APPENDIX H

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TOLKO INDUSTRIES LTD.
HIGH LEVEL LUMBER DIVISION

Life Requisite Summary of Selected Terrestrial Vertebrates within the Tolko Industries Ltd (HLLD) FMA Area

Prepared by

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A summary report compiled for Tolko Industries Ltd. (HLLD)

Front page photo credits clockwise from top left: Bison (Kim Morton), Pileated Woodpecker (Dennis Eckford), and Grizzly Bear (Kim Morton).

Executive Summary

Tolko Industries Ltd (HLLD) is currently in the process of compiling a summary document (the Detailed Forest Management Plan), outlining the operational plans for the next ten-year period. As Tolko Industries Ltd. (HLLD) intends to harvest timber over many years, the importance of a document outlining habitat needs of wildlife was deemed necessary by industry, government, and the general public. As all species can not be monitored concurrently, due to cost and logistical constraints, a group of selected species was chosen by Tolko Industries Ltd. (HLLD), government, and the author. These thirty-two species represent the habitat requirements of other species within the FMA area of Tolko Industries Ltd. (HLLD). By managing for this limited number of species, all available habitats can be managed and monitored in both a cost-effective and logistically sound manner. Species were also chosen based on several other criteria, including status, commercial importance, and public opinion. The information laid out herein includes all relevant, current knowledge for which future management goals may be based, as related to habitat needs. Information is categorized into several sections including food cover and reproduction. Separate sub-headings have also been incorporated to assess species-specific needs, such as nesting habitat, winter denning habitat, or winter thermal cover. Future plans to incorporate this document include the development of habitat suitability index (HSI) models, mapping of associated wildlife habitat complemented with vegetation assessments, and landscape management practices over long-term forest management cycles.

Disclaimer

Each species has a detailed account of habitat needs and requirements. At the end of each species are two supplementary sections. 'Management Implications' outlines best practices, either derived from published documents or expert knowledge and are considered important in regards to preserving the suitability of habitat. 'Research Needs' is a section added due to knowledge gaps in the current literature. Within the FMA area and even within Alberta, local studies are infrequent. Information must be gathered on both provincial and local area. Although deemed important by industry, government and the author, these **'research needs' are not necessarily the responsibility of Tolko Industries Ltd. (HLLD)**, as some of the studies could be undertaken by government and publicly-funded initiatives.

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Habitat Requirements

green = habitat use
yellow = secondary habitat use
red = definitely no habitat use
blank = limited importance/lack of information

								Young			Mature			Old			
	Grassland or meadow	Shrubland	Flowing Water	Standing Water	Edge	Shrubby Riparian	Wooded Riparian	Coniferous	Mixed	Deciduous	Coniferous	Mixed	Deciduous	Coniferous	Mixed	Deciduous	Wetlands
American Beaver			green	green		green	green	yellow	yellow	green	yellow	green	green	yellow	yellow	yellow	green
American Marten	red		red	red		yellow	yellow			yellow	green			green	green		
Black and White Warbler		yellow	red	red	green	yellow	yellow		green	green		yellow	yellow		green	yellow	yellow
Black Bear		yellow			yellow	yellow	yellow		yellow	yellow		green	yellow		yellow	yellow	
Black-backed Woodpecker	Primarily burnt forests									yellow	green	green	yellow	green	green		
Black-capped Chickadee		green			green	green			yellow	yellow	yellow	green	green	yellow	green	green	
Boreal Chorus Frog			green	green		green	green		yellow	yellow		yellow	yellow		yellow	yellow	green
Boreal Owl											green	yellow		green	yellow		
Canada Lynx						yellow	yellow	green	yellow	yellow	yellow	yellow	yellow	green	yellow	yellow	
Canadian Toad		green	green	green		green	green		yellow	yellow		yellow	yellow		yellow	yellow	green
Cougar						yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	
Dark-eyed Junco		yellow			green	yellow	yellow	green	green	yellow	yellow	yellow	yellow	green	green	yellow	
Great Gray Owl					green		yellow				yellow	green	green	yellow	green	green	
Grizzly Bear	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	green	green	green	green	green	green	yellow
Mink	red		green	green		green	green										green
Moose	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	green	green	yellow	green	green	green	green	green	yellow
Northern Goshawk					green						green	green		green	green		
Northern Myotis	red		red		green										green	green	
Olive-sided Flycatcher			yellow	yellow	green	green	green			red	green	green	red	green	green	red	green
Orange-crowned Warbler	yellow	green	yellow	yellow	green	green	green	green	green	green	yellow	yellow	yellow	yellow	yellow	yellow	yellow
Pileated Woodpecker						green	green	yellow	yellow	yellow	green	green	green	green	green	green	
Pine Grosbeak					green			green	yellow		yellow	yellow		green	green		
Red-breasted Nuthatch							yellow	yellow	yellow		green	yellow		green	green		
Ruffed Grouse	red	green			red	yellow	yellow	yellow	green	green	yellow	yellow	yellow				
Sharp-tail Grouse	green	green			green	yellow	yellow	yellow	green	green	yellow	yellow	green	yellow	yellow	yellow	green
Song Sparrow	yellow	green			green	green	green	green	green	green	yellow	yellow	yellow				green
Southern Red-backed Vole			yellow	yellow		yellow	yellow				yellow	yellow	yellow	green	green	yellow	yellow
Warbling Vireo					green		yellow		green	green		yellow	green				green
White-tailed Deer	green	green			green	green	green	yellow	green	green	yellow	yellow	yellow	green	green	green	green
Wolverine					yellow	yellow	yellow	yellow			yellow	yellow	yellow	green	green	yellow	
Wood Bison	green	green			green	yellow	yellow	yellow	yellow	yellow	yellow	yellow	green	yellow	yellow	yellow	green
Woodland Caribou	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	green	yellow	yellow	green

*These habitat requirements are a summary of literature at present; however, they are are specific of proven for Tolko Industries Ltd (HLLD) FMA area at this time

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American Beaver

Castor canadensis canadensis

Beaver (D. Eckford)

Introduction

The American Beaver is a very common year-round resident of Alberta. Unique morphology, habits and habitat use make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the American Beaver is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The American Beaver forages mainly on deciduous riparian vegetation, especially *Populus* and *Salix* species. General habitat use is aquatic and riparian, but dependant on suitable forage and construction materials. The effect the American Beaver has on the surrounding ecosystem is immense. By impeding the flow of water, changes occur in hydrogeochemical cycles, vegetation composition, invertebrate composition, and vertebrate composition, creating unique systems within the forest biome.

Food

- The diet consists of bark (from the soft cambium layer), leaves, and twigs of deciduous trees and shrubs, corms, rhizomes, stems of aquatic vegetation, coniferous vegetation, and occasionally feces (coprophagy). Trembling Aspen, Poplar and Willow are most common (Nash, 1951; Banfield, 1974; Munro and Fyfe, 1979; Forsyth, 1985; Wheatley, 1997c).
- Terrestrial vegetative matter is taken to the water, where it is eaten, stored, or used for construction of the lodge or dam (Banfield, 1974; Munro and Fyfe, 1979).
- A food cache must be built in the fall to supply the winter food requirements of individuals in the lodge for as long as ice cover is present. Deciduous species are utilized over coniferous species, but

as winter approaches, quantity rather than quality becomes important, and the variety of cached items increases (Busher, 1996; Wheatley, 1997a).

Wetland Habitat

- Beavers inhabit slow-moving streams, lakes, rivers, and marshes with abundant, adjacent deciduous vegetation. Areas with greater vegetative biomass supported more productive colonies. Pond habitat is more suitable (than riverine) for beavers due to greater food availability, predator protection, and relatively stable water levels (Nash, 1951; Banfield, 1974; Wheatley, 1997c; Fryxell, 2001).In coniferous mixed forests, the percentage of hardwood vegetation, watershed size, and stream width had significant positive effects on beaver density. An increased stream gradient and overly xeric soils proved to be negative habitat variables (Howard and Larson, 1986).
- Vegetation may serve several purposes for the Beaver. Aspen is the primary food source, Alder is a primary dam-building material, birch and willow are secondary food sources, shrubs are occasionally used for dam construction as well as food, and conifers are occasionally used in dam construction or for food (Barnes and Mallik, 1996; Barnes and Mallik, 2001). The total riparian browse area tends to be quite small (<2 ha), and the majority of harvested trees tends to be within 20m of the associated waterbody, possibly due to:
  - thermoregulatory restrictions (Beavers can become hyperthermic easily)
  - directionally-leaning trees towards water (due to growing conditions, trees close to water lean in that direction facilitating a more desirable felling direction
  - potential risk of predation (Banfield, 1974; Munro and Fyfe, 1979; Johnston and Naiman, 1990; Barnes and Mallik, 2001)
- Vegetation surrounding river-bank lodges tends to be left unharvested by the beaver, indicating a need for cover and concealment (Dieter and McCabe, 1989).
- The size of trees harvested by beavers is dependant upon the distance from the waters edge. The more distant, the smaller the tree (Banfield, 1974; Munro and Fyfe, 1979; Jenkins, 1980). The maximum diameter of Aspen harvested in Minnesota was 43.5 cm, while the average tends to be closer to 10.2 cm and 13.9 cm (Johnston and Naiman, 1990).
- Habitat layers used for foraging include the water surface, the terrestrial subsurface, the understory and the shrub midstory (Short and Williamson, 1984).

- The size of the home range and lodge location is dependant upon the quality of habitat, the density of foraging trees surrounding the body of water, size and sex of the individual and/or family group, and the size and shape of the waterbody itself (Wheatley, 1997a; Wheatley, 1997c). A minimum of 0.8 km of stream habitat and 1.3 km^2 of total available foraging area is assumed to be required for beaver colonization. Beavers will tend to remain close to shore while traveling, especially in larger bodies of standing water, thereby creating long, thin home ranges (Allen, 1983; Wheatley, 1997c). Summer range is obviously much larger than the winter range, due to confinement under the ice. Summer foraging range can be large, although the majority of time is spent in only 25% of the total area, usually a foraging area of approximately 10-12 ha (Wheatley, 1997a; Wheatley, 1997b). Winter range tends to be less than 1 ha and consists of the lodge and access to food caches (Wheatley, 1997a). Members of family units demonstrate smaller home ranges and smaller core areas than do individuals not belonging to a family unit. This can be related to the need for parental care for kits, which require nursing and the provision of solid food on a nightly basis. Solitary individuals do not need to return to the lodge on regular basis; therefore, they may travel farther distances from the lodge (Wheatley, 1997b). Colonies tend to move often, due to depleted food resources, to habitat areas which may fulfill all life requisites (Munro and Fyfe, 1979; Wheatley, 1997b); whereas, juveniles disperse after being removed (usually at age two) from the lodge by the parents. Juvenile dispersal distances can be great, up to 10 km (Banfield, 1974; Fryxell, 2001).
- Males show the largest home range, due to less involvement in the care of young (Wheatley, 1997b).
- Territoriality is limited due to overland distance between pond habitats (Wheatley, 1997c).
- Local ecological interaction is more important than widescale environmental processes, such as weather (Fryxell, 2001).
- Habitat models, produced by the U.S. Fish and Wildlife Service, are based on two life requisites (water and winter food) and three cover types, lacustrine, riverine and wetland (Allen, 1983).
  - local variations in food availability should be taken into consideration!
  - woody vegetation within 100m is optimal, 101-200m is marginal, >200 has no value
  - tree canopy cover (V_1): 0% = 0.0; 40% = 1.0; 60% = 1.0; 100% = 0.5
  - shrub crown cover (V_2): 0% = 0.0, 40% = 1.0, 60% = 1.0; 100% = 0.8
  - trees 2.5-15.2cm dbh (V_3): 0% = 0.2, 100% = 1.0
  - average height of tree canopy(V_4): 0m = 0.0; 2m = 1.0

