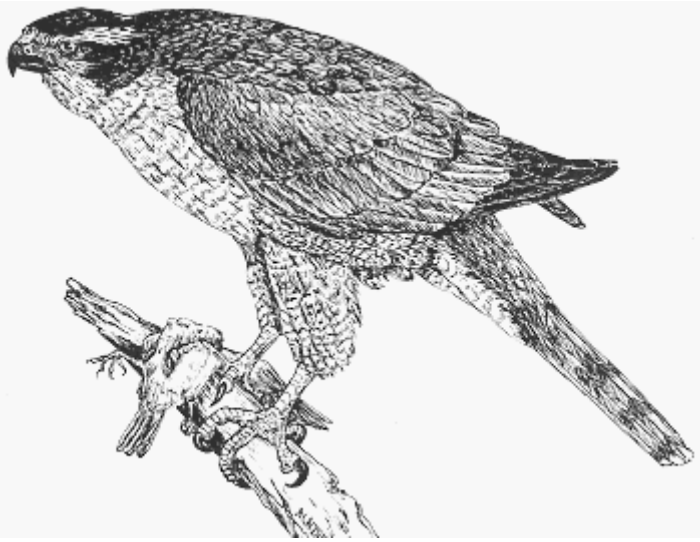
Managing Breeding Raptors in the Cariboo Forest Region:

A Case Study of the Alex Fraser Research Forest



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ABSTRACT

Raptors, or birds of prey, have large home ranges, nesting site requirements and a reliance on prey abundance and availability that makes them particularly vulnerable to habitat destruction. They are particularly sensitive while breeding because at this time disturbance, habitat loss and reduced prey availability can affect nesting success.

The birds of prey discussed in this report are the diurnal predators of the order Falconiformes. There are 15 species of Falconiformes found in the Cariboo Forest Region, 12 of which are known to breed there. Each of these 12 species have specific habitat requirements that must be met in order to breed successfully. Although some general management practices can be applied at a regional level, for the most part the effective resolution of breeding raptor habitat requirements and other potentially conflicting management objectives should be done at a smaller scale.

Management recommendations must incorporate the availability of suitable habitat, the liklihood of species being present, the population status of those species, and other management objectives that may constrain treatment options. The University of British Columbia / Alex Fraser Research Forest (AFRF) is used as an example of how raptor management may be incorporated into a working forest. The AFRF is composed of two forest blocks: Knife Creek and Gavin Lake. The forest spans four biogeoclimatic zones, three ecosections and two ecoprovinces within two Forest Districts of the Cariboo Forest Region, and potentially provides habitat for all twelve of the nesting raptors of the Cariboo.

The three main factors responsible for declines in raptor populations are the restriction and degredation of habitat, persecution by man and contamination by toxic chemicals. All of these are discussed as they relate to forest management, but it is the impacts on habitat over which forest managers can have the greatest control.

In order to be successful, raptor management must be considered in all phases of forest management, including planning, road building and maintenance, harvesting and silviculture. Some general considerations for each of these phases are discussed. The habitat requirements and status of each of the twelve breeding raptors, as well as species-specific management recommendations, are described in detail.

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INTRODUCTION

Avian predators, or birds of prey, are often referred to as "raptors". The taxonomic definition of this term is quite variable, but it most often refers to diurnal predators and does not usually include owls (Ehrlich et al., 1988; Kirk and Hyslop, 1998). For the purposes of this report the term raptor will refer to birds of the order Falconiformes, which includes the families Accipitridae (Accipiters, Buteos, harriers and eagles), Falconidae (falcons) and Pandionidae (ospreys), all of which are diurnal hunters.

Birds of prey are particularly vulnerable to habitat destruction due to their requirements for relatively large home ranges and suitable nesting sites (Ehrlich et al., 1988; Kirk and Hyslop, 1998). As predators, these birds are vulnerable to changes in prey populations, as well as changes in habitat which affect the availability of prey (Crocker-Bedford, 1990; Grant et al., 1991; Janes, 1984; Preston, 1990; Schmutz, 1984; Steeger et al., 1992; Steenhof et al, 1999; Widén, 1989). The population status of raptor species can be difficult to estimate because they are often dispersed and/or secretive species that nest in low densities, and their population can fluctuate cyclically in relation to prey abundance (Kirk and Hyslop, 1998). This can make management for raptors challenging, particularly in the context of other forest management objectives.

Raptors are most sensitive during the breeding season. Suitable nesting sites, which vary according to species, must exist in order for breeding to occur successfully. As well, breeding adults are much more prone to persecution (such as shooting) or disturbance. Human activities can cause incubating adults to leave their nests, which can potentially result in the loss of eggs or small chicks, or nest abandonment (Fraser et al., 1985; Holthuijzen et al., 1990). Some species also have a smaller foraging range when breeding than when not breeding (Marzluff et al., 1997; Reynolds et al., 1982). Food availability is critical year round, but during breeding season it is more so. This is because one member of the breeding pair often does most of the hunting, so must be able to catch enough prey for itself, its partner, and the fledglings in order to breed successfully. Because of this sensitivity, it is the impacts of forest management upon breeding raptors in particular that will be the focus of this report.

In order to incorporate the requirements of breeding raptors into forest management strategies, it is essential to first determine which species may breed in the area of interest. Several species of raptor may be found in the Cariboo Forest Region throughout the year, but not all of these species are likely to breed there. Information on the regional distribution and abundance of birds of prey is available, and may be useful in focussing attention on those species most affected by forest management.

Although it is helpful to know what species are likely to be present at a regional scale, it is not always possible to make broad, generalized recommendations regarding management of forests for raptors at this scale. Given that forest managers typically deal with multiple priorities at a sub-regional scale, it is important to determine the management of raptor species at a similar scale, in the context of those priorities. Factors such as the population status of the species in question, the abundance of nesting and foraging habitat, the degree of conflict of current management regimes with habitat requirements, and the relative importance of other management priorities must be considered when developing raptor management strategies. In fact, since some raptor species compete with one another for resources, managing for one raptor species may be in direct conflict with the habitat requirements of other raptor species.

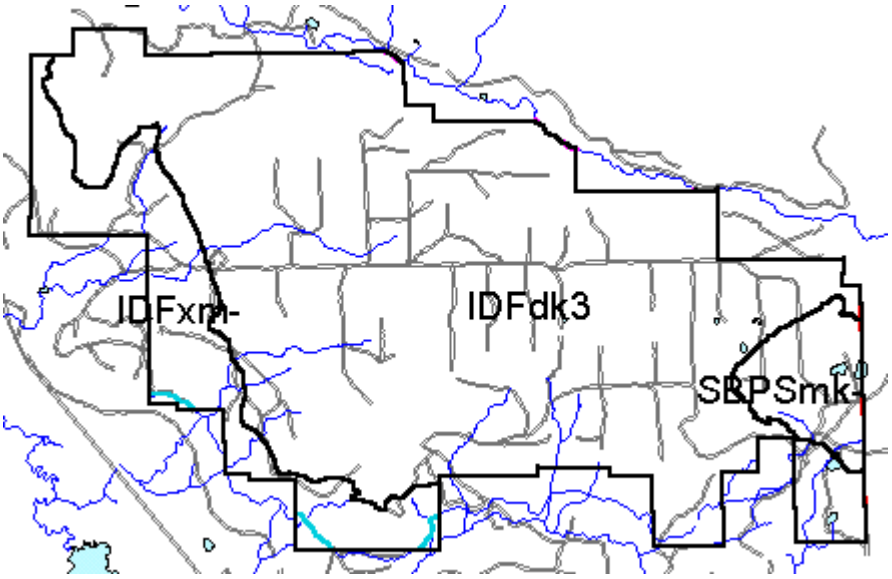
Some generalizations can be made when managing for raptors, but appropriate management often requires that a specific area be considered. In this report the Alex Fraser Research forest will be used as an example of how raptor management may be approached in a forested landscape.

