GOSHAWK AND RAPTOR INVENTORY IN THE CARIBOO, 1996

Prepared For:
Province of British Columbia
Ministry of Environment, Lands and Parks
Ste. 400 - 640 Borland Street
Williams Lake, B.C.
V2G 4TI

Prepared By:

_____date_____
Thomas Bosakowski, Ph.D., Principal Investigator
Beak Consultants Incorporated
12931 NE 126th Place
Kirkland, Washington 98034

_____date_____
John Rithaler, Project Manager
Beak Pacific Limited
Suite 720
1140 West Pender Street
Vancouver, B.C. V6E 4G1

April 1997
29900.033

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

1.0 INTRODUCTION 2

2.0 PERSONNEL 3

3.0 STUDY AREA 4

4.0 SUMMARY OF EXISTING INFORMATION 6

5.0 METHODS 7

5.1 Historic Nest Site Visits.....7

5.2 Systematic Call Surveys and Stand Watches.....7

5.3 Habitat Assessment.....8

5.4 Statistical Analysis.....10

6.0 RESULTS 10

6.1 Historic Nest Site Visits.....10

6.2 Broadcast Surveys.....11

6.3 Incidental Sightings 13

6.4 Other Raptors.....13

6.5 Mimick and Prey Species 16

6.6 Nest Site Habitat 16

TABLE OF CONTENTS (Continued)

Page

7.0 DISCUSSION 25

8.0 CRITIQUE OF INVENTORY PROTOCOLS 26

9.0 MANAGEMENT CONCERNS 27

10.0 CONCLUSIONS 30

11.0 LITERATURE CITED 32

APPENDIX A: Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

APPENDIX B: Site attributes for individual raptor nest sites and random sites in the Cariboo.

APPENDIX C: Red and blue listed species observed during the 1996 goshawk and raptor inventory of the Cariboo.

PHOTOS

LIST OF TABLES

Page

Table 1. Northern goshawk survey areas and distribution of survey stations in the Cariboo for 1996. 12

Table 2. Summary of 1996 northern goshawk detections and other incidental raptor sightings. 14

Table 3. Mean site attributes of northern goshawk nest sites and random sites in the Cariboo. Standard deviation given in parentheses. Statistically significant results are highlighted with an asterisk. 17

Table 4. Mean site attributes of northern goshawk nest sites classed according to biogeoclimatic zones in the Cariboo. Standard deviation given in parentheses. Statistically significant results are highlighted with an asterisk. 18

Table 5. Mean site attributes of northern goshawk nest sites classed according to biogeoclimatic zones in the Cariboo. Standard deviation given in parentheses. Statistically significant results ($p<0.05$) are highlighted with an asterisk. 21

Table 6. Forest cover analysis of goshawk nest site locations in the Cariboo at the landscape level of the goshawk home range (2400 ha). 23

Table 7. Forest cover analysis of goshawk nest site locations in the Cariboo at the landscape level of the goshawk post-fledgling family area (240 ha). 24

Table 8. Minimum structural attributes for identifying suitable goshawk nest stands and minimum canopy cover standards to be maintained after thinning in the PFA and foraging areas as recommended by the Goshawk Scientific Committee (Reynolds et al. 1992). 29

LIST OF FIGURES

Page

Figure 1. Map of the study area.....5

Figure 2. Scattergram comparison of total tree densities at goshawk nest sites and random sites.....19

EXECUTIVE SUMMARY

The Ministry of Environment, Lands, and Parks (MoELP) contracted Beak Pacific Limited (Beak) to conduct surveys for the northern goshawk *(Accipiter gentilis)* in the Cariboo Region of British Columbia. Northern goshawk surveys were conducted to: 1) determine occupancy and breeding success at historic nest sites, 2) survey areas in different biogeoclimatic zones within the region for new goshawk nests, and 3) obtain information on the habitat around goshawk nests and nests of other sympatric raptors. The survey was conducted from June 25 to August 6, 1996, with 40 days in the field. Historic nest visits were made at six goshawk nests and only one nest was active (Enterprise). Several other historic "unidentified raptor" nests were searched for, but the nests were not found, nor was there any raptor activity. In addition to historic nest visits, 308 call stations and 7 stand watches were completed. Some of these (134), we conducted around historic nest sites, and goshawk vocalizations were heard at 2 of 5 of the historic nest sites that were inactive. However, extensive searches for new nests were not successful in these areas. The remaining call stations and standwatches were done in new areas, but no goshawks responded. Two new goshawk nests reported by forestry personnel in 1996 were located by Beak biologists and reproduction was verified at these nests. Habitat analysis of nest sites was completed at all 8 known goshawk nests, two Great Grey Owl nests (probably former goshawk nests), one Red-tailed Hawk nest, one Osprey nest, and 20 random forest plots for statistical comparison. During habitat surveys, one adult goshawk was observed about 3 km from a historic nest (Boyer Lake) that did not yield responses during the call survey period. An additional goshawk family was located in a new area, about 8 km from another active goshawk nest (Mackin Creek), but there was not sufficient time to locate the nest. Overall, there were 3 active goshawk nests located in 1996 and an additional goshawk family observed. Goshawks were also detected at 3 of 5 inactive nest sites, showing that the birds had not abandoned their former territories despite the fact that some goshawks may not breed every year. In terms of habitat selection, all goshawk nests were in unmanaged stands, dominated by conifers. The stands selected by goshawks were not unlike available unmanaged stands throughout the region with the strong exception of tree density. Apparently, goshawks have a specific narrow range of tolerance for tree densities (500 to 820 trees per ha) as well as a strong avoidance for dense

saplings. Goshawks nested in dominant trees with larger diameters than the average dbh of the stand, but the nest tree was never the tallest in the plot. Goshawks in the IDF zone nested significantly higher-up in taller, larger diameter trees than goshawks in the SBPS zone, but this was simply a reflection of availability in the zone. Forest cover analysis revealed that the home ranges and PFAs were dominated by late-successional forest cover, mostly lodgepole pine and Douglas-fir. However, there may be some bias in the forest cover data because all nests were found during timber operations which normally target mature and old forest for harvesting. For conservation, goshawk surveys are recommended in all areas of timber sales so that conservative timber-wildlife prescriptions can be applied. A silvicultural option to create goshawk habitat was suggested by thinning overstocked stands (>820 trees/ha) to a more open stand condition (no less than 500 trees per ha) and reducing sapling densities during commercial or pre-commercial thinning.

1.0 INTRODUCTION

The Ministry of Environment, Lands and Parks (MoELP) contracted Beak Pacific Limited (Beak) to conduct surveys for the northern goshawk (*Accipiter gentilis*) in the Cariboo Region of British Columbia. Northern goshawk surveys were conducted to: 1) determine occupancy and breeding success at historic nest sites, 2) survey areas in different biogeoclimatic zones within the region for new goshawk nests, and 3) obtain site attribute information on the habitat around goshawk nests and nests of other sympatric raptors.

2.0 PERSONNEL

Surveys were designed and supervised by Dr. Thomas Bosakowski, and were conducted by Dr. Bosakowski, Frank Lapsansky, and Tim James.

Dr. Thomas Bosakowski has a Ph.D. in Biology and studied the goshawk and other members of the forest raptor community in New Jersey and New York for his dissertation research. He has published over 30 papers on the nesting, roosting, feeding, and habitat ecology of many raptors. He was recently invited to write a chapter in the forthcoming U.S. Forest Service technical report on the goshawk and to critically review all of the other chapters in the document. At Beak Consultants, he is a project manager and has designed and conducted surveys for northern goshawks, eagles, ospreys, breeding birds, and amphibians for the past three years in Washington. In addition, he has developed various GIS habitat suitability models, multivariate statistical models of habitat selection, and designed habitat conservation plans for timber companies.

Frank J. Lapsansky is a raptor biologist with extensive experience in conducting standardized protocol surveys for spotted owls and goshawks. He also has many years of experience radio-tracking, capturing, and banding spotted owls, goshawks, prairie falcons, and eagles in western North America. As a licensed falconer, he has personally trained two goshawks and several red-tailed hawks and is experienced with handling raptors and attaching radio-transmitters. He is also trained in aerial photo interpretation for delineation of suitable spotted owl and marbled murrelet habitat.

Tim Janes is a forester and forest wildlife specialist with extensive GIS training. He has supervised and assisted with numerous field studies in the forest environment, including standardized protocol surveys for spotted owls and goshawks in the Pacific Northwest and collection of vegetation data throughout Canada.

3.0 STUDY AREA

The study was conducted within the Cariboo Region of central British Columbia. More specifically, the study area was limited to the Williams Lake, Chilcotin, 100 Mile House, and Horsefly Forest Districts (Figure 1). This region falls mainly within the Interior Plateau bounded between the Coast Mountains to the west, and the Columbia Mountains and Southern Rockies to the east (Meidinger and Pojar 1991). The Interior Plateau is a region of broad flat terrain and rolling hills. Elevation of the plateau ranges from approximately 700 to 1500 m above mean sea level. Climate is varied across the plateau. Precipitation averages 41 to 46 cm annually from 150 Mile House and Alexis Creek. A pronounced rain shadow produced by the Coast Mountains produces low rainfall and poor site indices for tree growth in the Chilcotin area, while the eastern side of the plateau receives more rainfall and subsequently larger tree growth. Central British Columbia has a moderate winter climate compared to the rest of Canada, because of the mountain ranges on both sides of the province. Early summer may be relatively wet in the plateau, but mid to late summer are often dry and clear because of the dominance of the "Pacific high."

Although the region contains all of the biogeoclimatic (BEC) zones known to British Columbia, it is dominated by three. The Interior Douglas-fir (*Pseudotsuga menziesii*) BEC zone ("IDF") occupies a south-central position in the plateau and may also include lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), spruce (*Picea* spp.), and western redcedar (*Thuja plicata*). The Sub-boreal Pine-Spruce BEC zone ("SBPS") is made up mainly of lodgepole pine and white spruce (*Picea glauca*) and occurs in western and central areas of the plateau. The Sub-boreal Spruce (*Picea* spp.) BEC zone ("SBS"), comprised of Englemann spruce (*P. engelmannii*), white spruce, spruce hybrids, subalpine fir (*Abies lasiocarpa*), and Douglas-fir, occurs in the northern and eastern parts of the region. The SBS appeared to have the densest and tallest forest in the study area, while the SBPS had the most open forests with short stunted tree growth. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are deciduous trees which may occur sporadically or in stringers throughout the IDF and SBS zones.

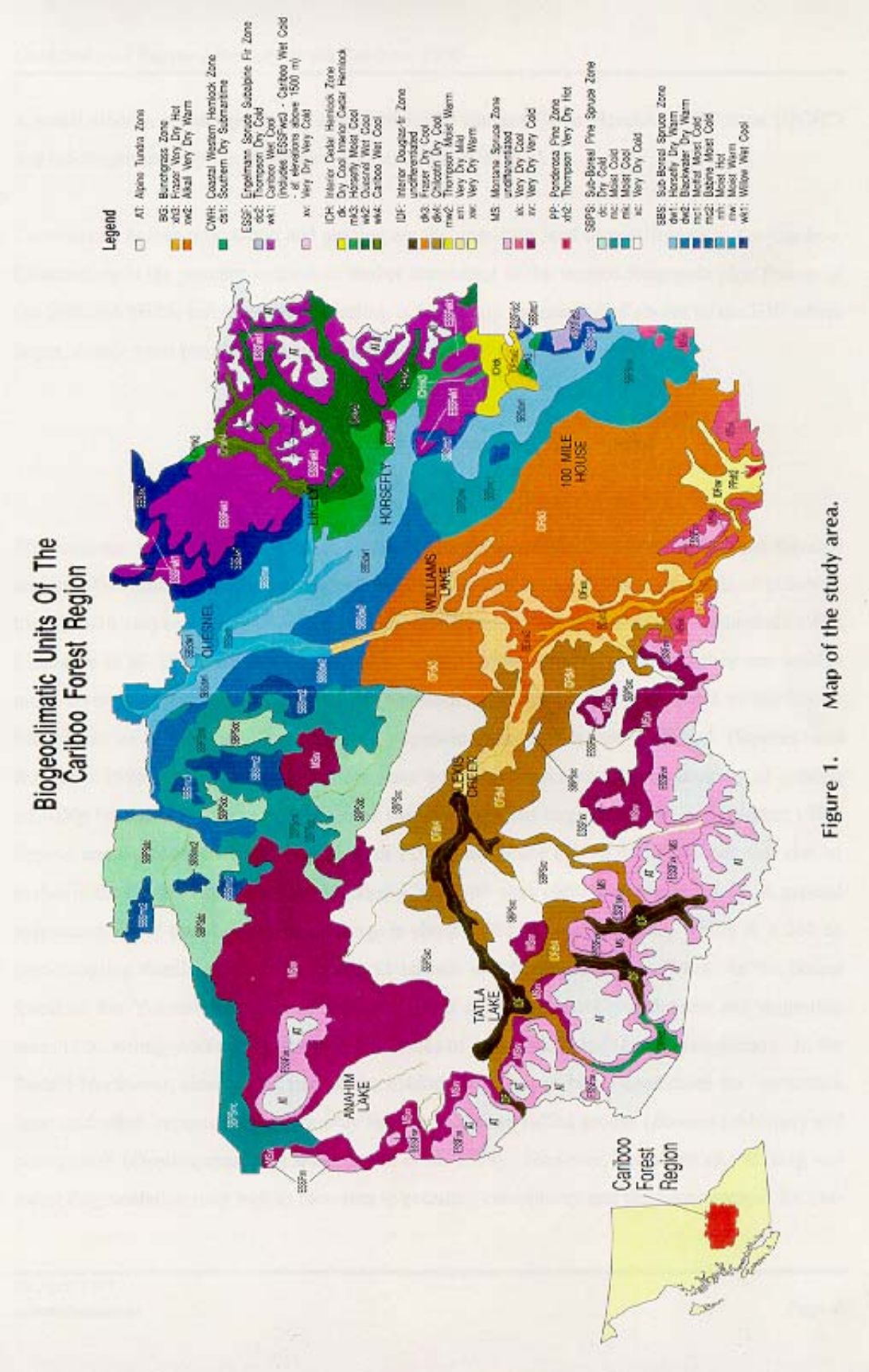


Figure 1. Map of the study area.