- species composition: woody vegetation (V_5): > 50% aspen willow, alder, cottonwood = 1.0; woody vegetation by other deciduous species = 0.6; woody vegetation mostly coniferous = 0.2
- lacustrine surface dominated by yellow or white lily (V_6): 0% = 0.0; 100% = 0.4
- stream gradient (V_7): <6% = 1.0; >15 = 0.0
- water fluctuation (V_8): limited = 1.0; moderate = 0.5; extreme = 0.0
- shoreline development (length/2($\sqrt{}$Area x pi) (V_9): 1 = 0.1; 3 = 1.0
- HSI winter food supply:
  - (a+b+c)/2.5 (for wetland habitat)
  - (b+c)/1.5 (riverine habitat)
  - (b+c)/1.5 + V_6 (lacustrine)
    - a = woody vegetation value within wetland $[(V_1 x V_2)^{1/2} x V_5]^{1/2} + [(V_3 x V_4)^{1/2} x V_5)^{1/2}$
    - b = woody vegetation within 100m of water edge $[(V_1 x V_2)^{1/2} x V_5]^{1/2} + [(V_3 x V_4)^{1/2} x V_5]^{1/2}$
    - c = woody vegetation 100-200m $0.5[(V_1 x V_2)^{1/2} x V_5]^{1/2} + [(V_3 x V_4)^{1/2} x V_5]^{1/2}$
- HSI riverine water supply (V_7 or V_8, whichever is lowest)
- HSI lacustrine water supply (V_7 or V_8, whichever is lowest, if area ≥8 ha at surface area; V_8 if <8 ha)
- HSI wetland water supply (V_8)

- Four important variables in predicting beaver habitat suitability are shallow marsh, seasonally-flooded meadow, wet-deciduous shrub, and ponds (Broschart et. al., 1989).
- Beavers are quite tolerant and will live in close proximity to disturbances (Jensen et. al., 2001).

Lodge Habitat

- Lodges are constructed in wetlands, ponds, lakes, and flowing water, although typically close to foraging and building supplies. Where lakes and ponds are utilized, the lodge is typically constructed in areas sheltered by wind and wave action. Lodges are typically constructed of willow, alder, and poplar, however, birch, tamarack, spruce, reeds and other fibrous vegetation, and shrubbery will also be used occasionally. Streams and rivers also provide suitable habitat for the beaver. If the water supply is limited or variable, a dam may be constructed of small stems (<4.4cm diameter), mud, and rocks, which impedes water flow, creating a pool. If, however, the river is of adequate size and stability, bank lodges may be built (Nash, 1951; Barnes and Mallik, 1997).

- Lodges are typically covered with mud in the autumn which freezes in winter, making the lodge relatively impenetrable to predators (Banfield, 1974).
- Beavers tend not to choose dam sites based on trembling aspen density but rather upstream watershed area and gradient (Barnes and Mallik, 1997).
- Besides the main lodge, colonies will have several bank burrows, due to the ease of construction and maintenance (Banfield, 1974; Wheatley, 1997c).
- Non-family individuals tend to occupy bank burrows (Wheatley, 1997c).
- The mean density of beaver colonies in Minnesota is 0.72/ 100 ha (Fuller and Markl, 1987).

Reproduction

- Beavers mate in January and February, with the kits being born about 3 ½ months later, from late April to early June (Banfield, 1974).
- Gestation time is 90 to 110 days (Forsyth, 1985).
- The average litter size is 2-4 (Banfield, 1974; Munro and Fyfe, 1979; Forsyth, 1985).
- Adults mate for life and produce one litter each year (Munro and Fyfe, 1979).
- Young stay with parents for about two years, when they are usually driven away by the parents (Munro and Fyfe, 1979). Dispersal of beavers (mean straight-line distance of 5.6 km) occurs at two years of age; however, some individuals may stay as part of the family group, but not as breeding adults (Van Deelan and Pletscher, 1996).
- A typical colony consists of an adult pair, kits and yearling from the previous year (Banfield, 1974).

Community Structure

- Predators of the beaver include bear, wolf, coyote, fox, wolverine, otter, lynx, marten, mink, fisher, and eagle (Nash, 1951; Banfield, 1974; Munro and Fyfe, 1979; Fuller and Keith, 1980; Forsyth, 1985; Fuller, 1989; Smith et. al., 1994; Forbes and Theberge, 1996; Rosell, et. al., 1996; Samson and Crête, 1997).
- Muskrats may use parts of active beaver lodges as a method of decreasing predation and decreasing energy expenditure in building an entire separate structure (McKinstry et. al., 1997).

- Water impoundment causes changes in stream channel geomorphology and hydrology, creation and maintenance of wetlands, alteration of nutrient cycles, alteration of shoreline shape and structure, and changes in habitat structure resulting in species compositional and community change. These new habitats may be unique within the local boreal community (McDowell and Naiman, 1986; Smith et al., 1991; Naiman et. al., 1995; Rosell and Parker, 1996; Snodgrass, 1997). The impounded water creates a stable microenvironment able to increase and sustain diverse populations of many species (Grasse, 1951; Beard, 1953; Neff, 1957; Hanson and Campbell, 1963; Lochmiller, 1975; Naiman et. al., 1986; Merendino et al., 1995; Rosell, and Parker, 1996; Snodgrass, 1997; Snodgrass and Meffe, 1998).
- Little is known about the relationships between beaver ponds and herpetofauna (Metts et. al., 2001). Some species prefer unimpeded streams; however, most anurans prefer beaver pond habitat.
- The collection of water, and thus accumulated sediment, along with the decomposition of dam and lodge materials, allows the deposition of nitrogen up to 1000 times more abundant than the surrounding habitat (Naimen and Melillo, 1984).
- Impoundment of water behind beaver dams floods the area, killing trees. These snags become useful habitat for animals such as bats (Menzel et. al., 2001).
- The resulting effect on surrounding ecosystems is dependant upon the geographical and topographical position of the catchment (Snodgrass, 1997).
- Increased levels of beaver foraging on Trembling Aspen (*Populus tremuloides*) can have a dramatic effect on the ecosystem and community. Tree density, basal area, and total above-ground biomass can drop as much as 43% within 1ha patches leading to optimal coniferous growing conditions and subsequent increased rates of succession, providing less suitable habitat (Johnston and Naiman, 1990; Barnes and Mallik, 2001; Fryxell, 2001). Thus, “the greatest threat to the beaver is the beaver itself,” due to overpopulation and the subsequent reduction in available food supply and habitat (Nash, 1951).”
- Beaver-pond communities 11-40 years old have the greatest structural and biological diversity (Ray et. al., 2001).
- The estimated number of beavers in northeastern British Columbia (1979) is between 136 000 and 204 000 individuals (Munro and Fyfe, 1979).

- Harvest data for the High Level area 1985-1989, as collected from volunteer submissions (AB Fish and Wildlife Div, 1990).

Beavers harvested	1984/1985	1985/1986	1986/1987	1987/1988	1988/1989
Map sheet 84 - E	432	597	647	522	382
Map sheet 84 – F	859	1003	1960	1043	254
Map sheet 84 – G	753	934	1322	890	424
Map sheet 84 – J	841	852	1098	490	738
Map sheet 84 – K	652	910	1003	668	302
Map sheet 84 – L	939	1154	920	461	445
Map sheet 84 – M	332	537	441	267	226
Map sheet 84 – N	768	822	1024	376	264
Map sheet 84 - O	69	48	178	82	59

Management Implications

- Riparian areas should be conserved as much as possible near watercourses as beaver will use habitat up to 200m from the waters edge.
- Cavity trees within near beaver habitat should be conserved as well, due to use by cavity-nesting waterbirds. If harvest is progressed, retention patches should be left surrounding the suitable nesting tree.
- Harvest should limit the amount of material that may enter the waterway, as stated in the ground rules.
- Wetlands associated with beaver ponds should be maintained due to the increased diversity and abundance of species.
- Terrestrial areas near suitable lodge habitat should be identified and foraging areas conserved.

Research Needs

Limited research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

1. Habitat suitability associations
2. Effects of anthropogenic disturbance
3. Community association, especially between beaver habitat and sensitive species, such as the Northern Myotis.
4. The effects of harvest on forest composition and the resultant increase in beaver use, due to new stands of deciduous timber.
5. Usage of beaver impoundments by cavity-nesting waterbirds.
6. Use of beaver impoundments by herpetofauna.
7. Harvest effects on trapper success

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American Marten (Pine Marten)

Martes americana actuosa

American Marten (USFWS)

Introduction

The American Marten is widely distributed and is a common resident throughout the boreal region of Alberta. Its range typically coincides with the northern boreal forest, as well as montane forests (Pattie and Fisher, 1999). Provincially, the American Marten is rated green by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The diet is quite varied, as the American Marten is quite opportunistic. General habitat preference consists of mature to old coniferous and mixed coniferous forests, with an abundance of coarse woody debris. Winter denning is tied to subnivean environments, especially associated with squirrel middens. The Marten is an excellent indicator of environmental conditions, and has long been known to be affected by timber harvest. Due to its lustrous fur, the Marten is one of most utilized fur-bearing species trapped in Alberta. Throughout North America, the American Marten is also known as the Pine Marten.

Food

- The American Marten feeds on a wide variety of species, including small mammals, squirrels, hares, pikas, beaver, marten, muskrat, porcupine, woodchuck, bobcat, fruit, insects, eggs, ungulates, grouse and other small birds, although most nutritional energy is gained from large mammals, such as the Snowshoe Hare (Cowan and Mackay, 1950; Lensink, et. al., 1955; Quick, 1955; Banfield, 1977; Koehler and Hornocker, 1977; Taylor and Abrey, 1982; Douglass, et. al., 1983; Hargis and McCullough, 1984; Forsyth, 1985; Thompson and Colgan, 1988; Cumberland et. al., 2001;

Nagorsen et. al., 1991; Sherburne, 1993 Buskirk and Ruggiero, 1994; Paragi and Wholecheese, 1994; Cumberland et. al., 2001).

- In winter, the American Marten is randomly active throughout the day and night, taking larger species. Snowshoe Hares are most prevalent during the night, while the other main prey species, the Red Squirrel, and are most active during the day. During the summer, however, small mammals are preyed upon more frequently (Foresman and Pearson, 1999; Bull, 2000).
- The Red-backed Vole is a major food item, but only because of opportunity. The vole is not sought out, but rather discovered while hunting Snowshoe Hares, especially as hare numbers decline (Poole and Graf, 1996; Simon, et. al., 1999).
- Small mammals (mice, shrews and voles) were more abundant at midden sites than at non-midden sites (Pearson and Ruggiero, 2001).
- There is evidence of predation of a Northern Goshawk (Paragi and Wholecheese, 1994).
- Males and females eat the same food, proving no resource partitioning (Simon, et. al., 1999).
- It is assumed that food is not limiting if adequate cover is present (Allen, 1982).

