plan (Wilson and Shackleton 2001). We have tried to augment these sources with most recent information and with information for species that have not been covered in these reviews.

We have not presented a separate literature review section, but have instead incorporated the references and ideas in a section called Analysis of Potential Impacts of Air Operations on Wildlife. However, we have ensured that our review is available by including both actual references and other materials in a references and bibliography section.

2.2. Risk Assessment

To analyze the potential impacts of air operations on wildlife we have had to assess the level of risk of operations having an impact and prioritize to which impacts are of concern at this level of discussion. We have adopted the following method of prioritizing issues based on a risk assessment methodology provided Harper and Eastman (2000). "*The resulting array of possible impacts is too large to address given the level of available resources. There is a need to provide a consistent and explicit basis for assessing risks so that management attention can be focused on the most critical issues. To provide this perspective, we adopted the risk assessment procedure used by the Compliance and Enforcement Branch (Ministry of Forests 1998). Initial risk assessment is based on two considerations: 1) the likelihood of a detrimental impact, and 2) the magnitude of the consequences. Given the lack of quantifiable assessments in the literature, qualitative judgments were used.*

Initial risk assessment has the following steps:

1) *Identifying the detrimental impacts*
2) *Estimating the likelihood of an adverse impact (rated as very high, high, moderate and low)*
3) *Estimating the magnitude of the consequences of the impact, based on the impact and the intensity of an event (rated as very high, high, moderate and low)*
4) *Combining the likelihood of impact with the magnitude of the impact to arrive an overall assessment of risk (rated as very high, high, moderate and low)."*

Table 1 presents the rating system applied in this report. The resulting assessment is a list of aircraft operations disturbances and types of accessing activities that is explicit and ranked.

TABLE 1. METHOD OF CALCULATING INITIAL RISK RATINGS BASED ON THE LIKELIHOOD AND MAGNITUDE OF ESTIMATED IMPACTS.

LIKELIHOOD	x	MAGNITUDE	=	RISK*
very high or high	x	very high or high	=	very high
very high or high	x	moderate	=	high
moderate	x	very high or high	=	high
moderate	x	moderate	=	moderate

very high, high or moderate	x	low	=	moderate
low	x	very high or high	=	moderate
low	x	moderate or low	=	low

* - after Ministry of Forests 1998 from Harper and Eastman 2000

The impacts of aircraft operations on wildlife resources vary greatly and will depend on the type of aircraft, the purpose of the flight, the geographic location, the wildlife species present, and the time of year.

Identified aircraft operations activities have been evaluated according to their potential impact, and the priority issues have been identified in the species specific statements.

2.3. Categories of potential impacts

The following table describes the severity of the categories of potential impacts we have chosen.

TABLE 2. CATEGORIES OF IMPACTS

Category	Characteristic of Impact
VERY HIGH:	▪ Direct mortality: immediate on-site death of an animal or bird eggs. ▪ Destruction of nests. ▪ Reduced use or abandonment of an area or nests: wildlife not using an area in the manner they normally would be, or vacating it.
HIGH	▪ Indirect mortality: eventual, untimely death of an animal or egg, caused by an event or agent that predisposed the animal to death. ▪ Lowered productivity: reduced fecundity rate, nesting success or reduced survival rate of young before dispersal from the nest or birth site. ▪ Reduced use or abandonment of preferred habitats. ▪ Increased susceptibility to predation.
MODERATE	▪ Flight to escape terrain, or flocks of birds taking flight or other changes in animal behavior. ▪ Changes in animal activity periods. ▪ Changes in animal bedding areas, feeding areas. ▪ Animals exhibit periods of high alert, reduction in foraging times.
LOW	▪ Animals have brief periods of alertness while maintaining activities.

	▪ Watching aircraft by animals. ▪ Minor changes in animals existing travel speeds, methods and routes. ▪ No change in animal group size or movements.
In addition, it is important to keep in mind the following generalizations:	• Reactions by animals depend upon type, intensity, duration, timing, predictability, distance and location of aircraft operations disturbance from the animal. • Reactions by animals can be immediate or delayed, direct or indirect. • Sometimes, some animals can become habituated to some disturbance caused by aircraft operations, but not all animals can become habituated. The apparently undisturbed animals seen by pilots and passengers is generally a very small proportion of the population and is not indicative of overall reactions and impacts • Habituation (or lack of obvious reactions) by some animals imposes energetic costs on animals; they are often under stress even though they may appear undisturbed. For example sheep in escape terrain cannot show obvious stress by running to escape terrain as they are already there, lack of movement masks the stress reactions of increased heart rate etc. • Motorized vehicles including helicopters, airplanes, snowmobiles, off-highway vehicles (OHVs), and jet boats are typically loud and fast. They have, both a great likelihood of disturbing wildlife, and a great potential of severe impact. It is important to also consider the impact of aircraft operations disturbances may be cumulative with the impact of other motorized disturbances.

3. Analysis of Potential Impacts of Air Operations on Wildlife

Aircraft are noisy machines that travel at high speed with the ability to approach wildlife closely. All aircraft approaches invoke some reaction from animals. The potential impact of this can vary from panicked mountain goats and sheep falling from cliffs and panicked birds flying into obstacles to, moose carefully watching a plane fly by at some distance. It is difficult to assess the impact of short-term reactions on populations, productivity and habitat use. The literature provides some insight into the potential for impacts by describing reactions; analyzing behavior and habitat use changes and even by monitoring evidence of stress through heart rates. While there is considerable literature, most studies are observational, for each species studies are few in number, not always conclusive and usually ask more questions than they answer. We have used the risk analysis methodology above, analyzed what literature is available and identified the following :

TABLE 3. ANALYSIS OF THE RISK OF VARIOUS IDENTIFIED IMPACTS.

Aircraft Feature	Risk of Impact
Noise	Very High to Moderate
Movement	Very High to High
Close approaches	Very High
Seasonality	High
Landing Sites	Moderate
Frequency	High to Moderate
Routes	Very high
Aircraft type	Moderate to Low
Daily timing	Moderate to Low
Activities following landing	Moderate to Low
Downwash	Very High to Moderate

3.1. Key Criteria and Sensitivities

Key issues of concern are identified (Table 4). These key issues can be habitat-related, such as those areas used by animals at critical times in their annual life cycle, such as winter ranges for ungulates or breeding sites for colonial-nesting birds. Key issues can also refer to particular aspects of a species' biology that make them vulnerable, or sensitive to human activities, such as, a hyper-sensitivity to stress or times of large aggregations.

TABLE 4. EXAMPLES OF KEY ISSUES RELATED TO HUMAN IMPACTS ON WILDLIFE.

Key Habitats	Behavioral issues	Addittional issues
Winter habitat	Flight by animals	Intensive activity at landing sites
Birth sites/Maternal areas (Birthing and Rearing)	Direct mortality, Reduced reproductive success	Activities in bear habitat
Escape Terrain	Indirect mortality	Frequency of disturbance
Migratory /molting sites	Reduced reproductive success	Timing of disturbance
Hibernation and denning sites	Stress in animals that don't show flight response	Cumulative Impacts
Nesting habitat	Range avoidance or abandonment. Reduced reproductive success	
Diurnal resting sites	Maternal groups	

Berry patches	Loss of foraging ability critical habitat alienation	

3.1.1. Ungulate Winter Ranges

A major concern about the effects of disturbance on ungulates (hoofed mammals, mountain sheep, mountain goats, caribou, elk, bison, moose, deer) is for the winter season because animals are most vulnerable to stress from adverse impacts at that time. During this season, ungulates are:

- Concentrated into smaller areas compared to other times of the year, so that any adverse activity or event is more likely to affect a greater number of individuals than at other seasons when they are more dispersed.
- Declining in physical condition and are less able to cope with extra stresses and disturbances, both natural and human-caused.
- Exposed to increased metabolic costs because of more inclement climatic conditions.
- Less able to disperse to other parts of the winter range because deep snow restricts or prevents their movements.
- Very limited in their choices of alternative habitats because deep snow and other physical factors precludes access to them.
- More susceptible to predation if disturbed in optimal habitat.

The above conditions and factors apply to the entire winter season, but they progressively are exacerbated over the winter, so that by the end of winter, ungulates are less capable of accommodating increased disturbance. The progressive loss of resilience and the resulting levels of over winter mortality vary according to the severity and duration of the winter.

If ungulates are exposed to excessive stresses over the winter, the effects are rarely observed immediately. More typically animals move away from a stress, and nothing more seems to happen. It is the cumulative, incremental effects of these seemingly innocuous events that are of greatest concerns. Consequences of these impacts are rarely immediate death; consequences are most likely be subtle and delayed (cumulative). They can occur in late winter/early spring or during lactation – chronic stress can impair immune responses, animals usually lose additional weight and may die of malnutrition, animals may be less able to escape predators or withstand disease (indirect death consequences), females can produce smaller fetuses so newborns fail to thrive, females can have inadequate milk supplies or maternal care is interrupted resulting in death or impaired growth in young.

These types of cumulative impacts are difficult to document. Studies of ungulate response to aircraft operations disturbances commonly measure behavioral changes, such as movements by animal when exposed to different activities at varying distances (Cote 1996, Frid 1998). The energetic costs of these responses can be determined by extrapolating from studies of ungulate locomotion. Other studies (Stemp 1983 and MacArthur et al. 1982) have used heart rate to monitor ungulate responses, because there is a strong correlation between heart rate and metabolic costs. Again, energetic costs can be estimated and impacts modeled based on energy budgets.

There are only limited areas that meet the habitat requirements of ungulates for winter range. Although each species has its own requirements for winter habitat, in most cases winter range is often limiting to the existence and abundance of the population. Consequently, aircraft operations disturbances that cause animals to reduce the physical extent of winter habitat they utilize places an additional demand on the animals, which may result in the loss of individuals or reduction in the health and abundance of the population. If very restricted winter range is severely disturbed it may result in the loss of entire local populations

Aircraft operations near winter ranges have a very high impact factor, and are likely to have severe cumulative consequences

3.1.2. Ungulate Spring (Birthing and Rearing) Ranges

Another critical season for ungulates is the post-winter or early spring period. At this point, ungulates have the fewest energy reserves in their annual cycle, and access to nutritious new forage is essential if individuals are to regain physical condition. Most adult females are in the last stages of pregnancy, preparing for birth and lactation. Energetic demands are especially heavy, and unrestricted access to nutritious forage is essential for their recovery, and for the successful birthing and rearing of newborns. Lactation is the most energetically demanding time of the annual cycle for females.

Aircraft operations near spring ranges have a very high impact factor and are likely to have severe consequences for individual young animals, and cumulatively during the season, with severity highest in early spring and declining toward the summer. See Appendix 1 and 2 for information on energy budgets and gestation/birthing periods.

3.1.3. Ungulate Escape Terrain (Cliffs)

Mountain sheep, mountain goats and to lesser extent caribou, elk and moose use escape terrain as security cover where they can avoid becoming a meal for predators. Most flight responses are to reach an area of higher security. Disturbance of these animals in this cliff terrain leaves the animals with nowhere to go except areas of less security. Animals when disturbed or approached in these cliff areas may fall when fleeing in this steep terrain, may move to less secure areas where they are subject to predation or may experience a period of terror and stress while holding still in a cliff area when a big, noisy, fast aircraft approaches. (Frid 1997,1998, Stemp 1983 and MacArthur et al. 1982, Cote 1996, Bleitch el al 1993)

Aircraft operations near cliff escape terrain can have a very high impact factor and are likely to have severe consequences for both individual animals, and cumulatively on the population.

3.1.4. Special Features

3.1.4.1. Migratory /molting sites

Migratory birds, especially waterfowl and waterbirds, tend to gather in certain wetlands or shallow lakes during migration, or during the molt when they are vulnerable to predation. While at these restricted sites these birds are very susceptible to disturbance impacts. Additionally the movement of large numbers of birds to and from these sites creates a hazard for both the birds and aircraft from collisions. Most of these shallow lakes and wetlands are easily identified and avoided. Most of these same habitats are areas of concentration during the molt when flight capability is reduced or absent, and the birds are very susceptible to disturbance.

Aircraft operations near migratory and molting sites can have a moderate to high impact factor and may have consequences for individual animals and populations.

3.1.4.2. Hibernation and denning sites

Bears and bats hibernate and most carnivores have denning sites. These sites are not often identified but occasionally are found in open locations where they are approachable by aircraft. The frequent disturbance of hibernacula and dens by close approach of aircraft, or from ground activities where people are brought in by aircraft can cause abandonment or reduced use of these sites.

Aircraft operations and aircraft supporting ground activities near hibernacula and dens normally have a low impact factor, but occasionally very approachable dens can have a high impact factor that may have consequences for individual animals and populations.

3.1.4.3. Nesting habitat

Birds and small mammals build nests in a great variety of habitats. Those nests in open areas such as the tops of trees or cliffs are susceptible to disturbance by aircraft operations. Additionally these open nests or many smaller nests in brushy areas near landing sites are susceptible to physical damage from wind effects of aircraft, especially downwash from helicopters. Helicopter downwash can move large debris and small nest components causing damage to the nests and hazards for nearby humans (See appendix 7.7).

Aircraft operations and aircraft supporting ground activities near nests can have high impact factor on individual nesting success.

3.1.4.4. Diurnal resting sites

A number of birds and mammals have resting sites that they use daily on a regular basis. These sites are selected for security and thermal reasons, and the loss of their use from disturbance can cause thermal distress or higher predation rates. Those sites on promontories, forested hilltops or in snags approachable by aircraft, are susceptible to disturbance and repeated or cumulative approaches.

Aircraft operations and aircraft supporting ground activities near diurnal resting sites normally have a low impact factor, but occasionally very approachable sites can have a high impact factor from repeated, or cumulative approaches that may have serious consequences for individual animals and populations.

3.1.4.5. Berry patches

Grizzly bears and black bears require access to high quality feed during the season when they have to fatten up for their winter hibernation. Some open (usually high elevation) berry patches play a key role in providing high quality feed, but bears on these sites are very susceptible to disturbance from aircraft operations due to the distance to security cover.

Aircraft operations and aircraft supporting ground activities near berry patches normally have a low impact factor, but very open, approachable sites can have a high impact factor from repeated or cumulative approaches that may have serious consequences for individual animals and populations.

3.1.4.6. Licks

A number of birds and mammals (especially ungulates) utilize mineral licks on a daily, or regular basis. These sites are accessed for minerals, and often pose significant security, thermal and travel costs for animals. The flight costs and the loss of their use from disturbance can cause distress, significant energy costs, higher predation rates and loss of a significant nutrient. Those sites on promontories, forested hilltops or in snags approachable by aircraft are susceptible to disturbance and repeated or cumulative approaches.

Aircraft operations and aircraft supported ground activities near mineral licks can have a high impact factor and very open, approachable licks can have a very high impact factor from repeated or cumulative approaches. These impacts may have serious consequences for individual animals and populations.

3.1.5. Wetlands and Shallow lakes

Wetlands, shallow lakes and large shallow bays and estuaries on large lakes are extremely productive ecosystems that provide habitat for a high diversity and abundance of wildlife, including birds. Large flocks of birds and moose foraging in the shallows are common images. Due to their openness these sites are very approachable by aircraft, but the openness that allows approach also means a lack of security cover for wildlife and birds. The wildlife that concentrates on these areas is very susceptible to disturbance and repeated or cumulative approaches by aircraft.

Aircraft operations near wetlands, shallow lakes, large shallow bays and estuaries on large lakes can have a high impact factor, to a very high impact factor from repeated or cumulative approaches. These impacts may have serious consequences for individual animals, and populations.