A small amount of surveying was also done in the Interior Cedar-Hemlock BEC zone ("ICH") and the Engelmann Spruce-Subalpine Fir BEC zone ("ESSF").

Commercial timber production and grazing are the dominant land uses of forests in the Cariboo. Clearcutting is the primary method of timber harvesting in the stunted lodgepole pine forests of the SBS and SBPS, but selective harvesting is frequently the method of choice in the IDF where larger, denser trees predominate, such as Douglas-fir.

4.0 SUMMARY OF EXISTING INFORMATION

The northern goshawk is a nearctic, forest-dwelling raptor which occurs throughout forested regions of British Columbia (Johnsguard 1990). The nest is usually built in stands of pole-size trees (26-30 cm) or larger with a high degree of canopy closure (Fleming 1987; Marshall 1992; Lilieholm et al. 1993; Squires and Ruggiero 1996). In the Pacific Northwest they can inhabit multi-layered, old-growth conifer stands (Reynolds et al. 1982; Hall 1984), but in the Rocky Mountains of Wyoming, single-storied lodgepole pine stands are preferred (Squires and Ruggiero 1996). The goshawk seldom uses younger, denser stands for hunting or nesting probably because of its large body size and wingspan, and the large size of its nest (Fischer 1986; Speiser and Bosakowski 1987). Hargis et al. (1994) found that habitat in the nest site was similar to that in the home range (telemetry locations), and both were older than random sites. A general approximation of the goshawk home range is about 2,400 ha which includes within it, a 240 ha post-fledgling family area (PFA), and a 12 ha nest site (Reynolds et al. 1992). In the boreal forest of the Yukon Territories (Doyle and Smith 1994), goshawk populations and migration seem to be strongly affected by population cycles of snowshoe hares (*Lepus americana*). In the Pacific Northwest, clearcutting part of the habitat can result in better conditions for snowshoe hare and other important goshawk prey species including ruffed grouse (*Bonasa umbellus*) and blue grouse (*Dendragapus obscurus*) (Irwin et al. 1989). However, excessive clearcutting and forest fragmentation may lead to increases in potential competitors and predators such as the red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) (Crocker-Bedford 1990).

5.0 METHODS

5.1 Historic Nest Site Visits

The first phase of the project was to interview Habitat Protection staff and forestry personnel in order to obtain specific directions to confirmed and unconfirmed nest sites of the goshawk and other raptors. Goshawks often show strong fidelity to their nest sites, breeding in the same "nest area" for up to 8 years (Speiser and Bosakowski 1991). In the southern Cascades of California, Detrich and Woodbridge (1994) reported occupancy of goshawk nest areas from 1 to 7 years (avg. 1.8) in marked females and only 1 to 3 years (avg. 1.3) in marked males. If nests were not occupied in 1996, the nest area was searched for the presence of a new nest or active alternate nest. Woodbridge and Detrich (1994) found that over 85 percent of alternate nests were less than 700 m from each other. If there were still no nests active after initial searches, formal broadcasts surveys were then conducted around the old nest site using 400 m intervals between call stations (RIC Standards 1996).

5.2 Systematic Call Surveys and Stand Watches

In order to effectively survey unknown areas, broadcast surveys (Bosakowski and Vaughn 1996) are an effective, standardized, and repeatable method for determining goshawk presence in a given stand. Survey routes for call stations were established at 480-m intervals throughout suitable goshawk habitat. Call stations were placed on forest roads and old logging trails as much as possible to maximize survey efficiency, but hike-in stations were also included in most areas searched. We used the goshawk wail call for all surveying due to the late start date for the surveys (25 June). On road stations, tapes were broadcast at 110 decibels through the vehicle cassette player to two outdoor powerhorn speakers (40 Watt output maximum). At foot stations, tapes were broadcast by a hand-held megaphone (Musical Powerhorn, Radio Shack, Fort Worth, Texas) wired to a mini-cassette tape player. All other RIC (1996) standards for raptor broadcast surveys were followed.

In addition to call stations, stand watches were conducted in areas with good vistas to observe territorial flight displays and courtship calling (Reynolds 1983). However, because of the late starting date and flat topography throughout much of the study area, this method was not frequently used.

At most stations, a portable GPS unit (Magellan 2000) was used to record the position in the field using UTM coordinates. In a few cases, we were not able to lock-on to three satellites, so no fix was obtained. In a few cases, call stations were done simultaneously by two or more parties and the GPS was not available to record the coordinates of all stations simultaneously. Notes on prey species and mimicking bird species were recorded at each station on the Wildlife Data Form and notes on tree and shrub cover were recorded on the Ecosystem Field Form. Following a goshawk detection, nest searches were initiated within a 200 m radius of the detection (Joy et al. 1994). Raptor nest locations, call stations, and standwatch locations were plotted on TRIM maps using a GIS system.

5.3 Habitat Assessment

Starting in August, all raptor nest sites were re-visited to collect site attribute information on the Ecosystem Field Form and user-defined form for nest habitat. Habitat variables were taken from circular plot samples (15-m radius) centered on the nest tree. All trees (>5 cm) within the plot were measured for diameter with a DBH tape and were identified to species. Heights of the nest and nest tree were taken with a Suunto clinometer. Maximum slope through the nest site was measured with a Suunto clinometer and slope aspect was noted. The presence or absence of canopy cover was noted at 20 points with an ocular sighting tube (James and Shugart 1970). Five points were systematically spaced at 5 m intervals from the nest tree in each of the four cardinal directions. At each point, the presence or absence of shrub/sapling cover within arm's reach was also noted (Collins et al. 1982). Only woody stems greater than 0.5 m in height or less than 5 cm in DBH were considered shrub/sapling cover.

For statistical comparison, 20 random sites were evaluated with the same methods for habitat quantification. Random sites were selected by a stratified random sampling design (Patton 1992). Two or three random sites were systematically located at 3, 6, and occasionally 9 km from all of the known goshawk nest sites. The initial distance of 3 km was selected because it was just beyond the theoretical radius of a goshawk home range (2,400 ha circle), but yet was close enough to serve as an appropriate control (e.g., same BEC Unit). Subsequent random sites were set at the same 3 km interval to retain the same scale of stochasicity which would allow for local variation, while retaining some degree of relatedness to the goshawk territory. Random sites were selected by driving along logging roads in a random direction (determined by a coin flip) away from goshawk nest sites using the vehicle odometer to measure the specified distance. At that point, we flipped a coin to determine the direction of travel, right or left and perpendicular to road, and walked 125 m into the forest using a hip chain to determine the plot center. Since all eight goshawk nests occurred in unmanaged forest, we felt the appropriate control was to select only random sites which occurred in unmanaged forest (i.e., forest without stumps, clearcuts, burns, roads, or powerlines within 125 m). If a site was rejected, we systematically drove at 500 m intervals until an unmanaged forest plot was found.

A forest cover analysis was also performed for all known goshawk nests at spatial scales of the PFA (240 ha) and home range (2,400 ha) as reported in Reynolds et al. (1992). Analysis was performed by plotting goshawk nest coordinates on digital forest cover maps with Beak's GIS system using a radius of 874 m and 2,764 m, respectively.

5.4 Statistical Analysis

Goshawk nest site variables and random site variables were tested for equality of variances with an F-test (two-tailed). If there was no significant difference, a pooled variance Student 's t-test

(two-tailed) was used to compare means. If a significant difference in variance was detected, an unpooled variance Student 's t-test (two-tailed) was applied (Hintze 1992). Multi-variate techniques such as discriminant function analysis and principal components analysis were not used since recent studies have shown that large sample sizes (n>35) are required for reliable results (Morrison 1984). Although multi-variate techniques are sometimes useful in determining which independent variables are better predictors for each group, they are not capable of critical hypothesis-testing between treatment and control groups (Kachigan 1989), and are therefore of little value in decision making for conservation planning.

6.0 RESULTS

6.1 Historic Nest Site Visits

All six previously known goshawk nests in the Cariboo were checked for occupancy. Only the nest at Enterprise (South of Williams Lake) was active, which produced two fledglings. However, two new suspected goshawk nests were reported near Mackin Creek (by MoF forestry personnel) and near Bull Mountain ski trails (by Lignum personnel) during mid-summer of 1996. Beak biologists located the nest sites and verified successful reproduction by goshawks at these nests. At least two young were successfully fledged at each nest, but since the young were already flight able, we could not be certain if additional young were produced. At two of the inactive historic nests (Chasm Park, Boyer Lake), an alternate nest was also present which was formerly used by great grey owls (*Strix nebulosa*), but was undoubtedly built by goshawks (owls do not build nests). However, both of these alternate nests were also inactive in 1996. An additional nest suspected to belong to red-tailed hawks (*Buteo jamaicensis*) was reported by Lignum personnel for the Bull Mountain area in mid-summer of 1996 and Beak biologists verified the nest as an active red-tailed hawk nest with one fledged juvenile and one adult still present. In addition, several other historic "unidentified raptor" nests and red-tailed hawk nests were searched for, but the nests were not found, nor was there any raptor activity during subsequent call surveys in these areas.

6.2 Broadcast Surveys

A total of 315 call stations and standwatches were performed during the study as summarized in Table 1 and shown individually in Appendix A. A total of 134 stations were established around inactive historic nests to determine if goshawks were still nesting in the area. Call stations around historic nest sites revealed goshawk vocalizations at two of the five inactive nest areas (Siwash/Scum Lake, Chasm Park). Chris Schmid (pers. comm.) also reported hearing goshawks near the historic Scum Lake nest during spring of 1996, but he was also unable to find a new nest. Subsequent intensive nest searching by Beak biologists failed to reveal a new nest at either location.

At one historic goshawk nest site (Hart Lake 8300 Rd.), an active osprey (*Pandion haliaetus*) nest was found 800 m from the historic goshawk nest during formal broadcast surveys of the goshawk nesting territory.

In addition to searching historic nest sites, 181 survey stations were established in new areas of suitable goshawk habitat in several different BEC zones. No goshawk responses were obtained at these stations.

Table 1. Northern goshawk survey areas and distribution of survey stations in the Cariboo for 1996.

SURVEY SITE	# OF STATIONS	FOREST DISTRICT	BIOGEOCLIMATIC ZONES
Big Lake, 1100 Rd., 100 Mile House	20	100 Mile House	IDF
Chasm Provincial Park	29	100 Mile House	IDF

Boyer Lake, Bonaparte Lake	19	100 Mile House	SBPS
Green Lake, Chasm P.P. Area	5	100 Mile House	IDF
Big Lake, 3400 Rd., 100 Mile House	19	100 Mile House	IDF
Hendrix Lake, 550 B7, 410 Rd., 620 Rd., 260 Rd., Canim Lake	41	100 Mile House, Horsefly	ESSF, ICH
Hart Lake, 8300 Rd., Beedy Creek	19	Williams Lake	ICH, SBS
Jacobie Lake, 2600 Rd., Jacobie L. Rd., Likely Area	50	Horsefly	ICH, SBS
Tatla Lake, 980 Rd.	27	Chilcotin	SBPS
Siwash, Scum Lake-Chilko River	20	Chilcotin	SBPS, IDF
Chilcotin River, 4200 Rd.	20	Chilcotin	IDF
Puntzi Lake, Bush Rd., Chilanko Forks	16	Chilcotin	SBPS, IDF
Mosley Creek, Bluff Lake	30	Chilcotin	IDF

6.3 Incidental Sightings

Incidental sightings of goshawks were rare during the study (Table 2) and occurred only during the habitat analysis fieldwork in August. One adult goshawk was observed flying swiftly across a logging road, about 3 km from the Boyer Lake nest site which was inactive (BOY022). An adult goshawk and young-of-the-year juvenile (MAC099) were flushed from a logging road (possibly dusting) about 8 km from the Mackin Creek nest (MAC001) which represents another successful nesting pair. A 2 hour search revealed another juvenile, but the nest was not found.

Another adult goshawk was also observed sitting on a logging road later the same day about 5 km away (MAC098).