Foraging Habitat

- The forest structure utilized by Martens consists of late-successional coniferous forest that provides protection from predators, access to subnivean space, and provides thermal protection in the winter. Mesic habitat, with trees over 15 cm dbh, decadent standing trees, and complex structural diversity, near the forest floor, is considered optimal habitat for the Marten and small mammal prey species such as *Clethrionomys* and *Microtus spp*. (Banfield, 1974; Marcot et. al., 1980; Taylor and Abrey, 1982; Douglass et. al., 1983; Forsyth, 1985; Slough, 1989; Buskirk and Ruggiero, 1994; Latour et. al., 1994; Sherburne and Bissonette, 1994; Thompson, 1994; Thompson and Colgan, 1994; Thompson and Curran, 1995; Chapin et. al., 1997). No studies showed a preference for deciduous habitat over coniferous habitat (Buskirk and Ruggiero, 1994), except in Quebec, where the critical habitat variable is considered mature to old deciduous stands, with a dense coniferous shrub layer (Potvin et. al., 2000).
- Important variables in determining habitat usage are proximity to water/meadows, large tree density, small tree density, percent litter cover, percent small deciduous trees, density of standing dead stems, tall herbaceous growth, greater canopy height, greater canopy closure, and the quantity of logs and

other woody debris on the ground (Spencer et. al., 1983; Thompson and Curran, 1995; Chapin et. al., 1997).

- Martens can use open habitats if a dense complex of coarse woody debris and a low overstory is present; however, stands less than sixty years old tend to lack these required attributes. Other habitat types that tend to be avoided are those with limited overhead cover, such as prairie, meadow, clearcuts, or tundra (Koehler and Hornocker, 1977; Hargis and McCullough, 1984; Buskirk and Ruggiero, 1994; Latour et. al., 1994; Thompson and Curran, 1995).
- Microhabitat for travel tends to always include low-hanging branches, useful for concealment, escape, or hunting (Hargis and McCullough, 1984).
- Resting sites in summer tend to be in coniferous canopies, usually in areas altered by mechanical or fungal damage, such as ‘witches broom’ (created by *Chrysomyxa arctostaphyli* and *Melampsorella caryphyllacearum*) (Steventon and Major, 1982; Wynne and Sherburne, 1984; Bull and Heater, 2000).
- Home range size is not significantly correlated with latitude or annual average temperature, but rather with local ecological factors in the local habitat, with male home range being larger (≈ 1.9 times) than female range. Overlapping, average home ranges vary 100 ha to 1100 ha, throughout the range of the Marten. Densities average of 0.8 – 1.1 Marten/ km^2, with an estimated minimum of 0.17 Martens/ km^2 in suitable habitat. The greatest degree of overlap occurs in female/female territories, while the least overlap occurs in male/male territories, where an increased degree of territoriality is exhibited (Steventon and Major, 1982; Buskirk and McDonald, 1989; Clark et. al., 1989; Slough, 1989; Buskirk and Ruggiero, 1994; Katnik et. al., 1994; Latour et. al., 1994; Thompson, 1994).
- Marten disperse as juveniles, when establishing a home territory, or when food resources are low. Typically, distances are limited under ten km; however, movements over 100 km are possible (Banfield, 1974; Thompson and Colgan, 1988; Slough, 1989; Veitch, 1997; Potvin et. al., 1999)
- Marten may prefer partially-cut mixed-woods or second-growth forests (Steventon and Major, 1982; Bowman and Robitaille, 1997).
- Harvest blocks, burned stands, and other areas of disturbed habitat are not considered suitable for the Marten. Although many attributes, such as abundant downed woody debris, plentiful herbaceous cover, and an exploding small mammal population may be present, the habitat may act as a population sink, and through evolutionary adaptation, Martens avoid these areas. Densities, thus, are

typically very low in harvest areas, ranging from 0.08-0.20 Marten/ km^2 (Steventon and Major, 1982; Hargis and McCullough, 1984; Thompson and Colgan, 1988; Latour et. al., 1994; Thompson, 1994; Paragi et. al., 1996; Hargis et. al., 1999; Potvin et. al., 2000). Marten typically incorporate harvest blocks into their home range, but tend to usually travel parallel to the block, using the harvest blocks less than expected. Marten will cross openings ≤50m wide, but will not rest or hunt in them. Openings >50m were only crossed by traveling through patches of scattered trees, to an average maximum of 135m. Some individuals have been shown to traverse large openings (up to 2km), but only when large wooded patches were present (Banfield, 1974; Steventon and Major, 1982; Hargis and McCullough, 1984; Buskirk and Ruggiero, 1994; Potvin et. al., 1999). Harvest blocks do not typically become suitable habitat until after at least 30 years of regeneration, but is dependant on stand composition (Thompson et. al., 1989; Potvin et. al., 1999).

- Marten appear to respond negatively to a low degree of forest fragmentation, to a general lack of suitable habitat when non-forest cover becomes greater than 25% (Hargis et. al., 1999).
- Martens are sensitive, not only to habitat loss, but also to the size and proximity of open areas within the range (Hargis et. al., 1999).
- Forest stands, with less than 100m between cuts, is considered unsuitable habitat as the Marten exhibits edge response to the strips (Hargis et. al., 1999).
- In Newfoundland, densities were higher in forest interior; however, after prescribed harvest, the abundance shifted to the riparian areas (Forsey and Baggs, 2001). The results suggest that even small changes can have immediate and significant consequences.
- Areas with spruce budworm outbreaks (15-20 years previous) are preferred (Potvin et. al., 2000).
- Four factors significantly affected the usability of habitat in the boreal forest. These include the percentage of spruce or fir trees, tree height, the number of downed logs, and percent canopy closure (Bowman and Robitaille, 1997).
- A model built for boreal coniferous forests of the United States in winter includes the following variables, all of equal value and importance $[(V_1xV_2xV_3xV_4)^{1/2}]$ (Allen, 1982):
  - Percent tree canopy closure (V_1): ≤25% = 0.0; ≥50% = 1.0
  - Percent tree canopy (spruce/fir) (V_2): 0%=0.1; ≥40% = 1.0
  - Successional stage (V_3): shrub-seedling = 0.0; pole sapling ≈ 0.25; young ≈ 0.75; mature/old growth ≈1.0
  - Percent CWD ≥7.6cm (V_4): 0% = 0.5; 20% = 1.0; 50% = 1.0; 100% = 0.5

- A model built for boreal coniferous forests in western Alberta in winter includes the following variables $[S_4x(S_1xS_2xS_3)^{1/2}]$ (Takats et. al., 1999).
  - Tree canopy closure (S_1): ≤5% ≈ 0; 30 - 70% ≈ 1.0; 100% ≈ 0.3
  - Percent tree canopy (spruce/fir) (S_2): 0% = 0.2; ≥50%: = 1.0
  - Tree Canopy Height (S_3): ≤5m =0.0; ≥15m = 1.0
  - Percent tree canopy (pine, spruce, fir) (S_4): ≤5m = 0.0; ≥15m = 1.0

Denning Habitat

- Resting and denning sites provide protection from predators, and relief from inclement and extremely cold weather. Optimal habitat is coniferous-dominant forest, in which a variety of structures are available to maximize subnivean accessibility. These include trees, logs, rocks, snags, log piles, middens, and root wads, which facilitate snow accumulation, increased interstitial space and abundance of entrance holes. Like summer habitat, use is influenced by prey abundance and availability (Allen, 1982; Douglass et. al. 1983; Bateman 1986; Spencer, 1988; Buskirk, et. al., 1989; Corn and Raphael, 1992; Buskirk and Ruggiero, 1994; Sherburne and Bissonette, 1994; Bull and Heater, 2000). Use is also dependant on air temperature. During periods of warm temperatures, Marten rested above the snow level. Alternately, as temperatures decrease, the use of subnivean structures increased (Buskirk, et. al., 1989).
- There is a significant relationship between subnivean access points and the presence of squirrel middens. As squirrels typically use old-growth coniferous stands, their middens are found in these areas. Through organic decay, middens provide heat and thermal relief for the Marten. Although the occurrence of predation is unclear, Marten and Squirrels appear to occupy the same middens during extremely cold weather (Buskirk, 1984; Buskirk et. al., 1989; Sherburne, 1993).
- Nearly all winter resting sites are subnivean, and vary between different types of forest structure: 42% in uncut stands, 28% in thinned stands, 26% in edge habitat between clearcuts and residual timber, and 4% in the harvest block (Steventon and Major, 1982).
- Resting sites are typically closer to surface water than random sites (Buskirk et. al., 1989).
- Martens tended to re-use subnivean sites more often than re-using non-subnivean sites as denning and resting areas (Spencer, 1988).

- Winter cover is more restrictive than summer cover; therefore, if winter cover is adequate and available, habitat will not be limiting throughout the year (Allan, 1982).
- The minimum winter habitat area in the western United States is estimated at $2.59km^2$ (Allen, 1982).
- Maternal dens vary throughout the rearing process. Although typically mature spruce forest is used, old burns, riparian shrub, and black-spruce bogs are incorporated as well. Kits are moved at different stages of development, using tree cavities and ground-level subnivean dens. Post natal dens are utilized in these habitats, plus also in slash piles (Wynne and Sherburne, 1984; Veitch et. al., 1997; Bull and Heater, 2000).
- Average American Marten natal and maternal den site characteristics (Ruggiero et. al., 1998):

	# Squirrel Middens	# hard logs >41cm dia	% canopy closure	Lodgepole Pine > 20cm dbh	Spruce/ Fir > 20 cm dbh	Snags 20-40 cm dbh	Snags > 40 cm dbh
Natal dens (0.04 ha)	1.1	4.7	67.4	7.2	23.6	2.0	1.6
Maternal dens (0.07 ha)	0.6	3.6	58.2	10.0	16.8	3.1	1.3
Random sites	0.2	2.0	58.2	14.4	10.4	1.5	0.7

Reproduction

- The mating season occurs typically between July and August (Banfield, 1974).
- Egg implantation is delayed seven to eight months, producing a gestation time of between 220-275 days (Banfield, 1974; Forsyth, 1985).
- Parturition occurs in late March to April (Banfield, 1974).
- The average litter size is 1-4 kits (Banfield, 1974; Forsyth, 1985).
- Juveniles do not breed until approximately 15-17 months (Banfield, 1974).
- Females move to denning sites mid-March to mid-June (Veitch et. al., 1997).

Community Structure

- Harvest data for the High Level area 1985-1989, as collected from volunteer submissions (AB Fish and Wildlife Div, 1990).