3.1.6. Alpine and Open Sub-alpine Habitats

Alpine and open sub-alpine basins and ridges are extremely productive ecosystems that provide habitat for a high diversity and abundance of wildlife, including birds. Caribou, sheep, elk, grizzly bears, wolverine and flocks of birds are common images. Due to their openness these sites are very approachable by aircraft, but the openness that allows approach also means a lack of security cover for wildlife and birds. The wildlife that concentrates on these areas is very susceptible to disturbance from repeated, or cumulative approaches by aircraft, and aircraft supported ground activities.

Aircraft operations and aircraft supported ground activities in alpine and open sub-alpine habitats can have a high, to a very high impact factor from repeated or cumulative approaches. These impacts may have serious consequences for individual animals and populations.

4. Selected Species/Groups – Mitigation Guidelines

4.1. Ungulates

4.1.1. Mountain Goat

Key issues of concern: human presence, especially in helicopters and snowmobiles.

Principal sources of information: Cote (1996), Cote and Festa-Bianchet (1997), Foster and Rahs (1983), Frid (1997), Joslin (1986) Harper and Eastman (2000) . Guidelines for Mountain Goat and Sheep in Alberta (Appendix 6.5).

Of all the ungulate species, mountain goats appear the most sensitive to disturbance, especially by helicopters (Wilson and Shackelton 2002). In Montana, increased disturbance by helicopters reduced productivity of mountain goats (Joslin 1986). In the Rocky Mountains of Alberta, mountain goats moved in response to helicopters from a distance of at least up to 1.5 km (Cote 1996, Cote and Festa-Bianchet 1997). In northern British Columbia, Foster and Rahs (1983) reported that goats required a buffer area of 2 km to completely avoid harassment. Cote (1996) and Frid (1997) recommended that helicopters should remain a minimum of 2 km horizontal distance to avoid disturbance to mountain goats.

An extensive problem analysis, literature review, and research program on human disturbance of Mountain Goats is available (Shackleton and Wilson, 2001).

The objective of Best Management Practices: Aircraft Operations and Wildlife for Mountain Goat is to maintain the current distribution and abundance of provincial populations. The following aircraft operations guidelines apply to all populations mountain goat:

A. Prior to project initiation, use existing Wildlife Capability, Terrestrial Ecosystem or Predictive Ecosystem mapping (scale usually 1:50,000 or larger), and local information from biologists, First Nations, guide outfitters and others to identify and map mountain goat habitat and populations.

B. Prior to project initiation, identify and map sensitive sites including escape terrain, lambing habitats, mineral licks and winter ranges.

C. Generally avoid mountain goat habitats by limiting helicopter and fixed-wing overflights to a minimum of 400 m above ground level (AGL), and a minimum 2000 m horizontal distance from mountain goat habitats. Circling or direct approach to animals is to be avoided.

D. Totally avoid mountain goat kidding (birthing/rearing) areas (May 15 through July 15), cliff escape areas (year round), and winter ranges (December 1 through May 15th) by limiting helicopter and fixed-wing overflights to a minimum of 400 m above ground level (AGL) and a minimum 2000 m horizontal distance. Circling or direct approach to animals is to be avoided.

E. Necessary inventory activities need to be planned to minimize impacts and avoid sensitive times and sites. Where possible, overflights for inventory purposes should generally be a minimum of 100m above ground level, circling or direct approach to animals is to be avoided. Coordination of inventory activities is required to prevent duplication of inventory disturbance by independent parties.

F. Geophysical exploration (seismic) activity or helicopter-supported recreation should be permitted within mountain goat habitat only during the period of July 15 to October 31 to avoid the winter, birthing/rearing and rut seasons.

G. To be generally consistent with Alberta guidelines, geophysical exploration (seismic) activity and helicopter supported recreation should be permitted within mountain goat habitat only under the following conditions:

   a. No more than one (1) program within a particular mountain goat population area in any given year; and

   b. No more than one third of a particular mountain goat population habitat area, comprised of a contiguous block, is to be available for activities during a given year.

H. Where helicopter support is required for an approved activity adjacent or within a portion of a mountain goat habitat area, flight paths to and from the approved activity area must avoid all steep cliff faces that may be used as escape terrain, as well as other known high use areas, such as mineral licks. A qualified biologist, who is knowledgeable and experienced with mountain goat in field situations, should be hired by the proponent company to monitor the location and activity of mountain goat within the mountain goat habitat in the general project area. The monitoring activity is to be used to redirect or temporarily curtail activities in the interest of minimizing disturbance to the animals, as well as to provide them with an opportunity to move into portions of their range that are not being actively explored.

I. Site-specific helicopter supported construction activities, such as well drilling and pipeline construction may be required in or near mountain goat habitat areas. This intensive activity will displace mountain goat and result in the loss of use of those areas during the activity period. To be generally consistent with standard H above and to deal with potential cumulative impacts the following conditions apply:

   a. No more than one (1) intensive activity within a particular mountain goat population area in any given year, and the following year; and

   b. No more than one third of a particular mountain goat population habitat area, comprised of a contiguous block, is to be disturbed by the intensive activities or helicopter overflights below 400 m (AGL) during a given year.

J. The cumulative impacts of disturbance on adjacent mountain goat habitat are to be monitored and assessed; so authorizing authorities have adequate information to ensure that the total amount of activity (cumulative impact) does not exceed thresholds that threaten wildlife populations and abundance.

K. A program of orientation and responsible behavior to wildlife mitigation measures and their importance, along with the specific program for the project is to be provided to all employees, clients and contractors transported or involved in aircraft operations.

4.1.2. Rocky Mountain Bighorn and Stone's Sheep

Key issues of concern: low and high elevation winter ranges, lambing grounds and mineral licks.

Principal sources of information: Harper and Eastman (2000), Frid (2000), Guidelines for Sheep and Goat in Alberta.

Wild sheep also seem more sensitive to human activities than forest dwelling ungulates, as might be expected by a species living in open habitats. In addition to habitat needs generally described for hoofed mammals, wild sheep have additional needs for escape terrain and for lambing, such as steep cliffs (Olliff et al. 1999, Paquet and Demarchi 1999). Aircraft operations that prevent wild sheep from accessing escape terrain or increase time spent in these areas probably increases stress, and may lower foraging efficiency.

Helicopter and fixed-wing aircraft activities does stress mountain sheep , (MacArthur et al. 1982, Krausman and Hervert 1983, Stemp 1983). While occasional exposure to these activities likely has minimal effect on wild sheep, chronic exposure potentially reduces forage efficiency and habitat utilization (Frid 1998,1999, Stockwell et al. 1991, Bleich et al. 1994) that, in turn, impacts growth and survival (Geist 1978). Chronic stress can also compromise the immune system in wild sheep, increasing their vulnerability to diseases. In the Todagin Mountain area, thinhorn sheep and mountain goats have abandoned the area within 4 to 5 km of the helicopter flight corridor used for mine development (S. Sharpe, pers. comm.).

The objective of Best Management Practices: Aircraft Operations and Wildlife for Mountain Sheep is to maintain the current distribution and abundance of populations. The following aircraft operations minimum standards apply to all species and subspecies of mountain sheep:

A. Prior to project initiation, use existing Wildlife Capability, Terrestrial Ecosystem or Predictive Ecosystem mapping (scale usually 1:50,000 or larger), and local information from biologists, First Nations, guide outfitters and others to identify and map sheep habitat and populations.

B. Prior to project initiation, identify and map sensitive sites including escape terrain, lambing habitats, mineral licks and winter ranges.

C. Generally avoid sheep habitats by limiting helicopter and fixed-wing overflights to a minimum of 400 m above ground level (AGL), and a minimum 2000 m horizontal distance from sheep habitats. Circling or direct approach to animals is to be avoided.

D. Totally avoid sheep lambing (birthing/rearing) areas (May 15 through July 15), cliff escape areas (year round) and winter ranges (December 1 through May 15th), by limiting helicopter and fixed-wing overflights to a minimum of 400 m above ground level (AGL) and a minimum 2000 m horizontal distance. Circling or direct approach to animals is to be avoided.

E. Necessary inventory activities need to be planned to minimize impacts and avoid sensitive times and sites, where possible overflights for inventory purposes should generally be a minimum of 100m above ground level. Circling or direct approach to animals is to be avoided. Coordination of inventory activities is required to prevent duplication of inventory disturbance by independent parties.

F. Geophysical exploration (seismic) activity or helicopter-supported recreation should be permitted within sheep habitat only during the period of July 15 to October 31 to avoid the winter, birthing rearing and rut seasons.

G. To be generally consistent with Alberta guidelines, geophysical exploration (seismic) activity, and helicopter supported recreation should be permitted within sheep habitat only under the following conditions:

   a. No more than one (1) program within a particular sheep population area in any given year; and

   b. No more than one third of a particular sheep population habitat area, comprised of a contiguous block, is to be available to for activities during a given year.

H. Where helicopter support is required for an approved activity adjacent or within a portion of a sheep habitat area, flight paths to and from the approved activity area must avoid all steep cliff faces that may be used as escape terrain, as well as other known high use areas, such as mineral licks and resting areas. A qualified biologist, who is knowledgeable and experienced with sheep in field situations, should be hired by the proponent company to monitor the location and activity of sheep within the sheep habitat in the general project area. Monitoring is to be used to redirect or temporarily curtail activities in the interest of minimizing disturbance to the animals, as well as to provide mountain sheep with an opportunity to move into portions of their range that are not being actively explored.

I. Site-specific helicopter supported construction activities, such as well drilling and pipeline construction may be required in or near sheep habitat areas. This intensive activity will displace sheep and result in the loss of use of those areas during the activity period. To be generally consistent with standard H above and to deal with potential cumulative impacts the following conditions apply:

   a. No more than one (1) intensive activity within a particular sheep population area in any given year and the following year; and

   b. No more than one third of a particular sheep population habitat area, comprised of a contiguous block, is to be disturbed by the intensive activities or helicopter overflights below 400 m (AGL) during a given year.

J. The cumulative impacts of disturbance on adjacent sheep habitat are to be monitored and assessed, so authorizing authorities have adequate information to ensure that the total amount of activity (cumulative impact) does not exceed thresholds that threaten wildlife populations and abundance.

K. A program of orientation and responsible behavior to wildlife mitigation measures and their importance along with the specific program for the project is to be provided to all pilots, employees, clients and contractors transported or involved in aircraft operations.

4.1.3. Caribou

Key issues of concern: human activity on late winter ranges, and at calving times.

Principal sources of information: Harper and Eastman (2000).

Caribou cover wide elevation and geographical ranges over the course of a year, and this extensive movement puts them into contact with many types of recreational and other human activities. The two areas of greatest concern for caribou are the calving and late winter ranges. During calving, caribou disperse to more isolated areas, with the result that they are even more susceptible to impacts. Late winter habitat in sub-alpine and alpine areas can be greatly impacted. Since caribou in the sub-alpine are particularly cryptic and difficult to see, and their tracks are often not visible in wind swept areas, aircraft operators may be deluded into believing no caribou are present and continue high levels of use.

Caribou have evolved a strategy of wintering at high elevations to obtain arboreal or terrestrial lichens and, presumably, to reduce their exposure to predation. While the concerns are greatest for mountain caribou, “northern” caribou herds are also facing pressure from human activities.

Stevenson et al. (1994) state that caribou can tolerate low levels of aircraft operations disturbances but avoid areas of heavy use, although this does not appear to be based on any systematic research. The key issue for backcountry recreation is level of use. Simpson and Terry (2000) examined the potential threat of four winter backcountry recreation activities on mountain caribou. They rated snowmobiling as “very high”, heli-skiing as “high”, snowcat skiing as “moderate” and backcountry skiing as “low.” The susceptibility of caribou to aircraft disturbance has been recognized and overflight guidelines are included in the Aircraft Inflight Procedures (A.I.P.) as identified in appendix 6.4.

The objective of Best Management Practices: Aircraft Operations and Wildlife for Caribou is to maintain the current distribution and abundance of provincial herds.

A. Prior to project initiation, use existing Wildlife Capability, Terrestrial Ecosystem or Predictive Ecosystem mapping (scale usually 1:50,000 or larger), and local information from biologists, First Nations, guide outfitters and others to identify and map sensitive seasonal habitats including calving, rutting, early and late winter ranges.

B. Seasonally (May 15 to July 15) avoid highly birthing/ rearing habitats by limiting helicopter and fixed-wing flights altitudes to a minimum of 400 m above ground level (AGL) and a minimum 2000 m horizontal distance from caribou habitats, circling or direct approach to animals is to be avoided.

C. Seasonally (December 1 to May 15) avoid high elevation winter habitats by limiting helicopter and fixed-wing flights altitudes to a minimum of 400 m above ground level (AGL) from alpine and subalpine habitats identified as caribou winter range, circling or direct approach to animals is to be avoided.

D. Select particular routes, heli-ports, heli-pads, and heli-spots for all helicopter activities to avoid caribou birthing/rearing areas and high elevation winter ranges.

E. Avoid landing sites on or near critical seasonal caribou habitats.

F. A program of orientation and responsible behavior to wildlife mitigation measures and their importance, along with the specific program for the project is to be provided to all employees, clients and contractors transported, or involved in aircraft operations.

4.1.4. Bison

Key issues of concern: human activity on winter ranges.

Principal sources of information: Harper and Eastman (2000).

The objective of Best Management Practices: Aircraft Operations and Wildlife for Bison is to maintain the current distribution and abundance of provincial populations of Plains and Wood Bison, and allow their expansion consistent with provincial management plans and national recovery efforts. The following aircraft operations guidelines apply to wild populations of both subspecies of bison:

A. Prior to project initiation, use existing Wildlife Capability, Terrestrial Ecosystem or Predictive Ecosystem mapping (scale usually 1:50,000 or larger), and local information from biologists, First Nations, guide outfitters and others to identify and map sensitive bison habitats, including calving, rutting habitats and winter ranges.

B. Seasonally avoid sensitive birthing/rearing habitats and aggregations and winter ranges by limiting helicopter and fixed-wing overflights to a minimum of 400 m (AGL) over open meadows and open sidehills that constitute bison habitats.

C. For helicopter activities in the vicinity of bison ranges, select routes, heli-ports, heli-pads, and heli-spots to avoid open meadows, open sidehills, alpine and subalpine habitats used by bison. Overflights should maintain 400 m (AGL), with no circling or direct approach of bison herds.

D. Avoid landing sites on or near seasonal bison winter or birthing/rearing habitats.

E. A program of orientation and responsible behavior to wildlife mitigation measures and their importance, along with the specific program for the project is to be provided to all employees, clients and contractors transported or involved in aircraft operations.

4.2. Carnivores

4.2.1. Grizzly Bear

Key issues of concern: denning habitat, early spring and late fall feeding grounds, especially area-concentrated sites.

Principal sources of information: Yellowstone report (Olliff et al. 1999), Weaver et al. (1996).

The presence of humans in bear habitat can create stress for grizzly bears and cause them to abandon a habitat, either temporarily or permanently. Vehicular traffic along open roads can also displace grizzly bears from 100-900m (Aune & Kasworm 1989; Kasworm & Manley 1990; Mattson et al. 1987; McLellan & Shackleton 1988). Mattson (1990) suggested that female grizzly bears use areas near roads and human settlements that males avoid, and in so doing, become habituated to humans and subsequently nuisance animals that are either destroyed or re-located. Habituation can also occur when bears feed on improperly handled garbage.