6.4 Other Raptors

Observations of other raptors occurred incidental to the goshawk surveys (Table 2). Red-tailed hawks and bald eagles (*Haliaeetus leucocephalus*) were the most commonly encountered at survey stations. Cooper's hawks (*Accipiter cooperii*) were detected at two stations. Single observations of American kestrels (*Falco sparverius*) were made at two stations, but they were numerous along highways. A single adult broad-winged hawk flew-in to the goshawk call and it was shortly joined by an adult red-tailed hawk as they proceeded to soar overhead. One sharp-shinned hawk (*Accipiter striatus*) reacted vocally to the goshawk call and continued to chant excitedly which was probably an indication of a nearby nest.

Brief nest searches (1-2 hours) were conducted near detections of the one sharp-shinned hawk (JAL015), two Cooper's hawks (JAL041, RAN020), and the broad-winged and red-tailed hawks (JAL002), but active nests were not found. Two active bald eagle nests and two inactive unidentified (eagle or osprey) nests were observed from roads. These nests were not found in goshawk habitat, and therefore, habitat was not analyzed.

Table 2. Summary of 1996 northern goshawk detections and other incidental raptor sightings (UTM coordinates are given in Appendix A).

SITE NO.	LOCATION	SPECIES	BEC ZONE	SUB ZONE	BROAD HABITAT CLASS
MAC001	Mackin Creek	Active goshawk nest, 2 young seen	IDF	dk3	mature forest
GOS002	Bull Mtn.	Active goshawk nest, at least 2 young heard	IDF	dk3	mature forest
GOS004	Enterprise Rd.	Active goshawk nest, 2 young seen	IDF	dk3	mature forest

RTH001	Bull Mtn.	Active red-tailed hawk nest, one adult, one juvenile seen	IDF	dk3	mature forest/ powerline
HAL014	Hart L. 8300 Rd.	Active osprey nest, 2 adults and one juvenile	SBS	dw1	wet meadow/ forest edge
RAN020	Mackin Creek	Cooper's Hawk juveniles protesting	IDF	dk3	mature forest
BIG020	Big Lake 1100 Rd.	American kestrel seen	IDF	dk3	mature forest
HEL015	Hendrix Lake	Red-tailed hawk seen	ESSF	wc3	mature forest
CHA008	Chasm Provincial Park	Merlin seen	IDF	dk3	mature forest
CHA035	Chasm Provincial Park	Goshawk wail calls heard near historic nest, no new nest found	IDF	dk3	mature forest
BOY022	Boyer Lake, Chasm	Adult goshawk flew across road about 3 km from historic nest	SBPS	mk	mature forest
HAL026	Hart Lake - 8300 Rd.	Active bald eagle nest	SBS	dw1	lakeshore/ meadow
JAL001	Jacobie Lake	Osprey seen	ICH	mk2	lakeshore
JAL002	Jacobie Lake	Adult broad-winged hawk seen, adult red-tailed hawk seen	SBS	dw1	mature forest
JAL015	Jacobie Lake	Sharp-shinned hawk protesting, osprey protesting	ICH	mk2	mature forest

Table 2. Summary of 1996 northern goshawk detections and other incidental raptor sightings (Continued).

SITE NO.	LOCATION	SPECIES	BEC ZONE	SUB ZONE	BROAD HABITAT CLASS
JAL020	Jacobie Lake	Unidentified raptor seen	ICH	mk2	mature forest/ clearcut
JAL041	Jacobie Lake	Cooper's hawk flew across road	SBS	mw	mature forest
JAL048	Jacobie Lake	Juvenile red-tailed hawk seen	SBS	mw	highway clearcut

GRL001	Green Lake	Unidentified Accipiter seen	IDF	dk3	mature forest
SIW002	Siwash, Scum Lake	Goshawk wail calls heard near historic nest, no new nest found	SBPS	xc	mature forest
BUS001	Puntzi Lake, Bush Rd.	Active bald eagle nest	SPBS	xc	lakeshore
MOS011	Mosley Creek, Bluff Lake	Bald eagle seen	IDF	unc	mature forest
MOS015	Mosley Creek, Bluff Lake	Red-tailed hawk seen	IDF	unc	mature forest
MOS024	Mosley Creek, Bluff Lake	Bald eagle seen	IDF	unc	mature forest
CLI001	Big Lake, Clinton	Bald eagle seen	IDF	dk3	mature forest
CLI006	Big Lake, Clinton	Red-tailed hawk seen, American kestrel seen	IDF	xw	mature forest
MAC098	Mackin Creek	Goshawk sitting on road (dusting?)	IDF	dk3	mature forest
MAC099	Mackin Creek	Adult goshawk and juvenile sitting on road (dusting?)	IDF	dk3	mature forest

6.5 Mimick and Prey Species

Vocalizations from mimick species (mainly Gray Jay and Stellar's Jay) in response to goshawk broadcasts were rare (only 7 cases listed in Appendix A), and were not usually difficult to discern from actual goshawk responses.

An unidentified shorebird was also heard making a call which sounded similar to the goshawk alarm call (from a distance). Potential prey species were recorded at survey stations and are summarized in Table 3. Red squirrels were the most numerous species, followed by American robin, Swainson's thrush, gray jay, varied thrush, and northern flicker.

6.6 Nest Site Habitat

The habitat of eight goshawk nest sites and 20 random sites are summarized in Table 4 and individual data for each site are presented in Appendix B. All of the eight goshawk nests were situated in unmanaged stands dominated by conifers. Timber harvesting was in evidence near 7 of 8 nest sites, but in all cases, evidence indicated that the nest sites existed before any harvesting or road building had occurred. The elevation of nest sites ranged from 920 to 1,200 m.

Stand Structure. -- In comparing variation of structural attributes within nest stands to available forest (random sites) there were three significant variables as determined by F-tests, i.e., nest stands displayed a significantly narrower standard deviation for total tree density, live tree density (no snags included), and sapling density (Table 4; Figure 2). In comparing means of structural attributes of nest stands to available forest (random sites) there was only one significant variable as determined by t-tests, i.e., sapling densities were significantly lower in nest sites (Table 4). All other stand structural attributes were not significantly different from available unmanaged stands, including: canopy height, canopy cover (%), shrub/sapling cover (%), total basal area, and quadratic mean diameter (qDBH).

Table 3. Potential prey species of the northern goshawk recorded at survey stations in the Cariboo.

SPECIES	NUMBER OBSERVED
MAMMALS	
Red Squirrel (*Tamiasciurus hudsonicus*)	130
Columbian Ground Squirrel (*Citellus columbianus*)	1
BIRDS	
American Robin (*Turdus migratorius*)	75
Swainson's Thrush (*Catharus ustatus*)	34
Gray Jay (*Perisoreus candensis*)	29

Varied Thrush (*Ixoreus naevius*)	12
Northern Flicker (*Colaptes auratus*)	7
Steller's Jay (*Cyanocitta stelleri*)	4
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	3
Common Snipe (*Gallingo gallingo*)	2
Common Crow (*Corvus brachyrhynchos*)	2
Killdeer (*Charadrius montanus*)	2
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	2
Common Nighthawk (*Chordeiles minor*)	1
Black-backed Woodpecker (*Picoides arcticus*)	1
Three-toed Woodpecker (*Picoides tridactylus*)	1
Western Tanager (*Piranga ludoviciana*)	1
Ruffed Grouse (*Bonasa umbellus*)	1
Hairy Woodpecker (*Picoides villosus*)	1
Hermit Thrush (*Catharus guttatus*)	1
Black-headed Grosbeak (*Pheucticus melanocephalus*)	1
TOTAL	311

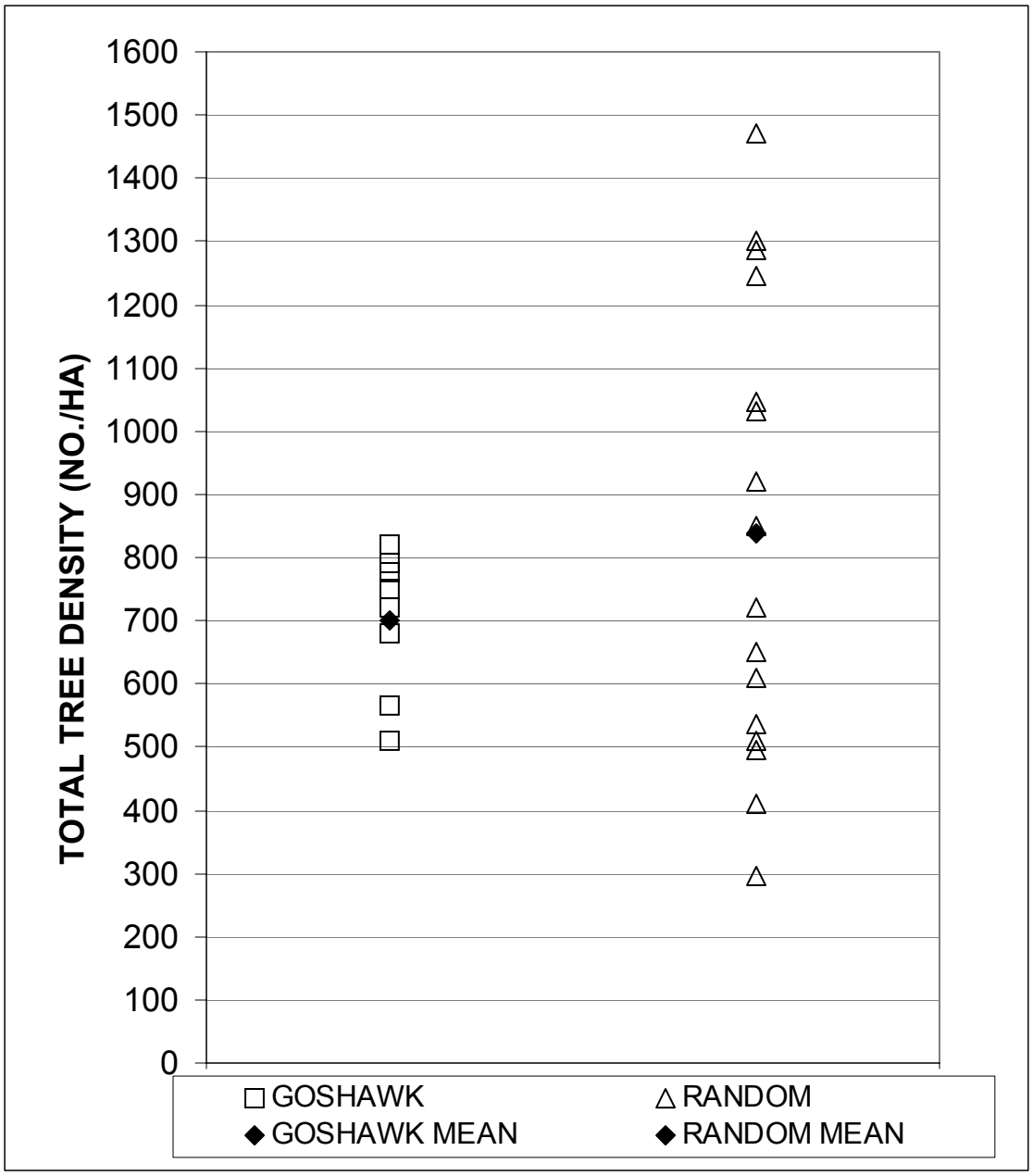
Table 4. Mean site attributes of northern goshawk nest sites and random sites in the Cariboo. Standard deviation given in parentheses. Statistically significant results ($p < 0.05$) are highlighted with an asterisk.

VARIABLE	NEST SITES	RANDOM SITES	T-TEST P-VALUE	F-TEST P-VALUE
Sample size	8	20	-	-
Nest Height (m)	12.3 (4.27)	-	-	-
Nest Tree Height (m)	20.9 (5.11)	-	-	-
Nest Tree DBH (cm)	35.5 (12.9)	-	-	-

Canopy Height (m)	23.8 (6.66)	22.3 (6.03)	0.592	0.758
Canopy Cover (%)	51.9 (20.3)	57.8 (19.2)	0.478	0.852
Shrub Cover (%)	47.5 (21.0)	49.5 (21.9)	0.827	0.904
Basal Area (m^2/ha)	35.5 (18.7)	30.9 (12.0)	0.444	0.172
Mean qDBH (cm)	22.8 (7.41)	22.2 (7.20)	0.859	0.929
Total Trees (no./ha)	701 (111)	838 (350)	0.293	0.002*
Live Trees (no./ha)	585 (157)	752 (317)	0.170	0.040*
Saplings [1] (no./ha)	118.5 (79.3)	360.8 (291)	0.002*	0.000*
Snags (no./ha)	99.0 (137)	77.1 (110)	0.662	0.492
Douglas-fir (no./ha)	207 (291)	252 (311)	0.729	0.833
Lodgepole Pine (no./ha)	334 (255)	386 (345)	0.704	0.354
White spruce (no./ha)	24.8 (34.4)	80.6 (175)	0.186	0.000*
Aspen (no./ha)	14.1 (29.3)	32.5 (69.2)	0.332	0.015*
Paper Birch (no./ha)	1.76 (4.99)	1.41 (4.34)	0.854	0.666
Elevation (m)	1040 (96.2)	-	-	-

[1] included all trees from 5-9 cm in diameter (dbh), all other densities were calculated with trees 10 cm or greater.