Marten harvested	1984/1985	1985/1986	1986/1987	1987/1988	1988/1989
Map sheet 84 - E	762	492	699	625	329
Map sheet 84 – F	443	236	542	291	121
Map sheet 84 – G	522	398	851	1172	657
Map sheet 84 – J	943	655	1124	1349	629
Map sheet 84 – K	1522	915	1440	1598	519
Map sheet 84 – L	2406	1785	2480	2982	1719
Map sheet 84 – M	622	844	1348	2485	1295
Map sheet 84 – N	1369	1276	1837	1988	826
Map sheet 84 - O	410	480	666	1067	489

- Metapopulation dynamics does not prevail with the American Marten (Buskirk and Ruggiero, 1994).
- The Marten uses many structures constructed by other species, including tree cavities, squirrel structures, and middens (Buskirk and Ruggiero, 1994).
- Predators include fisher, wolf, lynx, coyote, large owls, and man (Forsyth, 1985).

Management Implications

- Marten are reliant on coarse woody debris, and therefore this habitat should be maintained throughout the harvest area.
- Marten require large tracts of intact forest. Marten management areas of 1000 ha can be selectively harvested leaving greater than 50% of stand in patches greater than 100 ha.
- Marten tend not to cross large open spaces; therefore, disturbance to hiding cover should be minimized through block design and residual patches.
- Blocks should not be harvested within 100m of another block harvested recently.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

8. Habitat suitability associations
9. Use of slash piles left on harvest blocks in relation to size and/or distance from edge
10. Use of harvest blocks with variable attributes (width, woody debris, residual patches/strips)
11. Harvest effects on trapper success.

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Black and White Warbler

Mniotilta varia

Introduction

The Black and White Warbler is an uncommon migratory resident of Alberta. Unique coloration and habits make this species an easily identifiable in Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small increase of 2.4% /year; however, the data is deficient, and may be inconclusive (Sauer et. al., 2001). Provincially, the Black and White Warbler is rated yellow B (may require special management) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Black and White Warbler forages mainly on insects through a variety of hunting tactics, although prey are usually taken from the trunk and other woody portions of vegetation by gleaning in much the same manner as nuthatches. General habitat use consists of a variety of forest types, although dense, young deciduous is preferred, especially close to edge habitat. Nesting occurs in well hidden scrapes at ground level. The Black and White Warbler occupies a niche similar to many other species in the community, such as the Downy Woodpecker.

Food

- The Black and White Warbler generally gleans arthropods from the bark of trees, unlike other Warblers (Kricher, 1995; Fisher and Acorn, 1998)
- The diet consists of insects, invertebrate eggs, beetles, and spiders, with a focus on Lepidopteran larvae (Kricher, 1995; Fisher and Acorn, 1998).
- Feeding habits are very similar to nuthatch foraging methods (Kricher, 1995).

Roosting and Foraging Habitat

- The Black and White Warbler is correlated with young deciduous mixedwoods in Alberta. Some studies show use of these stands to be as high as 90%. Thick alder and willow growth is also utilized, especially in mesic (often swampy) habitat, near muskegs and wooded ponds (L.G.L. Ltd, 1973; Semenchuk, 1992; Schieck and Nietfeld, 1995; Schieck and Roy, 1995; Fisher and Acorn, 1998). Studies in different areas of the distribution typify the Black and White Warbler with mature forest stands, also in highly mesic, even swampy areas (Collins et. al., 1982; Welsh, 1992; Kricher, 1995; Canterbury and Blockstein, 1997).
- Optimal foraging is in the shrub layer and the canopy layer and the habitat attributes which are deemed most important are tree density (<20 cm dbh) and willow density (Kricher, 1995; Schieck and Roy, 1995; Schieck and Nietfeld, 1995)
- The Black and White Warbler is negatively associated with riparian areas directly adjacent to the waterbody. Although mesic habitat is preferred, noticeable increases in density occur as the distance from the waterbody increases. Riparian areas associated with standing water, such as muskegs, bogs, and small pools, are preferred over flowing water due to the increased soil satuaration, and increased mesic characteristics (Semenchuk, 1992; Murray and Stauffer, 1995; Morneau, et. al., 1999).

Distance from stream (m)	4	154	304	454
Abundance	0.188	0.375	0.750	0.875

- The Black and White Warbler may be well adapted to the ever-changing structure of the boreal forest, including fragmentation (possibly anthropogenic). However, individuals may avoid hard edge habitat, and therefore require a large patch to maintain viable habitat (Kroodsma, 1984; Sodhi and Paszkowski, 1997).
- As the Black and White Warbler can utilize early successional habitat, it is assumed that it will respond well to disturbance by harvest. In west-central Alberta, the highest density of Black and White Warbler territories occurred 14 years after harvest. After this time, territory density decreased to 0 by approximately 80 years (Westworth and Telfer, 1993; Annand and Thompson, 1997).

- When used, the most common post-harvest stage was pole-sized timber and selection logging, which are the same requirements as the Veery, Dark-eyed Junco, Black-throated Blue Warbler, and the Black-capped Chickadee (Thompson and Capen, 1988).
- In Minnesota, Black and White Warbler abundance was significantly greater in logged areas (0.42 males/ ha) than in burned areas (0.14 males/ ha) (Schulte and Niemi, 1998).
- The Black and White Warbler exhibited higher densities after harvest, possibly due to a greater abundance of large, live residual trees and a taller shrub layer (Hobson and Schieck, 1999).

Reproduction

- The clutch size is usually 4-5 (Semenchuk, 1992; Fisher and Acorn, 1998).
- Incubation time is usually 10-13 days (Semenchuk, 1992; Fisher and Acorn, 1998).

Nesting Habitat

- Nests are placed on or very close to the ground, in a scrape or other similar depression formed by disturbed earth, live vegetation, and/or woody debris. Nests are typically lined with moss, grass, leaves and other vegetative material (Salt, 1973; Semenchuk, 1992; Schieck and Roy, 1995; Sodhi and Paszkowski, 1997; Fisher and Acorn, 1998; Artman et. al., 2001).
- The nest structure is usually well hidden. In Alberta, the nest is typically associated with a deciduous tree, bush, mossy bank, fallen tree, stump, or windfall, providing overhead concealment cover. Although the Black and white Warbler is fairly common in wet areas dominated by Black Spruce, nests are seldom associated with these trees (Salt, 1973; Kricher, 1995).
- Nesting success is markedly increased in contiguous forest stands, rather then in fragmented forests; however, natural, soft edge habitat is preferred in the western boreal forests, when the nest is constructed within mature forest stands (Smith, 1992; Sodhi and Paszkowski, 1997).
- One component of breeding habitat for this species was the presence of dense forest (Thompson and Capen, 1988).
- Birds occur at relatively low densities (0.03-0.61 males/ ha), regardless of forest type (Sodhi and Paszkowski, 1997).

- Territories are typically defended by males and range between 10 and 30 territories/ 40 ha in optimum habitat (Kricher, 1995).
- After forest harvest and successive years of regeneration, the Black and White warbler population fell to 0 individuals in upstate New York. The trend is constant for neotropical birds, which show an overall decline of 55% in harvested areas (Litwin and Smith, 1989).
- Minimum patch size must be at least 7.5 ha (Galli et. al., 1976).
- Water tends to always be near the nest (Salt, 1973).
- Nesting habitat within 0.04ha in Minnesota averaged (Collins et. al., 1982):
  - groundcover = 65.5%
  - canopy cover = 72.5%
  - tree species diversity = 5.8 spp
  - trees 7.5-15cm dbh = 17.5
  - trees 23.1-30cm dbh = 8.6
  - trees 38.1-53cm dbh = 2.6
  - trees >68cm dbh = 0.0
  - shrubcover = 51.5%
  - canopy height = 14.8m
  - conifer component = 30.5%
  - trees 15.1-23cm dbh = 8.8
  - trees 30.1-38cm dbh = 5.7
  - trees 53.1-68cm dbh = 0.3

Community Structure

- European Starlings may have a negative effect on native bird nesting and breeding (Weitzel, 1988).
- The Brown Headed Cowbird infrequently parasitizes Black and White Warbler nests, although the outcome of the Cowbird egg is unclear (Kricher, 1995).
- Although little information exists in regards to predation of adults, young, and eggs, it can be assumed due to habitat use and nest location that predation rates are quite high (Kricher, 1995).

Migratory Behaviour

- The Black and White Warbler arrives in Alberta near the middle of May in mixed flocks (Salt, 1973; Semenchuk, 1992).
- Winter migration usually ends by the first week of September, when individuals form into mixed flocks (Salt, 1973; Semenchuk, 1992).
- The Black and White Warbler is considered a long-distance migrant, with wintering habitat typically in Central America and the northern aspect of South America (Kricher, 1995).

Management Implications

- Long-term goal should be to provide a mosaic of forest types, with an emphasis on deciduous and deciduous-dominant mixedwood stands.
- As ground-level habitat is utilized, understory and ground vegetation should be disturbed as little as possible.
- The Black and White Warbler is a forest interior species. Large, contiguous patches should therefore be retained at early seral stages, such as a young mixedwood stand.
- Maintain vegetative integrity by protecting water source (marsh, bogs, and small ponds) as suitable habitat.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

12. Habitat suitability associations
13. Nesting efficiency as related to edge (both natural and anthropogenic)
14. Local population dynamics, as the Black and White Warbler is uncommon
15. Use of harvest areas in relation to differing residual structure
16. Threshold size of interior forest patches necessary to provide suitable habitat for Black and White Warblers.

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Black Bear (K. Morton)

Black Bear

Ursus americanus americanus

Ursus americanus cinnamomum

Introduction

The Black Bear is a common resident of north-western Alberta. Its coloration (light brown through black), lack of shoulder hump, smaller size, and facial profile make the Black Bear easily identifiable, (and discernable from the Grizzly Bear) within Tolko Industries Ltd (HLLD) FMA area. Provincially, the Black Bear is rated green by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks The Black Bear forages mainly on plant material, although this omnivore will also consume carrion and hunt other vertebrates. Generally considered a forest inhabitant, the species prefers mature mixed forest, near dense cover. Winter denning usually occurs under overhead cover, such as a cave, overhanging rock, deadfall, or root wad, where excavations are made to provide a small compartment. This well-known resident has few natural predators, other than man.

Food

- The Black Bear, like the Grizzly Bear, is omnivorous, feeding on grasses, flowers, sapwood, roots, bulbs, tubers, corms, berries, forbs, fruit, nuts, twigs, leaves, invertebrates (typically insects), fish, and mammals (Forsyth, 1985; (Herrero, 1985; Jacoby et. al., 1999).
- Vegetation comprises the majority of the Black Bear diet, making up greater than 70% of the total (Boileau et. al., 1994; Pattie and Fisher, 1999).

- Diet composition changes throughout the season. Herbage, such as graminoids and other green vegetation comprise approximately 60% of the spring forage. Through summer and autumn, seeds, nuts and berries become the main component of the diet, making up approximately 65% at this time (Herrero, 1985; Holcroft and Herrero, 1991; Boileau et. al., 1994).
- Water must be a component of the home range, for drinking, thermal regulation, and the growth of highly nutritious foods (Roger and Allen, 1987).