INTRODUCTION TO THE ALEX FRASER RESEARCH FOREST

The University of British Columbia / Alex Fraser Research Forest (AFRF) is located near Williams Lake, B.C., and consists of two geographically separate forest blocks. The Knife Creek block is 3000 ha in size, and is located primarily in the Interior Douglas Fir biogeoclimatic zone (IDF), including both the dry cool (IDFdk) and very dry mild (IDFxm) subzones. The eastern end of the Knife Creek block transitions to the Sub Boreal Pine Spruce moist cool subzone (SBPSmk) (Figure 1). The Gavin Lake block is 6000 ha in size, and falls within both the Interior Cedar Hemlock moist cool subzone (ICHmk) and the Sub Boreal Spruce dry warm subzone (SBSdw) (Figure 2). Both blocks are located within the central interior ecoprovince (CEI). Knife Creek is located within the Cariboo Basin (CAB) ecosection of the Williams Lake Forest District and Gavin Lake in the Cariboo Plateau (CAP) ecosection of the Horsefly Forest District. A small portion of the Gavin Lake block may also fall within the Quesnel Highlands (QUH), an ecosection of the Southern Interior Mountains (SIM) ecoprovince (Anonymous, 1999a).

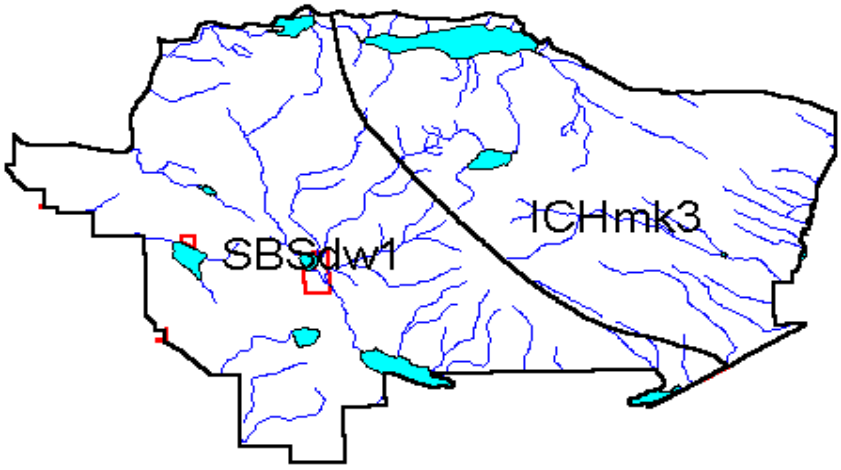
The most recent Management and Working Plan for the AFRF (Day, 1996) recognizes that biodiversity and identified wildlife should be incorporated into resource management decisions. This is to be done in a manner consistent with the Forest Practices Code and the Cariboo-Chilcotin Land Use Plan (CCLUP) resource targets. Although few bird species are specifically mentioned within the CCLUP targets, some species may be referred to indirectly through references to species at risk, sensitive habitats and biodiversity.

Figure 1. Biogeoclimatic subzones of the Knife Creek block of the Alex Fraser Research Forest



Biodiversity is defined as "the diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them" (Anonymous, 1995). Biodiversity management in British Columbia is currently based on a "coarse filter" approach, which attempts to preserve native species and ecological processes by mimicking the forest structure resulting from historical disturbance patterns (Anonymous, 1995). This general management philosophy, however, is not necessarily adequate to preserve the habitat requirements of all species in British Columbia. In cases where wildlife requires additional management attention, the Identified Wildlife Strategy has been put in place to provide specific management recommendations. It should be noted, however, that only endangered, threatened or vulnerable species of vertebrates and invertebrates, endangered or threatened plants and plant communities, and regionally important vertebrates may be designated as Identified Wildlife (Anonymous, 1999a).

Figure 2. Biogeoclimatic subzones of the Gavin Lake block of the Alex Fraser Research Forest



RAPTOR SPECIES PRESENT IN THE CARIBOO FOREST REGION

There are several resources available for determining the presence of raptor species in a given geographic area. Local naturalist clubs are an excellent resource, and many will have regional bird checklists available. In the case of the Cariboo Forest Region, the Checklist of Cariboo Birds (Roberts and Gebauer, 1992) lists the species of raptors found in the region, their seasonal abundance, and whether they are known to nest there.

There are other sources of information that can determin the likelihood of a species being present at a subregional scale. The Resource Inventory Committee of BC. (RIC, 1996) maintains a list of raptor species present in BC, their status, and the ecoprovinces they are found in during breeding and non-breeding seasons. Information on the seasonal abundance of raptors in the biogeoclimatic zones and subzones of BC is available in Stevens (1995). Other sources of information on species distribution and status include the B.C. Conservation Data Centre's Rare Species Lists for each Forest District in BC. (BCCDC, 1999).

A list of raptor species known to occur in the Cariboo Forest Region is provided in Table 1. Their population status and whether they nest in the region is also included.

Table 1. Raptor species present in the Cariboo Forest Region.

Common Name	Scientific Name	Status	Identified Species	Nesting
American Kestrel	*Falco sparverius*	Not listed		Y
Bald Eagle	*Haliaeetus leucocephalus*	Blue listed		Y
Cooper's Hawk	*Accipiter cooperii*	Not listed		Y
Golden Eagle	*Aquila chrysaetos*	Not listed		Y
Gyrfalcon	*Falco rusticolus*	Blue listed		N
Merlin	*Falco columbarius*	Not listed		Y
Northern Goshawk	*Accipiter gentilis atricapillus*	Not listed	Y	Y
Northern Harrier	*Circus cyaneus*	Not listed		Y
Osprey	*Pandion haliaetus*	Not listed		Y
Peregrine Falcon	*Falco peregrinus anatum*	Red listed		Y
Prairie Falcon	*Falco mexicanus*	Red listed	Y	Y
Red-tailed Hawk	*Buteo jamaicensis*	Not listed		Y
Rough-legged Hawk	*Buteo lagopus*	Not listed		N
Sharp-shinned Hawk	*Accipiter striatus*	Not listed		Y
Swainson's Hawk	*Buteo swainsoni*	Blue listed		N

FOREST MANAGEMENT FOR BREEDING RAPTORS

General Considerations

According to Newton (1979), the three main factors responsible for general declines in raptor populations are the restriction and degradation of habitat, persecution by man, and contamination by toxic chemicals. The use of toxic chemicals usually refers to the use of pesticides, particularly organochlorines such as DDT, which have been found to thin egg shells and reduce nesting success (Newton, 1979). The use of pesticides is not common in forest management, with the exception of herbicides such as glyphosate and triclopyr. Neither of these compounds are organochlorines. The use of herbicides is not common on the AFRF. One Pesticide Use Permit is currently active on the AFRF, under which only glyphosate is approved. Glyphosate is a chemical that does not bioaccumulate, and is not generally considered toxic to non-aquatic vertebrates. Herbicides are probably not of great importance to raptor populations on the AFRF.

Persecution of raptors can take many forms, including hunting, poaching, collecting and disturbance by human activities conducted near nests. The persecution and disturbance of raptors within the AFRF could be affected by increasing road access or by conducting forestry-related activities close to active nests. Other sources of persecution, such as human population encroachment, is beyond the scope of forest management planning. Protecting raptor species from persecution is of little value, however, if the population is limited by habitat availability (Newton, 1979).

Habitat degradation can occur in two ways. The first is the reduction of formerly widespread habitat to tiny fragments, which reduces the availability of quality habitat. Although these fragments may support raptors at a similar density, the total amount of habitat is reduced and consequently the ability of the land base to support raptors is also reduced. The second is the reduction of general habitat quality by land use practices which reduces the density that a given area can support. Both of these types of degradation can be affected by forest management practices.

In order to address habitat destruction, it is essential to know which species are, or may be, present, and what the habitat requirements of these species are. Tables 2 and 3 summarize some of the information specific to the ecoprovinces, biogeoclimatic subzones and Forest Districts of the Knife Creek and Gavin Lake blocks respectively, which is relevant to the management of raptors in these areas. Since the habitat requirements of raptor species are quite different and often conflicting, it is also important to prioritize each species for management purposes.