Figure 2. Scattergram comparison of total tree densities at goshawk nest sites and random sites.



Species composition. -- Only five tree species occurred in nest site plots. Stand composition ranged from completely monotypic stands of lodgepole pine to stands heavily dominated by Douglas-fir (Appendix A). White spruce and aspen comprised a minor portion of most nest sites, and paper birch was recorded only once. Nest stands displayed a significantly narrower

range for white spruce and aspen density (Table 4), probably because no nest site was dominated by either of these species as were some of the random sites. Snag density, Douglas-fir density, lodgepole pine density, and paper birch density did not differ between nest sites and random sites. High snag densities occurred at some of the nest sites and random sites, apparently resulting from pine beetle infestation (Chris Schmid, pers. comm.).

Nest trees. -- Nests tended to be built in larger diameter trees (mean DBH = 35.5 cm) of the stands which averaged only 22.8 cm qDBH, but the nest tree was never the tallest tree in the plot sample. Accordingly, nest tree height (20.9 m) averaged less than average canopy height (23.8 m) of the nest site plots. Goshawk nest trees were more often conifers (3 Douglas-fir, 3 lodgepole pine), but some were aspens (2).

Biogeoclimatic Zone comparison. -- Goshawk nests were found in only three BEC units in the Cariboo: IDF, SBPS, and SBS zones (Table 5). Sample sizes were large enough for statistical testing between only two of the zones: IDF and SBPS. Goshawks in the IDF nested significantly higher-up in taller, larger diameter trees than goshawks in the SBPS. Canopy height, mean diameter (qDBH), canopy cover, and shrub cover were also higher in the IDF. Elevation of nest sites in the IDF was significantly lower than the SBPS. Douglas-fir and white spruce densities were zero in the SBPS causing a significant F-test result in each case, but aspen density was significantly higher in the SBPS.

Table 5. Mean site attributes of northern goshawk nest sites classed according to biogeoclimatic zones in the Cariboo. Standard deviation given in parentheses. Statistically significant results ($p < 0.05$) are highlighted with an asterisk.

	BEC UNIT			F-TEST	F-TEST
	SBS	IDF	SBPS	P-VALUE	P-VALUE

Sample size	1	4	3	-	-
Nest Height (m)	8.3	15.6 (3.31)	9.30 (2.18)	0.038*	0.563
Nest Tree Height (m)	26.3	23.4 (2.16)	15.8 (4.13)	0.023*	0.381
Nest Tree DBH (cm)	56	39.2 (9.03)	23.7 (3.51)	0.039*	0.214
Canopy Height (m)	32.4	26.2 (4.54)	17.5 (4.04)	0.045*	0.872
Canopy Cover (%)	70	61.2 (18.0)	33.3 (10.4)	0.064	0.455
Shrub Cover (%)	40	62.5 (11.9)	30.0 (20.0)	0.042*	0.477
Basal Area (m^2/ha)	68.3	37.5 (15.5)	21.9 (6.90)	0.171	0.282
Mean qDBH (cm)	33.1	25.8 (3.22)	15.2 (4.25)	0.012*	0.699
Total Trees (no./ha)	778	636 (117)	764 (578)	0.164	0.537
Live Trees (no./ha)	736	587 (94)	533 (241)	0.692	0.213
Saplings [1] (no./ha)	198	113 (83)	99 (88)	0.837	0.934
Snags (no./ha)	42.4	49.4 (29)	184 (217)	0.263	0.022
Douglas-fir (no./ha)	693	240 (273)	0	0.197	0.000*
Lodgepole Pine (no./ha)	0	293 (224)	500 (230)	0.286	0.971
White spruce (no./ha)	28	42.4 (41.7)	0	0.146	0.000*
Aspen (no./ha)	0	3.5 (7.0)	33 (45.5)	0.246	0.030*
Paper Birch (no./ha)	14.1	0	0	-	-
Elevation (m)	1020	980 (76.6)	1127 (70.2)	0.049*	0.904

[1] included all trees from 5-9 cm in diameter (dbh), all other densities were calculated with trees 10 cm or greater.

Landscape Level Forest Cover Analysis. -- At the level of the goshawk home range (2,400 ha), lodgepole pine was the most important canopy species and was found at all nest sites (Table 6). Douglas-fir was the second most important species and was more dominant than lodgepole pine in three home ranges. Pure stands of spruce and aspen were minor components in the landscape, but occurred as minor species along with the dominant lodgepole pine and Douglas-fir. Clearcut

habitats represented by NSR and NSRL were found in all home ranges. They varied from a high of 26.6 percent at the Siwash nest site to a low of 3.0 percent at the Tatla Lake nest site. Meadows, brush, and lakes were inconsistent and miniscule components of the home range suggesting that they are not required by goshawks. Age classes of timber revealed that home ranges were dominated by late-successional forest. All home ranges were dominated (60%) by mature forest (60+ years) cover and 7 of 8 home ranges had at least 45 percent old forest (100+ year) cover.

At the level of the PFA (240 ha), the results were similar, but of course, the number of different forest types was less because of the smaller area. Lodgepole pine was the most important canopy species, but was not dominant in all PFAs (Table 7). Douglas-fir was the second most important species and was more dominant than lodgepole pine in four PFAs. Pure stands of spruce and aspen were almost non-existent in the landscape, but occurred as minor species along with the dominant lodgepole pine and Douglas-fir. Clearcut habitats represented by NSR and NSRL were found in five of eight PFAs and usually represented a smaller proportion than found in the home range. Meadows and brush were non-existent, and only one lake was found in a PFA (site GOS004). Age classes of timber revealed that PFAs were also dominated by late-successional forest although slightly lower proportions than the home range. All PFAs had at least 44 percent mature forest (60+ years) cover and 7 of 8 home ranges had at least 27 percent old forest (100+ year) cover.

Table 6. Forest cover analysis of goshawk nest site locations in the Cariboo at the landscape level of the goshawk home range (2,400 ha).

COVER TYPE	HAL011	GOS004	GOS002	CHA030	MACOO1	BOY001	SIW001	TAL003
Unclassified	58.1	67.4	82.9	15.7	142.1	129.6	28.4	4
Aspen	18.5	7	0	192.1	0	4	0	0
Aspen/Mix	193.3	0	1.3	0	16	8.6	0	9.9
Brush	12.9	0	3.3	3.4	0	3.3	5.5	0
Douglas-fir	112.8	494.7	67.7	112.8	182.7	39.3	0	1.6
Douglas-fir/Mix	550.4	611.2	1134.6	663.2	285.8	0	0	13.2
Lake	0	9.8	10.9	0	62.7	87.6	0.4	2
Meadow	0	16.4	0	0	39	0	0	8.4
NSR[1]	57.9	114.4	15.6	57.9	185.3	113.4	13.6	71.2
NSRL	143.8	339.5	58.4	143.8	198.7	0	624.7	0
Lodgepole Pine	300.9	507.5	96.4	300	563.4	958.6	1569.4	2261.8
Lodgepole Pine/Mix	248.2	210.6	714.0	1122.3	496.6	1679.4	0	29.6
Spruce	24.9	0	0	24.9	0	6.5	0	0
Spruce/Mix	62.2	0	201.0	62.2	284.9	47.3	2.5	2.7
Age Class (years)	**HAL011**	**GOS004**	**GOS002**	**CHA030**	**MACOO1**	**BOY001**	**SIW001**	**TAL003**
clearcut, unclassified	285.2	547.6	232.2	62.6	582.4	293.6	231.4	102.4
1. 1-20	47.7	64.4	150.6	164.1	114.8	256.8	0	0
2. 21-40	140.9	150.3	126.2	134.1	76.9	0.9	0	65.5
3. 41-60	471.9	197.2	166.8	307.5	378.6	36.1	0	464.1
4. 61-80	235.4	161.4	85.8	676.0	104.3	190.4	312.8	609.5
5. 81-100	351.0	262.8	0	382.8	159.6	16.8	128.6	79.3
6. 101-120	1059.7	330.7	267.7	380.1	270.9	191.9	1199.5	831.9
7. 121-140	0	325.2	1237.0	34.5	664.1	715.8	27.3	182.7
8. 141-250	75.0	348.0	111.1	158.4	301.4	410.2	288.1	72.1
9. 251+	0	0	0	0	0	0	25.3	0

[1] NSR = not satisfactorily stocked (logging history unknown), NSRL = same but logged.

Table 7. Forest cover analysis of goshawk nest site locations in the Cariboo at the landscape level of the goshawk post-fledgling family area (240 ha).

COVER TYPE	HAL011	GOS004	GOS002	CHA030	MACOO1	BOY001	SIW001	TAL003
Unclassified	5.3	5.0	6.0	0	23.0	0	0	0
Aspen	0	0	0	0.2	0	0	0	0
Aspen/Mix	0	0	0	0	0	0	0	0
Brush	0	0	0	0	0	0	0	0
Douglas-fir	5.3	41.4	0	4.7	15.5	0	0	0
Douglas-fir/Mix	50.7	37.6	141.4	54.1	78.0	0	0	0
Lake	0	5.5	0	0	0	0	0	0
Meadow	0	0	0	0	0	0	0	0
NSR[1]	28.5	0	0	0	43.0	2.1	0.9	0
NSRL	0	102.9	0	0	11.1	0	4.8	0
Lodgepole Pine	16.8	30.4	0	170.3	56.9	85.4	233.0	238.4
Lodgepole Pine/Mix	111.1	16.9	91.2	9.5	11.0	139.1	0	0
Spruce	16.4	0	0	0	0	0	0	0
Spruce/Mix	17.4	0	0.2	0	0	13.7	0	0
Age Class (years)	**HAL011**	**GOS004**	**GOS002**	**CHA030**	**MACOO1**	**BOY001**	**SIW001**	**TAL003**
clearcut, unclassified	29.0	113.5	6.0	0	71.7	0	4.7	0
1. 1-20	0	9.6	0	2.6	5.4	2.1	0	3.0
2. 21-40	0	0	0	0	11.7	0	0	0
3. 41-60	0	12.0	3.0	53.7	1.8	8.3	0	6.1
4. 61-80	32.5	26.6	0	81.0	0	5.2	22.9	21.2
5. 81-100	88.9	11.7	0	5.4	0	0	18.0	0.4
6. 101-120	66.6	58.7	0.2	82.9	0.3	126.4	197.8	185.5
7. 121-140	0	0	229.6	8.5	50.2	30.3	0	25.1
8. 141-250	21.7	7.8	0	4.7	97.6	64.2	0	0
9. 251+	0	0	0	0	0	0	0	0

[1] NSR = not satisfactorily stocked (logging history unknown), NSRL = same but logged.

7.0 DISCUSSION

During the course of this study, northern goshawks were observed nesting successfully at three different nests in the Cariboo in 1996. Reproduction was high with at least 2 young fledged per known nest. In addition, several other detections and incidental sightings of goshawks occurred in the Cariboo during the 1996 surveys, three at inactive historic nests sites, one additional goshawk family, and a lone adult were observed in new areas. Overall, the formal broadcasts detected some goshawks at inactive historic nest sites, but failed to detect goshawks in new areas of suitable habitat. At two of the inactive historic nest sites, only vocalizations were heard, so there is a slight possibility that the calls were made by mimicks, although goshawks were heard earlier in the spring at one of these nest areas. There is also the possibility that a new nest was built beyond the limit of the call stations in each case or that the new nest was somehow missed, despite careful searching effort. Although we are fairly certain that nesting did not occur in these three territories, it is extremely difficult to prove non-occupancy because maximum response rates of goshawks to broadcasts may be as low as 80 percent (Kennedy and Stahlecker 1993). At the Boyer Lake site, the observation of an adult 3 km away from the historic nest could mean that the birds moved a significant distance from their old nest, or else were not breeding in 1996.

The failure of detecting new birds with formal broadcast survey may indicate that goshawk densities are low, making random detection efforts difficult. Joy et al. (1994) reported 1.5 detections per 100 stations in one of the densest populations of goshawks known. Using this same detection rate, only a maximum of 2.7 goshawks could have been expected for the effort established (181 stations) in new areas of the Cariboo in 1996. With this small a sample size it is difficult to determine if the result of zero was due to stochastic factors or to a low density of goshawks in the Cariboo. Dunbar and Blackburn (1994) suggested that habitat quality would affect the density of northern spotted owls (*Strix occidentalis*) in southern British Columbia. It is likely that the quality of Cariboo forests can not sustain the same prey biomass found in richer, more productive southern ecosystems that support high goshawk densities (Reynolds et al. 1994).

In terms of habitat selection, all goshawk nests were in unmanaged stands, dominated by conifers. The stands were not unlike available unmanaged stands throughout the region with the strong exception of tree density. Apparently, goshawks have a specific narrow range of tolerance for tree densities (Figure 1) as well as a strong avoidance for dense saplings. At the high end of tree densities, flight for foraging or nest defense is impeded. At the low end, the limitation is reduced canopy cover which could result in lack of thermal protection, reduced predator avoidance, and increased competition by generalist predators such as red-tailed hawk and great horned owl (Crocker-Bedford 1990).