Foraging Habitat

- The Black Bear is adapted to the forest environment, using areas of both deciduous and coniferous forests; however, forests consisting of a mosaic of habitat types are most beneficial to the Black Bear (Banfield, 1974; Herrero, 1985).
- The Black Bear is correlated with mature Aspen mixedwoods (≈70%), old Aspen mixedwoods (≈25%) and young Aspen mixedwoods (≈5%) for cover habitat; however, mature Aspen mixedwoods offer very little forage opportunities for the Black Bear (Banfield, 1974; Unsworth et. al., 1989; Clark et. al., 1993; Boileau, 1994; Roy, et. al., 1995; Schieck and Roy, 1995). Homogenous Spruce and Muskeg areas are not avoided, but are used significantly less than available during the non-denning period (May through October) (Young and Ruff, 1982).
- The seasonal changes in habitat use are dependant upon changing forage requirements throughout the summer, suitable cover habitat, den sites, and mating grounds. Black Bears typically do not venture more than 200 meters from security cover, which tends to be extraordinarily dense, when compared to the surrounding composition (Herrero, 1985; Boileau, 1994).
- A preference for forests with insect outbreaks is favoured when available. Ant populations may increase due to retention of downed woody debris on harvested blocks, drawing bears into the block (Boileau, 1994).
- Bedding areas are variable with weather conditions, time of day, and the time of the year (Herrero, 1985).
- Home ranges typically encompass the variety of structure needed to fulfill the yearly life requisites of food acquisition, den sites, and mating areas. Home range size is quite variable and is dependant on the total available dietary biomass available. Female home range averaged between 1000 and 5000 ha. Male home ranges were substantially larger and averaged between 1 500 and 25 000ha

(Fuller and Keith, 1980; Young and Ruff, 1982; Clark et. al., 1993; Boileau, 1994; Samson and Huot, 1998). Range overlap can be quite common, and extensive in some ranges. The most overlap occurs between female/female ranges, whereas the least overlap occurs within male/male territories (Young and Ruff, 1982). In Alaska, all sub-adult males dispersed upon break-up of the family unit, while 97% of sub-adult females remained in the local habitat area of the mother (Schwartz and Franzmann, 1992).

- Disturbances in mature forest, such as logging, insect outbreaks, and fire create optimal summer foraging habitat for Black Bears, due to the increased fruit production of early successional shrubs. Blocks more than 17 years after disturbance appear to be ideal due to a balance between vegetation availability as well as suitable cover habitat (Boileau, 1994; Stelfox et. al., 2000). Due to the limitations of optimal foraging habitat, these areas tend to belong to several home ranges, leading to overlap of territories (Samson and Huot, 2001).
- Black Bears showed no preference for scarified or unscarified forest (Stelfox et. al., 2000).
- After disturbance, Black Bear abundance gradually increases to the maximum capacity as the age of the cutblock increases. After a critical age, habitat becomes less suitable, and the carrying capacity will decrease (Boileau, 1994; Stelfox, et. al., 2000).
- Dispersing sub-adult males have a relatively high mortality rate, due to usage of easily-traveled corridors such as roads, which make them more susceptible to human disturbance including hunting (Schwartz and Franzmann, 1992).
- A model built for boreal coniferous forests in western Alberta in winter includes the following variables (Zapisocki et. al., 1998).
  - Stand dbh (S_1): ≤10cm = 0.0; ≥20cm = 1.0
  - Percent canopy cover (S_2): ≤10% = 0.0; ≥70% = 1.0
  - Shrub cover (S_3): 0% = 0.0; ≥10% = 1.0
  - Distance from cover (S_4): ≤200m = 1.0; ≥400m = 0.0
  - Distance from linear disturbance (S_5): 0m = 0.0; ≥250m = 1.0
  - Distance from human activity (S_6): 0km = 0.0; ≥5km = 1.0
    - HSI (cover) = S_1 x S_2
    - HSI (foraging) = S_3 x S_4
    - HSI (effective cover) = S_5 x S_6
    - HSI (effective foraging) = S_5 x S_6

- A model built for the upper Great Lakes region, including portions of Michigan, Minnesota, and Wisconsin, evaluates the entire female average home range (Rogers and Allen, 1982):
  - Percent wetland (excluding open water) (V_1): 0% = 0.5; 5-25% = 1.0; 100 = 0.5
    - HSI (spring food) = V_1
  - Percent canopy cover (soft-mast producing shrubs) (V_2): 0% = 0.1; ≥25% = 1.0
  - Number of soft-mast producing species (V_3): 0 = 0.1; ≥6 = 1.0
    - HSI (summer food) = $(V_2 \times V_3)^{1/2}$
  - Basal area (m^2/0.4 ha) hard-mast producing species ≥40 years (V_4): 0.0 = 0.1; 6.975-8.37 = 1.0; 9.3 = 0.9
  - Number of hard-mast producing species (≥1 mature tree/ 0.4 ha) (V_5): 1 = 0.75; 2 = 0.9; 3 = 1.0
    - HSI (fall food) = $(V_4 \times V_5)^{1/2}$
  - Percent non-forest cover ≤250m from forest (V_6): 0% = 0.2; 25-50% = 1.0; ≥75% = 0.0
  - Percent area with hard mast species (V_7): 0% = 0.1; ≥35 = 1.0
  - Percent inside zone of human influence (V_8): 0% = 1.0; 100% = 0.05
    - Z = K/DM
      - Z = zone of influence
      - K = number of bears killed per year at sink
      - D = bear density
      - M = maximum annual sustainable mortality
    - HSI (human influence) = V_8
    - HSI = $\left[\frac{\text{(spring food)} + [\text{(summer food)} \times V_6] + [\text{(fall food)} \times V_7]}{3}\right] \times \text{(human influence)}$

  May need to weigh variables based on entire range, due to variable forest coverage!

Reproduction

- Cubs are usually born every second year, with an average litter size of two (Forsyth, 1985). Females are able to rear consecutive-year litters as long as suitable food supplies exist; alternatively, a failure in food supply can cause lower cub production the following year. Food supply is thus a limiting variable for Black Bear populations (Young and Ruff, 1982; Seguin, 1992).

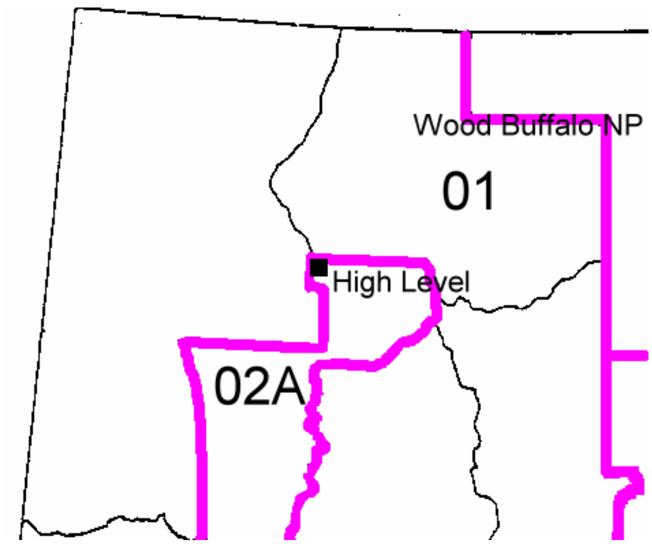
- The size of the reproductive range depends on sex, age, and reproductive status, although distinctive mating areas may not be prevalent (Herrero, 1985; AB. Env. Prot., 1993).
- Mating typically occurs from June through August, with implantation of the embryos delayed until the sow enters the winter den. The overall gestation period is approximately 210-220 days, with cubs being born while the sow is still hibernating, from January through March (Britton and Graves, 1985; Forsyth, 1985; Pattie and Fisher, 1999).
- Family-group break-up occurs mid-May to mid-July the following year (Schwartz and Franzmann, 1992).

Denning Habitat

- Denning habits in the winter seem to be a response to a lack of food supplies, rather than refuge from the cold. In Alberta, denning typically occurs October through November (Tietje and Ruff, 1980; Herrero, 1985).
- Den sites were placed near the periphery of the summer home range, typically within mature (86%) mixed-wood or spruce forests, although lowland spruce and other muskeg areas were avoided (Tietje and Ruff, 1980).
- Dens are typically built on the forest floor, unlike dens built by Grizzly Bears, which tend to be on sloping areas. Brush piles, rock crevasse, hollow trees, and upturned root masses may also be used as supporting structure as dens are usually excavated to a depth of between 33 and 111cm in Alberta (Banfield, 1974; Tietje and Ruff, 1980; Fuller and Keith, 1980; Alt, 1984; Herrero, 1985).
- Black Bears may reuse dens excavated from a previous winter, or construct a new den (Fuller and Keith, 1980; Tietje and Ruff, 1980; Alt, 1984).
- Industrial disturbance near denning sites elicited variable responses, but typically resulted in abandonment, significantly increasing the rate of cub mortality (Linnell et. al., 2000).
- Emergence form the den site occurred in March and April in east-central Alberta (Tietje and Ruff, 1980).

Community Structure

- Black Bears will displace Cougars, and subsequently consume their kill (Murphy et. al., 1998).
- There is no major threat to Black Bears in Canada at the present time, with Alberta's population in 1993 at an estimated 39, 600 individuals (Pelton et. al., 1999).
- Tolko Industries Ltd. (HLLD) is in bear management zone 1 and 2A (AB. Env. Prot., 1993).
- Gypsy moth infestation appears to have little effect on the Black Bear (Kasbohm et. al., 1996).
- Predators are quite limited, but Grizzly Bears, Wolves, and man do increase mortality (Forsyth, 1985; Boyd and Heger, 2000).



Black Bear Management Areas in Alberta (Ab. Env Prot. 1993).

- The Black Bear typically avoids human conflict, although they may become habituated, and develop into nuisance bears consuming garbage and increasing the potential for encounters with people (Herrero, 1985; Pattie and Fisher, 1999).
- Estimated numbers of Black Bears near High Level, Alberta in 1990 (AB. Env. Prot., 1993).

WMU	524	528	534	535	536	537	540
Bear Numbers	950	1050	1200	450	2400	400	1100

- Estimated harvest data for the High Level area 1995, as collected from volunteer submissions (AB Env. Prot, 1997).

Demographic	WMU	524	528	534	535	536	537	540
Male		34	12	4	8	21	10	8
Female		4	0	0	0	4	0	0
Young		0	0	0	0	0	0	0

Management Implications

- Preservation of understory shrubbery, especially fruit-bearing vegetation.
- Stands disturbed by fire or insects may provide suitable habitat.
- Management should be based year-round as requirements are variable through the seasons.
- Den sites should be left undisturbed during winter.
- Coarse woody debris, especially large stumps and large-bole logs, should be maintained as suitable ant colonization substrate. This may increase suitability of harvest blocks for the Black Bear.
- At a larger scale, forests should be managed as a mosaic with components from all age classes.
- Denning sites should be avoided if encountered during harvest, as disturbance may lead to cub and/or mother death.

Research Needs

Little research has been conducted within the north-western boreal region of Alberta. Future research should be directed towards:

17. Habitat suitability associations
18. Denning microhabitat variables
19. Local population dynamics
20. Habitat suitability variables of post-harvest areas such as vegetation type, age, cover, and post-harvest treatment.
21. The optimal age to harvest timber in relation to decreasing carrying capacity.
22. Harvest effects on hunter success.