Table 2. Seasonal abundance of the breeding raptor species of the Cariboo Forest Region in areas specific to the Knife Creek block.

	Presence in BEC Subzones of B.C.*			**Present in CEI Ecoprovince****		**Williams Lake Forest District Rare Species List*****
Common Name	**SBPSmk**	**IDFxm**	**IDFdk**	**Breeding**	**Non-breeding**	
American Kestrel	sm	PSAw	PSAw	Y	N	
Bald Eagle	swM	swM	swM	Y	N	Y
Cooper's Hawk	sm	sm	sm	Y	N	
Golden Eagle	sm	y	y	Y	Y	
Merlin	sm	y	y	Y	Y	
Northern Goshawk	y	y	y	Y	Y	
Northern Harrier	sM	swM	sM	Y	N	
Osprey	PSa	PSaw	PSa	Y	N	
Peregrine Falcon	ps	y	sm	Y	N	Y
Prairie Falcon				Y	N	Y
Red-tailed Hawk	sm	Y	PSAw	Y	N	
Sharp-shinned Hawk	sM	swM	swM	Y	Y	

P = spring (March – May)
S = summer (June – August
A = autumn (September – November)
W = winter (December – February)

M = migratory (spring and autumn)
Y = yearlong
uppercase = common or abundant
lowercase = uncommon, scarce or rare

* Stevens, 1995
** RIC, 1996
*** BCCDC, 1999

It is impossible to select a single management regime appropriate to all raptors, since each species has different requirements. Decisions regarding raptor management must often be made within the context of higher priority management objectives. Specific prescriptions must therefore be done on a case-by-case basis. Primary management objectives have been identified for most of the research forest. The primary use priority for the entire Knife Creek block is mule deer winter range. This area is under uneven-aged management. The Gavin Lake block has been broken down into compartments, each having its own use

priorities (Figure 3). Management for raptor habitat must be done within the context of these land-use priorities since they are used to guide management objectives in prescriptions.

Table 3. Seasonal abundance of the breeding raptor species of the Cariboo Forest Region in areas specific to the Gavin Lake block.

Common Name	Presence in BEC Subzones of B.C. *		Present in CEI Ecoprovince**		Present in SIM Ecoprovince**		Horsefly F.D. Rare Species List***
	SBSdw	ICHmk	Breeding	Non-Breeding	Breeding	Non-Breeding	
American Kestrel	PsA	SwM	Y	N	Y	Y	
Bald Eagle	PsAw	sM	Y	N	Y	Y	
Cooper's Hawk	sm	ps	Y	N	Y	Y	
Golden Eagle	ps	y	Y	Y	Y	Y	
Merlin	sm	y	Y	Y	Y	Y	
Northern Goshawk	y	y	Y	Y	Y	Y	Y
Northern Harrier	sM	M	Y	N	Y	Y	
Osprey	PSa	ps	Y	N	Y	N	
Peregrine Falcon		sm	Y	N	N	N	
Prairie Falcon		y	Y	N	N	N	Y
Red-tailed Hawk	sm	sm	Y	N	Y	Y	
Sharp-shinned Hawk	sM	sM	Y	Y	Y	N	

P = spring (March – May)
S = summer (June – August
A = autumn (September – November)
W = winter (December – February)

M = migratory (spring and autumn)
Y = yearlong
uppercase = common or abundant
lowercase = uncommon, scarce or rare

* Stevens, 1995
** RIC, 1996
*** BCCDC, 1999

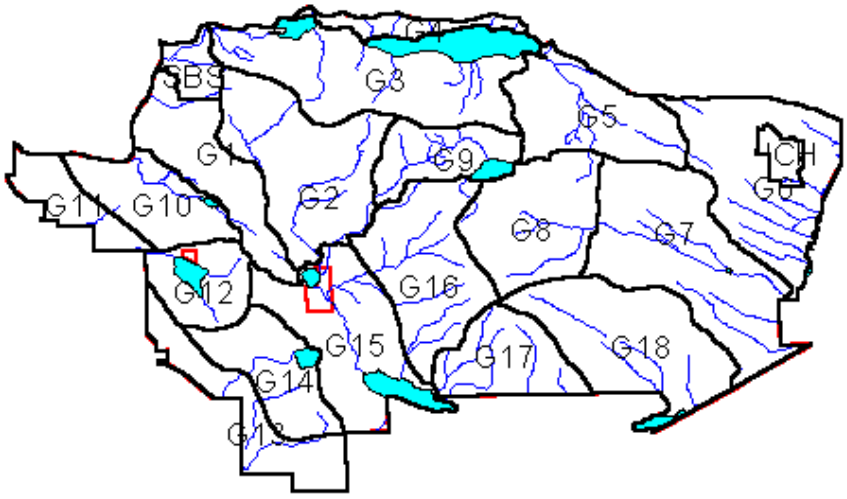
There are some overlying principles which apply to the management of all raptor nests: do not destroy the nest, leave a large enough wildlife tree patch around the nest to protect it from windthrow, ensure suitable nesting and/or foraging habitat exists, and establish no-activity buffers around active nests. In order to be successful raptor management plans must include all phases of forest management, including planning, road building and maintenance, harvesting and silviculture.

Planning, or pre-development, is the most critical phase. It is at this stage that nests, particularly active nests, should be identified. If a nest location is known, then it is easier to plan the timing of activities near the nest. Nests, whether actively being used or not, should never be destroyed. Aside from this, activities can take place outside of the breeding season. If it is necessary to conduct activities in the vicinity of the nest during breeding season, then a buffer zone must be established around the nest until it can be determined whether the nest is active or not. Figure 4 shows the critical season for each of the birds that may breed on the research forest. If no nesting activity occurs during this period, or activity is abandoned by the end of the egg-rearing period, then the nest can be considered inactive.

It is easiest to locate the nests of those species that build large stick nests. These nests are highly visible, particularly from the air or from adjacent openings. Several such nests have been identified on the AFRF.

For those species that have nests that are less easy to find, it is important to be observant during block planning and layout. Birds showing a high fidelity to an area, particularly in pairs, may have a nest nearby. In such a case the nest location should be determined if possible, and considered during layout (for example in the design of wildlife tree patches or the selection of silviculture systems). Where nests are inactive or layout is done outside of the breeding season, it may be difficult to identify nesting sites. In such cases, assuming a reasonable effort has been made to find nests, it must be assumed that wildlife tree patches, riparian management areas, or silviculture systems that result in the retention of some trees will provide adequate protection of current nesting sites or provision of future sites.

Figure 3. Management priorities of Gavin Lake block.



Compartment	Primary Use	Secondary Use	Tertiary use	Management
G1	Deer	Timber	Range	Uneven-aged
G2	Timber	Deer	Moose	Even-aged
G3	View	Timber	Range	Even-aged
G4	Recreation	Timber	Range	Even-aged
G5	Timber	View	Range	Even-aged
G6	Timber	Range		Even-aged
G7	Timber	Range		Even-aged
G8	Timber	Range		Even-aged
G9	Timber	Range		Even-aged
G10	Deer	Range	Timber	Uneven-aged
G11	Deer	Timber	Range	Uneven-aged
G12	Deer	Recreation	Range	Uneven-aged
G13	Deer	Timber	Range	Uneven-aged
G14	Deer	Timber	Range	Uneven-aged
G15	Deer	Range	Timber	Uneven-aged
G16	Timber	Moose		Uneven-aged
G17	Timber	Moose		Uneven-aged
G18	Timber	Moose		Uneven-aged

It is important to try to identify the species that built the nest when considering management objectives. If the species is known, critical breeding times can be more accurately identified and proper management decisions can be made. For example, northern goshawks and red-tailed hawks can have nests that appear

very similar, but the management regimes appropriate for these two species are very different. Species identification can be difficult when nests are not active.