At the landscape level, forest cover analysis of the goshawk home range (2,400 ha) and PFA (240 ha) revealed that mature and old forest were dominant components of the landscape. Lodgepole pine was the most important canopy species, followed by Douglas-fir. Spruce, Aspen, and Birch were minor components. Fleming (1987) noted that in his study, all goshawk nests were found during timber operations so there was a bias for detecting goshawks in the oldest, largest timber available. Likewise, goshawks in the Cariboo were all found as a result of logging operations which probably selected older ages and certain species of timber for harvesting. Thus, goshawks may inhabit a wider range of stand ages and species composition than indicated by the present data and more nests need to be found by random search methods to determine how much bias is really occurring (if any). On the other hand, Lilieholm et al. (1993) suggested that interior Douglas-fir stands would not reach habitat suitability for goshawk nesting until about 75 to 80 years which is fairly consistent with the present analysis.

8.0 CRITIQUE OF INVENTORY PROTOCOLS

In order to improve future detectability of goshawks in the Cariboo, future call surveys will need to increase the number of survey teams as well as improve survey efficiency. Surveys can be streamlined by having all the survey stations mapped in advance (Joy et al. 1994; Bosakowski and Vaughn 1996) and by reducing the requisite paperwork which is required at every station. In addition, we felt that recording miscellaneous information about prey species, mimick species, vegetation, and site description was very time-consuming, greatly reduced the number of stations

completed each day, and reduced our focus on detecting goshawks (the most important task). Collecting this kind of qualitative information at all stations is wasteful because a negative goshawk response never proves non-occupancy (e.g., even at 100 m from active nests, Kennedy and Stahlecker 1983 - only provoked responses 80 percent of the time) or non-use (i.e., the site could be used tomorrow). Therefore, a correlational analysis based on the presence or absence of goshawks would be pervasively flawed with incorrect assumptions. Furthermore, attempting to use qualitative data from single survey points to explain goshawk habitat use over a tremendous spatial scale (2,400 ha home range) is fraught with logistical and statistical pitfalls. This type of correlational analysis may work for small neotropical songbirds with home range sizes <0.5 ha, but not for highly mobile raptors. For 1997, we suggest that only GPS location and site ID number are recorded as well as any pertinent information on goshawk sign and activity. In addition, we noted that the RIC standard interval for goshawk call stations (400 m) was actually misquoted from an earlier abstract of our research which recommended a 480 m interval (Bosakowski and Vaughn 1996).

9.0 MANAGEMENT CONCERNS

The fact that all eight goshawk nest sites were found in unmanaged forest suggests that clearcutting, thinning, diameter cutting, or selection cutting may not be tolerated by goshawks in the Cariboo, at least within the nest site (12 ha). At the Enterprise nest, a 1.4 ha goshawk reserve was left after heavy selection logging, clearcutting, and road building occurred. Goshawks did nest successfully here in 1996, but probably because they started nesting activities before most of the timber removal began. Goshawks should be monitored over the next two to three years to see if they continue to nest in this reserve. Other goshawk reserves did not appear to be effective for promoting goshawk reproduction in 1996 at Hart Lake, Scum Lake, Tatla Lake, Boyer Lake, and Chasm Park, although nesting activity should be evaluated for several years before this determination can be formally made.

By the time that goshawks are usually discovered, much of their territory has already been clearcut which limits the opportunity to apply a conservative timber-wildlife prescription. Until an ecosystem level approach can be developed for management of Cariboo forests, goshawks

should probably be managed on a site-by-site basis. Formal broadcast surveys (RIC Standards 1996; Joy et al. 1994; Bosakowski and Vaughn 1996) would be needed in all areas of suitable goshawk habitat prior to timber sales to determine occupancy. Ideally, surveys should be completed twice if possible (Joy et al. 1994), especially since goshawks may not breed every year (Marquis and Newton 1981) and an average annual nesting failure rate of 15 percent of occupied nests (Reynolds et al. 1994) could also limit responses.

For goshawk management in the Pacific Northwest, the U.S. Forest Service (USFS 1994) currently protects the nest site (12 ha) and the PFA(160 ha) from all harvest in certain National Forests, but incorporates no special management of the surrounding 2228 ha foraging area where clearcutting is the usual method of timber harvesting. Depending on the specific timber history in the area, limited timber harvesting can sometimes occur in the PFA, but at least 60 percent of the area is to be retained in sawtimber (30 cm dbh) or older age classes. A different plan was adopted for use in the southwestern United States (Reynolds et al. 1992) where selection cutting is the predominant harvest method. In this plan, three nest sites and three replacement sites (totaling 72 ha) are completely protected from harvest, only seasonal protection in the surrounding PFA (168 ha) is provided along with a harvest plan that maintains at least 60 percent of the PFA and foraging area (2328 ha) in the sawtimber stand condition or older. The Goshawk Scientific Committee (Reynolds et al. 1992) advocated thinning from below as the major method of timber harvest, leaving at least 50 to 70 percent canopy cover in the PFA, and at least 40 to 60 percent canopy cover in the foraging area, depending upon forest type (Table 8). In addition, small clearcuts of 0.8 ha for the PFA and 1.6 ha for the foraging area were recommended for ponderosa pine forest and mixed conifer forest, and clearcuts of 0.4 ha for the PFA and 0.8 ha for the foraging area in spruce-fir forests (Reynolds et al. 1992).

Table 8. Minimum structural attributes for identifying suitable goshawk nest stands and minimum canopy cover standards to be maintained after thinning in the PFA and foraging areas as recommended by the Goshawk Scientific Committee (Reynolds et al. 1992).

	VARIABLES	PONDEROSA PINE	MIXED CONIFER[a]	ASPEN	SPRUCE-FIR

	SITE INDEX	<55	>55	<50	>50	ALL	ALL
Nest Site (No-harvest)	Canopy Trees/ha	100	75	112	88	50	88
	Total BA (m^2/ha)	28	33	26	30	12	33
	Canopy Cover%	50+	60+	50+	60+	60+	70+
PFA	Canopy Cover%	50-60+[b]		60+		not provided	60-70+[b]
Foraging Area	Canopy Cover%	40+		40-60+[b]		not provided	40-60+[b]

[a] Includes Douglas-fir as a dominant, with spruce, pine, fir, and aspen possible.

[b] Varies depending on structural size class of trees, see Reynolds et al. (1992) for further detail.

Neither goshawk-timber plan has been formally tested and some studies have suggested that thinning over a large area could have negative impacts on goshawk populations. In one study, Crocker-Bedford (1990) reported that even a light thinning (one-third timber volume removal on 80% of the area) significantly reduced goshawk reproduction and nest reoccupancy despite the fact that uncut nest buffers were provided around all nest sites. Therefore, further applied studies on thinning in goshawk PFAs and foraging areas are needed before precise silvicultural

prescriptions could be selected for the Cariboo Region. Since goshawks only nested within a narrow range of tree densities (500-820 trees per ha) in the Cariboo, the data suggest that unmanaged stands are frequently overstocked and could be thinned to create suitable stands for goshawks, albeit stand density does not fall below 500 trees per ha. In addition, sapling densities could be markedly reduced either during normal commercial thinning operations or during pre-commercial thinnings (Smith 1986) to improve habitat suitability for goshawks.

10.0 CONCLUSIONS

Recent historic information on goshawk nesting was relatively scarce in the Cariboo Region. All eight nest sites documented in this report were the result of incidental sightings by forestry personnel during timber cruising, road building, or logging. Goshawk nest sites were all within unmanaged forest stands, but active or recent logging had occurred near 7 of the 8 nests by the time that the nests were discovered. Despite small nest buffers or a suspension of logging when the birds were found, the nest sites were not occupied in 1996, except for two cases where nesting had already begun before timber removal was complete. The third active nest was in an undisturbed area that was being cruised for upcoming logging. Goshawks were seen or heard near three of the unoccupied historic nests, thus it remains possible that they shifted to nearby territories or were simply not breeding in 1996. Thus, all historic nest sites should be surveyed for the next couple of years before conclusions can be drawn about the impact of these logging operations and the efficacy of the residual nest buffers. Analysis of nest site habitat revealed that goshawks selected unmanaged forest with only a narrow range of tree densities (500-820 trees per ha) and avoided higher densities of saplings. This means that overstocked unsuitable habitat might be convertible to suitable goshawk habitat by thinning tree density to no lower than 500 trees per ha and reducing sapling densities. Forest cover analysis revealed that the home ranges and PFAs were dominated by late-successional forest cover, albeit there may be some bias in the data because all nests were found during timber operations which normally target mature and old forest for harvesting.

Formal broadcast surveys in new areas did not result in any detections of goshawks, but a few other forest raptor species were detected. Detections may be difficult to obtain in the Cariboo if the goshawk population is small, but locally abundant in patches of optimal habitat (metapopulation centers). During surveys, we noted large areas of recent clearcut or over-thinning (canopy closure <30%) which could impact landscape level suitability for individual pairs and reduce connectivity between metapopulations. In future surveys, more extensive numbers of broadcast stations need to be done, especially in areas of potential timber sales where traditional nesting areas could be lost.

Conclusions drawn from this report are based on a relatively small sample size, and therefore, any management regulations based on the present data set should be subject to adaptive management (i.e., changed according to the addition of new data). Eventually, enough data should be acquired from each BEC zone so site-specific management can be tailored and applied to each zone.

11.0 LITERATURE CITED

Bosakowski, T. and M. E. Vaughn. 1996. Developing a practical method for surveying northern goshawks in managed forests of the Western Washington Cascades. Western J. Appl. Forestry 11:109-113.

Collins, S. L., F. C. James, and P. G. Risser. 1982. Habitat relationships of wood warblers (Parulidae) in northern central Minnesota. Oikos 39:50-58.

Crocker-Bedford, D.C. 1990. Goshawk reproduction and forest management. Wildl. Soc. Bull. 18:262-269.

Detrich, P. J. and B.Woodbridge. 1994. Territory fidelity, mate fidelity, and movements of color-marked northern goshawks in the Southern Cascades of California. Studies in Avian Biol. 16:130-132.

Dunbar, D. and I. Blackburn. 1994. Management options for northern spotted owl in British Columbia. Canadian Spotted Owl Recovery Team. 180 pp.

Fischer, D. L. 1986. Daily activity patterns and habitat use of coexisting Accipiter Hawks in Utah. Ph.D. Thesis, Brigham Young Univ., Provo, UT.

Hall, P. A. 1984. Characterization of nesting habitat of goshawks (Accipiter gentilis) in northwestern California. M.S. Thesis, Humboldt State University, Arcata, CA.

Hargis, C. D., C. McCarthy, and R. D. Perloff. 1994. Home ranges and habitats of northern goshawks in Eastern California. Studies in Avian Biology 16:66-74.

Hintze, J. L. 1992. Number cruncher statistical system, version 5.03, installation and reference manual. NCSS, Kaysville, Utah.

Irwin, L. L., J. B. Buchanan, T. L. Fleming, and S. M. Speich. 1989. Wildlife use of managed forests: a review. National Council for Air and Stream Improvement, Inc., Corvallis, Oregon. 176 pp.

Fleming, T. L. 1987. Northern goshawk status and habitat associations in western Washington with special emphasis on the Olympic Peninsula. Unpublished report. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Olympia, WA.

Franklin, J. F. and C. T. Dyrness. 1984. Natural vegetation of Oregon and Washington. Oregon State Univ. Press, Corvallis. 452 pp.

James, F. C. and H. H. Shugart, Jr. 1970. A quantitative method of habitat description. Audubon Field Notes 24:727-736.

Johnsgard, P. A. 1990. Hawks, eagles, and falcons of North America. Smithsonian Institution Press, Washington and New York. 403 pp.

Joy, S. M., R. T. Reynolds and D. G. Leslie. 1994. Northern goshawk broadcast surveys; hawk response variables and survey cost. Studies in Avian Biology 16:24-30.

Kachigan, S. K. 1989. Multivariate statistical analysis. Second Edition, Radius Press, New York.

Kennedy, P. L. and D. W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. J. Wildl. Manage. 57:249-257.

Lilieholm, R. J., W. B. Kessler and K. Merrill. 1993. Stand density index applied to timber and goshawk habitat objectives in Douglas-fir. Env. Manage. 17:773-779.

Marshall, D. B. 1992. Status of the northern goshawk in Oregon and Washington. Audubon Society of Portland, OR. 34 pp.

Marquiss, M. and I. Newton. 1982. The goshawk in Britain. Brit. Birds 75:243-260.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. Special Report Series No. 6, British Columbia, Ministry of Forests, Victoria, BC 330 pp.

Morisson, M. L. 1984. Influence of sample size on discriminant function analysis of habitat use by birds. J. Field Ornithol. 55:330-335.

Patton, D. R. 1992. Wildlife habitat relationships in forested ecosystems. Timber Press, Portland, OR. 392 pp.