The objective of Best Management Practices: Aircraft Operations and Wildlife for Grizzly Bear is to maintain the current distribution and abundance of provincial populations, and prevent the habituation of grizzly bears to humans and human activities. The following aircraft operations guidelines apply to all populations of grizzly bear:

A. Identify and map high quality bear avalanche and berry feeding sites.

B. Avoid landing sites on or near bear avalanche and berry feeding sites. Ensure bears do not have access to human supplied foods by storing food and garbage in bear proof containers, and by maintaining good sanitation of all landing sites.

C. Limiting helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over bear avalanche and berry feeding sites.

D. Limiting helicopter and fixed-wing overflights of general bear habitat to a minimum of 200 m (AGL), with no circling or direct approach of observed animals.

E. Minimize relocation or destroying of bears due to human encounters through a Bear Emergency Plan, and Bear Reporting and Monitoring Program.

F. Train employees, contractors and clients on responsible behavior near sensitive grizzly bear habitats.

4.2.2. Wolf

Key issues of concern: natal den site: disturbance of observed animals.

Principal sources of information: Harper and Eastman (2000).

In a review paper, Weaver et al. (1996) note that most field researchers have found that wolves tend to avoid human settlements, and to exhibit slight aversion within about 1 km of open roads, but use gated and unplowed roads readily. Among their cited papers was Thurber et al. 1994, and Paquet (1993) who observed that wolves avoided exploiting their prey near clusters of human habitation and development, especially in narrow river valleys. Weaver et al. (1996) also remarked that wolves are sensitive to human disturbance near active den sites from mid-April to July, but provided no evidence in support of this statement.

The objective of Best Management Practices: Aircraft Operations and Wildlife for Wolf is to maintain current distribution and abundance of provincial populations. The following aircraft operations guidelines apply to all populations of wolf:

A. Limiting helicopter and fixed-wing overflights to a minimum of 200 m (AGL), with no circling or direct approach of observed animals.

B. Select particular routes, heli-ports, heli-pads, and heli-spots for all helicopter activities to avoid areas near wolf dens between April 15 and July 15, to prevent displacement of wolves during critical denning period.

4.2.3. Wolverine

Key issues of concern: natal den sites.

Principal sources of information: Weaver et al. (1996).

Wolverine occupy large home ranges, and so they are likely to intersect winter aircraft operations disturbances of many types, depending on the area. Winter is the critical period for wolverine and other carnivores, and so winter aircraft operations disturbances can potentially affect wolverine by displacement.

In late winter, female wolverines have litters in dens at or below the timberline in the same subalpine cirques that snowmobilers and heliskiers seek (Hansen 2000). Females with kits are extremely vulnerable to human disturbance and will abandon den sites if disturbed (Cannings et al. 1999).

The objective of Best Management Practices: Aircraft Operations and Wildlife for Wolverine is to maintain current distribution and abundance of provincial populations. The following aircraft operations guidelines apply to all populations of wolverine:

A. Prevent human aircraft operations landings within 2 km of known/predicted/observed denning sites from mid-February to May.

B. Limit helicopter and fixed-wing overflights to a minimum of 200 m (AGL), with no circling or direct approach of observed animals.

4.3. Waterfowl And Shorebirds

Many waterfowl and shorebirds congregate and nest in productive wetlands, including shallow lakes and shallow bays on large lakes. These animals are subject to disturbance from overflights and their nests are subject to destruction from the downwash from closely approaching helicopters. The following general guidelines apply to all aggregations of birds, to reduce damage to nests in the nesting period which extends from May 15 to August 15 .

A. Limiting helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over wetlands and flocks of birds.

B. Utilize existing airstrips and mid-lake for fixed wing landings and takeoffs, use existing disturbed areas for helicopter landings.

C. Use 100 m long-lines to avoid downwash damage to stick nests and small bird nests in brushy areas.

4.3.1. Sandhill Crane

Key issues of concern: disturbance of nest sites and observed animals.

Principal sources of information: Harper and Eastman (2000).

The objective of Best Management Practices: Aircraft Operations and Wildlife for the Sandhill Crane is to maintain current distribution and abundance of their populations in the province. The following aircraft operations guidelines apply to all populations of sandhill crane:

A. Identify and map nesting and foraging habitats.

B. Limit helicopter and fixed-wing flights approaches to a minimum of 500 m of observed animals.

C. Limiting helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over nests and aggregations.

4.3.2. Trumpeter Swan

Key issues of concern: disturbance of nest sites and observed animals.

Principal sources of information: Harper and Eastman (2000); Guidelines for Trumpeter Swan Habitat in Alberta.

The objective of Best Management Practices: Aircraft Operations and Wildlife for the Trumpeter Swan is to maintain current distribution and abundance of their populations in the province by protecting nesting sites. The following aircraft operations guidelines apply to all populations of trumpeter swan:

A. Identify and map nesting and foraging habitats.

B. Limiting helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over nests and aggregations.

C. Limit helicopter and fixed-wing flights approaches to a minimum of 500 m of observed animals.

4.4. Raptors - Birds Of Prey

Key issues of concern: disturbance of nest sites and observed animals.

Principal sources of information: Harper and Eastman (2000).

4.4.1. General Considerations for Raptors

Most concern for raptors focuses on the impact of human activities during the breeding and rearing season, and the loss of nest sites. Raptors are sensitive to disturbance and although some species will actively defend their nest sites, given sufficient disturbance, raptors will abandon nests. From a conservation perspective, the two key groups of raptors of particular concern for aircraft operations are those that nest on cliffs and those that nest in trees.

4.4.2. Red-Listed and Blue-Listed Cliff-nesting Raptors

There are three species or subspecies of cliff-nesting raptors that are of conservation concern, that is, they are either Red-Listed or Blue-Listed (Table 5). These species lay their eggs on cliffs, usually with little effort at nest building. Generally, the season for egg-laying and rearing of young extends from April through to September. During this period, the birds are sensitive to disturbance whether from the air, via aircraft and hang gliders, or from the ground, by rock-climbers. Little information exists on the sensitivity of these raptors to these types of disturbances, but given their conservation status, a precautionary approach is warranted.

Table 5. Cliff-nesting raptors of conservation concern.

Species	Conservation in status in B.C.	Nest site features	Remarks
Prairie Falcon	Red-Listed	Shallow cavities on bare rock on protected cliff ledges	Nest sites frequently re-used; seldom build nests
Peregrine Falcon, anatum ssp.	Red-Listed	Hollows on inaccessible cliff ledges	Rarely on large broken-topped tree or ledges of tall city buildings
Gyrfalcon	Blue-Listed	Rocky crags or shelves	Occasionally nest in trees, using raven's nests

The objective of Best Management Practices: Aircraft Operations and Wildlife for Red-Listed and Blue-Listed Cliff-Nesting Raptors is to maintain current distribution and abundance of their populations in the province. The following aircraft operations guidelines apply to all populations of Red-Listed and Blue-Listed cliff-nesting raptors:

A. Avoid flights and landings within 500 m of cliff nesting areas.

B. Limit helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over nests and aggregations.

C. Limit helicopter and fixed-wing flights approaches to a minimum of 500 m of observed animals.

4.4.3. Red- and Blue-listed Tree-nesting Raptors

Key issues of concern: disturbance of nest sites and observed animals.

Principal sources of information: Harper and Eastman (2000).

There are two species or subspecies of tree-nesting raptors that are of conservation concern or have high public visibility (Table 6). These species lay their eggs in trees, and their stick nests are often prominent. Generally, the season for egg-laying and rearing of young extends from April through to September.

Table 6. **Tree-nesting raptors of conservation concern or special interest.**

Species	Conservation status in B.C.	Nest features	Remarks
Bald Eagle	Not at-risk	Large sticks in tall tree	Nests often re-used; high visibility with the public
Northern Goshawk, gentilis ssp.	Red-Listed	Stick platform in tall tree	Usually uses conifers; often several sites

The following aircraft operations guidelines apply to all populations of Red-Listed and Blue-Listed Tree-Nesting Raptors:

A. Avoid flights and landings within 500 m of stick nests areas.

B. Limit helicopter and fixed-wing overflights to a minimum of 400 m (AGL), with no circling over nests and aggregations.

C. Limit helicopter and fixed-wing flights approaches to a minimum of 500 m of observed animals.

5. General Mitigation Actions

The objective of Best Management Practices: Aircraft Operations and Wildlife is to provide best management practices that ensure the protection of diversity and abundance of northeastern British Columbia's exceptional wildlife resources. Aircraft are used for transportation of humans and materials to remote sites for resource industries, commercial recreation, but also for research, inventory, sightseeing and wildlife viewing.

The following general guidelines will mitigate the impacts of aircraft activity on wildlife.

A. Wildlife concerns are identified by using:

- Existing Wildlife Capability, Terrestrial Ecosystem or Predictive Ecosystem mapping (scale usually 1:50,000 or larger)

- Gathering of local Information from biologists, First Nations, guide outfitters and others

B. A written plan is prepared, containing the following elements to avoid/mitigate impacts on wildlife:

- Designates wildlife species and seasons of concern (timing windows).
- Designates avoidance distances (400m vertical x 2000m horizontal rule).
- Seasonally avoids sheep and goat winter range and birthing/rearing areas.
- Avoids cliff habitat potentially used by sheep, goats, and cliff-nesting raptors.
- Avoids wetlands, shallow lakes, alpine and sub-alpine (open forest) habitats.
- Avoids special features; mineral licks, nest trees, and animal concentrations.
- Predetermines suitable flight routes to: maintain avoidance distances, visual screening and reduced frequency of flights near critical areas.
- Specifies suitable landing sites.
- Plan flight paths so there is buffer space between aircraft operations and wintering ungulates. Maintain sight barriers, noise barriers and hiding cover between areas of aircraft operations, winter ranges and other sensitive habitats.
- Plan flights for predictable timing within defined areas to decrease flight responses.
- Uses quieter aircraft to reduce harassment of wildlife.
- Includes information on other activities in the area is solicited to assist in coordination with other programs in the area to reduce cumulative impacts. Authorizing agents need to ensure that the total amount of activity does not exceed thresholds that threaten wildlife populations and abundance.

C. The avoidance/mitigation program is conveyed to all field staff.

D. A program to monitor wildlife sightings and aircraft activities for adherence to plans and adaptive management, where appropriate.

6. Additional Mitigation Options

In addition to the Species Specific and General Guidelines for mitigating the impact of aircraft operations on wildlife, the following may provide additional options to assist in mitigating impacts.

Noise and movement are the most significant stimuli from aircraft operations that create impacts on wildlife. While avoiding low-level aircraft activity (within 500 meters above highest ground level within a 2 km radius) is the best way to avoid impacts. The following considerations may be taken into account in the development of a mitigation plan.

6.1. Noise

Noise reduction provides the most options for additional mitigation. The following may significantly reduce the noise footprint.

- Choice of helicopters. Aircraft with similar capabilities may have significantly different noise levels (See Appendices 8, 9 and 10). Of special note is the existence of NOTAR® helicopter, one of the quietest and most technologically advanced helicopters. NOTAR® (No Tail Rotor) helicopters are apparently up to 50% quieter than conventional helicopters (MD Helicopters 2000). These light duty helicopters are currently being used in Alberta, as well as urban settings to mediate noise. Additionally non turbine helicopters and helicopters with larger numbers of rotor blades have substantially less noise footprint and should be used were possible.

- Choice of propellers for fixed wing aircraft. While there may be limited choice of suitable fixed wing aircraft for an application, fixed wing generally have a smaller noise footprint than helicopters and the choice of propellers for any individual aircraft can make a substantial difference. General rule is shorter propellers, often with additional blades are substantially quieter.

6.2. Movement

- Mountain goats and mountain sheep disturbance has more impact when it occurs during their bedding period in midday. Low elevation air operations near their feeding and escape terrain have marginally less impact in early morning and late evening (Frid 1998). Other ungulates (moose, elk, caribou and deer) however, experience less disturbance at midday when they are resting in secure escape cover.

- Flight paths where movement is either at a great distance or brief in duration is helpful. Flying on the opposite side of the valley in excess of minimum horizontal distances, using adjacent valley to known mountain goat or sheep use areas, or blocking detection by flying behind ridges all have been utilized to reduce visibility impacts.

6.3. Cumulative/Successive disturbance

Disturbance for wildlife is an additive effect. While the occasional disturbance may be of limited short term impact, each successive disturbance can rapidly escalate the impact. The duration of disturbances can be of escalating importance. Wildlife initial response to disturbance is to flee to a secure area, so the ability to have a security area available where there is no disturbance is crucial for mitigation of short-term and long-term impacts.

The following may be considered to mitigate cumulative impacts.

- Where aircraft operations impact wildlife, impacts should be restricted to a minority of their habitat use areas. For example a number of US National Parks have75% of the area of the parks off limits to flights to prevent cumulative impacts. Alberta has proposed that only one seismic program per year be allowed to impact mountain goat and mountain sheep, and this single program is restricted to the least impact time window.

- Additionally, to help identify and mitigate impacts many programs utilize a qualified biologist to monitor activity of the goat and sheep within these areas, and recommend adjustments. Pre-scouting with biologist to determine flight path and biologist on site for guidance on flight path and report on activity is also recommended. A report on wildlife mitigation and monitoring assists in adaptive management for the individual program, and others that may follow.

- Protocols can identify:
  - Only one flight path to be used.
  - Helicopter will not standby in or around higher elevation habitats
  - Where possible flight paths will be restricted to lower elevation corridors
  - In the event of an emergency situation, helicopter access with no restrictions will be permitted
  - Aircraft meeting stricter noise standards be allowed to fly in a special "incentive corridor."

The best way of avoiding cumulative impacts is for each program to have a plan to avoid and mitigate impacts. The following checklist should be helpful for designing a best management aircraft operations plan.

6.3.1. Aircraft Operations Wildlife Mitigation Plan Checklist

1. Do you know which sensitive wildlife species and habitats are in your project area by checking maps, local knowledge and other information?
2. Do you have flight plans that avoid disturbing wildlife and sensitive areas, specifying preferred routes, minimum approach distances and areas to avoid?
3. Have you ensured that you are using aircraft most suited to the job that provides the fewest number of flights and the least noise? Are there adaptations for the aircraft to help accomplish this?
4. Have you located your landing sites to minimize impacts?
5. Have you provided orientation to employees and contractors to ensure they help minimize impacts on wildlife while getting the job done?
6. Do you have a monitoring and contingency plan to ensure you are protecting wildlife and dealing with unpredictable events?
7. Are you looking for better ways to get the job done and protect and maintain wildlife?

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8. Appendices

8.1. Large Mammal Gestation periods and timing NE BC

GESTATION

Species	**Gestation Period**	**Impregnation**	**Parturation**
Elk	8 - 8.5 months	Mid Sept.	Late May/Early June
Moose	8 months	Late Sept./Early Oct.	Late May/June
Caribou	227-229 days	Mid Oct.	Late May/Early June
Mountain Goat	178 days/6 months	Late Nov./Early Dec.	Late May/Early June
Stone's Sheep	170 days	Mid Nov./Early Dec.	Late May/Early June
Grizzly Bear	229-266 days	Late May/Mid July	Jan./Feb.

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8.2. Energetic requirements and forage availability.