Roadbuilding and harvesting are loud, destructive activities that potentially disrupt nesting behaviours at active nests. Such activities are acceptable during the non-breeding season, or near inactive nests during the breeding season, but should be minimized near active nests. Some studies have suggested that low level human disturbances should be restricted within 500 m of active nests (Fraser et al., 1985; Holthuijzen et al., 1990). In the case of Prairie Falcons it has been recommended that blasting, construction and similar activities should not be undertaken within 1000 m of active nests (Holthuijzen et al., 1990); forest road construction and harvesting likely fall into this category. Similarly, management of the prairie falcon as an identified wildlife species in B.C. requires that no road construction, harvesting or salvage should occur within 1000 m of active nests during the breeding season (Anonymous, 1999a).

Figure 4. Critical periods for active raptor nests

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AMKE			*eggs*						*young*			
BAEA	*eggs*								*young*			
COHA				*eggs*					*young*			
GOEA			*eggs*						*young*			
MERL			*eggs*					*young*				
NOGO			*eggs*						*young*			
NOHA			*eggs*					*young*				
OSPR			*eggs*						*young*			
PEFA			*eggs*					*young*				
PRFA		*eggs*						*young*				
RTHA		*eggs*						*young*				
SSHA					*eggs*			*young*				

As a general rule Identified Wildlife procedures and measures take precedence over other management considerations where applicable. Where those are not in effect, active nests of non-identified species should also be protected from disturbance – representatives of the Ministry of Environment, Lands and Parks must be consulted regarding management of these nests. A conservative approach, based on literature describing the prairie falcon and bald eagle, would involve the establishment of buffers around nests in active use. Low level disturbance such as surveying, planting and layout should be restricted within 500 m of known active nests where possible. Higher level disturbances, such as road construction, harvesting, salvage, spacing and manual brushing, should be restricted within 1000 m of active nests.

Such restrictions will not always be possible to maintain. Narrow operational windows or restrictions due to other management priorities may necessitate some activity within these buffer zones. In such cases, representatives of the Ministry of Environment, Lands and Parks should be consulted. Even if permission to work within established buffers can be obtained, efforts should be made to minimize the amount of disturbance to the active nest. Where Identified Wildlife species are involved, a variance must be obtained before contravening management recommendations, as outlined in the Identified Wildlife Management Strategy (Anonymous, 1999a). In other cases, nests may be built near highways or well-travelled mainline roads. Should these nests be active, it is rarely possible to restrict vehicle traffic along such roads.

Chemical brushing can affect prey availability. Application of glyphosate has been shown to affect populations of songbirds (MacKinnon and Freedman, 1993; Santillo et al., 1989), which are important prey for some raptors. Overall, however, the silvicultural use of glyphosate has relatively small, short-term effects on the prominent bird species of regenerating clearcuts (MacKinnon and Feedman, 1993). Even this effect can be minimized by leaving untreated patches of vegetation and staggering herbicide treatments on large clearcuts (Santillo et al., 1989). The benefit of chemical herbicide treatment is that it reduces the amount of cover available to prey, and it does so for longer than manual brushing. This should increase prey availability, even if prey abundance drops (so long as it remains above the critical threshold). At the AFRF chemical brushing is seldom used and is done at a localized level and a small scale. It is therefore expected to have a negligible impact on raptor populations.

Spacing, although potentially disturbing to actively breeding pairs, should be benficial to most raptor habitat. Dense young stands provide excellent cover for prey and are very difficult to fly through. Thinning the stand improves the ability of most species to hunt. Trees in thinned stands also get larger faster, and generally have thicker branches. This means that trees will be available for perching and nest-building sooner. However, stand thinning may also result in deeper crowns and a reduced abundance of small diameter dead branches which may be used as nesting material. The ideal spacing depends on the species being managed for, as well as the growth characteristics of the site. *Accipiters* would likely benefit more from a higher target spacing than would red-tailed hawks because their superior agility would make them more competitive in that environment.

Species Specific Management Recommendations

On the Alex Fraser Research Forest, raptor species have been prioritized for management according to a combination of species status, habitat requirements and probability of breeding on the forest. All species that potentially breed on the research forest are listed in order of management priority. General management recommendations are given for each species based on existing guidelines and literature. Regardless of these recommendations, however, BC Environment officials should always be consulted before operating near known nesting sites.

1. Northern Goshawk

The highest priority for management on the AFRF is the northern goshawk. There are two subspecies of northern goshawk in British Columbia. The *laingi* subspecies, or Queen Charlotte goshawk, is red-listed and restricted to coastal forests. The *atricapillus* subspecies, which is present in the AFRF, is not a listed species in British Columbia, but is considered regionally important. Although it has been designated as "not at risk" in Canada by COSEWIC (1999), the goshawk is considered a species of conservation in British Columbia. This is because it is associated with habitats that are becoming rare, and because it is a species for which B.C. has a global responsibility because adjacent jurisdictions have listed it at risk (Anonymous, 1997). For this reason, the atricapillus subspecies is addressed in the Identified Wildlife procedures and measures (Anonymous, 1999a).

Goshawks prefer to inhabit and breed in deep, conifer-dominated forest or open woodland, and prefer those composed of mature or old-growth trees (Ehrlich et al., 1988; Reynolds et al., 1982; Scott, 1987). Goshawks are more likely to build nests in old growth, particularly in large diameter trees (Beier and Drennan, 1997; Crocker-Bedford, 1990; Mannan and Meslow, 1984; Reynolds et al., 1982), though nests have been found in second growth coniferous stands and aspen stands (Reynolds et al, 1982). Eggs may be present from early April and young have usually fledged by late August (Campbell et al., 1990; RIC, 1996). Young remain dependent on adults for 30 to 40 days after fledging (Ehrlich et al., 1988).

Under normal conditions, northern goshawks prefer hunting in large tracts of mature or old growth forest (Beier and Drennan, 1997; Crocker-Bedford, 1990; Ehrlich et al., 1988; Kenward and Widén, 1989; Reynolds, 1982; Scott, 1987; Widén, 1989). The morphology and behaviour of goshawks are well adapted to hunting in moderately dense forests (Beier and Drennan, 1997). Some studies of the European subspecies (*gentilis*) indicate that it is food availability, not nesting habitat, that normally limits populations (Widén, 1989), and that goshawks will show a strong preference for hunting within 200 m of the forest edge when prey availability is very high in an adjacent opening (Kenward and Widén, 1989).

Prey availability is more important than prey abundance in habitat selection. Assuming prey are present above a minimum threshold, favourable vegetation structure will improve hunting efficiency. Northern goshawks prefer vegetation that permits them to approach prey unseen and use their maneuverability to advantage. Dense stands with large trees, high crown closure and open understory conditions are preferred, though goshawks have been known to forage in less ideal conditions when preferred conditions were not available (Beier and Drennan, 1997; Widén, 1989). It has also been suggested that habitat attributes important for the maintenance of important prey species should also be managed for. These include snags, downed logs, woody debris, small openings, large trees and herbaceous or shrubby understorey (Reynolds et al., 1992).

If conditions get too open, reduced hunting success and increased competition from open forest raptors can cause displacement of goshawks (Crocker-Bedford, 1990). North American goshawk subspecies are more dependent on continuous closed-forest conditions than the European *gentilis* subspecies. It is believed that the red-tailed hawk and great horned owl provide much greater competition for food and nesting sites than their European equivalents. The North American competitors are also much more aggressive; great horned owls regularly kill northern goshawks. Although goshawks may be capable of foraging outside of their preferred habitat, competition with other birds of prey often limits them to forested habitat where their superior agility provides a competitive advantage (Kenward, 1996).

Northern goshawks forage low in woodland, using aerial pursuit or low patrol to hunt prey (Ehrlich et al., 1988). Nearly all attacks are launched from perches, upon which they stay for long periods of time (Widén, 1989). Goshawks hunt primarily for ground-dwelling birds and ducks, but may also prey on other birds, or mammals as large as hares (Ehrlich et al., 1988; Scott, 1987). Widén (1989) found that in Sweden, prey preference depended upon the season; birds were the primary prey during breeding season, while squirrels were the primary prey during the winter. In Oregon, breeding adults tended to concentrate their foraging activities within 75 m of the nest, often upslope from the nest tree (Reynolds et al., 1982).