Reynolds, R. T. 1983. Management of western coniferous forest habitat for nesting Accipiter hawks. USDA Forest Service General Technical Report RM-102, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Reynolds, R. T., R. T. Graham, M. H. Reiser, R. L. Bassett, P. L. Kennedy, D. A. Boyce, Jr., G. Goodwin, R. Smith and E. L. Fisher. 1992. Management recommendations for the northern goshawk in the southwestern United States. USDA Forest Service Gen. Tech. Rep. RM-217, Fort Collins, CO. 90 pp.

Reynolds, R. T., S. M. Joy, and D. G. Leslie. 1994. Nest productivity, fidelity, and spacing of northern goshawks in Arizona. Studies in Avian Biol. 16:106-113.

RIC (Resorce Inventory Committee, Elements Working Group). 1996. Standardized inventory methodologies for components of British Columbia's biodiversity. DRAFT 1. April 1996.

Speiser, R. and T. Bosakowski. 1987. Nest site selection by northern goshawks in northern New Jersey and southeastern New York. Condor 89:387-394.

Speiser, R. and T. Bosakowski. 1991. Nesting phenology, site fidelity, and defense behavior of northern goshawks in New York and New Jersey. J. Raptor Res. 25(4):132-135.

Squires, J. R. and L. F. Ruggiero. 1995. Nest-site preference of northern goshawks in southcentral Wyoming. J. Wildl. Manage. 60:170-177.

U. S. Forest Service (USFS). 1994. Goshawk monitoring, management, and research in the Pacific Northwest: 1994 Status Report. (T. Schommer and G. Silovsky, Compilers). USDA Forest Service, Portland, OR.

Woodbridge, B., and P. J. Detrich. 1994. Territory occupancy and habitat patch size of northern goshawks in the Southern Cascades of California. Studies in Avian Biol. 16:83-87.

APPENDICES

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
2	MAC001	XXXXXX	XXXXXXX	GN	MACKIN CREEK	GOSHAWK NEST 96
3	GOS002	XXXXXX	XXXXXXX	GN	BULL MTN.	GOSHAWK NEST 96
4	HAL011	XXXXXX	XXXXXXX	GN	HART L. 8300 RD	GOSHAWK NEST
5	GOS004	XXXXXX	XXXXXXX	GN	ENTERPRISE RD	GOSHAWK NEST 96
6	SIW001	XXXXXX	XXXXXXX	GN	SIWASH/ SCUM L.	GOSHAWK NEST
7	TAL003	XXXXXX	XXXXXXX	GN	TATLA L 980 RD	GOSHAWK NEST
8	BOY001	XXXXXX	XXXXXXX	GN	BOYER L	GOSHAWK NEST
9	CHA030	XXXXXX	XXXXXXX	GN	CHASM PARK	GOSHAWK NEST
10	BOY004	XXXXXX	XXXXXXX	WN	BOYER L	GR. GREY OWL NEST
11	RTH001	XXXXXX	XXXXXXX	RN	BULL MTN.	RED-TAILED HAWK NEST 96
12	CHA031	XXXXXX	XXXXXXX	WN	CHASM PARK	GR. GREY OWL NEST
13	HAL014	XXXXXX	XXXXXXX	ON	HART L. 8300 RD	OSPREY NEST 96
14	RAN001	537300	5802448	RS	MACKIN CRK	RANDOM SITE
15	RAN002	556757	5790326	RS	BULL MTN.	RANDOM SITE
16	RAN003	569351	5818592	RS	HART L. 8300 RD	RANDOM SITE
17	RAN004	568078	5821367	RS	HART L. 8300 RD	RANDOM SITE
18	RAN005			RS	BULL MTN.	RANDOM SITE
19	RAN006	579880	5749317	RS	ENTERPRISE RD	RANDOM SITE
20	RAN007	574442	5747980	RS	ENTERPRISE RD	RANDOM SITE
21	RAN008	570653	5750331	RS	ENTERPRISE RD	RANDOM SITE
22	RAN009			RS	BULL MTN.	RANDOM SITE
23	RAN010	461193	5754865	RS	SIWASH/ SCUM L.	RANDOM SITE
24	RAN011	459829	5756753	RS	SIWASH/ SCUM L.	RANDOM SITE
25	RAN012	403758	5764444	RS	TATLA L 980 RD	RANDOM SITE
26	RAN013	406270	5766602	RS	TATLA L 980 RD	RANDOM SITE
27	RAN014	651662	5671061	RS	BOYER L	RANDOM SITE
28	RAN015	651562	5671081	RS	BOYER L	RANDOM SITE
29	RAN016	646394	5672016	RS	BOYER L	RANDOM SITE
30	RAN017			RS	CHASM PARK	RANDOM SITE
31	RAN018	614535	5674302	RS	CHASM PARK	RANDOM SITE
32	RAN019	533938	5802552	RS	MACKIN CRK	RANDOM SITE
33	RAN020	545758	5792575	RS	MACKIN CRK	RANDOM SITE - COHA PROTESTING JUVENILES
34	BIG001			CS	BIG L 1100 RD	
35	BIG002			CS	BIG L 1100 RD	
36	BIG003			CS	BIG L 1100 RD	
37	BIG004			CS	BIG L 1100 RD	
38	BIG005	601445	5721243	CS	BIG L 1100 RD	
39	BIG006	601273	5722072	CS	BIG L 1100 RD	
40	BIG007	600731	5721323	CS	BIG L 1100 RD	
41	BIG008	599961	5721260	CS	BIG L 1100 RD	
42	BIG009	599510	5721153	CS	BIG L 1100 RD	
43	BIG010	599197	5720805	CS	BIG L 1100 RD	
44	BIG011	598720	5720410	CS	BIG L 1100 RD	
45	BIG012	598447	5719822	CS	BIG L 1100 RD	
46	BIG013	598149	5719352	CS	BIG L 1100 RD	
47	BIG014	597005	5718369	CS	BIG L 1100 RD	
48	BIG015	596383	5717934	CS	BIG L 1100 RD	
49	BIG016	595696	5717832	CS	BIG L 1100 RD	
50	BIG017	602124	5722249	CS	BIG L 1100 RD	
51	BIG018	602963	5720803	CS	BIG L 1100 RD	

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
52	BIG019	603377	5720771	CS	BIG L 1100 RD	
53	BIG020	603883	5720569	CS	BIG L 1100 RD	AMKE
54	HEL001	643539	5780952	CS	HENDRIX L	
55	HEL002	643947	5781079	CS	HENDRIX L	
56	HEL003	643938	5781099	CS	HENDRIX L	
57	HEL004			CS	HENDRIX L	
58	HEL005	643541	5781189	CS	HENDRIX L	
59	HEL006	642370	5784779	CS	HENDRIX L	
60	HEL007	643509	5781641	CS	HENDRIX L	
61	HEL008	642740	5784662	CS	HENDRIX L	
62	HEL009	643801	5783094	CS	HENDRIX L	
63	HEL010	642997	5784295	CS	HENDRIX L	
64	HEL011	643241	5783498	CS	HENDRIX L	
65	HEL012	643046	5784233	CS	HENDRIX L	
66	HEL013	646666	5782853	CS	HENDRIX L	
67	HEL014	643870	5782251	CS	HENDRIX L	
68	HEL015	646331	5782671	CS	HENDRIX L	RTHA
69	HEL016	644429	5782553	CS	HENDRIX L	
70	HEL017	645922	5782945	CS	HENDRIX L	
71	HEL018	644795	5782817	CS	HENDRIX L	
72	HEL019	645461	5783036	CS	HENDRIX L	
73	HEL020	645159	5783161	CS	HENDRIX L	
74	HEL021	647608	5783998	SW	HENDRIX L	
75	HEL022	645442	5768499	CS	HENDRIX L	
76	HEL023	645543	5767007	CS	HENDRIX L	
77	HEL024	645890	5768865	CS	HENDRIX L	
78	HEL025	646153	5768159	CS	HENDRIX L	
79	HEL026	646167	5768452	CS	HENDRIX L	
80	HEL027	645974	5768864	CS	HENDRIX L	
81	HEL028	645631	5768784	CS	HENDRIX L	
82	HEL029	647035	5769052	CS	HENDRIX L	
83	HEL030	645770	5770678	CS	HENDRIX L	
84	HEL031	647074	5769570	CS	HENDRIX L	
85	HEL032	646732	5770579	CS	HENDRIX L	
86	HEL033	647092	5768524	CS	HENDRIX L	
87	HEL034	647007	5767932	CS	HENDRIX L	
88	HEL035	647003	5767293	CS	HENDRIX L	
89	HEL036	650127	5763045	CS	HENDRIX L	
90	HEL037	650772	5762345	CS	HENDRIX L	
91	HEL038	651905	5761127	CS	HENDRIX L	
92	HEL039	652308	5760835	CS	HENDRIX L	
93	HEL040	652654	5760521	CS	HENDRIX L	
94	HEL041	653152	5760279	CS	HENDRIX L	
95	CHA003			CS	CHASM PARK	
96	CHA004			CS	CHASM PARK	
97	CHA005			CS	CHASM PARK	
98	CHA006			CS	CHASM PARK	
99	CHA007			CS	CHASM PARK	
100	CHA008			CS	CHASM PARK	MERL
101	CHA009	*511331	*1212645	CS	CHASM PARK	*LAT-LONG
102	CHA010	*511327	*1212703	CS	CHASM PARK	*LAT-LONG

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
103	CHA011	*511318	*1212714	CS	CHASM PARK	*LAT-LONG
104	CHA012	*511318	*1212727	CS	CHASM PARK	*LAT-LONG
105	CHA013	*511317	*1212746	CS	CHASM PARK	*LAT-LONG
106	CHA014	*521317	*1212746	CS	CHASM PARK	*LAT-LONG
107	CHA033	609179	5674966	CS	CHASM PARK	
108	CHA034	609518	5674811	CS	CHASM PARK	GRJA MIMICKING NOGO
109	CHA035	609521	5675044	CS	CHASM PARK	NOGO WAIL CALLS - 3 SETS OF 3 CALLS
110	CHA036	609286	5675123	CS	CHASM PARK	
111	CHA037	608990	5675224	CS	CHASM PARK	
112	CHA038	609659	5674449	CS	CHASM PARK	
113	CHA039	609711	5674717	CS	CHASM PARK	
114	CHA040	609612	5674269	CS	CHASM PARK	
115	CHA041	609919	5674959	CS	CHASM PARK	
116	CHA042	609937	5674672	CS	CHASM PARK	
117	CHA043	609911	5674437	CS	CHASM PARK	
118	CHA044	599704	5680993	CS	CHASM PARK	NOGO WAIL CALLS (3)
119	CHA045	608153	5674837	CS	CHASM PARK	GRJA MIMICKING NOGO
120	CHA046	608277	5675133	CS	CHASM PARK	
121	CHA047	608369	5675573	CS	CHASM PARK	
122	BOY002			CS	BOYER L	
123	BOY003	653303	5674652	CS	BOYER L	
124	BOY005	652997	5673293	CS	BOYER L	
125	BOY006	653441	5673263	CS	BOYER L	
126	BOY007	652909	5673675	CS	BOYER L	
127	BOY008	652657	5673706	CS	BOYER L	
128	BOY009	652513	5674028	CS	BOYER L	
129	BOY010	653115	5675044	CS	BOYER L	
130	BOY011	653994	5675403	CS	BOYER L	
131	BOY012	653079	5675341	CS	BOYER L	
132	BOY013	654654	5674663	CS	BOYER L	
133	BOY014	653671	5675763	CS	BOYER L	
134	BOY015	654909	5674235	CS	BOYER L	
135	BOY016	653934	5675842	CS	BOYER L	
136	BOY017	654961	5673856	CS	BOYER L	
137	BOY018	653938	5676446	CS	BOYER L	
138	BOY019	654478	5672950	CS	BOYER L	
139	BOY020	654510	5676746	CS	BOYER L	
140	BOY021	653869	5675584	SW	BOYER L	
141	BOY022	651662	5671061	WS	BOYER L	NOGO FLEW ACROSS ROAD
142	HAL001			CS	HART L 8300 RD	
143	HAL002			CS	HART L 8300 RD	
144	HAL003			CS	HART L 8300 RD	
145	HAL004			CS	HART L 8300 RD	
146	HAL005			CS	HART L 8300 RD	
147	HAL006			CS	HART L 8300 RD	
148	HAL007			CS	HART L 8300 RD	
149	HAL008			CS	HART L 8300 RD	
150	HAL009			CS	HART L 8300 RD	
151	HAL010	*523035	*1220024	CS	HART L 8300 RD	SACR (3), *LAT-LONG
152	HAL011			CS	HART L 8300 RD	
153	HAL012	588350	5825050	CS	HART L 8300 RD	