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Black-backed Woodpecker

Picoides arcticus

Black-backed Woodpecker (USFWS)

Introduction:

The Black-backed Woodpecker is an uncommon year-round resident of Alberta, but easy to view, once located within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, no data exists for Alberta-exclusive populations, although boreal forest trends have shown a general decrease of 2.3 to 10.0% /year (Sauer et. al., 2001). Provincially, the Black-backed Woodpecker is rated yellow B (may require special management) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000 and S2 (imperilled in Alberta) by the Heritage status ranks. The Black-backed Woodpecker forages primarily on insects, especially the larvae of wood-boring beetles. Habitat composition is varied with the utilization of mature-to-old coniferous forest; however, a preference for burned-over areas is exhibited. Nesting occurs in cavities excavated in many different species of trees, showing little preference for living, dead, or burned substrate. The Black-backed Woodpecker occupies habitat very similar to the Western Tanager.

Food

- The Black-backed Woodpecker feeds mostly on wood-boring beetle larvae, particularly those which colonize forest stands immediately following fire disturbance. Preferred species taken include Long-horned Beetles (Cerambycidae), and Metallic Wood-boring Beetles (Buprestidae), comprising >75% of the diet. Engraver beetles, pine beetles, spiders, cambium mast, and wild fruit are also consumed

(Semenchuk, 1992; Villard and Beninger, 1993; Villard and Schieck, 1997; Murphy and Lenhausen, 1998; Hoyt, 2000).

- Both male and female Black-backed Woodpeckers obtain food typically through drilling, although flaking, pecking, or excavating are methods also employed (Semenchuk, 1992; Villard, 1994; Murphy and Lenhausen, 1998).

Foraging Habitat

- The breeding range of the Black-backed Woodpecker is closely associated with the extent of the northern boreal forest. Although tree species composition varies geographically, similarities within the range are observable. Preferred habitat is associated with contiguous mature to old coniferous and coniferous-mixedwood forests. Important tree species include Spruce, Tamarack, northern Pines, Red Fir, Mountain Hemlock, Douglas Fir, Ponderosa Pine, Lodgepole Pine, and Trembling Aspen. The abundance of Black-backed Woodpeckers in undisturbed habitat, however, is dependant on the quantity and quality of burned areas available within their distribution. Burned-over areas, especially coniferous, are preferred habitats and are actively colonized when available (Boch and Boch, 1974; Apfelbaum and Haney, 1981; Smith, 1992; Villard, 1994; Villard and Schieck, 1997; Fisher and Acorn, 1998; Murphy and Lehnhausen, 1998; Imbeau et. al., 1999; Dixon and Saab, 2000; Hoyt, 2000; Setterington et. al., 2000).
- Individuals may occupy burns in as little as three months post disturbance, and utilization may continue for up to eight years, depending on the severity of the burn and the abundance of standing timber remaining. Typically, abundance decreases markedly between 8-16 years as the habitat becomes unsuitable for the wood-boring beetles (Dixon and Saab, 2000; Hoyt, 2000).
- Stands where insect defoliation is prevalent may provide alternate habitat for the Black-backed woodpecker. Unburned older forest is possibly a ‘refuge’ habitat when local, burned forests are unavailable. Although Black-backed Woodpeckers use unburned mature forest as secondary habitat, fitness level is assumed to be at a lower level than those individuals inhabiting burned areas (Hutto, 1995; Murphy and Lehnhausen, 1998; Hoyt, 2000; Setterington et. al., 2000).
- Utilized old growth Black Spruce in Alberta had a mean density of 3.0 deciduous trees / 100m^2, compared to a total of 60.3 total standing trees /100m^2, and 16.20cm dbh (Hoyt, 2000).

- Large snags are very important in habitat areas of unburned forest, as they provide for nesting and foraging habitat (Setterington et. al., 2000).
- Although most foraging occurs on standing timber, trunks and recently downed, charred spruce, tamarack and jack pine logs can be a very important foraging substrate for the Black-backed Woodpecker, especially in Alberta (Villard, 1994; Murphy and Lehnhausen, 1998; Hoyt, 2000).
- In Newfoundland, the Black-backed Woodpecker predominantly used old forests (>80 years), whereas young (≤40years) and mature (41-80 years) were used very sporadically (Setterington et. al., 2000). The stand attributes associated with the old forest were:

  - tree density (stems/ ha) = 1253
  - small tree density (stems/ ha) = 692
  - white birch density (stems/ ha) = 18
  - snag density (stems/ ha) = 975
  - white birch snag density = 57
  - snags > 20cm dbh (stems/ ha) = 132
  - canopy cover (%) = 66.5
  - mean snag dbh (cm) = 11.8
  - mean snag height (m) = 6.5
  - woody debris > 10 cm (m3/ ha) = 55.2

- Foraging site characteristics of burned habitat in Alaska (Murphy and Lehnhausen, 1998):

	% Spruce	% Standing	Burn Severity Index (1= unburned; 5=burned heavily)	Tree Height(m)	Tree Circum. (cm)
Male	97.8	94.8	3.2	24.7	114.3
Female	100.0	97.6	3.7	26.2	109.9
Total	98.5	96.1	3.4	25.4	115.7

- Densities in burned Alaskan forests were as high as 0.25 individuals/ ha (Murphy and Lehnhausen, 1998).
- When burns are available, individuals may not use adjacent old growth (Hoyt, 2000).
- Home range size is variable as new territories are founded in newly burned areas. In Vermont, home range averaged 61 ha and in Oregon averaged 124 ha (summary in Dixon and Saab, 2000).
- Irruptive movements occur well outside of the breeding range, possibly in search of possible feeding sites (Dixon and Saab, 2000).
- Black-backed Woodpecker abundance followed the developmental cycle of the White-spotted Sawyer Beetle (*Monochamus scutellatus*) in Alaska. Once beetles were transformed into adults, Black-backed Woodpeckers disappear from the local area (Murphy and Lehnhausen, 1998).

- Individuals show fidelity to larger areas (≈500ha) than home range, possibly to incorporate burned areas (Dixon and Saab, 2000).

Reproduction

- Breeding season is typically May through June (Dixon and Saab, 2000).
- Eggs are usually laid June through August (Dixon and Saab, 2000).
- Clutch size is usually 3-4 eggs (Semenchuk, 1992).
- Incubation time is approximately 14 days (Semenchuk, 1992).
- Young fledge at around 24 days (Dixon and Saab, 2000).

Nesting Habitat

- Breeding occurs in dense, mature to old forest, often in areas disturbed by fire, logging, windfall, insect damage, or natural openings such as meadows, ponds, lakes, bogs and other wetlands. Evidence shows use of both coniferous and deciduous stands for mating and nesting, although coniferous is highly preferred (Semenchuk, 1992; Villard, 1994; Villard and Schieck, 1997; Hoyt, 2000; McClelland and McClelland, 2001).
- Nests are built in live or dead trees including Quaking Aspen, Paper Birch, Douglass Fir, Western Larch, Red Maple, Jack Pine, Lodgepole Pine, Ponderosa Pine, Red Pine, Tamarack, Black Spruce, White Spruce, Balsam Fir, Noble Fir, and Silver Fir, although in Alberta, coniferous trees are used exclusively (Dixon and Saab, 2000; Hoyt, 2000).
- Nesting typically occurs in excavations (within the sapwood, rather than heartwood) in the trunk, or large limb, of dead or living coniferous trees (Semenchuk, 1992; Fisher and Acorn, 1998; Dixon and Saab, 2000).
- In Alberta, nests were occupied as little as two weeks after decimation by a major fire, although the excavation may have been completed prior to the fire by another species (Villard and Schieck, 1997).
- Nest trees are typically large (>35cm dbh) and tall (> 20m), with the nest hole typically around 10m high (summary in Dixon and Saab, 2000).

Community Structure

- Little information exists for predators, although it can be assumed that owls and hawks prey on adults and fledglings. Predators of young may include owls, hawks, and small mammals (Dixon and Saab, 2000).
- Black-backed Woodpecker habitat needs (white spruce and mixed forests) are the same as the Western Tanager, Boreal Chickadee, Brown Creeper, Solitary Vireo, white-winged Crossbill, Bay-breasted Warbler, Blackburnian Warbler and the Winter Wren (Hobson and Bayne, 2000).
- The foraging ecology of the Black-backed Woodpecker is very similar to the Three-toed Woodpecker and the Hairy Woodpecker; however, there does seem to be some dietary differences (Murphy and Lenhausen, 1998).

Management Implications

- Can mimic insect outbreaks by killing 4-5% of trees within a stand, and leaving them standing.
- Disturbed, standing, large bole timber should be conserved in large, contiguous blocks. Salvage logging should be limited in burned areas that are very small.
- Old growth forest is secondary habitat for the Black-backed Woodpecker and harvest should be limited in these stands.
- In burned spruce and pine mixed stands, salvage logging should retain >10 trees (>15 cm dbh) /100m^2. In areas dominated by white spruce >30 trees (>15 cm dbh)/ 100m^2 should be retained. All other small-diameter trees, saplings and burnt shrubbery should be maintained as well.

Research Needs

Some research has been conducted within the northern boreal region of Alberta, particularly by Jeff Hoyt, in fulfillment of his MSc at the University of Alberta. Future research should be directed towards:

23. Habitat suitability associations.
24. Nesting efficiency as related to natural or mimicked burns.
25. Effects of salvage logging on the Black-backed Woodpecker.

26. How is habitat used within Tolko Industries Ltd (HLLD) FMA area when burned areas are limited.
27. Population dynamics, particularly source-sink dynamics

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Black-capped Chickadee

Parus atricapillus septentrionalis

Black-capped Chickadee (Ben Israel)

Introduction

The Black-capped Chickadee is a very common year-round resident of Alberta. Unique coloration and vocalization make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small increase of 0.5% /year (Sauer et. al., 2001). Provincially, the Black-capped Chickadee is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Black-capped Chickadee forages mainly on insects, through a variety of hunting tactics. General habitat use consists of a variety of forest types, although mature to old deciduous is preferred, especially close to edge habitat. Nesting occurs in cavities of partially decayed, predominantly deciduous trees. The Black-capped Chickadee has similar habitat needs to many other species within Tolko Industries Ltd (HLLD) FMA area.

Food

- The diet of the Black-capped Chickadee is variable throughout the year due to the fluctuating availability of food items. During winter, the diet is comprised of approximately 50% animal and 50% vegetable matter. During the summer, however, insects comprise 80-90% of the diet due to their seasonal abundance. Common insect prey includes Lepidopteran larvae (≈50-75%), Arachnida (≈10-15%), Coleoptera and Lepidopteran adults. The Black-capped Chickadee will also occasionally scavenge fat from large dead vertebrates (Hamerstrom, 1942; Kluyver, 1961; Southern, 1966; Glase, 1973; Valone and Lima, 1987; Smith, 1991). Plant material eaten includes weed seeds, conifer seeds, and soft fruiting bodies (Smith, 1993; Koenig and Knops, 2001).

- Several methods of prey capture are employed, including gleaning, hanging, hovering, probing and hawking (Robinson and Holmes, 1982).
- The chickadees will cache seeds and sometimes insects, in holes, under bark, on conifer needle bunches, or even in the snow/dirt (Heinrich and Collins, 1983; Smith, 1993).
- Individual members of a flock feed within 10m, but seldom at close quarters (Smith, 1993).
- Water is taken if there is a source nearby (surface/snow), although they probably obtain much of their water from prey items consumed (Odum, 1942; Smith, 1993).