Since the Northern Goshawk is an identified species, its management is dictated by the identified wildlife procedures and measures (Anonymous, 1999a), which are similar to recommendations made for the management of this species in the southwestern United States (Reynolds et al., 1982).

Management of the northern goshawk involves establishing a two-tiered wildlife habitat area (WHA) at breeding sites. The entire WHA consists of a 240 ha post-fledging area (PFA), which should include three 12 ha nest sites. One of the nest areas should include an active nest, and the other two should provide alternate nesting sites that must include appropriate nesting habitat and may or may not include inactive nests. Suitable habitat is defined as an open understorey, closed canopy (60% or greater), and low ground vegetation.

No roads should be constructed within the designated nest areas without an approved variance, nor should any harvest or salvage be undertaken except for those treatments aimed at maintaining or improving stand structure for nesting. Understorey thinning to maintain or promote desired stand structure (e.g. single storied, crown closure $\geq$ 60% and uniform trees $\geq$ 60 cm dbh) is an example of such a stand-improving treatment. Where such activities are planned, the breeding period (March 15 to September 1) should be avoided.

No blasting should occur within the 240 ha PFA during courtship and nest establishment (usually between March 15 and June 30, but actual times may vary by site and year). No road construction or modification should occur within 200 m of an active nest between March 15 and September 1 without an approved variance.

No logging or salvage should occur within a WHA with an active nest from March 15 to September 1 without an approved variance. Any harvesting that takes place within a WHA should be restricted to less important goshawk habitat (i.e. stands with an open canopy and multiple storied stands). Moderately important stands are those with a closed canopy, but moderate amounts of intermediate canopy. The most important stands are those with dense canopy cover and an open understorey; harvesting in these areas should be avoided.

No silviculture treatments should be conducted between March 15 and June 30 within 500 m of an active nest unless a variance is approved by the District Manager and the Regional Fish and Wildlife Manager. Activity restrictions on all phases of forest management are removed after June 30 for inactive and unsuccessful nests.

The Identified Wildlife Procedures and Measures also dictate that the harvesting sequence should be planned to create a mosaic of successional stages interspersed in patches, with at least 20% in closed canopy old-growth and 40% in mature forest (or old forest, if mature is unavailable). The remaining 40% should be managed with no more than 20% in young forest. This may be a suitable strategy for even-aged stands, but is not relevant to uneven-aged management.

Knife Creek, the site of the AFRF's only known northern goshawk nest, is currently being managed for mule deer winter range using uneven-aged management. Under the current management regime, 1/3 of the area is to be targeted as a "low" crown closure habitat class, 1/3 as "moderate", and 1/3 as "high" (Day, pers. comm.). Table 4, taken from Anonymous (1999b) shows the basal area targets for these habitat classes.

Within the constraints set by factors affecting mule deer winter range, the WHA associated with the Knife Creek goshawk nest should be treated as high a crown closure habitat class as possible. The high crown closure is preferred, but even the moderate treatment provides some of the closed canopy conditions with larger diameter trees that are preferred by northern goshawks. Crocker-Bedford (1990) found that partial harvesting in Arizona had an adverse effect on nesting goshawks, regardless of nest buffers. However, the residual basal area in these stands ranged from 10 to 25 m^2/ha, and no mention was made of attempts to retain larger stems. Given that the moderate and high crown closure habitat classes are either at the upper end or exceed the range given in that study, and that the larger stems preferred by goshawks will be

retained to a greater degree, the current management regime in Knife Creek is likely adequate to protect the habitat of the northern goshawk.

Table 4. Basal area targets for management of mule deer winter range stands in IDFxm and IDFdk3 biogeoclimatic units in the Cariboo Forest Region.

Crown Closure Habitat Class	Biogeoclimatic Unit	Minimum Residual Basal Area Immediately Post-Harvest**		Other Criteria Applicable to All IDF Zone Mule Deer Winter Range Prescriptions
		Total Basal Area ≥12.5 cm. (m^2/ha)	Total Basal Area ≥40 cm. (m^2/ha)	
Low	IDFxm and IDFdk3	≥ 16	≥ 6	▪ Minimize residual damage ▪ Harvest non-fir species first
Moderate	IDFxm (A)*	≥ 22	≥ 8	▪ Maintain clumpy stem distribution
	IDFxm (B)*	≥ 22	≥ 11	▪ Distribute harvest in relation to micro-topography
	IDFdk3	≥ 22	≥ 11	
High	IDFxm	≥ 27	≥ 15	▪ Maintain or promote multi-storied stands
	IDFdk3	≥ 29	≥ 16	

* Two recommendations are given for moderate crown closure habitat in IDFxm: (A) for warm aspect stands with slopes ≥ 30%, and (B) for all other stands.
** Basal area targets are stated as residual basal area minimums. These are the minimum basal area targets for the stand immediately after harvest.

2. Prairie Falcon

The prairie falcon is red-listed in British Columbia, and is also an identified species. It is consequently a very high management priority, but since nesting habitat is very limited, it may not be present on the AFRF. The prairie falcon shows a strong preference for nesting on cliffs, particularly those that are perpendicular and inaccessible to man. Taller cliffs are capable of supporting a higher density of nesting sites. Prairie falcons do not actually build nests, rather the eggs are laid in scrapes on bare ground or gravel (Ehrlich et al., 1988; Harrison, 1979; Steenhof et al., 1999). Prairie falcons will re-use nesting sites, and have been known to return to a nest the year after a failure (Holthuijzen et al., 1990).
Prairie falcons inhabit open habitat in mountainous regions, shortgrass prairie and alpine tundra (Ehrlich et al., 1988; Scott, 1987). They show a strong preference for foraging in open habitat, and have been known to breed in the Chilcotin-Cariboo basin (Campbell et al., 1990; Hooper, 1997).

It has been suggested for prairie falcons that 500 m buffers be placed around nests for low-level human activities, such as surveying, and 1000 m buffers for construction and similar activities (Holthuijzen et al, 1990), but since this is an identified species, provincial regulations take precedent. The identified wildlife measures of B.C. require that a WHA be established at all nest sites (Anonymous, 1999a). The WHA should include a 150 m radius "no activity" core area centered on the nest, and an 850 m buffer area. Roads should not be constructed at all within the core area, and should not be constructed within the buffer

during breeding season (March to September 15) without an approved variance. Similarly, no harvesting or salvage should occur in the core area at any time, or in the buffer zone during breeding season unless an approved variance is obtained. Although it is not explicitly stated in the procedures and measures, the restrictions on activity within the buffer zones probably do not apply to inactive nesting sites; the Ministry of Environment, Lands and Parks should be consulted if this is an issue.

A selection of mature trees (age class 6-9) and/or large snags (e.g. the largest within the stand that are preferably decay class 2-4) and shrubs should be retained in the buffer. The use of pesticides in the WHA should be avoided. Spot treatments with herbicides may be used in exceptional circumstances (e.g. noxious weeds) where it can be demonstrated that the herbicide will not be harmful to the species or habitat being managed. Recreation sites should not be established within the WHA.

Prairie falcon breeding distribution tends to be restricted to cliffs in the Fraser and Chilcotin River valleys of the Chilcotin-Cariboo Basin with open grasslands or sagebrush flats nearby (Hooper, 1997). There are cliffs in the western portion of the Knife Creek block that may provide suitable nesting habitat. This area should be mapped as a potential breeding site. If any activities are planned within the 1000 m of this habitat, the cliffs should be inspected closely during breeding season (Figure 4) to ensure that no active nests exist. If nests are found, then appropriate buffers can be put in place.