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
154	HAL016	567378	5817647	CS	HART L 8300 RD	
155	HAL018	567586	5818451	CS	HART L 8300 RD	
156	HAL020	568013	5817361	CS	HART L 8300 RD	
157	HAL021			CS	HART L 8300 RD	GRJA IMITATING NOGO WAIL CALL
158	HAL024	570235	5816212	CS	HART L 8300 RD	
159	HAL025	570361	5816007	CS	HART L 8300 RD	
160	HAL026	XXXXXX	XXXXXXX	WS	HART L 8300 RD	BAEA NEST
161	HAL027			CS	HART L 8300 RD	
162	JAL001			SW	JACOBIE L 2600 RD	OSPR
163	JAL002	572161	5828928	CS	JACOBIE L 2600 RD	BWHA, RTHA
164	JAL003	566067	5834094	CS	JACOBIE L 2600 RD	
165	JAL004	566161	5833324	CS	JACOBIE L 2600 RD	
166	JAL005	566571	5833665	CS	JACOBIE L 2600 RD	
167	JAL006	566981	5833450	CS	JACOBIE L 2600 RD	
168	JAL007	567342	5833062	CS	JACOBIE L 2600 RD	
169	JAL008	567657	5832730	CS	JACOBIE L 2600 RD	
170	JAL009	568055	5832396	CS	JACOBIE L 2600 RD	
171	JAL010	568450	5832210	CS	JACOBIE L 2600 RD	
172	JAL011	568850	5831878	CS	JACOBIE L 2600 RD	
173	JAL012	570167	5831213	CS	JACOBIE L 2600 RD	
174	JAL013	570698	5831141	CS	JACOBIE L 2600 RD	
175	JAL014	571269	5831217	CS	JACOBIE L 2600 RD	
176	JAL015	584207	5822833	CS	JACOBIE L 2600 RD	SSHA PROTESTING, OSPR CALLING
177	JAL016	584501	5822953	CS	JACOBIE L 2600 RD	
178	JAL017	583211	5822656	CS	JACOBIE L 2600 RD	
179	JAL018	582711	5822564	CS	JACOBIE L 2600 RD	
180	JAL019	582236	5822565	CS	JACOBIE L 2600 RD	
181	JAL020	582056	5822898	CS	JACOBIE L 2600 RD	UNID. RAPTOR
182	JAL021	570929	5831597	CS	JACOBIE L 2600 RD	
183	JAL022	570751	5832002	CS	JACOBIE L 2600 RD	
184	JAL023	570831	5832595	CS	JACOBIE L 2600 RD	
185	JAL024	566775	5833840	CS	JACOBIE L 2600 RD	
186	JAL025	565554	5835108	CS	JACOBIE L 2600 RD	
187	JAL026	565219	5835671	CS	JACOBIE L 2600 RD	
188	JAL027	568841	5815568	CS	JACOBIE L 2600 RD	
189	JAL028	567933	5836075	CS	JACOBIE L 2600 RD	
190	JAL029	564678	5836415	CS	JACOBIE L 2600 RD	
191	JAL030	564348	5836340	CS	JACOBIE L 2600 RD	
192	JAL031	569927	5830546	CS	JACOBIE L 2600 RD	
193	JAL032	569977	5830437	CS	JACOBIE L 2600 RD	
194	JAL033	580922	5824906	CS	JACOBIE L 2600 RD	
195	JAL034	580422	5825057	CS	JACOBIE L 2600 RD	
196	JAL035	579977	5825181	CS	JACOBIE L 2600 RD	
197	JAL036	579518	5825360	CS	JACOBIE L 2600 RD	
198	JAL037	579276	5825717	CS	JACOBIE L 2600 RD	
199	JAL038	576147	5827086	CS	JACOBIE L 2600 RD	
200	JAL039	574947	5828366	CS	JACOBIE L 2600 RD	
201	JAL040	574570	5828425	CS	JACOBIE L 2600 RD	
202	JAL041	574334	5828807	CS	JACOBIE L 2600 RD	COHA FLEW ACROSS ROAD 60M SOUTH
203	JAL042	569813	5830831	CS	JACOBIE L 2600 RD	
204	JAL043	567420	5832921	CS	JACOBIE L 2600 RD	

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
205	JAL044	567270	5832386	CS	JACOBIE L 2600 RD	
206	JAL045			CS	JACOBIE L 2600 RD	
207	JAL046			CS	JACOBIE L 2600 RD	
208	JAL047			CS	JACOBIE L 2600 RD	
209	JAL048			WS	JACOBIE L 2600 RD	RTHA JUVENILE - OFF HWY/JACOBIE L RD
210	JAL049			CS	JACOBIE L 2600 RD	
211	JAL050			CS	JACOBIE L 2600 RD	
212	JAL051			CS	JACOBIE L 2600 RD	
213	GRL001	617749	5689714	CS	GREEN LAKE CHASM	UNID. ACCIPITER
214	GRL002	617564	5690265	CS	GREEN LAKE CHASM	
215	GRL003	617500	5690722	CS	GREEN LAKE CHASM	
216	GRL004	618086	5688810	CS	GREEN LAKE CHASM	
217	GRL005	618239	5688519	CS	GREEN LAKE CHASM	
218	TAL001	398918	5762989	CS	TATLA L 980 RD	
219	TAL002	399467	5762736	CS	TATLA L 980 RD	
220	TAL004	399575	5763189	CS	TATLA L 980 RD	
221	TAL005	399576	5763701	CS	TATLA L 980 RD	
222	TAL006	399971	5763544	CS	TATLA L 980 RD	
223	TAL007	399979	5763163	CS	TATLA L 980 RD	
224	TAL008	XXXXXX	XXXXXXX	CS	TATLA L 980 RD	UNID. EAGLE NEST 500M AZ185
225	TAL009			CS	TATLA L 980 RD	
226	TAL010			CS	TATLA L 980 RD	
227	TAL011			CS	TATLA L 980 RD	
228	TAL012			CS	TATLA L 980 RD	
229	TAL013			CS	TATLA L 980 RD	
230	TAL014	400524	5763110	SW	TATLA L 980 RD	
231	TAL015	402770	5763761	CS	TATLA L 980 RD	
232	TAL016	403622	5764203	CS	TATLA L 980 RD	
233	TAL017	404059	5764494	CS	TATLA L 980 RD	
234	TAL018	404893	5764918	CS	TATLA L 980 RD	
235	TAL019	406751	5764031	CS	TATLA L 980 RD	
236	TAL020	411420	5767655	CS	TATLA L 980 RD	
237	TAL021	411823	5767584	CS	TATLA L 980 RD	
238	TAL022	412518	5767429	CS	TATLA L 980 RD	
239	TAL023	410030	5764333	CS	TATLA L 980 RD	
240	TAL024	410415	5764820	CS	TATLA L 980 RD	
241	TAL025	410599	5765241	CS	TATLA L 980 RD	
242	TAL026	410942	5765562	CS	TATLA L 980 RD	
243	TAL027	410942	5765607	CS	TATLA L 980 RD	
244	TAL028	411565	5766515	CS	TATLA L 980 RD	
245	TAL029	411886	5766735	CS	TATLA L 980 RD	
246	SIW002	465853	5754134	CS	SIWASH/ SCUM L.	NOGO WAIL CALL (3) 60M AZ192
247	SIW003	465611	5753753	CS	SIWASH/ SCUM L.	
248	SIW004	465263	5753827	CS	SIWASH/ SCUM L.	
249	SIW005	465773	5754165	CS	SIWASH/ SCUM L.	
250	SIW006	465577	5754354	CS	SIWASH/ SCUM L.	
251	SIW007	465491	5754751	CS	SIWASH/ SCUM L.	
252	SIW008	464121	5754131	CS	SIWASH/ SCUM L.	
253	SIW009	464460	5754289	CS	SIWASH/ SCUM L.	
254	SIW010	464806	5754683	CS	SIWASH/ SCUM L.	
255	SIW011	464859	5755077	CS	SIWASH/ SCUM L.	

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
256	SIW012	464955	5767076	CS	SIWASH/ SCUM L.	
257	SIW013	464514	5766850	CS	SIWASH/ SCUM L.	
258	SIW014	464049	5766665	CS	SIWASH/ SCUM L.	
259	SIW015	463667	5766284	CS	SIWASH/ SCUM L.	
260	SIW016	463240	5765812	CS	SIWASH/ SCUM L.	
261	SIW017	462721	5765533	CS	SIWASH/ SCUM L.	
262	SIW018	462221	5765433	CS	SIWASH/ SCUM L.	
263	SIW019	462959	5765241	CS	SIWASH/ SCUM L.	
264	SIW020	463900	5764855	CS	SIWASH/ SCUM L.	
265	SIW021	464511	5764677	CS	SIWASH/ SCUM L.	
266	CHL001	463624	5773881	CS	CHILCOTIN R 4200 RD	
267	CHL002	463417	5774619	CS	CHILCOTIN R 4200 RD	
268	CHL003			CS	CHILCOTIN R 4200 RD	
269	CHL004	463861	5775255	CS	CHILCOTIN R 4200 RD	
270	CHL005	463988	5775614	CS	CHILCOTIN R 4200 RD	
271	CHL006	465274	5776827	CS	CHILCOTIN R 4200 RD	
272	CHL007	465600	5777068	CS	CHILCOTIN R 4200 RD	
273	CHL008	463195	5773946	CS	CHILCOTIN R 4200 RD	
274	CHL009	462679	5774031	CS	CHILCOTIN R 4200 RD	
275	CHL010	462220	5773887	CS	CHILCOTIN R 4200 RD	
276	CHL011	461753	5773764	CS	CHILCOTIN R 4200 RD	
277	CHL012	461267	5773583	CS	CHILCOTIN R 4200 RD	
278	CHL013	461039	5776028	CS	CHILCOTIN R 4200 RD	
279	CHL014	460917	5775494	CS	CHILCOTIN R 4200 RD	
280	CHL015	460920	5774936	CS	CHILCOTIN R 4200 RD	
281	CHL016	460917	5774533	CS	CHILCOTIN R 4200 RD	
282	CHL017	460517	5773854	CS	CHILCOTIN R 4200 RD	
283	CHL018	461078	5773965	CS	CHILCOTIN R 4200 RD	
284	CHL019	461117	5773528	CS	CHILCOTIN R 4200 RD	
285	CHL020	461323	5772920	CS	CHILCOTIN R 4200 RD	
286	BUS001	XXXXXX	XXXXXXX	WS	BUSH RD PUNTZI L	BAEA NEST - I YOUNG
287	BUS002	433834	5792811	CS	BUSH RD PUNTZI L	
288	BUS003	432726	5792120	CS	BUSH RD PUNTZI L	
289	BUS004	432755	5791912	SW	BUSH RD PUNTZI L	
290	BUS005	433102	5792304	CS	BUSH RD PUNTZI L	
291	BUS006	431222	5788017	CS	BUSH RD PUNTZI L	
292	BUS007	433482	5792594	CS	BUSH RD PUNTZI L	
293	BUS008	431115	5787653	CS	BUSH RD PUNTZI L	
294	BUS009	431024	5787251	CS	BUSH RD PUNTZI L	
295	BUS010	430570	5786926	CS	BUSH RD PUNTZI L	
296	BUS011	429709	5786559	SW	BUSH RD PUNTZI L	
297	MOS001	376865	5730855	CS	MOSLEY CR, 6300 RD	
298	MOS002	370055	5729112	CS	MOSLEY CR, 6300 RD	
299	MOS003	376140	5730558	CS	MOSLEY CR, 6300 RD	
300	MOS004	370559	5729328	CS	MOSLEY CR, 6300 RD	
301	MOS005	375682	5730376	CS	MOSLEY CR, 6300 RD	
302	MOS006	370520	5729517	CS	MOSLEY CR, 6300 RD	
303	MOS007	375202	5730321	CS	MOSLEY CR, 6300 RD	
304	MOS008	370956	5729213	CS	MOSLEY CR, 6300 RD	
305	MOS009	374783	5730125	CS	MOSLEY CR, 6300 RD	
306	MOS010	371515	5729285	CS	MOSLEY CR, 6300 RD	

Appendix A. Locations of call stations, stand watches, nest sites, random sites, and incidental sightings.