After Gasaway and Coady 1974

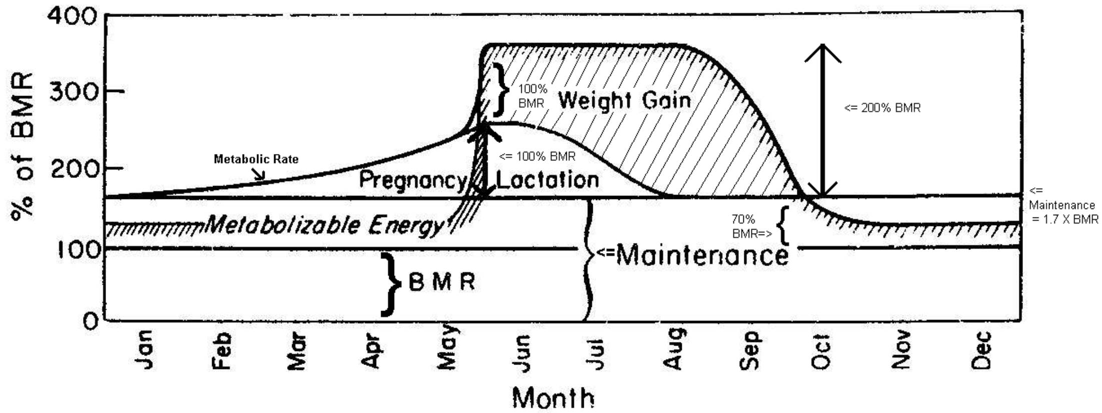

Figure 1. Seasonal energy required and metabolizable energy produced by adult female moose in interior Alaska as a percent of Basal Metabolic Rate.

BMR (Basal Metabolic Rate): minimal energy requirements that a resting animal requires to fuel itself for a given time.

Maintenance Energy: composite of requirements for BMR and Fasting Metabolic Rate, which is greater than BMR by the amount of energy expended in standing and small postural movement during measurement. Gasaway and Coady estimated this maintenance energy in moose to be 1.7 X BMR (or 70% greater than BMR).

Metabolizable Energy: that portion of gross energy (food consumed) not excreted in feces, urine or gaseous products of rumen fermentation.

After Toweill and Thomas 2002 pg319

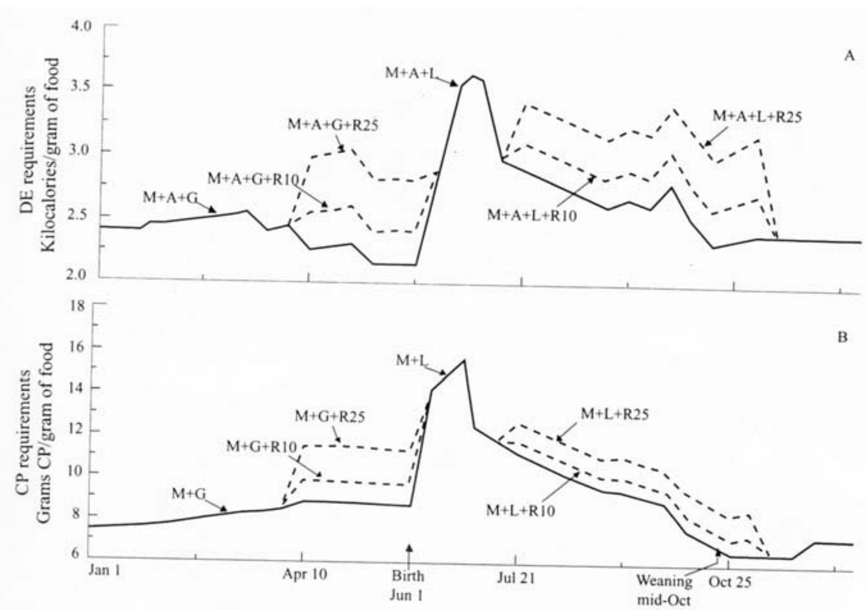

Figure 119. (A) Concentration of digestible energy (DE) and (B) concentration of crude protein (CP) in forage required to satisfy daily metabolizable energy and protein requirements of adult cow elk for maintenance (M), activity (A), gestation (G), lactation (L) and replacement of winter-catabolized tissues, assuming either 10% (R10) or 25% (R25) winter weight loss. The DE requirements probably are overestimated for June (early lactation) and underestimated in April, May (third trimester).

8.3. Muskwa- Kechika Management Area: Summary of research on the impacts of Helicopter and Aircraft on Large Mammals

From Glaholt et al 2002 Muskwa-Kechika Management Area Heliportable Drilling Feasibility Study, Environmental Sub Report.

Muskwa-Kechika Management Area
Heliportable Drilling Feasibility Study *Environmental Report*

TABLE 5

SUMMARY OF RESEARCH ON THE IMPACTS OF HELICOPTER AND AIRCRAFT ON LARGE MAMMALS

Species	Aircraft	Location	Observation	Reference
Dall's Sheep	Helicopter	Yukon	Observed that sheep responded sooner to helicopters the more distant they were from suitable escape terrain or concealing terrain. Response was strongest when sheep were on steep rocky terrain, were in small groups or where groups had large proportions of lambs.	Frid (1998) as cited by Paquet and Demarchi (1999)
Bighorn Sheep	Helicopter	Alberta	Recorded elevated heart rates in sheep. Multiple overpasses resulted in heart rates that were elevated for long periods (up to two hours). Response appeared to vary significantly with habitat (greater when sheep are away from escape terrain). Some habituation reported.	Stemp (1983)
Bighorn Sheep	Helicopter	Alberta	Sheep abandoned an area of winter range during a period of heavy helicopter activity in November and returned a month alter after activity had ceased.	Morgantini (1993)
Bighorn Sheep	Unspecified	Alberta?	Demonstrated that low flying aircraft at =>400 m did not elicit a heart rate response in ewes.	MacArthur *et al.* (1979, 1982)
Bighorn Sheep	Helicopter	Alberta	Rarely allowed helicopter to approach closer than 800 m before running.	Horesji (1975) as cited by Shank (1979)
Bighorn Sheep (*Ovis Canadensis nelsoni*)	Helicopter	Arizona	Observed that bighorn sheep were sensitive to disturbance in winter (43% reduction in feed intake) but not during spring. Identified a disturbance threshold of 250 m to 450 m.	Stockwell *et al.* (1991)
Desert Bighorn Sheep (*Ovis canadensis mexicana*)	Cessna 172 and 182	Western Arizona	Sex and age classes had similar reactions. Sheep in this area appeared accustomed to aircraft flying >100 m above ground level (agl), flights at <50 m agl caused sheep to leave the area.	Krausman and Hervert (1983)
Desert Bighorn Sheep	Bell 206 B III	California	Adult males and females moved about 2.5 times farther the day following a helicopter survey than the day prior to the survey. Proximity of escape terrain did not affect the strength of response. Reported that even a low intensity survey resulted in "major changes in mountain sheep distribution" and that "mountain sheep reacted severely to our helicopter surveys".	Bleich *et al.* (1990)
Mountain Goat	Helicopter (Bell 206B Turbo and Bell 212)	Alberta	Studied 109 marked mountain goats. Mountain goats were disturbed by 58% of flights and were more adversely affected when helicopters flew within 500 m. 85% of flights within 500 m caused goats to move >100 m, 9% caused them to move >1,500 m. Observed some breakup of social groups and one severe injury. Recommended restriction of helicopter flights within 2 km of alpine areas and cliffs that support mountain goats.	Cote (1996)
Moose	Aircraft	Unspecified	Moose are considered a northern ungulate least affected by aircraft disturbance though research lacking. Reported to be less reactive than caribou. More than half of moose flown at =< 60m reacted strongly. Other data referenced suggested 13% of moose reacted strongly when aircraft =< 60m.	Shank (1979) citing numerous studies.
Elk	Helicopter	Alberta	Bull elk showed little reaction to helicopter whereas cows and calves showed a greater flight distance. Flight distance was greater when they were in the open.	Horesji (1975) as cited by Shank (1979)

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TABLE 5 Cont'd

Species	Aircraft	Location	Observation	Reference
Elk	Helicopter	Muskwa-Kechika, Southern Alberta	Elk show tolerance to helicopter fly-overs and one time circling above approximately 500 m. Continuous circling invariably results in flight to cover. Response inversely proportionate to distance.	Glaholt pers. comm.
Bison	Helicopter	Muskwa-Kechika	Bison show some tolerance to be displaced by single fly-overs and some circling above approximately 500 m. Response inversely proportionate to distance.	Glaholt pers. comm.
Woodland Caribou	Helicopter	Alberta	Caribou approached the helicopter after it landed	Horesji (1975) as cited by Shank (1979)
Woodland Caribou	Helicopter	Muskwa-Kechika and Pine Pass Area	Appear relatively tolerant of single higher elevation fly-overs and some higher altitude circling (>500 m). Appear more sensitive during early post calving and less sensitive during fall and winter. Observed bull caribou cross and feed within 100 m of helicopter following landing.	Glaholt pers. comm.
Barren Ground Caribou	Aircraft	Northwest Territories, Yukon and Alaska	Highly variable response. Response seems to vary with season. Winter is quite commonly reported as season of greatest sensitivity followed by calving period.	Shank (1979) citing numerous studies.
Barren Ground Caribou	Bell 206 B Turbo	Northwest Territories	A greater percentage of caribou were walking, trotting or galloping during post-helicopter disturbance than pre-helicopter disturbance. The rates of nursing were slightly higher during pre-disturbance than post disturbance and were lowest during the disturbance.	Gunn *et al.* (1982)
Peary Caribou	Bell 206 B Turbo	Northwest Territories	Reported that group size and type, number of calves in the group, sun position and wind direction relative to the helicopter and animals, previous activity of the animals and terrain all contributed to the level of response exhibited by the animals. Observed an inverse relationship between response level and helicopter altitude or distance away.	Miller and Gunn (1979)
Mule Deer	Helicopter	Alberta	Reported to be more sensitive than elk.	Horesji (1975) as cited by Shank (1979)
Grizzly Bear	Helicopter	SE British Columbia, Montana	Strongest response when bears in open. Flight direction relative to bear appeared important. In forested habitat high intensity activity is required to elicit response. Most grizzly bears in forested habitats stayed around for hours or days after helicopter activity and those that did move, did so slowly.	McLellan and Shackleton (1989)
Grizzly Bear	Helicopters and Fixed wing	Various North America	58% of bears responded strongly to fixed wing, while 71% responded strongly to helicopter. Bears may run from aircraft 0.4 to 0.9 km distant at 1000 m agl. Others suggest altitude has little effect. Feeding bears show little fear. Bears have been suggested to be more sensitive than moose or caribou. Reaction to aircraft believed more severe where there is no cover. Previous experience with aircraft plays very important role in bear reaction (greater response by bears that were captured using aircraft).	Shank (1979) citing numerous studies.
Grizzly Bear	Helicopters and Fixed wing		Reported that grizzly bear may be more sensitive to helicopter than to fixed wing aircraft. A study found that 90% of grizzlies reacted strongly to helicopters and 21% reacted strongly to fixed wing aircraft	The Interagency Grizzly Bear Committee (1997)
Wolves	Helicopter	Muskwa-Kechika	Intolerant of circling below about 500 m	Glaholt pers. comm.

TABLE 5 Cont'd

Species	Aircraft	Location	Observation	Reference
Wolves	Aircraft	Various North America	Reaction is highly dependent on past experience with aircraft. Wolves habituate quickly when they are not hunted from the air.	Shank (1979) citing numerous references
Bald Eagle	Helicopter	Arizona, Michigan	Bald eagles responded more to helicopters than fixed wing.	Grubb and Bowerman (1997)
Bald Eagle	Aircraft	Arizona	Response varied inversely with distance from aircraft. Aircraft were less disturbing than pedestrians, boats or gunshot.	Grubb and King (1991)
Golden Eagle	Jet Ranger	Montana, Wyoming	Nesting golden eagles remained on nest when helicopter was within 100 m. Ferruginous hawks left nest when helicopter was closer than about 500 m.	Glaholt pers. comm.
Wildlife (general)	Aircraft	Unspecified	Helicopter overflights are more stressful than fixed wing. Frequent predictable overflights are more likely to lead to habituation.	National Park Service (1994).
Wildlife (general)	Aircraft	northeastern BC	Aircraft impacts are a function of how close and loud the aircraft is, and becomes a serious issue when frequency of disturbance is high.	Harper and Eastman (2000)

8.4. Aviation Regulations for Wildlife-A.I.P Canada

1.14.2 **Protection of Wildlife**

It is desired to impress on all pilots the importance of the conservation of wildlife; to urge them to become familiar with the game laws in force in the various provinces; and to co-operate with all game officers to see that violations of game laws do not occur.

The following is a list of the Provincial and Territorial Game Officers in Canada. Information with regard to the preservation of wildlife within the various provinces may be obtained from the officer shown for each province. Information pertaining to the migratory bird regulations may be obtained directly from the Director General, Canadian Wildlife Service, Environment Canada, Ottawa ON KIA 0H3.

1.14.3 **Reindeer, Caribou, Moose and Muskoxen Conservation**

Pilots should be aware that flying low over herds of reindeer, caribou, moose or muskoxen may result in reducing the animal population. Accidents resulting in broken bones may increase. Exhausted and disorganized animals are more susceptible to be attacked by wolves; feeding is interrupted; and normal herd movement and reproductive functions may be seriously disrupted.

It is important that all pilots flying aircraft in the north country realize the value of these animals to native welfare. The co-operation of all is requested in eliminating any action which might lead to unnecessary losses of these valuable animals.

Pilots should not fly at an altitude less than 2 000 feet AGL when in the vicinity of herds of reindeer or caribou.

1.14.5 **National, Provincial and Municipal Parks, Reserves and Refuges**

To preserve the natural environment of parks, reserves and refuges and to minimize the disturbance to the natural habitat, overflights should not be conducted below 2 000 feet AGL.

The landing or takeoff of aircraft in the national parks and national park reserves may take place at prescribed locations.

To assist pilots in observing this, boundaries are depicted on the affected charts.

The following is taken from the *National Parks Aircraft Access Regulations* (98-01-29):

(1) Subject to subsection (2) and section 5 no person shall take off or land an aircraft in a park except in a park set out in column I of an item of the schedule, at a take-off and landing location set out in column II of that item.

(2) No person shall take off or land an aircraft in a park set out in column I of any of items 1 to 6 of the schedule unless that person holds a permit.

Schedule (Sections 2 and 5)

Item	Column I Park	Column II Take-off and Landing Location
1.	Auyuittuq Reserve	Any location
2.	Ellesmere Island Reserve	Any location
3.	Northern Yukon National	(a) Margaret Lake at latitude 68°50'00"N, longitude 140°08'48"W (b) Nunaluk Spit at latitude 69°34'17"N, longitude 139°32'48"W (c) Sheep Creek at latitude 69°10'07"N, longitude 140°08'48"W (d) Stokes Point at latitude 69°19'49"N, longitude 138°44'13"W
4.	Kluane Reserve	(a) Big Horn Lake at latitude 61°08'30"N, longitude 139°22'40"W (b) Quinteno Sella Glacier at latitude 60°36'20"N, longitude 140°48'30"W (c) Hubbard Glacier at latitude 60°34'00"N, longitude 140°07'30"W (d) Cathedral Glacier at latitude 60°14'15"N, longitude 138°58'00"W (e) South Arm Kaskawulsh Glacier at latitude 60°30'30"N, longitude 138°53'00"W
5.	Kluane National Park	(a) Lowell Lake and Lowell Lake Bar at latitude 60°17'10"N, longitude 137°57'00"W (b) Onion Lake at latitude 60°05'40"N, longitude 138°25'00"W
6.	Nahanni Reserve	(a) Rabbitkettle Lake at latitude 61°57'00"N, longitude 127°18'00"W (b) Virginia Falls at latitude 61°38'00"N, longitude 125°38'00"W
7.	Wood Buffalo National Park	Garden Creek Airstrip at latitude 58°42'30"N, longitude 113°53'30"W

1.15.2 Migratory Birds

The accompanying charts show spring and autumn migratory bird flyways and staging areas. Indicated also are the approximate numbers of birds involved, the periods during which the flyways may be used by the various species and the altitudes at and below which flocks may be encountered. Ducks normally weigh from 1 to 4 pounds and the larger geese, swans and cranes may vary from 3 1/2 to 25 pounds.