3. Peregrine Falcon

As with the prairie falcon, the *anatum* subspecies of the peregrine falcon is red-listed in British Columbia (RIC, 1996; Stevens, 1995), and has been known to breed in the Chilcotin-Cariboo basin (Campbell et al., 1990). Peregrine falcons will almost always nest on inaccessible ledges on rocky cliffs, but will rarely use old tree nests or cavities. Nests are usually well-rounded scrapes in accumulated debris on a ledge or in the ground. Cliff sites are traditionally used for many years (Ehrlich et al., 1988; Harrison, 1979).

Peregrine falcons most commonly inhabit open wetlands near cliffs. They have been known to utilize a variety of open habitats, including tundra, savannah, seacoasts, high mountains, and occasionally open forest and cities (Ehrlich et al., 1988; Scott, 1987). Since the peregrine shares the prairie falcons preference for nesting on cliffs near open habitat, it is likely limited to the same habitat in the Knife Creek block as the prairie falcon.

As with the prairie falcon, if any activities are planned within 1000 m of the cliff habitat in Knife Creek, it should be inspected during breeding season (Figure 4). There are no specific guidelines in place for managing this species, so the following guidelines are recommendations intended to minimize disturbance of nesting sites.

Since most of the foraging done by the peregrine falcon is likely to be conducted in the unforested areas adjacent to the research forest, the critical factor is minimizing disturbance to active nests. If an active nest is found, a 500 m buffer should be placed around it. Low-level activities should be minimized in this zone as long as the nest is active. Major activities such as road building or harvesting should not be conducted within 1000 m of an active nest during the breeding season. Most activities do not need to be restricted while nests are inactive, but no activities should be undertaken which will directly damage the nest.

4. Bald Eagle

The bald eagle is listed as "not at risk" by COSEWIC (1999). In British Columbia it is a yellow listed species according to the BC Conservation Data Center (1999), but the Stevens database (1995) and the Resource Inventory Committee (1996) state that it is blue listed. The bald eagle is seasonally common to the habitats present on the AFRF; in both the Gavin Lake and Knife Creek blocks it is most common during the spring and fall, especially as a migrant (Stevens, 1995).

Bald Eagles build platform nests, often in the fork of a large tree. Conifers are usually preferred as a nesting site, but the species of tree is not as important as the size, shape and distance from other nesting eagles. Nests may also be built on cliffs (Ehrlich et al., 1988; Harrison, 1979). The bald eagle prefers habitat associated with coasts, rivers and large lakes in open areas (Ehrlich et al., 1988; Scott, 1987). In British Columbia, bald eagles usually select large trees for nest support that are located adjacent to aquatic food sources. In the interior, nests are usually found along major rivers characterized by low gradients and extensive flood plain development, around lakes and reservoirs of various sizes, particularly low-elevation lakes with good fish populations, and in areas where many small lakes or wetlands occur in proximity to one another (Blood and Anweiler, 1994).

Eagles generally need tracts of undeveloped shoreline to breed successfully, and will avoid shoreline areas where development or other human activities are high (Buehler et al., 1991a; Fraser et al., 1985). In coastal British Columbia, however, bald eagles have been known to nest successfully in urban areas, though at lower densities than would be expected in pristine areas. This difference in density was attributed to a loss of nesting trees rather than foraging habitat (Blood and Anweiler, 1994). Nests are generally found within 200 m of aquatic habitats in coastal British Columbia, but some nests were found more than a kilometer away. Nests were rarely located this far from water, however, and this usually only occured where nearshore areas were heavily settled or logged, such as southern Vancouver Island (Blood and Anweiler, 1994). The impacts of these nest locations on breeding success were not discussed.

A study in Oregon showed that nesting failure can result from conspecific breeding pairs nesting within 1.6 km of one another (Anthony et al., 1994). This indicates that any disturbance or habitat alterations that force bald eagles to nest close to other eagles could affect nesting success.

Food supply is often as important as nesting habitat when managing for this species (Dzus and Gerrard, 1993) and in some cases can be the key factor limiting breeding success (Elliot et al., 1998). Prey consists largely of fish (especially salmon), but bald eagles also eat small mammals (especially rabbits), waterfowl and carrion (Ehrlich et al., 1988). Roosting trees are also important to bald eagles. These trees tend to be larger in diameter with greater canopy cover than normal trees. Summer roost trees are generally more accessible than winter sites and usually protrude above the canopy with a more northerly exposure (Buehler et al, 1991b). Winter perches tend to be protected from cold winter winds (Buehler et al., 1991b; Steenhoff et al., 1980

No bald eagle nests are known to exist on the AFRF, but the possibility of bald eagles breeding on the forest does exist, particularly adjacent to the larger fish bearing lakes and streams. There are no lakes located in the Knife Creek block, but there are eight lakes in the Gavin Lake block classified as L1 lakes. According to the 1999-2003 Forest Development Plan for Gavin Lake, L1 lakes have a 10 m riparian reserve zone, and a 200 m riparian management zone under direction received from the District Manager (Day, 1998). Assuming that large trees are retained within the 210 m riparian management area, then sufficient nesting habitat should be retained. Aspen and cottonwood are particularly important nesting trees in the B.C. interior (Blood and Anweiler, 1994), so should be conserved in these areas.

Buffers should be placed around any bald eagle nests that are found in the AFRF. Bald eagles seldom breed in developed areas or where human activity is high (Buehler et al, 1991), but it has been suggested that 500 m buffer zones should be adequate for most intrusive human behaviour (Fraser et al., 1985). It is reasonable to assume, however, that activities such as roadbuilding, harvesting and hauling would create more noise and disturbance. In such cases a 1000 m buffer would likely be more appropriate during the breeding season around an active nest, as recommended in the literature for the prairie falcon.

5. Red-tailed Hawk

The red-tailed hawk is listed as “not at risk” by COSEWIC (1999), and is not on the provincial rare vertebrate tracking list (BCCDC 1999). Red-tailed hawks are, in fact, the most common Buteo in North America. According to Kirk and Hyslop (1998), the increasing red-tailed hawk population in Canada may be linked to deforestation and agricultural intensification. The red-tailed hawk is commonly sighted on

blocks of the research forest throughout most of the year, but is less likely to be present during the winter months (RIC, 1996; Stevens, 1995; Campbell et al., 1990).

Red-tailed hawks build platform nests, generally in the crotch of large trees; deciduous trees are preferred, but conifers are acceptable. Nests may also be built on cliffs, or built using abandoned golden eagle or common raven nests as a base (Ehrlich et al., 1988; Harrison, 1979). Red-tailed hawks will generally have several perennial nests which are used alternately (Ehrlich et al., 1988).

The habitat of red-tailed hawks is highly variable. Woodlands with nearby open land is preferred, but open country with scattered trees, desert, plains and prairie groves may all be utilized (Ehrlich et al., 1988; Scott, 1987). Red-tailed hawks are poorly adapted to hunting in flight, and the presence of dispersed perches throughout their feeding territory enables them to forage more effectively. Fewer perches are needed, however, where topographic relief produces declivity currents, which provide favourable conditions for aerial foraging (Janes, 1984; Preston, 1990). The prey of red-tailed hawks consists primarily of small mammals, particularly rodents which make up more than 85 % of their diet. Birds, reptiles, amphibians, insects, crayfish, fish and offal may also be eaten (Ehrlich et al., 1988). The stability and distribution of red-tail populations has been linked to the abundance of prey, but generally this effect is secondary to the availability of perches which allow efficient foraging (Janes, 1984; Preston, 1990).

There are two suspected red-tailed hawk nests present on the AFRF, one in Knife Creek and one in Gavin Lake, neither of which were active in 1999. Both of these nests are in aspen trees adjacent to young even-aged stands. Since red-tailed hawks prefer to hunt in open areas, but require trees for nesting and perching, even-aged management, particularly clearcutting, appears to provide excellent habitat. However, because of their reliance on perches to take advantage of foraging habitat, extensive clearcuts without reserves would be under-utilized. The ideal treatment for this species would be clearcut with reserves. Current regulations requiring a maximum distance of 500 m between wildlife tree patches should serve to enhance the utilization of clearcut areas.