Roosting and Foraging Habitat

- The preferred habitat of the Black capped Chickadee is comprised of Deciduous and Deciduous mixedwoods, willow thickets, and riparian brush, although individuals may use open conifer and harvested cover types even when deciduous elements are present (Desrochers, 1989; Semenchuk, 1992; Smith, 1993; Hutto and Young, 1999). Stand age appears to not affect habitat suitability, as individuals have been found in young Deciduous mixedwood stands (≈20%), mature Deciduous mixedwood stands (≈35%) and in old Deciduous mixedwood stands (≈45%) in Alberta (Schieck and Nietfeld, 1995). Generally, the species is more common near wooded edges, but can be found within the middle of large wooded tracts. Black-capped Chickadees were most abundant on upland mixed/lowland spruce edges, when compared to several other edge types (Smith, 1992; Smith, 1993; Hawrot and Niemi, 1996).
- Habitat layers associated with Black-capped Chickadee habitat suitability include the understory, the shrub midstory and the overstory canopy (Short and Williamson, 1984). Habitat attributes which are deemed most important in Alberta parkland are tree density (<20 cm dbh), and willow density, and shrub/sapling density (Schieck and Nietfeld, 1995).
- Black-capped Chickadees are typically arboreal foragers, utilizing deciduous species >80% of the time (Robinson and Holmes, 1982; Smith, 1993). Foraging substrate in SW Alberta was primarily in trees (76.01%), and shrubs (11.97%) (Hill and Lein, 1988; Schieck and Roy, 1995). Foraging location is affected by several factors other than prey availability, including weather and social class (Glase, 1973; Grubb, 1975, Grubb, 1978; Desrochers et. al, 1989).

- Foraging is concentrated on smaller diameter substrates: limb <2.0cm 52.70%; limb >2.0cm 33.86%; trunk 6.16%; however, during summer, leaf microhabitat provides for ≈40% of foraging substrate, with small limbs <2.0cm utilized less (Robinson and Holmes, 1982; Hill and Lein, 1988; Smith, 1993).
- The average foraging height, in SW Alberta, is 4.30m in an average height tree of 7.34m (Hill and Lein, 1988). In Montana, the optimal foraging habitat was in forests with a well-developed canopy above 8 metres (Ramsden, et. al., 1979).
- Caterpillars, an important food source, are directly related to total volume of foliage; therefore, increased canopy volume leads to increased insect abundance, which leads to better foraging opportunities. In Washington, the highest Black-capped Chickadee densities occurred when canopy volumes were approximately $10.2m^3$ of foliage for every $1m^2$ basal area (Schroeder, 1983).
- Flock size in Massachusetts averaged 7.9 birds; in Alberta averaged 8.1 birds; and 7-12 birds in New York (Odum, 1942; Desrochers et. al., 1988; Smith, 1994).
- Flocks (populations) have larger communal wintering (non-breeding) home ranges, than breeding ranges. The winter range averages between 4 and 15 ha from studies throughout the entire distribution (Odum, 1941a; Odum, 1942; Smith, 1967; Hartzler, 1970; Glase 1973; Samson and Lewis, 1979; Smith, 1984; Smith and Van Buskirk, 1988; Haney, 1999). Territories generally are established in the winter, but are not heavily defended. Once the breeding season approaches, lower ranking birds are driven away and mating territories are confirmed (Odum, 1942; Smith, 1967; Desrochers et. al. 1988).
- Winter roosts tend to be dense coniferous branches rather than in cavities such as when nesting, due to a need for thermal protection (Odum, 1942).
- In spring or fall, individuals (floaters) may range even farther than the wintering range (Odum, 1941a).
- This species does not migrate, however irruption does occur, both to the north and to the south. Weather can induce irruptive behaviour; however, habitat destruction, food deficiency, and great reproductive success resulting in excess young, also contribute to these movements (Odum, 1942; Bent, 1964; Elder and Zimmerman, 1983; Smith, 1993; Koenig and Knops, 2001).

- The probability that Black-capped Chickadees will cross a gap (cutblock and agricultural found to have same effect) is directly related to the gap's width (Desrochers and Hannon, 1997), although any gap less than 30 meters is assumed to have no effect.

Width of Gap (m)	Probability of Crossing
20	0.80
40	0.40
60	0.20
80	0.10
100	0.05
120	<0.01

- The Black-capped Chickadee prefers unscarified spruce and mixedwood stands over scarified treatments; however, a preference for scarified pine harvest blocks is evident (Stelfox et. al., 2000).
- In Minnesota, Black-capped Chickadee abundance was equal in logged areas (0.20 males/ ha) than in burned areas (0.22 males/ ha) (Schulte and Niemi, 1998).
- A model built for the entire breeding-range distribution of the Black-capped chickadee was developed for breeding season habitat needs (Schroeder, 1983):
  - Percent tree canopy closure (V_1): 0% = 0.0; 50% - 75% = 1.0; 100% = 0.6
  - Average height of overstory trees (V_2): 0m = 0.0; ≥15m = 1.0
  - Tree canopy volume/ area of ground surface (V_3): 0 m^3/m^2 = 0.0; ≥10 m^3/m^2 =1.0
    - Coniferous canopy volume = $(\pi/3) \times (h_o r_o^2 - h_i r_i^2)$
    - Deciduous canopy volume = $2(\pi/3) \times (h_o r_o^2 - h_i r_i^2)$
      - h_i = the inner height of the canopy (living foliage)
      - h_o = the outer height of the canopy
      - r_i = the inner radius of the canopy (living foliage)
      - r_o = the outer radius of the canopy
  - Number of snags 10-25cm dbh/ 0.4 ha (V_4): 0 = 0.0; ≥2 = 1.0
    - HSI (food) = $(V_1 \times V_2)^{1/2}$
    - HSI (food) = (V_3)
    - HSI (reproduction) = V_4

Reproduction and Development

- Pair bond formation occurs mostly in the fall and winter (Odum, 1941a; Semenchuk, 1992; Smith, 1993). Pairs bonds may last for life (Odum, 1941a).
- Clutch size is 6.7 eggs (Odum, 1941b; Kluyver, 1961; Semenchuk, 1992)
- Incubation period is usually 11-13 days (Odum, 1941b; Kluyver, 1961; Semenchuk, 1992; Smith, 1993).
- The hatchling of one year will breed the following year (Smith, 1993).
- Dispersal from the natal site usually occurs two to four weeks after leaving the nest (Odum, 1941; Glase, 1973). Usually the distance is quite short with males travelling an average 211m, while the females travelled 198m. A maximum of 11.2km dispersal distance was recorded (Weise and Meyer, 1979).
- The annual cycle of the Black-capped Chickadee is usually described in relation to the seasons, as follows (Odum, 1942):
  - Prevernal period (Spring movements)
  - Vernal Period (Pair-formation and territory establishment)
  - Estival Period (Period of actual nesting)
  - Serotinal Period (Flocking of juveniles and molting of the adults)
  - Autumnal Period (Highly social behaviour and increased dispersal)
  - Hiemal Period (Winter association of small flocks)
- The average lifespan is approximately two and a half years (Sullivan, 1995); however, a significant proportion of individuals in one study were five years old (Loery and Nichols, 1985). One individual was recorded at twelve years old (Smith, 1993).

Nesting Habitat

- The nest is built mostly by the female with little help from the male (Odum, 1941b; Smith, 1993).
- The female will roost in the nest cavity from the beginning of nest excavation to the fledging of the young, while the male will roost elsewhere (Odum, 1942).

- The black-capped Chickadee is a cavity nester, especially in old woodpecker holes found in dead snags and rotten branches. Although deciduous species are most commonly used, the particular tree species favored for nesting depends on the region. Artificial, man-made nesting structures are also used. The cavity may not be complete, and may be preferred in that condition, as the female partially excavates portions of the nest herself (Odum, 1941b; Stauffer and Best, 1980; Sedgwick and Knopf, 1986; Semenchuk, 1992; Smith, 1993; Grubb and Bronson, 1995; Sullivan, 1995).
- Snags, including artificial, man-made snags (Grubb and Bronson, 1995), appear conducive to successful nesting and thus, successful reproduction and increased fitness (Stauffer and Best, 1980; Sedgwick and Knopf, 1986).
- Nest site habitat in SW Alberta consists of: 76.52% Trembling Aspen; 53.30% canopy; 65.50% ground cover; canopy height 12.89 m; 9.20% percent dead standing trees (Hill and Lein, 1988).
- Nest site habitat in Colorado consists of: basal area 15.2 m2/ha; 26.5% canopy cover; 107.0 trees/ha; 117.9 m to the closest edge; 26.0 cavities/ha; 6.0 snags/ha; large tree (>69cm dbh) density of 18.0/ha; small tree (<23cm dbh) density of 53.0/ha (Sedgwick and Knopf, 1990).
- The Black-capped Chickadee shows preference for the following nest tree characteristics: hardwood (93%); broken-top (96%); soft sapwood (75%); exposed, decayed wood (73%); Conks (52%); no branch or stem stubs (77%); 0-25% sound wood (80%) (Runde and Capen, 1987).
- Nest height is quite variable with nest sites ranging from ground level to 20m, although the average is generally built below 4.6m (Odum, 1941b; Smith 1991).
- Nests in SW Alberta are 3.70 m high (+/- 2.07), in trees 4.57 m tall (+/- 2.67) and 13.20 cm dbh (3.82) (Hill and Lein, 1988).
- Reuse of a nest cavity is rare from year to year (Odum, 1942, Smith, 1993).
- The average size of nesting territories in New York averaged 5.3 ha (3.4 ha – 7 ha) (Odum, 1941a).
- Nest habitat layer consists of the tree bole (Short and Williamson, 1984).

Community Structure

- Predators of adults consist mostly of hawks, owls and shrikes, while the main nest predators are small mammals (Smith, 1993).

- When Tent Caterpillar (an unpalatable species) outbreaks occur, the resultant defoliation causes a general decline in palatable prey abundance. The overall fitness of the Black-capped Chickadee is decreased, due to this decline (Pelech and Hannon, 1995).
- Flocks showed a high degree of mutual tolerance towards other flocks on their territory. Some species, such as the Red-breasted Nuthatch, will actually merge their flock with a wintering flock of Black-capped Chickadees (Odum, 1942; Desrochers and Hannon, 1989).
- Cowbird parasitism occurs infrequently with the Black-capped Chickadee (Smith, 1993).
- There is a dominance hierarchy within populations, with adult males dominating females and adults dominating younger members of their own sex (Glase, 1973, Desrochers et. al., 1988; Desrochers, 1989). In Alberta, class structure relationships are seen in foraging substrate, where males feed at the lower level of the canopy where prey density is greatest and predator pressure is at a minimal level (Glase, 1973; Desrochers, 1989; Smith, 1994). In New York state, the relative foraging position was opposite, with males near the top of the tree and females below (Glace 1973). This could be a result of different predator pressures (Shrike in Alberta and the Sharp-shinned Hawk in New York) (Desrochers, 1989).
- There is very little range overlap with other chickadee species, usually due to alternate habitat suitability for other *Poecile* spp. (Smith, 1993; Sullivan, 1995).
- The habitat needs of the Black-capped Chickadee (aspen forest with a coniferous understory) are the same as the Hairy Woodpecker, Magnolia Warbler, and Ovenbird (Hobson and Bayne, 2000).