Migratory birds are capable of flying above clouds and between layers at speeds of 30 to 45 KT. Flocks of 100 to 200 birds may be expected in flights strung out over several miles. The altitudes at which the birds may be encountered depend on the distance from the staging areas from which they have departed, assuming a rate of climb usually not more than 125 feet per minute or 100 feet per mile to an optimum altitude which varies with bird species and weather conditions. Near the staging areas, they are generally encountered at or below 2 000 feet AGL. In the mountainous regions of British Columbia, flocks are concentrated in the major valleys (Rocky Mountain Trench and Okanagan Valley). As a result, very dense concentrations occur up to 2 000 feet at any time of the day.

Information on migratory bird activity will be given on ATIS and by ATS.

<u>SPRING</u>

Normally, migratory birds leave their staging areas between dusk and midnight and during the first three hours after dawn; however, they may leave at any hour of the day or night, particularly after long periods of poor weather. They will not leave a staging area against surface winds in excess of 10 KT. Major movements, involving hundreds of thousands of birds, often follow the passage of a ridge of high pressure.

Figure 1.3(a) –Spring Migration Routes –Cranes, Ducks and Canada Geese

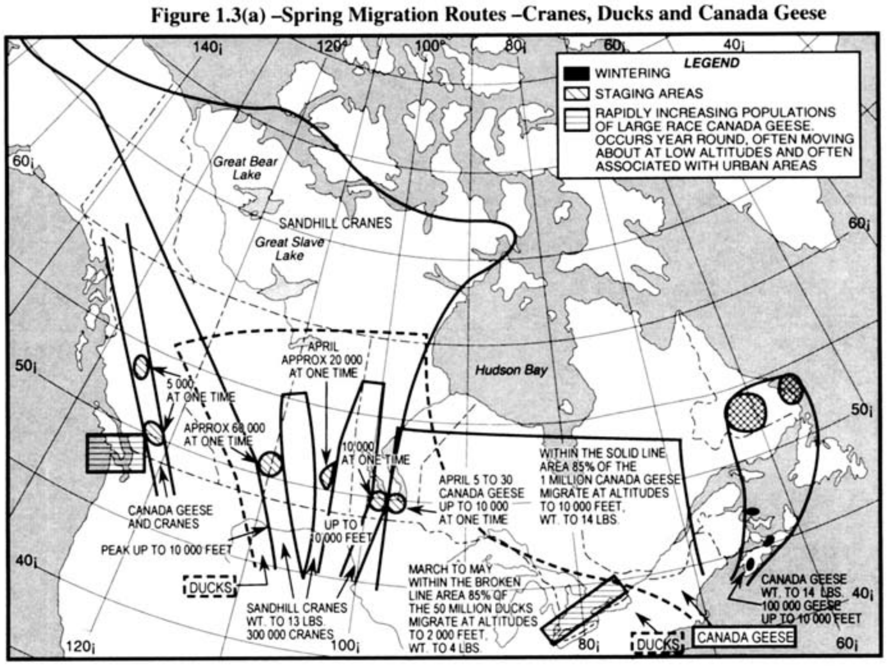
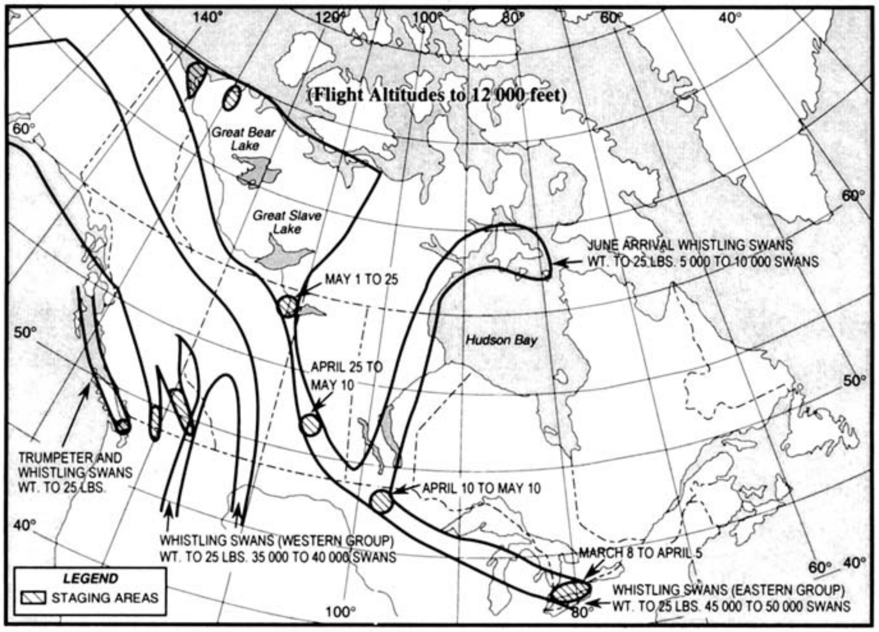


Figure 1.3(c) –Spring Migration Routes –Swans
(Flight Altitudes to 12 000 feet)



A.I.P. Canada RAC 1-35

Figure 1.4(b) – Autumn Migration Routes – Other Geese

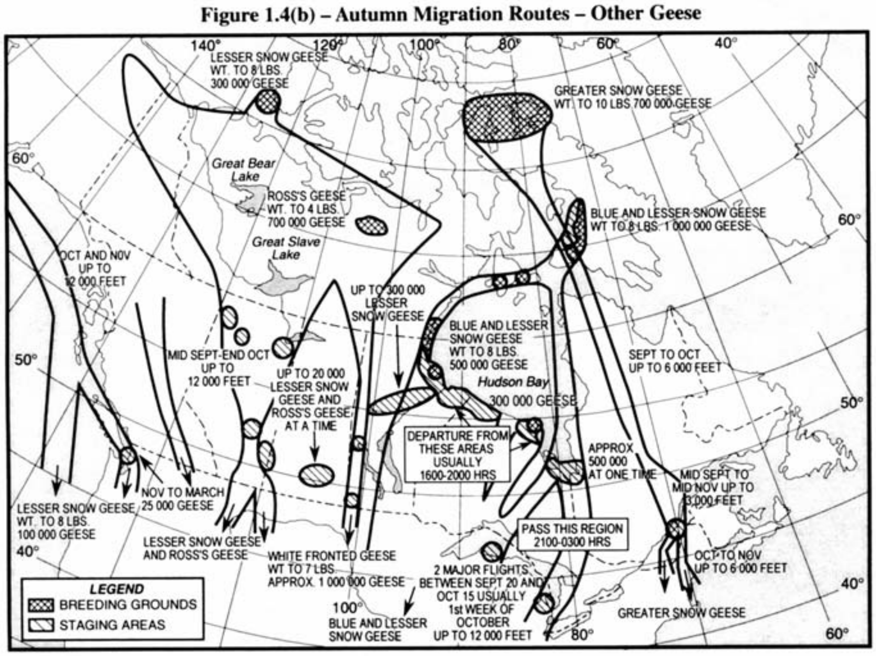
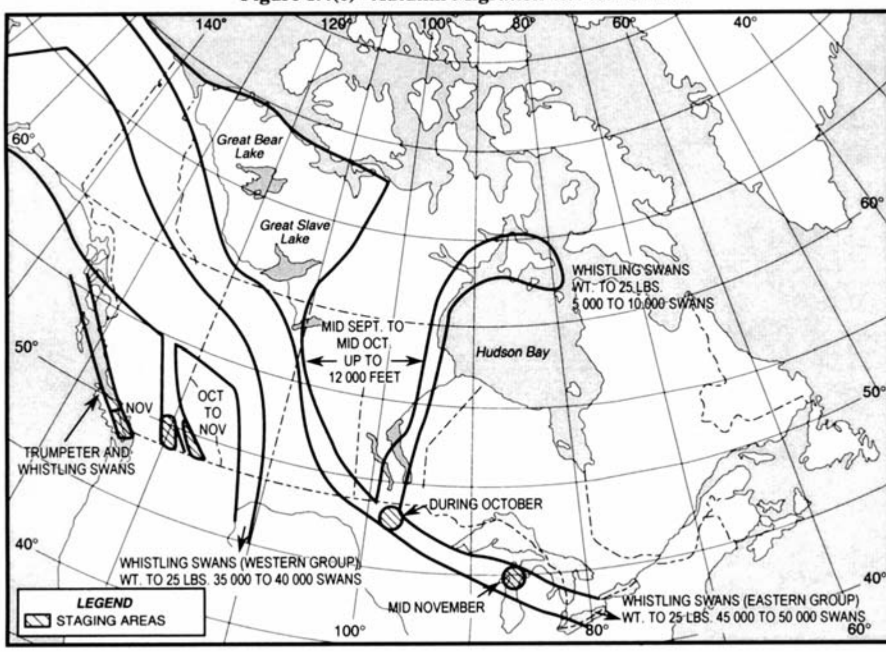


Figure 1.4(c) –Autumn Migration Routes –Swans



8.5. Guidelines for Mountain Goat and Sheep in Alberta

http://www3.gov.ab.ca/srd/fw/landuse/pdf/SheepGoat.pdf

Recommended Land Use Guidelines for Mountain Goat and Bighorn Sheep Ranges in Alberta

Introduction and Rationale

Mountain goat and bighorn sheep are alpine ungulates that react to predator/human disturbance by running to escape terrain typically consisting of cliffs and very steep slopes. The majority of goat and sheep ranges in Alberta are contained in Prime Protection Zones (Zone 1) where industrial activity is not permitted (A Policy for Resource Management of the Eastern Slopes 1977, revised 1984). However, there are a number of ranges that fall within the 'Critical Wildlife Zone' (Zone 2) designation (initially under the Eastern Slopes Policy and subsequently under various Regional and Sub-Regional Integrated Resource Plans). In these areas, the intent "is to protect ranges of terrestrial and aquatic habitats that are crucial to the maintenance of specific fish and wildlife populations".

Every effort should be made, within identified critical goat and sheep ranges, to: a) avoid land use disturbances that may have a direct or indirect adverse effect on the behaviour of the animals, and b) avoid permanent alteration of physical habitat conditions. The potential for significant direct effects on sheep and goat populations will vary with time of year and the total amount and duration of various land use activities. Of particular concern is low level aircraft activity (particularly helicopters) and any disturbances during the spring and early summer lambing and kidding period. Localized steep cliffs, that are likely to be used as escape terrain, should be given particular protection.

Research in Alberta involving heart-rate telemetry on bighorn sheep (MacArthur *et al* 1982; Stemp 1983) demonstrated negative responses to helicopter overflights. MacArthur *et al* (1982) recorded heart rate responses when helicopters were within 400 m and direct overflights at 90-250 m above ground level resulted in significant responses in terms of level and duration of heart rate and the observation of animals running to escape terrain. Stemp (1983) documented much greater responses to helicopters with repeated overpasses producing sustained anxiety for several hours. Stemp (1983) recommended avoiding helicopter use in and near to bighorn sheep range and restricting any flights to corridors and overflights to > 400 m above alpine terrain.

Cote (1996) studied the impact of geophysical helicopter activity on mountain goats on Caw Ridge, near Grande Cache, Alberta. This paper has become the definitive reference dealing with the effects of repeated helicopter activity on mountain goats in North America. The author recommends a 2000 m buffer between mountain goats (i.e. treeline) and intensive helicopter activity (i.e. heli-portable geophysical programs). Recently, this strategy has successfully been used to define limits for heli-hiking proposals in south-eastern British Columbia and for mineral exploration in Alaska.

The above-noted research findings from several ranges in Alberta, in combination with a significant increase in heliportable geophysical proposals (particularly 3-D programs) in proximity to mountain goat and bighorn sheep ranges, has led to the development of this 'Provincial Land Use Operating Guideline'. The following specific guidelines are intended to be **minimum requirements for industrial land use activities** within, and adjacent to, identified goat and sheep ranges. Additional or different requirements may be applied where:

a) Particularly unique conditions exist, such as at the Pinto Creek Goat Range north of Hinton, which is in a predominantly forested area.
b) Unusually adverse weather conditions exist at the time of the proposed activity.
c) Particularly critical habitat elements (e.g., cliffs providing escape terrain and mineral licks) occur within local portions of the identified range and require additional protection from industrial activity.
d) Other types of land use activities are prevalent, such as heli-supported tourism, and potential cumulative impacts are a particular concern.

Guidelines

1. The **goat/sheep land use zone** shall apply to industrial land use activities within and adjacent to identified critical sheep and goat ranges.
2. The 'goat/sheep land use zone' includes all of the mapped critical sheep and/or goat range, plus an additional 800 m buffer around the range.
3. Industrial activity, within a 'goat/sheep land use zone', whether ground or air based, is to occur only between July 1 and Aug. 22, inclusive. [This is designed to avoid disturbance during the spring lambing/kidding season, land use conflicts with hunters during the late summer/fall big game hunting season in alpine areas, and stresses on animals restricted to localized areas during the critical winter season.]
4. Geophysical exploration (seismic) activity may be permitted within a 'goat/sheep land use zone' during the open window period of July 1 to Aug. 22 under the following conditions:
   a) No more than one (1) composite program[1] within a particular 'goat/sheep land use zone' in any given year, and
   b) No more than one third of a particular 'goat/sheep land use zone', comprised of a contiguous block, is to be available to geophysical exploration during a given year.
5. Where helicopter support is required for an approved seismic program within a portion of a 'goat/sheep land use zone', flight paths to and from the approved activity area should avoid all steep cliff faces that may be used as escape terrain, as well as other known high use areas, such as mineral licks. A qualified biologist, who is knowledgeable and experienced with mountain goats and bighorn sheep in field situations, should be hired by the exploration company to monitor the location and

[1] A composite program for geophysical exploration would be a combined and co-ordinated seismic operation involving all private industry interests who want to conduct geophysical exploration within a designated goat/sheep land use zone during a particular year. Development of the composite program would require notification to Alberta Sustainable Resource Development by May 15th at the latest, so that companies could be put in touch with each other to develop a common program which would cover no more than one third of a given sheep/goat range, as a contiguous block, in any one year.

activity of sheep and/or goats within the land use zone. The monitoring activity is to be used to redirect or temporarily curtail exploration activities in the interest of minimizing disturbance to the animals, as well as to provide them with an opportunity to move into portions of their range that are not being actively explored.

6. All aircraft (helicopter and fixed-wing) flights over the 'goat/sheep land use zone' should be at least 400 m above ground level (agl), except where specifically authorized, within the intent of these guidelines.
7. No **new** ground access should be developed within the 'goat/sheep land use zone'. For those alpine ranges that currently have access, quad-supported ground crews should remain on existing exploration trails.
8. The drilling of exploration wells to prove up promising formations beneath 'goat/sheep land use zones' should be done from outside of the 'zone' using directional drilling technology, wherever feasible. Should any wells and other associated infrastructure be developed within the ' goat/sheep special management zone', road access should be designed for temporary use, and usage should be strictly controlled by locked gates and regular monitoring. Operations should involve remote technology to the fullest extent possible.