Where large clearcuts are not appropriate, patch cuts or group selection shelterwoods may provide adequate foraging area. It is not clear, however, what minimum opening size, or degree of opening is required for red-tailed hawks to forage effectively. In areas where the patchwork of woodland and open areas favoured by red-tails is replaced by unbroken woodland, populations are expected to decline (Preston and Beane, 1993). The portions of the AFRF under uneven-aged management are not likely, therefore, to provide long-term habitat for the red-tailed hawk, but since there is no shortage of land under even-aged management at the landscape level, this is not currently a concern.

Where possible, active red-tailed hawks should be given the same buffers as suggested for other species: 500 m for low-level disturbances and 1000 m for high-level disturbance during breeding season. Several red-tailed hawk nests have been noted in the area of the research forest that are close to highways and busy mainlines. It is possible, therefore, that red-tails are able to tolerate a certain amount of disturbance. Without knowing the success of such nests compared to those in more isolated locations, however, such an observation is not conclusive.

6. Cooper's Hawk / Sharp-shinned Hawk

Neither the Cooper's hawk nor the sharp-shinned hawk are listed by COSEWIC (1999) or the provincial rare vertebrate tracking list (BCCDC 1999). Both of these species may nest in coniferous or deciduous trees, but Cooper's hawks tend to prefer deciduous trees, while sharp-shinned hawk nests are usually found in coniferous trees. Most sharp-shinned hawks prefer to build a new nest annually, but will sometimes repair an old one (Ehrlich et al., 1988). Cooper's hawks will occasionally use old crow nests (Ehrlich et al., 1988; Harrison, 1979).

Sharp-shinned hawks are found in mixed woodlands and are usually fairly common over much of their range, while Cooper's hawks prefer broken woodlands or streamside groves, especially when composed of deciduous trees (Ehrlich et al, 1988; Scott, 1987). Cooper's hawks show a preference for riparian areas (Ehrlich et al., 1988; Grant et al., 1991). A study in Oregon, however, indicated that both species showed a preference for even-aged, second growth stands. Sharp-shinned hawks tended to favour dense younger stands, 40 to 60 years old, while Cooper's hawks preferred 50 to 80 year old stands (Reynolds et al., 1982). In both species, young remain dependent on adults for many days post-fledging (Ehrlich et al., 1988).

The Cooper's hawk diet consists primarily of birds and small mammals, but reptiles and amphibians may also be consumed (Ehrlich et al., 1988). In Oregon it was found that Cooper's hawks foraged within 100 m of the nest tree during breeding season and that most adult activity prior to fledging was concentrated upslope of the nest (Reynolds et al., 1982). The sharp-shinned hawk's diet consists primarily of birds, but they will occasionally take small mammals, frogs, lizards or insects (Ehrlich et al., 1988; Scott, 1987). In Oregon, breeding adults were found to concentrate their foraging activities within 50 m of the nest, usually upslope from it (Reynolds et al., 1982).

The sharp-shinned hawk and the Cooper's hawk have similar requirements to the goshawk in that they prefer forests with closed canopies and open understories. They do not necessarily require large trees as the northern goshawk does, and have been known to breed successfully in a variety of habitats including younger, denser second growth stands. There are no known sharp-shinned or Cooper's hawk nests on the

forest, but they could be difficult to see in a dense canopy. If active nests are found, steps should be taken to protect the area immediately surrounding the nest during that year, including the 50 and 100 m upslope areas for the sharp-shinned hawk and cooper's hawk respectively. Harvesting should not be conducted adjacent to these nests during the breeding season.

Since these species do not show a strong fidelity to nesting sites from year to year (Ehrlich et al, 1988), landscape level management should be adequate to meet their habitat needs. In areas under even-aged management, tracts of dense second growth should exist at any given time if the age class structure is balanced. This should ensure that some adequate habitat is retained. As well, preservation of riparian areas will provide preferred habitat for the Cooper's hawk. Uneven-aged management, assuming crown cover is not extensively reduced, should also provide adequate habitat.

7. Osprey

The osprey is not listed by COSEWIC (1999), and it is not a listed species in British Columbia (RIC, 1996; Stevens, 1995). The osprey does not overwinter locally (Campbell et al., 1990; RIC, 1996), but is otherwise common in habitats present on the both blocks of the AFRF (Stevens, 1995).

Osprey usually build their platform nests on coniferous or deciduous trees (dead or alive) near or over water. They are opportunistic nesters, however, and have also been known to build on utility poles, cliffs, aerials, billboards and other unusual locations (Ehrlich et al., 1988; Harrison, 1979). Ospreys may avoid nesting bald eagles, and the relocation of nests by eagles has been known to cause a redistribution of nesting ospreys (Campbell et al., 1990). Osprey breed near fresh or salt water, along rivers, lakes and coasts (Ehrlich et al., 1988; Scott, 1987). The young are subject to piracy by bald eagles (Ehrlich et al., 1988).

The diet of ospreys consists almost exclusively of fish, but occasionally small mammals and birds are also taken (Chubbs and Trimper, 1998, Ehrlich et al., 1988; Scott, 1987). Small mammals and birds are more likely to be taken if fish availability is low, the supply of these alternative food sources is abundant, or if crippled or easily captured prey is available (Chubbs and Trimper, 1998). Reproductive success is often linked to food supply, so foraging success is critical. Prolonged storms, fish kills, murky water, or the lack of skill in young birds may all affect prey availability (Chubbs and Trimper, 1998; Steeger et al., 1992).

There are currently several osprey nests identified on the AFRF, in both the Knife Creek and Gavin Lake blocks. Even though osprey diets consists primarily of fish, their nests on the research forest range between 400 m and 2000 m from the nearest lake. Nesting sites do not appear to be limited on the forest,

but activities should be restricted near active nests during breeding season. The 500 m and 1000 m buffers suggested for other raptors should be more than adequate for ospreys as well.

8. Northern Harrier

The northern harrier is listed as "not at risk" by COSEWIC (1999), and is not a listed species in British Columbia (RIC, 1996; Stevens, 1995). It is most commonly found as a migrant, but may breed on the forest as well, particularly in the Knife Creek block (Campbell et al., 1990; Stevens, 1995).

Northern harriers nest on the ground, in shrubs less than five feet high, or occasionally over shallow water. Nests are flimsy to well-made platforms built with sticks, grass, straw, etc, and loosely lined with fine materials. They tend to be placed on elevated ground or in thick vegetation (Ehrlich et al., 1988; Grant et al., 1991; Harrison, 1979). The harrier inhabits wetlands, marshes, wet meadows, sloughs, prairie or savannah (Ehrlich et al., 1988; Grant et al., 1991; Preston, 1990; Scott, 1987).

Northern harrier distribution is generally a response to prey biomass availability, which is a function of both rodent abundance and amount of cover. Hunting success is often lower where dense vegetation provides cover for prey. Distribution is not as closely related to perch availability as it is in the red-tailed hawk (Preston, 1990). The diet of the northern harrier consists primarily of small mammals (especially voles), birds, snakes, frogs, insects (especially grasshoppers) and carrion (Ehrlich et al., 1988; Scott, 1987). Harrier abundance has been found to track the density of microtine prey (Grant et al., 1991).

The preferred habitat of the northern harrier generally does not grow timber, so its conservation is rarely in conflict with other timber management objectives. The greatest threats to this species are destruction of freshwater and estuarine wetlands, conversion of grasslands to monotypic farming and over-grazing. The most important threats to harrier nests include mechanized agriculture, haying near nests and trampling by cattle (MacWhirter and Bildstein, 1996).

With respect to forest management, the two main considerations for this species are conducting activities near active nests and perch availability. Harriers do not commonly breed in the research forest, so it should not be necessary to avoid activities near all wetlands. No harrier nests have been identified on the forest, but they may be present. Because their nests are built on the ground, they are much less visible. If mature individuals were seen in breeding habitat during mating season, however, it would be prudent to look for a nest or assume one is present, and establish a buffer around the nest or wetland area.