	A	B	C	D	E	F
1	**SITE NO.**	**EASTING**	**NORTHING**	**TYPE**	**LOCATION**	**NOTES**
307	MOS011	374545	5729710	CS	MOSLEY CR, 6300 RD	BAEA SOARING 1.5KM AZ147
308	MOS012	371788	5729531	CS	MOSLEY CR, 6300 RD	GRJA MIMICKING NOGO
309	MOS013	374179	5729539	CS	MOSLEY CR, 6300 RD	
310	MOS014	372373	5729496	CS	MOSLEY CR, 6300 RD	
311	MOS015	373613	5729533	CS	MOSLEY CR, 6300 RD	RTHA SOARING
312	MOS016	370350	5729860	CS	MOSLEY CR, 6300 RD	
313	MOS017	373218	5729582	CS	MOSLEY CR, 6300 RD	
314	MOS018	369359	5729248	CS	MOSLEY CR, 6300 RD	
315	MOS019	368946	5729104	CS	MOSLEY CR, 6300 RD	
316	MOS020	368664	5728382	CS	MOSLEY CR, 6300 RD	
317	MOS021	368042	5728626	CS	MOSLEY CR, 6300 RD	
318	MOS022	367542	5728652	CS	MOSLEY CR, 6300 RD	
319	MOS023	366243	5728192	CS	MOSLEY CR, 6300 RD	
320	MOS024	366209	5728895	CS	MOSLEY CR, 6300 RD	BAEA ADULT 3-4KM AZ322
321	MOS025	365597	5728773	CS	MOSLEY CR, 6300 RD	
322	MOS026	365130	5728671	CS	MOSLEY CR, 6300 RD	
323	MOS027	364648	5728997	CS	MOSLEY CR, 6300 RD	
324	MOS028	365900	5728241	CS	MOSLEY CR, 6300 RD	
325	MOS029	366330	5728265	CS	MOSLEY CR, 6300 RD	
326	MOS030	366881	5728142	CS	MOSLEY CR, 6300 RD	
327	PUZ001			CS	PUNTZI L	GRJA MIMICKING NOGO
328	PUZ002			CS	PUNTZI L	GRJA MIMICKING NOGO
329	PUZ003	397233	5776571	CS	PUNTZI L	
330	PUZ004	396559	5776841	CS	PUNTZI L	
331	PUZ005	396447	5777404	CS	PUNTZI L	GRJA MIMICKING NOGO
332	PUZ006	396439	5777668	CS	PUNTZI L	
333	CLI001			CS	BIG L CLINTON	BAEA 800M AZ260
334	CLI002	593866	5669266	CS	BIG L CLINTON	
335	CLI003	594541	5669723	CS	BIG L CLINTON	
336	CLI004	594992	5669818	CS	BIG L CLINTON	
337	CLI005	596529	5669457	CS	BIG L CLINTON	
338	CLI006	605487	5667676	CS	BIG L CLINTON	RTHA PERCHED ON SNAG, AMKE
339	CLI007	605654	5667268	CS	BIG L CLINTON	
340	CLI008	605437	5666766	CS	BIG L CLINTON	
341	CLI009	605378	5666360	CS	BIG L CLINTON	
342	CLI010	604812	5867338	SW	BIG L CLINTON	
343	END001	615970	5674575	CS	3400 RD CLINTON	
344	END002	615457	5674036	CS	3400 RD CLINTON	
345	END003	617716	5672984	CS	3400 RD CLINTON	
346	END004	617174	5673141	CS	3400 RD CLINTON	
347	END005	617841	5673360	CS	3400 RD CLINTON	
348	END006	617308	5673432	CS	3400 RD CLINTON	
349	END007	617717	5673642	CS	3400 RD CLINTON	
350	END008	617957	5673840	CS	3400 RD CLINTON	
351	END009	618187	5674133	CS	3400 RD CLINTON	
352	MAC098	533942	5802552	WS	MACKIN CRK	NOGO ON ROAD
353	MAC099	540759	5797614	WS	MACKIN CRK	NOGO ADULT AND YOUNG ON ROAD
354	ROU001	XXXXXX	XXXXXXX	WS	MCCLEESE L	EAGLE OR OSPREY NEST - INACTIVE

Appendix B. Site attributes for individual raptor nest sites and random sites in the Cariboo.

SITE NO.	TYPE	elevation	NESTHT	NESTRHT	NESTDBH	CANHT	CANCOV	SHRCOV	TOTBASL	QDBH	TOTDENS
MAC001	Goshawk	920	18	22.5	51	31.1	85	50	54.8	30.1	749.6
GOS002	Goshawk	1000	18.5	26.5	39	28.6	65	55	45	25.9	721.4
HAL011	Goshawk	1020	8.3	26.3	56	32.4	70	40	68.3	33.1	777.9
GOS004	Goshawk	920	14.2	23.2	29	24.5	50	70	30.6	25.2	565.8
SIW001	Goshawk	1120	10.8	13.5	27	16.1	25	30	18.6	11	678.9
TAL003	Goshawk	1060	6.8	13.2	20	14.4	30	50	17.3	15.1	820.4
BOY001	Goshawk	1200	10.3	20.5	24	22.1	45	10	29.9	19.5	792.1
CHA030	Goshawk	1080	11.5	21.5	38	20.8	45	75	19.7	22.3	509.2
BOY004	Gr. Grey Owl	1200	14.3	24.3	33	22.6	65	90	24.2	22.4	594.1
RTH001	Red-tailed Hawk	860	21	27	33	28.1	60	85	32.3	26.9	523.3
CHA031	Gr. Grey Owl	1080	9.3	22	34	21	50	50	24.3	19.9	763.8
HAL014	Osprey	1000	30	30	59	30.8	45	80	48.6	35.3	495
RAN001	Random					21.4	75	35	28.4	17.8	1117.4
RAN002	Random					25.9	75	55	37.7	21.8	961.8
RAN003	Random					22.5	60	55	37.4	21.5	976
RAN004	Random					32.4	75	100	37.4	36.9	339.5
RAN005	Random					26.2	70	60	16.9	21.8	919.4
RAN006	Random					28.4	80	45	51.9	36.5	495
RAN007	Random					21.5	55	10	44.9	21.4	1244.7
RAN008	Random					19.8	80	55	39.1	18.1	1471
RAN009	Random					29	70	90	40	28	650.6
RAN010	Random					13.7	45	20	19.4	12.9	1301.3
RAN011	Random					15	25	55	23.2	12.1	1032.5
RAN012	Random					11.5	35	50	9.2	17.2	297
RAN013	Random					12.7	25	45	11.3	12.3	848.7
RAN014	Random					21.9	60	55	35.3	17.7	1287.1
RAN015	Random					29.1	80	55	37.3	34	410.1
RAN016	Random					20.3	45	65	26.1	21	721.4
RAN017	Random					20.5	45	40	22.7	23.1	537.5
RAN018	Random					20.9	30	30	19	21.3	509.2
RAN019	Random					31.2	50	55	34.5	26.6	608.2
RAN020	Random					22.9	75	15	46.9	22.6	1046.7

Appendix B. Site attributes for individual raptor nest sites and random sites in the Cariboo.

SITE NO.	TYPE	LIVDENS	SAPLDENS	DFDENS	LPDENS	WSDENS	SFDENS	ASDENS	PBDENS	MADENS	SGDENS
MAC001	Goshawk	693.1	84.88	608.2	0	70.7	0	14.1	0	0	56.6
GOS002	Goshawk	636.5	28.29	282.9	240.4	84.9	0	0	0	0	84.6
HAL011	Goshawk	735.5	198.06	693.1	0	28.3	0	0	14.1	0	42.4
GOS004	Goshawk	523.3	240.5	70.7	438.5	14.1	0	0	0	0	42.4
SIW001	Goshawk	254.6	28.29	0	240.5	0	0	14.1	0	0	424.3
TAL003	Goshawk	678.9	198.06	0	678.9	0	0	0	0	0	0
BOY001	Goshawk	664.8	70.74	0	579.9	0	0	84.9	0	0	127.3
CHA030	Goshawk	495	226.35	0	495	0	0	0	0	0	14.1
BOY004	Gr. Grey Owl	565.8	580.03	0	169.7	127.3	268.7	0	0	0	28.2
RTH001	Red-tailed Hawk	452.6	381.97	127.3	84.9	226.3	0	14.1	0	0	70.7
CHA031	Gr. Grey Owl	707.2	339.53	14.1	693.1	0	0	0	0	0	56.6
HAL014	Osprey	480.9	113.18	0	0	325.3	70.7	0	42.4	42.4	14.1
RAN001	Random	1060.8	551.74	579.9	297	0	0	183.9	0	0	56.6
RAN002	Random	905.2	650.77	721.4	183.9	0	0	0	0	0	56.6
RAN003	Random	834.5	113.18	28.3	806.2	0	0	0	0	0	141.4
RAN004	Random	311.1	42.44	198	70.7	28.3	0	0	14.1	0	28.2
RAN005	Random	891.1	339.53	325.3	28.3	523.3	0	0	14.1	0	28.3
RAN006	Random	495	396.12	438.5	14.1	42.4	0	0	0	0	0
RAN007	Random	1188.1	141.47	990.1	127.3	0	0	70.7	0	0	56.6
RAN008	Random	1386.1	834.68	424.3	169.7	608.2	0	183.9	0	0	84.9
RAN009	Random	650.6	608.32	212.2	70.7	169.7	0	198	0	0	0
RAN010	Random	1117.4	679.06	0	1117.4	0	0	0	0	0	0
RAN011	Random	537.5	127.32	0	537.5	0	0	0	0	0	495
RAN012	Random	240.5	381.97	0	240.5	0	0	0	0	0	56.6
RAN013	Random	806.2	1103.47	0	806.2	0	0	0	0	0	42.4
RAN014	Random	1089.1	240.5	14.1	1046.7	28.3	0	0	0	0	198
RAN015	Random	410.1	240.5	183.9	42.4	183.9	0	0	0	0	0
RAN016	Random	650.6	183.91	28.3	622.3	0	0	0	0	0	70.7
RAN017	Random	523.3	84.88	28.3	495	0	0	0	0	0	14.1
RAN018	Random	452.6	56.59	0	452.6	0	0	0	0	0	56.6
RAN019	Random	551.6	297.09	42.4	466.8	28.3	0	14.1	0	0	56.6
RAN020	Random	947.7	141.47	820.4	127.3	0	0	0	0	0	99.9

Appendix C. Red and blue listed species observed during the 1996 goshawk and raptor inventory of the Cariboo.

SPECIES						
SPECIES	**LOCATION**	**UTMs**	**DATE**	**AGE**	**BEHAVIOR**	**HABITAT**
American White Pelican	Puntze Lake	none taken	7-02-96	Adult	Floating on lake	Lacustrine
Broad-winged Hawk	Jacobie Lake	572161E, 5828928N	6-29-96	Adult	Soaring	Mature Forest
Sandhill Crane	Hart Lake	523035E, 1220024N	6-26-96	Adult	Foraging	Clearcut

PHOTOS

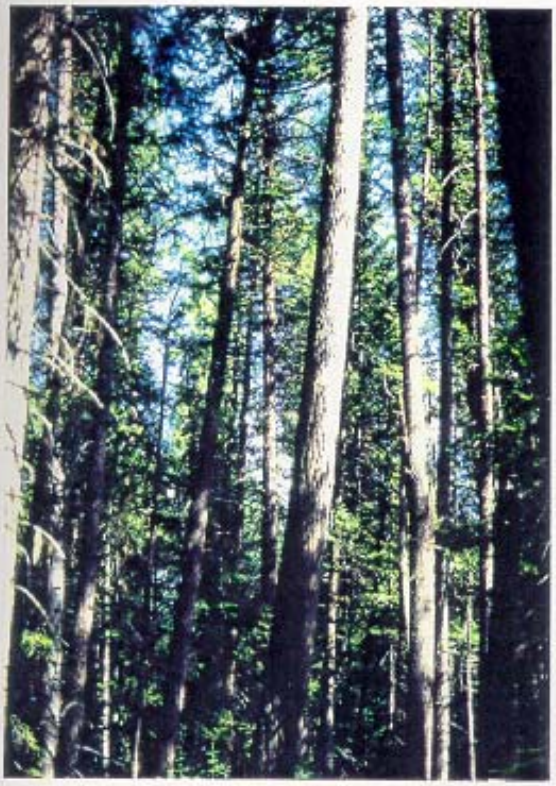


Photo A. Mackin Creek goshawk nest.
Photo B. Hart Lake goshawk nest.

Photo C. Siwash/Scum Lake goshawk nest.
Photo D. Enterprise goshawk nest.

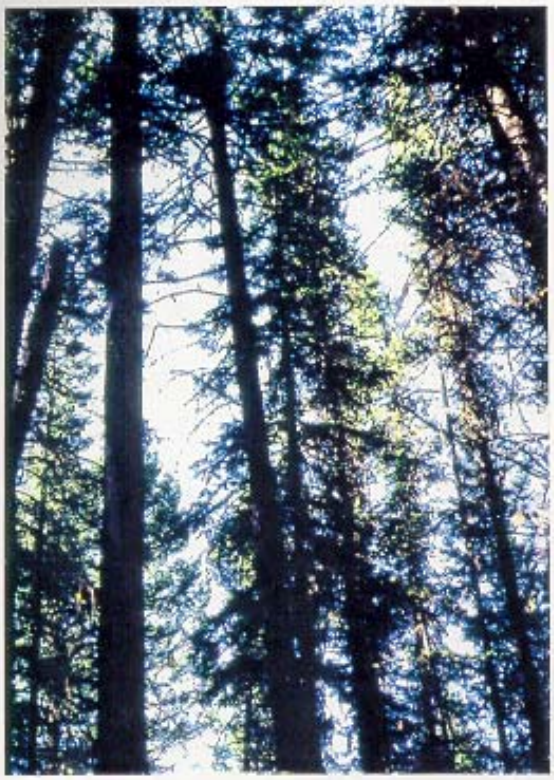


Photo E. Bull Mountain goshawk nest.
Photo F. Tatla Lake goshawk nest.

Photo G. Chasm Provincial Park goshawk nest.
Photo H. Boyer Lake goshawk nest.

Photo I. Boyer Lake great grey owl nest.
Photo J. Chasm great grey owl nest.

Photo K. Hart Lake osprey nest.
Photo L. Bull Mountain red-tailed hawk nest.

Photo L. Heavy thinning and goshawk reserve in background, Enterprise.
Photo O. Multi-storied Douglas-fir forest, Mackin Creek goshawk habitat.

Photo M. Boyer Lake-Chasm Park, unfragmented forest.
Photo N. Leave trees (cedar and Douglas-fir) and stubs in a clearcut unit.