Approval Process: Roles and Responsibilities

The areas where these conditions apply will be illustrated on regional wildlife land use referral maps. The standard approval process will continue to be used.

Emergency Situations

It is recognized that in emergency situations (injuries, illness) that these helicopter restrictions will not apply.

Literature Cited

Cote, S.D. 1996. Mountain goat responses to helicopter disturbance. Wildlife Society Bulletin, 24(4): 681-685.

MacArthur, R.A., V. Geist and R.H. Johnston. 1982. Cardiac and behavioural responses of mountain sheep to human disturbance. J. Wild. Manage. 46(2): 351-358.

Stemp,R.E.1983. Heart rate responses of bighorn sheep to environmental factors and harassment. M .Env. Design. Univ. of Calgary. 314 pp plus Appendices

8.6. Guidelines for Trumpeter Swan Habitat in Alberta

http://www3.gov.ab.ca/srd/fw/landuse/pdf/TrumpeterSwan.pdf

Recommended Land Use Guidelines for Trumpeter Swan Habitat

Rationale for Special Protection of Trumpeter Swan Habitat

Trumpeter Swans breed on lakes, beaver ponds, and marshes scattered mainly across the Aspen Parkland and Boreal natural regions of Alberta. The majority of swans are found in northern Alberta near Grande Prairie, Peace River, High Level, High Prairie, Edson, and Lac La Biche. Small populations are also found in southern Alberta near Pincher Creek and central Alberta near Elk Island National Park. The species formerly bred throughout Alberta, but was thought to have been extirpated by the early 1900s, at which time it was thought to be close to extinction across its range.

Today, trumpeter swans are listed as a Threatened species under Alberta's *Wildlife Act*, and as such are afforded protection against hunting and the destruction of nests. The population of trumpeter swans in Alberta is increasing, but very small (fewer than 1000 breeding individuals). There are still concerns about whether the recovery will continue, as well as concerns about the security of the wintering habitat of the Alberta birds. Populations do not appear to establish themselves easily in new wintering habitat. Therefore, as long as wintering habitat is limited, the risk of regional extinction for Trumpeter Swans in Alberta will not be reduced by immigration from neighbouring populations. Accidental hunting and power line collisions are also threats.

Trumpeter swans are sensitive to human disturbance, and human activity in breeding areas may decrease survival of eggs or cygnets. Trumpeter swans that are disturbed repeatedly may not nest or may abandon an existing nest. Therefore, the breeding population continues to be dependent on current management practices and habitat protection. For further information on trumpeter swans, please see *Alberta's Threatened Wildlife* (www3.gov.ab.ca/srd/fw/threatsp/index.html) and *Alberta Wildlife Status Reports* (www3.gov.ab.ca/srd/fw/status/reports/index.html).

In an effort to continue the recovery of trumpeter swans, industrial land use guidelines must reflect the sensitive nature of this species. These guidelines serve three primary purposes:

a) protection of the long term integrity and productivity of trumpeter swan breeding habitat;

b) avoidance of industrial disturbance to trumpeter swans during nesting and rearing of cygnets; and

c) minimise the access created near swan lakes to reduce the potential for secondary disturbance of trumpeter swans from recreational use.

Land Use Guidelines

The Fish and Wildlife Division of Alberta Sustainable Resource Development recommends the following conditions be applied to activities near trumpeter swan habitat through the land use permit system:

All Activities:

- April 1 to Sept. 30, no activity within 800 m of the high water mark of identified lakes or water bodies.
- April 1 to Sept. 30, no direct flights over identified lakes or water bodies.
- No long term development (roads, wells, pipelines, etc.) within 500 m of the high water mark on identified lakes or water bodies.

Geophysical:

- Conventional clearing of new lines must terminate 800 m from the high water mark of identified lakes or water bodies.
- Low impact seismic (LIS) lines must terminate 500 m from the high water mark of identified lakes or water bodies.
- Heliportable and/or hand-cut lines (up to 2.5 m wide) must terminate 100 m from the high water mark of identified lakes or water bodies.
- A survey line of sight (0.5 m) is permitted from 100 m up to the edge of the water body.
- Reuse of existing lines is permitted, however, no re-clearing or disturbance of vegetation is permitted beyond the line widths listed above.
- No shot holes where water or ice exists or on dry lakes (air/mud guns only).

Livestock Grazing:

- No new grazing leases issued adjacent to identified lakes or water bodies
- No range improvement within 500 m of the high water mark on identified lakes or water bodies

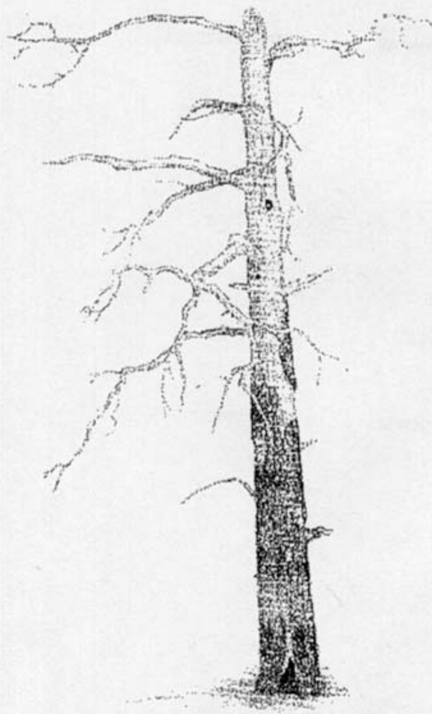
Timber Harvesting:

- No timber harvesting within 200 m of high water mark for identified lakes or water bodies. Establishment of a special management zone for timber harvesting between 200 m and 500 m from high water mark, with a detailed plan, is required.

8.7. Wildlife Danger Tree Information On Downwash Velocities

Wildlife/Danger Tree Assessor's Course Workbook

Forest Harvesting and Silviculture Module



An initiative of the:
Wildlife Tree Committee of British Columbia
in cooperation with:

Workers' Compensation Board of British Columbia

Ministry of Water, Land and Air Protection

British Columbia

Revised June 2001

Table 1. Levels of disturbance for unprotected workers in various work activities

Wind Speed Equivalency (km/h)	Level of Disturbance*	Example Types of Work Activities
<40	1	• tree planting • brushing • tree pruning (stems <20 cm dbh) • use of light-duty machinery (e.g., weed whips, brush saws) • road travel with heavy vehicles (>5500 kg GVWR) on ballasted and compacted roads
	2	• road travel with heavy vehicles (>5500 kg GVWR) on non-ballasted, non-compacted roads • maintenance or construction activities without heavy equipment (e.g., small machines such as "bobcats") • tree pruning (stems >20 cm dbh) • juvenile spacing or slashing (stems <15 cm dbh) • tree bucking – WITH NO ASSOCIATED FALLING • fire control with hand tools and/or water hoses
40–65	3**	• tree falling (any tree >15 cm dbh) • cable yarding • ground skidding • mechanical harvesting and forwarding • helicopter logging (lift <2200 kg) with workers exposed to rotor wash • use of light and intermediate helicopters where workers are exposed to rotor wash (e.g., helipads) • mechanical site preparation with heavy machinery • maintenance or construction activities with heavy equipment
+ 65	4	• trees adjacent to corridors in partial-cut cable logging operations • harvesting operations in structurally damaged stands (e.g., wildfire burns) • blasting • helicopter logging (lift >2200 kg) with workers exposed to rotor wash • use of medium and heavy helicopters where workers are exposed to rotor wash

Table 1A should be used to determine Level of Disturbance Windspeed Equivalency. For example, where an assessment has been conducted for level of disturbance 1 or 2, constant winds or frequent gusts (as opposed to infrequent gusts) which exceed 40 km/h during the work activity render the initial assessment invalid.

Therefore, in order to work under higher wind conditions, either stop work or reassess the potentially dangerous trees to an appropriate higher level of disturbance.

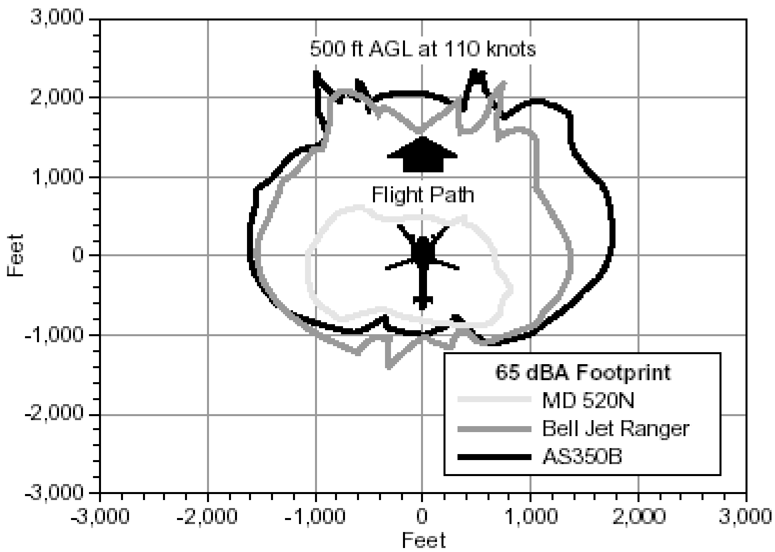
In addition, trees can initially be assessed at a higher level of disturbance in order to compensate for expected higher winds during the period of work activity, or because the work activity itself may change (e.g., cable logging level 3 becomes heavy lift helicopter with chokerman level 4).

Table 1A. Influence of wind speed on level of disturbance

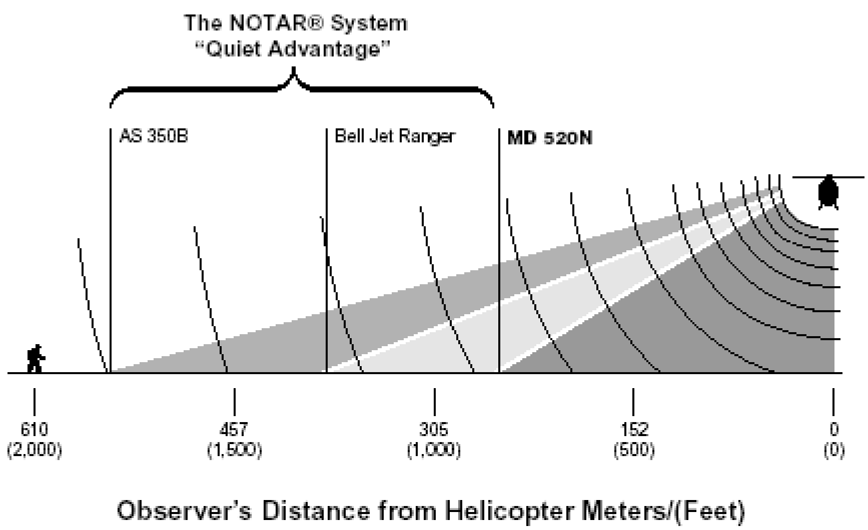
Wind Speed (km/h)	Description	Level of Disturbance Equivalency
0–40	**light breeze** (dust and loose paper raised; small branches move) to **fresh breeze** (small trees sway; tops of large trees sway)	1–2
40–65	**strong breeze** (small branches fly in the air; whole tree in motion; resistance felt when walking against wind)	3
65+	**gale** (branches broken off trees; walking impeded)	4

8.8. Low External Noise Helicopter Design MD NOTAR® System

The elimination of the high-tip-speed tail rotor assembly makes the MD 520N the quietest turbine helicopter in the world. Recent comparative FAA tests conducted by MDHI indicate the MD 520N is a minimum of 50 percent quieter than comparable helicopters. This lower noise signature makes the MD 520N a "good neighbor' when used in areas where noise is objectionable. Lower noise levels also increase survivability in hostile operational roles.

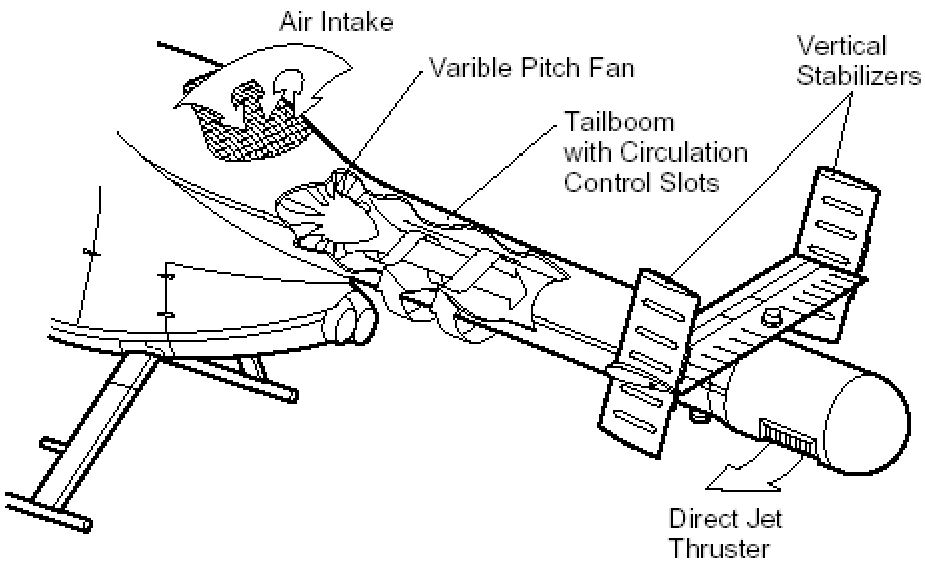


Noise inside each respective contour is 65 dBA or greater, about the same level as a noisy residential environment



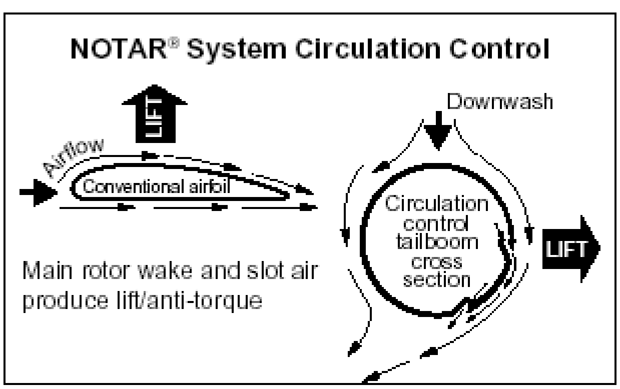
DESCRIPTION OF THE NOTAR® SYSTEM

The NOTAR system is an anti-torque system made up of an enclosed fan driven by the main rotor transmission, a circulation control tailboom, a direct jet thruster and a horizontal stabilizer with two vertical stabilators.



NOTAR® System Components

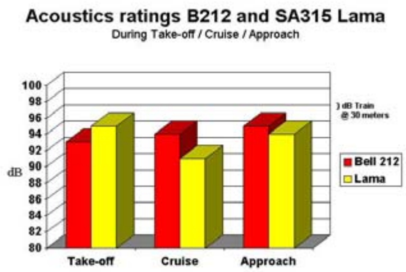
The vertical stabilizers are connected to the pilot's anti-torque (rudder) pedals. The left stabilizer moves through approximately 29 degrees of motion and provides sufficient control power for autorotation. It serves the additional purpose of unloading the thruster during forward flight to permit optimum cruise performance.