Harriers do not rely on perches for successful foraging to the same degree as red-tailed hawks, but they will utilize them. Where nests are known or suspected, steps should be taken to ensure that some perches are

available, whether they are trees, old snags or fenceposts. Riparian management areas or wildlife tree patches located adjacent to the wetland should provide adequate perching and protection of wetland habitat.

9. Golden Eagle

The golden eagle is listed as "not at risk" by COSEWIC (1999), and is not a listed species in British Columbia (RIC, 1996; Stevens, 1995). Golden eagles build platform nests, generally in commanding positions on rocky cliffs or in trees. Most nests in B.C. are located on cliff ledges, bluffs and pinnacles, with only 27% found in trees (Campbell et al., 1990). Nests are perennial, but birds often build two or more nests and use them alternately. New nests may be quite small, but are added to year after year to eventually become quite large and bulky (Ehrlich et al., 1988; Harrison, 1979).

The golden eagle prefers open country, especially in mountainous or hilly terrain (Ehrlich et al., 1988; Scott, 1987). Home ranges tend to be very large, but individuals usually have a smaller core area which they frequent. These core areas often consist of preferred foraging habitat, though there is some variation between individuals, and tend to be smaller during breeding season than non-breeding season (Marzluff et al., 1997). Small mammals, especially jackrabbits, are the preferred prey, but other food sources such as carrion, birds, reptiles and insects may be utilized when mammals are scarce (Ehrlich et al., 1988; Marzluff et al., 1997)).

Since cliffs or other rocky outcrops are scarce in the Alex Fraser Research Forest, it is unlikely that golden eagles will nest there. However, since some pairs have been known to build nests in trees, it is possible that this species could breed on the forest. No known golden eagle nests have been found, but should one be identified, a buffer zone should be established around the active nest during breeding season. Like red-tailed hawks, golden eagles prefer hunting in open terrain, so clearcuts probably provide better habitat than closed-canopy forest management systems. Golden eagle populations are often strongly linked to prey availability, particularly that of lagomorphs, so any condition that affects this will affect golden eagles.

10. Merlin

The merlin is listed as "not at risk" by COSEWIC (1999), and is not a listed species in British Columbia (RIC, 1996; Stevens, 1995). Merlins will nest in a variety of habitats, including open woodland, savannah and occasionally urban areas. They will often use abandoned nests of crows, magpies and hawks as a base, but may also use natural tree cavities with a commanding view, cliffs or (rarely) a scrape on the ground in treeless country. Merlins will often return to the same area each year to breed (Ehrlich et al., 1988; Harrison, 1979; Little, 1995). Merlins are widely distributed in B.C., and can be found in almost any type

of country (Campbell et al., 1990). Birds compose more than 90% of the merlin's diet, but they may also eat small mammals and insects (Ehrlich et al., 1988; Scott, 1987).

Merlin nests are very difficult to identify since a variety of nesting sites can be utilized. Because of the apparent robustness of their ability to utilize nesting and foraging sites, forest management likely has little impact on this species. Presumably tracts of mature forests, wildlife tree patches and riparian areas would provide suitable nesting sites if required. Any corvid or abandoned hawk nests should be incorporated into wildlife tree patches to provide potential nesting sites.

11. American Kestrel

The American kestrel is not listed by COSEWIC (1999), and is not a listed species in British Columbia (RIC, 1996; Stevens, 1995). American kestrels are cavity nesters. For the most part they use natural tree cavities or old woodpecker holes, but will also use man-made nest boxes and building eaves (Ehrlich et al., 1988; Harrison, 1979). The American kestrel prefers open or partly open habitats with scattered trees, and is often found in cultivated and urban areas (Ehrlich et al., 1988; Scott, 1987).

Like the Eurasian kestrel, the American Kestrel will hunt from perches as well as from hovering flight. The choice of method often depends upon wind speed, since greater wind speed makes hovering more efficient (Ehrlich et al., 1988; Village, 1983). Other factors that may influence foraging technique selection are prey density and food requirements. Eurasian kestrels were found to be more likely to use the less energy efficient but more effective hovering method when prey densities were higher or during breeding season when nutritional demands were higher (Village, 1983). The diet of the American kestrel consists primarily of insects, reptiles and small mammals, but they will also eat small birds, chiefly in winter (Ehrlich et al., 1988; Scott, 1987). American kestrel abundance may be correlated with prey abundance in some habitats (Grant et al., 1991).

Since they prefer to forage in open habitat, American kestrel nests are probably located close to these areas. Cavity nests are difficult to find, but wildlife tree patches that include snags and hollow trees should provide nesting habitat for kestrels, as well as other species. This would be especially important in forested areas adjacent to farmland or other large openings.

CONCLUSION

There are 15 species of raptors found in the Cariboo Forest Region, 12 of which are known to breed there. In order to manage for these species, it is essential to understand their status, distribution and habitat

requirements. It is also necessary to clearly understand other management objectives and regulations relevant to the habitat in question. Although there are some guidelines for raptor management that can be applied at a regional level, effective planning and management should be done at a smaller scale.

The UBC / Alex Fraser Research Forest was used to provide an example of raptor management strategies in a defined area of forest. The 9000 ha of the AFRF includes a diversity of ecological areas and habitat features. The recommendations provided here were specific to the habitat and management objectives of the research forest, but the general approach and many of the species-specific recommendations could be applied throughout the Cariboo region.

GLOSSARY OF TERMS

***Aerial pursuit*:** Chases and catches birds in midair, stoops, or snatches them from their perches

***AFRF*:** UBC / Alex Fraser Research Forest

***Blue List*:** Includes any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened.

***COSEWIC*:** Committee on the Status of Endangered Wildlife in Canada

***CAB*:** Cariboo Basin ecosection

***CAP*:** Cariboo Plateau ecosection

***CEI*:** Central Interior ecoprovince

Corvid: Birds of the family Corvidae, including ravens, crows, magpies and jays.

Declivity Currents: Air currents associated with slopes.

***Diurnal*:** Conducts most activities during the day. Opposite of nocturnal.

Ecoprovince: A region of British Columbia delineated according to broad ecological characteristics. For example, the Coast and Mountains, Central Interior and Southern Interior Mountains are among the ecoprovinces of B.C.

Ecosection: Ecoprovinces are further divided into smaller ecological regions called ecosections. For example, the Bulkley Ranges, Central Chilcotin Ranges, Western Chilcotin Ranges, Bulkley Basin, Cariboo Basin, Cariboo Plateau, Chilcotin Plateau, Fraser River Basin, Nazko Upland, Nechako Upland, Quesnel Lowland and Western Chilcotin Upland are the ecosections of the Central Interior ecoprovince.

***Hawking*:** Sallies from perch on short flights to capture flying insects

***High Diving*:** Drops from height into water, usually to catch fish, but sometimes to take waterfowl or other prey.

***High Patrol*:** Soars at high altitude in search of carrion or prey

***Hovering (and Pouncing)*:** Hovering before swooping or dropping down on prey

***Lagomorphs*:** Rabbits, hares, bunny wabbits etc.

***Low Patrol*:** Seeks prey in low searching flight

***Microtine*:** Rodents, particularly voles

***Passerines*:** Songbirds

***QUH*:** Quesnel Highlands ecosection

***Raptors*:** Birds of prey, usually referring to diurnal hunters, but often including the owls.

***Red List*:** Includes any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Red-listed taxa include those that have been, or are being, evaluated for these designations.

***SIM*:** Southern Interior Mountains ecoprovince

***Stoops / stooping*:** Drops on flying birds from above, killing them in midair with a blow from the talons

***Swooping*:** Snatches up prey from ground in talons after gliding descent from perch with wings spread

***Yellow List*:** Any indigenous species or subspecies (taxa) which is not at risk in British Columbia. The CDC tracks some Yellow listed taxa that are vulnerable during times of seasonal concentration (eg breeding colonies).

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