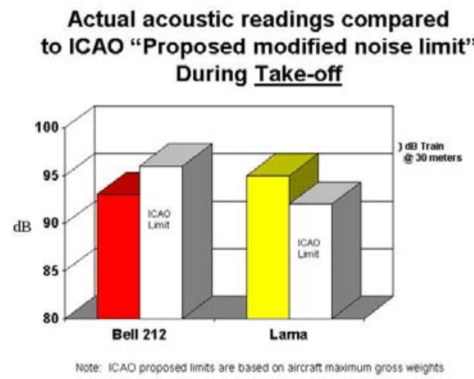


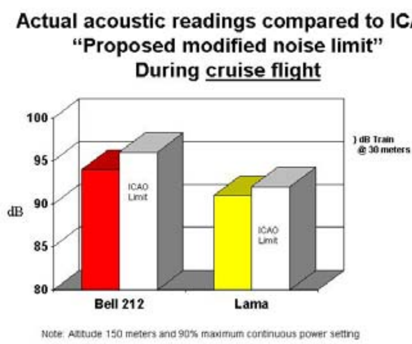
Boundary Layer Control Produces Anti-Torque Force

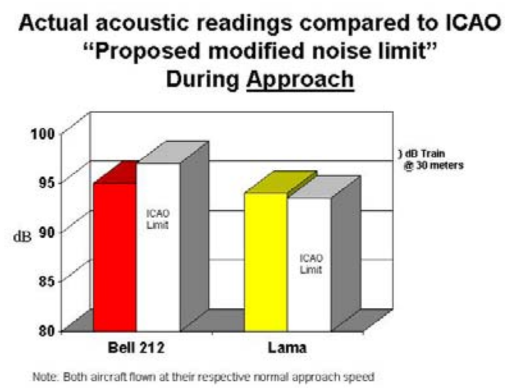
For more information
http://www.mdhelicopters.com/Rotorcraft/MD520N/MD520N_Technical_Description_Contents.htm overview provides technical information for this Notar helicopter

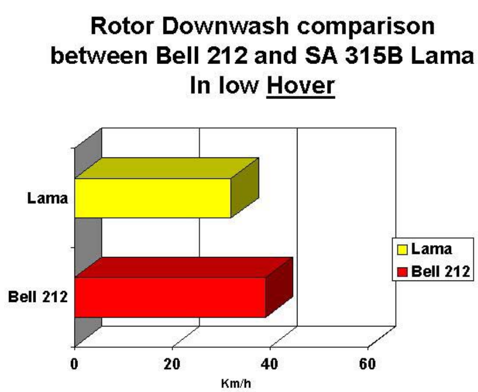
8.9. Noise Level & Downwash Comparison B 212 and SA 315 Lama

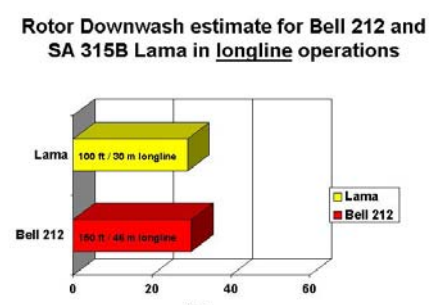












8.10. Aircraft Noise

From Britain's ***Pilot*** Magazine
by Stephan Wilkinson
Copyright Stephan Wilkinson,
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IMAGINE that an evil *djinn* wants to create a torture chamber to assault the senses; to turn his victims into addled idiots. A good start would be a box made of thin, flexible, drumhead aluminum sheets. Then bolt a powerful, compact machine to it that creates thousands of unmuffled explosions every minute, at the same time swinging a huge metal bat that pummels the aluminum at much the same rate. Finally, suspend the whole thing from a skyhook a mile up in the air, jam your chosen unfortunates into the cell and leave them hanging there for three hours.

Some would call it hell. We'd call it a general-aviation airplane.

Do you want to see how loud your airplane's cabin really is, and get an indication of what the noise is doing to your hearing? It requires no fancier test equipment than the radio in your car. Next time you drive to the airport, tune it to a station that provides a well-modulated level of sound (chamber music, easy-listening pops or speech rather than heavy metal). Adjust the volume to a pleasing level. When you park and shut off the radio, don't touch the volume control. If it's part of the on/off knob, mark the setting somehow.

Go fly for a couple of hours, and when you drive home, turn the radio back on and see how much added volume you need to achieve a comfortable listening level. You might be surprised! Now note the new setting. Particularly when you go out the next morning, turn the radio on to that setting for your daily commute to work and hear how loud it now sounds.

What you're seeing is temporary hearing damage, and then the recovery. What you've experienced, however, is a cumulative assault on the cilia of your inner ear - the tiny hairlike cells that vibrate in response to sound energy and communicate that sound to the brain. Excessive noise eventually wears them out permanently.

So why aren't concert rock musicians all deaf from standing amid loudspeakers powerful enough to levitate a locomotive? For one thing, they go through earplugs like popcorn. For another, according to New York City musician, pilot, and record producer **Tony Bongiovi**, a Twin Comanche owner who has done extensive work in soundproofing his own airplane as well as others, the noise of a concert runs up and down the scale of frequencies constantly, "but the danger of aircraft noise is that it's relentlessly focused, flight after flight, on exactly the same frequencies, since we all fly at the same power setting day after day."

Think of a loud concert as incredibly bright sunlight. Think of the drone of an IO-360 turning a two-blade prop as a lens continually focusing that sunlight on a particular spot in your inner ear.

Bongiovi feels that much of general aviation's noise problem - both inside the cockpit and on the ground below the air-plane - can be traced back to generations of pilots for whom noise was an integral part of the performance equation. They're the people who designed, marketed and originally bought the airplanes we're flying today, and for them, a silent Cessna is about as appealing as a Harley-Davidson with a BMW R60's mufflers. And left-ear deafness is a proudly worn badge of... oh, say 10 years of flying the night mail in short-stacked Twin Beeches. "I'd happily accept an additional 150 pounds of weight and reduction in performance to make my airplane quieter," Bongiovi says. "For me, it's transportation, not a thrill ride."

There are four basic sources for the noise that assaults pilots, passengers, and people on the ground below them.

The most important is undoubtedly **the propeller** - the baseball bat that pounds the airframe with fat pulses of air roughly 4,800 times a minute in the case of a two-blade prop, 7,200 time with three.

Next in priority probably is purely **aerodynamic noise** - the slipstream, turbulence, leaks, and vibrations set up by airframe protrusions. (I say "probably" because the situation varies from airplane to airplane, even among identical models, and because acoustic engineers often disagree as to the import of various noise sources. One noise can be "louder" yet less intrusive than another frequency that may be lower on the dB scale but consider-ably more annoying.)

How bad can aerodynamic noise get? If you've ever flown in a metal Schweizer glider, you'll have had a hint, and you'll know that the sailplane's beloved "silent flight" is in fact an oxymoron. Imagine what the 60-mph Schweizer's hammering and whistling and vibrating would sound like at 180, and you'll have a sense of what happens when pure airflow sets aluminum in motion even in the absence of an engine and prop.

Then comes the **engine's exhaust**, even though you'd intuitively think the bark of the tailpipes takes a bigger bite out of cabin quietude than does aerodynamic noise. "If you use a Bonanza as an example," says Olen Nelson, president of an innovative California aircraft soundproofing company called Aero Sound Shield, "the exhaust is released right about below the rudder pedals, and the airflow is going to push each pulse right up against the bottom of the fuselage. It's regenerating a lot of noise right through the belly skin, just as though a bass drummer were pounding on it and you were sitting inside the drum."

It's hard to say exactly what exhaust noise "is," but the intuitive sense that one is literally hearing the explosions inside the engine is really not true. Much exhaust noise is created by the sudden expansion of extremely hot gases into cold air, which is one reason why short stacks are louder than long tailpipes: the air has a chance to cool considerably inside the tailpipe.

Another major component of exhaust noise, particularly when an airplane engine is bugling through tubular headers rather than an ordinary cast-iron automotive exhaust manifold, is the impact of the shock wave of every single exhaust pulse upon the thin stainless-steel pipe wall nearest the exhaust valve. Again, imagine a ball-peen hammer whacking away at the metal 1,200 times a minute.

Finally, our fourth and probably least critical source of cabin noise is **engine vibration**, though we should count that exhaust-pipe ball-peen hammer as part of this. If you could run a Lycoming or Continental on the ground with no prop and a totally silent exhaust system, you'd be stunned at the amount of mechanical clatter, air-induction roar and general metal-to-metal hysteria you'd hear. (Stick your head inside a well-muffled Porsche Carrera's engine bay and you'll see what I mean: air-cooled engines are real thrashers.)

OKAY, so we know what creates the noise. What do we do about it?
Noise control is no mystery. It's an established engineering discipline. Indeed, one can subscribe to the monthly journal **Sound and Vibration**, "the noise and vibration control magazine," - and my most recent issue coincidentally includes the feature article "The Measurement of Noise and Vibration Transmitted into Aircraft Cabins." This is not a black art.

Automobiles can be made so quiet that the Lexus LS400, for example, now has an ignition interlock that prevents the starter from being cranked when the engine is already running; early models suffered a spate of chipped flywheel teeth as owners kept trying to restart engines that were already running. But automobiles have a number of big advantages:

- Water-cooled engines are innately quieter than are their air-cooled equivalents, due to the blanketing effect of the water jacket as well as the absence of cooling fins to "ring."

- Catalytic converters make excellent mufflers

- Elastomeric automotive engine mounts have become so sophisticated that they make even the best certificated-in-the-'70s Lord mounts look positively primitive.

- Automotive engines are much smoother and less vibration-inducing than are aircraft powerplants swinging big props, and even many economy four-cylinder car engines have such things as balance shafts and other technology unknown to general aviation.

- Cars can afford to carry a huge mass of sound-damping material and devices.

- Car windows and windscreens are made of stiff, laminated glass rather than flexible plastic.

- And most important of all, a Lexus doesn't need a propeller.

PROPELLERS: At worst, a propeller creates a supersonic shock wave at each of its tips, when the combination of blade length and engine rpm means the outermost part of each blade is traveling at or very near the speed of sound. No engineer would allow a prop design to do this at cruise, since that shock wave utterly destroys the lift-producing (i.e.. thrust-producing) ability of that part of the blade, but it can happen at takeoff rpm.

Cessna 180/185's are infamous offenders, as are Harvards - though the North American trainer's tooth-loosening takeoff rasp is actually the product of a variety of prop and engine characteristics.

Still, one of the simplest and most effective noise-reduction techniques is dialing back prop speed, to slow the rate at which the tips are traveling and to lessen the energy of the pulses of air thrown off the blades.

"We've recently started a program of trying different propellers on our testbed Bonanza to see what different noise levels are produced," explains **Olen Nelson of Aero Sound Shield**. "The airplane initially had a Hartzell with long, fat blades. Changing from that to a Hartzell with shorter blades resulted in a significant noise reduction. Going to a McCauley with shorter and also thinner blades again measured quieter. We're about to test a four-blade Q-Tip prop, and we expect very significant reductions."

Prof. Howard Patrick of Embry-Riddle Aeronautical University in Florida feels that there are several means of quieting propellers. "Half the noise of a conventional propeller is simply due to loading - where you get your thrust," Patrick ex-plains. "The other half of the noise is due to the thickness of the blade - the noise of the air being pushed outward by the prop and having to come back together after the prop's passage. The thicker the blade, the greater that effect is, but with advanced materials, you could reduce the propeller noise just by reducing the thickness."

The noise reduction engendered, however, would be only on the order of three dB. "Even though that's halving the noise, it's barely perceptible to the human ear," Patrick says. "The ear is a nonlinear device. It's half the noise energy, but not half the apparent sound."

The decibel scale is not arithmetic but geometric. "The energy of the noise doubles with every three-dB increase," ex-plains **Terry Carraway**, a Maryland occupational health consultant who happens to fly A-10 Warthogs for the U. S. Air National Guard. "Government standards consider 80 dB to be acceptable - a sound that can be experienced for four hours without danger of any permanent hearing damage. So 83 dB is good for two hours, 86 dB for one hour, 89 dB for half an hour, 92 dB for 15 minutes and 95 dB, which is typically the sound level in a light-aircraft cockpit, for seven and a half minutes."

Patrick is pursuing research on ducted props with active noise-canceling technology as part of the prop shroud--literally, loudspeakers broadcasting a signal 180 degrees out of phase with the major prop frequency and thus canceling it. "You get some noise-blocking effect just by having the duct there, but it's mainly a place to put the speakers," Patrick explains.

EXHAUST: Once you've done what you can about prop noise, one's thoughts inevitably turn to muffling the exhaust. After all, didn't light de Havilland - and a variety of other between-the-Wars types have mufflers? Well, not really. Their long tailpipes might well have had some muffling effect, but generally, the reason for such installations was to carry exhaust gases away from open cockpits, which often were low-pressure areas and attracted the fumes.

Opinion varies widely on how effective automotive-type mufflers would be. Some think they do a little good at the cost of a lot of performance. Others, such as Olen Nelson of Aero Sound Shield, feel that even modifying the tip of the tailpipe could make a big difference. "You can do a lot by closing up the end of the exhaust pipe and redirecting the exhaust through a lot of slots or holes, which spreads the exhaust pulse out and raises the frequency of the sound," Nelson says. "We're just starting to experiment with it, but there's no reason it shouldn't work."

Borla Performance Systems of Oxnard, California makes exhaust systems for everything from formula racecars, Italian exotics, and high-performance motorcycles to package delivery trucks. (In one of their biggest recent contracts, Borla has replaced all the exhaust systems, from headers to tailpipes, of the entire U. S. fleet of UPS vans.) Borla also does design and consulting work for Chrysler and Ford. Alex Borla is a pilot - a Beech Baron owner - who feels that aircraft mufflers can make a big difference, and Borla is currently experimenting with such devices.

T
he company has instrumented the Baron so they can run muffling tests on one engine while leaving the other one stock while making simultaneous noise measurements at exactly matched power settings (confirmed through strain gauges on the engine mounts). Problem is, Borla's exhaust systems are too good. "We don't employ any baffles in our automotive and motorcycle mufflers," Alex Borla explains. "Everything is straight-through. As a result, we're able to tune the exhaust system all the way out to the tip of the

tailpipe. With a baffle-type muffler, as soon as the exhaust pulse hits the first baffle, the tuning effect is over."

On an airplane, however, tuning the exhaust will buy you trouble. "If the product we make enhances the power of the engine, we can't get an STC on it," Borla points out. "I know from just looking at the manifold on the IO-520 in the Baron that I can get at least a 12 to l5 percent increase in power. Which is 30 or 40 extra horsepower, and that's a big number. I can also bring the engine internal temperatures down and convert that horsepower gain into performance and better mileage."

But to sell an aviation system, Borla would have to dumb down his product, "And that's tough to do, with the patented design that we have. But the way the FAA regs are written, I'd have to almost recertify the airplane if I used it."

Still, Piper has contacted Borla for help in designing a muffling system for the European market. "Piper is very concerned about the European market," says Professor Patrick of Embry-Riddle, "and there's every reason to think the environmental laws in the U. S. will eventually become just as strict. All that U. S. manufacturers can do right now to meet those noise requirements is to use reduced power. Or fit mufflers, but that doesn't do a thing about propeller noise."

Whatever Borla does with his mufflers, they won't be heavy external fitments. "You see all sorts of appendages hanging out of Bonanzas and stuff in Europe," Borla says. "They're after-thoughts - basically a knee-jerk reaction to a noise problem - and I think they definitely impede the performance of the airplane substantially. You probably lose 15 percent of your performance by fitting them, but the only other choice is that you can't fly without them."

But wouldn't weight, cost and finding under-cowling space all be problems? Not necessarily: Borla Performance already manufactures compact carbon-fiber mufflers with stainless-steel end caps for motorcycles, and Borla estimates that a Baron-size installation would only add seven or eight pounds per engine using similar mufflers. "And if the motorcycle industry can handle the cost, the aircraft business certainly can.'

SOUNDPROOFING: A moderately expensive but increasingly effective way (due to the use of some interesting new materials) to make a lightplane cabin more comfortable is to thoroughly soundproof it. This means adding some kind of dampening and insulating material between the outer skin and the inner panels of the airframe, and Olen Nelson's Aero Sound Shield specializes in this technology.

Back when Cessnas and Pipers were being pumped out by the thousands and airplanes were sold on performance, price and sex appeal, the manufacturers simply stuffed fiberglass "insulation" into the voids between the aluminum and the Royalite interior panels. "That only works at the higher frequencies at the very high end of our hearing range, it's not helping a lot," Nelson points out.

Aero Sound Shield firmly glues foam panels backed with aluminum foil to the inside of every skin panel. "What has the most effect is the glue itself. It ties the skin down and makes it vibrate at a higher frequency," Nelson says. "If you did your whole airplane with that, you might net about a two-dB reduction. But beyond that, we make bags of insulation that contain an inch of acoustical glass, an inch of closed-cell neoprene acoustical foam and then another inch of acoustical glass. The bags are pressed to fit in between the stringers and bulkheads, filling the area completely." Since the acoustical foam is isolated between cushioning layers of glass, it takes considerable energy to reach the foam and cause it to vibrate, which is what regenerates noise.

Another effective form of soundproofing involves the addition of thicker windshield and window Plexiglas. New York record producer Tony Bongiovi claims to have sound-deadened his Twin Comanche to a level that he says is "no louder than a good sports car." In fact, his airplane is equipped with a 160-watt, 10-speaker hi-fi system that he listens to without a headset. He made complex noise studies of the airplane using extremely sophisticated recording-industry equipment and then bonded sound-proofing foam to the skin panels, but he also attributes a lot of the quietude to considerably thicker windowpanes. (Bongiovi has worked as a noise consultant for Mooney and then Roy LoPresti on the SwiftFire program and also does individual retrofit projects - most recently OJ Simpson lawyer F. Lee Bailey's Commander Shrike).

Double-paned "insulating" glass, however, does little to mitigate noise unless the panels are at least an inch apart - four inches is optimum - which means only relatively large GA aircraft have the depth to accept such an installation.

Aero Sound Shield is currently soundproofing a particularly large corporate jet - a converted McDonnell-Douglas MD-87 - for a Las Vegas hotel owner who is almost totally blind and who has compensated by developing extremely sensitive hearing. "He wants a 60-dB airplane, which is quieter than a Lexus," Nelson points out. Because there are 35 inches of stringer depth between the inner and outer skins of the cabin, Nelson feels they can achieve this with a complex, multi-Walled version of the bagged-insulation system plus almost totally isolating the cabin from the airframe via shook mounts, so it's as close as possible to floating free. "That way, it won't pick up any vibrations," Nelson avers.

Unfortunately, your airplane and mine can't accept the mass and weight of MD-87 measures. "I rode one time in a Piper Arrow that was very quiet," Nelson recalls, "but it was completely lead-lined. It could carry two people and half a load of fuel. That was fine for that guy, because that's all he ever wanted to carry, but it wasn't very practical."

VIBRATION DAMPENING: Some of the most interesting and advanced practical aircraft noise-control work is being done in the U. S. by the **Lord Corporation**, makers of the familiar rubber-biscuit Lord mounts that cradle many Lycomings and Continentals. But Lord's NVX Active Noise Control Systems go far beyond rubber shock mounts. "Our traditional business has been passive-elastomeric engine mounts," Lord Market Specialist Rebecca Weih explains. "Now, however, we have three different versions of active noise and vibration control for aircraft. One is active isolation control, where we put actuators into the engine mounts, connected to a computer, that make the mounts vibrate in apposition to the engine's vibration. It doesn't stop the engine from vibrating, but it keeps that vibration from being transmitted to the cabin." This system is intended for jets, and will first appear on the Cessna citation X.

Lord's second level of defense against noise is called active structural control, and it's also a big-league program: it would probably cost on the order of $40,000 to $45,000 to retro-fit to a King Air-class aircraft. Small actuators are attached to the inside of an aircraft's skin, and they are made to vibrate like tuning forks, at frequencies that cancel the noise-producing vibration of the skin itself. There can be as many as 30 of them - one for each unsupported area of skin around the cabin that is delineated by the airframe bulkheads and stringers - and they're all connected to a small central computer that constantly adjusts the frequencies at which the actuators vibrate.

Except for the cost of such a system, active structural control would work splendidly in light GA aircraft, for one of the major "noise propagation paths" in an airframe is any large area of thin skin paneling set to vibrating by prop pulses. The aluminum acts almost like huge loudspeaker cones. Nor does it help that the tail cone of most light planes is shaped like a megaphone. The flatter the skin panel and the greater the area of unsupported aluminum, the more effective the skin is as a noise propagator. (Flat-bottomed, slab-sided, minimally bulk-headed Piper Cherokees and their offspring should therefore tend to be louder than the equivalent Cessnas and Beechcraft, though I don't know of any studies proving that surmise.)

Lord is working on a third level of noise-cancellation technology that will have light-aircraft applications, and it's called **active noise control**. The active noise-reduction headsets that increasing numbers of us are wearing work by broadcasting inaudible signals inside each earcup that exactly cancel out the two or three predominant low-frequency tones that otherwise would be assaulting the pilot's ears. Lord active noise control essentially removes the earcups and broadcasts the same signals from half a dozen or more speakers inside the aircraft cabin, and the effect is much the same, except that the entire cabin becomes the earcup.

This system has already been commercially installed in a King Air and goes for around $35,000, but Lord hopes to soon let the benefits trickle down. "We plan to develop a more generic system," Rebecca Weih says. "Right now, the technology is pretty much custom-designed for each aircraft, but we need a system with which we can tell an FBO, 'Find a space to put the computer, and here's how to determine the best locations for the speakers and the sensor microphones.' From what we can tell, people with sophisticated singles and light twins might be willing to spend $5,000 to $10,000 on such a system, and we need to drive the cost down to that."

Weih agrees that lowering aircraft noise levels is not something that old-timers care much about. "We've found that the very experienced King Air pilots aren't particularly impressed by our active noise-control systems," she admits, "probably because they're already half-deaf. You have to get medium-experienced pilots who are bothered by the noise because they can still hear it. "

THE ENVIRONMENT and THE FUTURE: Fortunately, many of the things that we can do to make lightplane cockpits and cabins more livable also lower the noise level for people on the ground--particularly propeller changes and exhaust muffling. Crowded Europe is a decade or more ahead of the wide-open-spaces United States in terms of anti-noise legislation - aircraft enthusiasts would say it's a decade behind us - but such legislation is as inevitable here as is the appearance of catalytic converters on aircraft engines.

Some local anti-noise regulations are already in place. "If you take off from our local airport, at Torrance, California, in a 210 and don't pull that guy back to 24 square at 500 feet, you'll get a letter," Alex Borla says. "Do it twice in a row and they won't let you back in."

"I'm based at Santa Monica Airport, and they monitor every single flight that goes out of here," says fellow Californian Olen Nelson. "The neighbors complain a lot, and I think we're eventually going to get pushed into more and more anti-noise regulation."
At Sugarbush, Vermont, an area dotted with environmentally conscious summer- and winter-resort homeowners, the busy local soaring operation has equipped its fleet of Cessna L-19 towplanes (essentially a military version of the 180) with four-blade Hoffman composite props of considerably reduced diameter. They've lost some performance but gained a reduction in climb-out noise.

For decades, general-aviation supporters have used the argument, "We were here first," when homeowners complain about airport noise. Unfortunately, that is an increasingly irrelevant defense. In Manhattan, loft-seekers move into light-industry areas of the city and then complain about smelly dry-cleaning plants that were "there first." Invariably, the apartment-dwellers win. In the Midwest, suburban sprawl butts up against century-old farms that reek of fertilizer, and it's the farmers who are forced to clean up their acts. As Los Angeles has grown over the years, it has rolled over trap-shooting ranges, sprint-car racetracks, rocket test sites and other noise producers, and complaints that "we were here first" are invariably ignored.

"People want quieter cars, quieter apartments, less noise from the freeways," Olen Nelson points out. "Because we're moving closer together, people have become much more sensitive to whatever privacy and quiet they can get. People try to upgrade the quality of life wherever they live, even when it's near an airport. That's the natural thing to do." Even reducing aerodynamic noise will help. "An airplane is a noise radiator," says industrial hygienist Terry Carraway, "and if there's less noise for it to radiate, there's less to bother people on the ground."

Soon, we may be forced to make our aircraft quieter - if not for our own good, certainly for that of people on the ground below. It'll require a high-performance lightplane probably made of leak-free, clean composites (even airframe add-ons such as antennas make aerodynamic noise) that are stiff enough to resist vibration but not so solid that the airframe itself becomes one big noise pathway. The engine will be liquid-cooled, driving a small-diameter, many-blade, ducted pusher prop made of advanced materials yet light and cheap enough to be usable and affordable. It'll have a light yet effective internal muffling system, not just a heat exchanger can. The cabin will be extensively soundproofed from the git-go, not as an expensive retrofit, and it will make use of active noise-reduction technology.

Trouble is, this is never going to happen in an industry that manufactures a couple of thousand airplanes a year. So look at it this way: Either general aviation becomes healthy enough to support advanced technology rather than born-again Skyhawks… or there will be so few of us flying light planes that nobody will care about the occasional noise we make.
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8.11. Bear viewing guidelines.

<u>Bear Viewing Guidelines from *Commercial Recreation on Crown Land - Guidelines for Staff and Applicants* (Ministry of Environment, Lands and Parks 1998).</u>

Wildlife viewing provides excellent opportunities to promote the appreciation of wildlife and habitat conservation. Bears, in particular, have broad public appeal and are popular for viewing purposes. Despite this, the conservation of bears must remain the primary objective of all bear management and cannot be compromised to increase viewing opportunities. Bears, particularly grizzlies, are already facing stresses from a variety of sources including habitat loss, fragmentation and alienation. To compound these current impacts with the additional stress of a human presence, often at prime feeding locations, may be unacceptable in some locations.

Viewing programs in some areas have led to the displacement of individuals, particularly adult males who are generally resistant to habituation. However, whether this impacts bears at the population level is difficult to measure and has not been well studied. The potential for impact on bear populations is thought to vary depending on whether the bears congregate at a point concentration, are found along linear habitats (usually a river with a salmon run) or are dispersed across several habitats. The nature and degree of human use is also a variable which must be considered in determining the appropriateness of each bear viewing program.

Hunting around bear viewing areas poses an ethical dilemma and can be quite controversial. Some degree of habituation is likely to occur for most bears using these sites, particularly at point and linear concentrations. Here, management objectives must be clearly set prior to the commencement of viewing. If hunting is desired, viewing programs should avoid habituation and separate seasons set for both activities.

As with any backcountry enterprise, commercial operators must ensure a reasonable level of safety for their clients. Therefore, visitors should be given an overview of bear behaviour, food and waste management and how to react in the event of a bear encounter prior to any viewing event.

Considerations in Reviewing an Application Involving Bear Viewing

The main objective should be the conservation of bears. This must take precedence over all other objectives.

The impacts on bears of backcountry tourism both within and outside protected areas, and increased access, can be considerable, especially when they are cumulative. A major concern in the establishment of bear viewing opportunities is the stress placed on bears. This stress may alter behaviour resulting in displacement from prime habitat. This is particularly relevant because the best bear viewing opportunities occur at sites to which bears reliably return, usually due to a consistent food source, such as salmon. Not coincidentally, these areas represent prime habitat, usually with important food resources. Displacement from such resources may impact survivorship of some individuals, although such concerns are difficult to test and have not been well documented.

Viewing must not compound impacts currently faced by individual bears and bear populations in British Columbia.

Site-specific restrictions should be employed to mitigate potential impacts on bears. These include, but are not limited to:

- Visitor number restrictions. Optimal group size is determined by various on-site factors including topography, ability to build blinds and proximity to the bears.
- Distance restrictions. Viewers should be required to maintain a maximum distance from bears for their own safety and to reduce stress on the bears, e.g., in Khutzeymateen Provincial Park, viewers are required to maintain at least 150m from the bears.
- Seasonal restrictions. Bear viewing should be restricted to set seasons, which should be determined on a site-specific basis. Seasonal viewing restrictions will help reduce conflict with hunting activities and allow bears time at critical food sources (e.g., salmon runs, berry patches) without human disturbance.
- Access restrictions. Bears should be left an option to feed without human observation. There is also concern regarding potential impacts from helicopter and fixed-wing overpasses for viewing purposes as well as jet-boat tours. The potential disturbance of such activities on bears is unknown and requires further investigation. Should such access methods be shown to be disruptive, they should be abandoned in favour of more benign viewing programs.

Areas with high potential for impacting bear behaviour should not be considered as suitable commercial viewing operations.

All commercial bear viewing should be led by a licensed guide with requisite training in bear behaviour, local ecology, ethics and conservation, pertinent regulations, first aid and a primer on tourism service to ensure a quality product is offered.

Commercial viewing operations provide excellent interpretive opportunities to educate the public about bear behaviour, ecology and conservation. Such knowledge may help reduce the number of backcountry confrontations and subsequent need to remove "problem" bears. All bear viewing operations should be required to develop an interpretive program to supplement the viewing experience.

Bear viewing seasons should not coincide with bear hunting seasons.

Whenever habituation of bears is observed, hunting should be discontinued within the radius of an average home range for an adult female (grizzly or black bear depending on the species present) from the viewing site.

Human safety should be paramount in day-to-day operations. Although managing bear populations should be the primary objective at bear viewing sites, visitor safety should be paramount in terms of day-to-day operations. These priorities require that visitation be cancelled in the event of an unstable situation with a potential "problem bear".

Prior to any viewing event, all visitors should be given a thorough overview on bear behaviour, acceptable human behaviour, food and waste management and proper reactions to close encounters with bears.

A hazard/risk assessment should be completed for all trails advertised for public bear viewing.

When approached, the government should assist in initiating a review process involving local authorities and other interested parties in the area affected by the proposed endeavour. The review process should ensure the inclusion of:

a. A management plan with clearly stated objectives and that addresses the conservation of bears.

b. Information of the status of the bear population in the area (should be stable).

c. Stable land ownership/tenure.

d. Visitor management techniques should be clearly described, including any daily and seasonal limits.

e. Adequate private funding for both start-up capital (including EIA) and long term support.

f. An interpretive component should be included in all viewing programs to educate visitors about bear behaviour, ecology and conservation.

An Environmental Impact Analysis should be undertaken prior to commencing tours and monitored at regular intervals to ensure what impacts, if any, the operation has on individual bears as well as populations.

Landfills are not acceptable locations for bear viewing. Food or garbage conditioned bears represent a risk to human safety. In addition, the interpretive value of observing bears at landfills is very low; it may in fact be negative. More than 800 black bears and over 50 grizzlies are destroyed annually due to bear-human conflicts, often as a result of bears having access to non-natural foods such as garbage.