Management Implications

- Overall survival rate in harvested blocks declined slightly, probably due to increased predator pressure; however, the recruitment rate increased.
- Long-term goals for wildlife management should strive for sites with a mosaic of age structures.
- Removal of snags and trees with dead limbs decreases available nest site habitat for black-capped chickadees, and therefore, should be conserved. The number of nesting snags is proportional to population density.
- Although black-capped chickadees are very tolerant of habitat alteration, several negative associations have been observed. These include removal of all woody vegetation, thinning of

understory (after partial removal of canopy), removal of sapling/shrubbery, and removal of snags. These coarse woody components should be conserved.

- Food suitability can be determined by canopy volume/basal area. Canopy volume is proportional to population density, as foraging is typically within this layer. Thus, adequate canopy should be conserved to best suit the Black-capped Chickadee.
- Optimal nesting habitat includes alternate nesting sites.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

28. Habitat suitability associations
29. Nesting efficiency as related to edge (both natural and anthropogenic)
30. Community dynamics

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Boreal Chorus Frog

Pseudacris triseriata maculata

Chorus Frog (E.Kloppers)

Introduction:

The Boreal Chorus Frog is widely distributed throughout Alberta, including the FMA area of Tolko Industries Ltd. (HLLD) FMA area (Russell and Bauer, 1993). It is very common throughout, and although its color may range from dull brown to vibrant green, the Boreal Chorus Frog is easily identified. Provincially, the Boreal Chorus Frog is rated green (secure) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000, and S5 (secure) in Saskatchewan and Manitoba, by the Heritage Status ranks. The preferred diet of the Boreal Chorus Frog includes insects, snails, millipedes, and other invertebrates. Wetland areas, with ample vegetation and dryer upland areas, typify breeding habitat and summer habitat. Winter hibernation occurs in loose soil, below the frost line. Although the Boreal Chorus Frog has a relatively stable population, the species should be monitored as the extinction rate for amphibians is dramatically higher than the expected rate (Grillitsch, 2000). Many factors lead to declines; however, it is unclear as to the extent of each.

Food

- The small body size of the Boreal Chorus Frog dictates optimal prey selection to be small terrestrial arthropods, which are abundant in wet areas (Christian, 1982). Ground-dwelling insects, snails, millipedes, and other small invertebrates comprise the majority of the diet of the Boreal Chorus Frog, although flying insects are taken as well (Russell and Bauer, 1993; Takats, 1997; Constible et. al., 2000).

- Larvae eat a variety of items, including diatoms, blue-green algae, green algae, decomposed plant material, protozoa, fecal matter, and pollen (Britson and Kissell, 1996).

Reproduction and Development

- Breeding usually occurs April through June in any body of water, from large permanent wetlands to rain-filled ground depressions. Preferred habitat includes areas in close proximity to water with a high percentage of graminoids (grasses, sedges, rushes). High shrubs and herbaceous cover, with a low canopy are also favored (Stebbins, 1985; Russell and Bauer, 1993; Takats, 1997; Constible et. al., 2000).
- Eggs are deposited over just a few days, and range from 150-1500. Development takes approximately ten to fourteen days, when the larvae are ready to depart the egg itself. Complete metamorphosis is usually complete within two months (Russell and Bauer, 1993).
- Larvae are predominantly inactive and benthic in the presence of predators (Lawler, 1989).
- Species richness is ultimately affected by environmental factors, which affect colonization and extinction rates within a metapopulation. Most hypotheses indicate anthropogenic sources for change (Hecnar and M'Closkey, 1996a).
- Forest harvesting creates many small depressions, which can fill with runoff and precipitation. These temporary pools draw Boreal Chorus Frogs, up to nine times more often than adjacent forest, as breeding ponds, which is unlike most other amphibians which avoid harvested areas. These ponds, however, may provide inadequate habitat. Without suitable input of water into the depression, the temporary pond is likely to dry out and result in frog desiccation. As the majority of individuals will typically not survive, these harvest-resultant pools act as population sinks (deMaynadier and Hunter, 1995; McLeod and Gates, 1998; Waldick et. al., 1999; Constible et. al., 2000).
- The average home range, for each individual, must include a water body in the breeding season and is typically between 0.05 and 0.65 ha. While breeding, home ranges overlap in time and space, but after the breeding season, individuals are rarely found within 3 - 4 m of one another (Kramer, 1974).
- Life span is generally under two years, with death occurring after the second breeding season (Russell and Bauer, 1993).

Summer Habitat

- Boreal Chorus Frogs are correlated with mature mixedwood forests in Alberta. Habitat areas include grassy pools, lakes, marshes, riparian areas and almost any other body of water, although some upland forest habitat is also used (Russell and Bauer, 1993; Schieck and Roy, 1995; Cossel, 1997).
- Riparian woodlands and some upland forests are also used, although presence is dependant upon uncompacted, deep, leaf litter, variable ground cover in the form of coarse woody debris (variable in size, shape, decay class, and composition), increased soil moisture, and patches of suitable shade to limit evaporation and temperature accumulation (Stebbins, 1985; Russell and Bauer, 1993; deMaynadier and Hunter, 1995; Constible et. al., 2000).
- Seasonal and semi-permanent streams, within 30m of forested patches, provide optimal habitat for Boreal Chorus Frogs. Habitat suitability decreases as distance from water increases; however, the abundance of regional woodlands within the system has a positive effect on species success, as well as general amphibian richness and density, by supporting the variables as mentioned above (Hecnar and M'Closkey, 1998; (Kolozsvary and Swihart, 1999; Constible et. al., 2000). The abundance of the Boreal Chorus Frog is likely to be increased with the permanency of the home wetland (Kolozsvary and Swihart, 1999).
- The average aquatic habitat, used for oviposition, was 117 litres, where an average of 2.74 individuals /litre were present at time of hatching (Smith, 1990).
- The majority of individuals remained in close proximity (20m) of the breeding pool throughout the summer, while no individuals are observed in excess of 100m (Roberts and Lewin, 1979).
- There is a negative association between Boreal Chorus Frogs and low pH wetlands, possibly due to altered community structure (Constible et. al., 2000), although pH has no effect on the growth or development of larvae (Kiesecker, 1996), except in areas of highly stressed anthropogenic activity (Hecnar and M'Closkey, 1996b).
- Cutblocks adjacent to wetlands act as sink habitats, where eggs are deposited in small intermittent pools of water created from run-off/precipitation filling depressions left by operations, while the wetland acts as the source habitat, supplying individuals to disperse to the sink-habitat harvest blocks (Constible et. al., 2000).
- Larvae occur least frequently in permanent ponds, but have high survival rates. Larvae in temporary pools occur in high densities; however, survival rates are considerably lower. Natural ponds

dehydrate, through the summer, in the same manner as do harvest-blocks. The rate of evaporative loss is, however, much lower than on harvest blocks. Larval amphibians must have metamorphosized to an adequate degree before the pool evaporates completely, to ensure survival. If transformation is not complete by this time, the lack of water may lead to a significant source of mortality, in that both the sink and source habitats have the potential to lose many individuals to desiccation (Skelly, 1996).

Hibernation

- Chorus frogs are able to withstand the freezing of much of the water in their body (Packard, et. al., 1998).
- Burrows are dug in sandy, loose material under woody debris, or in the mud at the waterbody, so that individuals may get below the frost line (Russell and Bauer, 1993; Packard, et. al., 1998).

Community Structure

- Diving beetles and other aquatic predators take larvae; however, Odonates (dragonflies) are an important source of mortality. So many larvae can be preyed upon that a change in the demography of the population of frogs can occur (Van Buskirk, 1988; Russell and Bauer, 1993).
- Increased permanence of a water body leads to an increased probability of predator occurrence within the system (Skelly, 1996).
- Chorus frogs are eaten by a variety of other species including snakes, fish, birds, small mammals, and large insects (Russell and Bauer, 1993)

Management Implications

- Retention patches could be placed in close proximity to low-lying wet areas. All understory vegetation and organic layers should be disturbed to the least possible extent.
- Selected boles of diseased, deformed, or otherwise low-value timber should be left intact and on the ground.

- Scattered retention patches of both tress and snags, along with undisturbed understory and downed woody debris should be managed for within every harvest block.
- Vegetation retention near suitable habitat should vary proportionately to stream width, harvest intensity, and slope.
- Possible causes for amphibian decline:
  - natural causes
  - man-made causes
  - structural habitat changes
  - physical and chemical changes
  - climatic changes
  - radiation and acid rain
  - eutrophication
  - environmental chemicals biological changes
  - parasites

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

31. Habitat suitability associations
32. Effects of harvest blocks on populations within Tolko Industries Ltd FMA area.
33. Can harvest area be managed and maintained to allow for more stable water catchments.
34. Community dynamics
35. Most information documented is based on the breeding season; thus, information should be ascertained on summer and hibernation habits/habitats.
36. Determine the optimal amount of vegetation retention near waterbodies. This should be proportional to waterbody size, intensity of harvest, and slope.

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Boreal Owl

Aegolius funereus richardsoni

Boreal Owl (W.H. Lane)

Introduction:

The Boreal Owl is a widely distributed, but uncommon resident throughout the boreal region of Alberta (Semenchuk, 1992). Due to low population density, elusive nature, and relatively inaccessible terrain, the Boreal Owl is not often casually observed within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Boreal Owl is rated yellow B (warrants management attention) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S4 (apparently secure in Alberta) by the Heritage status ranks. The Boreal Owl diet consists mainly of voles and other small mammals. Foraging and roosting habitat preference consists of mature to old coniferous and mixed coniferous forests. Nesting, however, occurs in cavities of partially decayed, predominantly deciduous trees, usually excavated by Pileated Woodpeckers. In Europe, this species is known as Tengmalm's Owl.

Food

- The Boreal Owl feeds mainly on voles (*Clethrionomys* spp and *Microtus spp*) and other small mammals, although larger mammals, small passerine birds, and insects are also taken (Hayward and Hayward, 1993; Boutin et. al., 1995; Hakkarainen et. al., 1997).
- During years of excellent vole density, the proportion of voles taken in the diet can be as high as 70-90% (Hakkarainen et. al., 1997).
- The mainstay of the Boreal Owl diet is the Southern Red-backed Vole, which comprise ≈ 37% of the diet in summer and ≈ 50% in winter (Hayward et. al., 1993).

Foraging and Roosting Habitat

- In Alaska and Canada, the Boreal Owl is positively correlated with several different forest types within the boreal forest system. It is assumed that foraging habitat will be present if suitable nesting and roosting habitat is available within the home range; however, no single vegetation type provides optimal nesting, foraging and roosting habitat (Bondrup-Nielson, 1984; Heinrich et. al., 1999).
- In the western boreal forest of Canada, the Boreal Owl prefers thick, homogenous mature to old coniferous forest (usually Black Spruce) with limited edge habitat in summer (Smith, 1992; Hayward and Hayward, 1993; Lane et. al., 1997b; W. H. Lane, pers. comm). Mature spruce and fir forests are especially important as winter habitat, because snow conditions (uncrusted snow) facilitate access to prey (Korpimäki, 1988; Hayward, 1993). In early spring, the use of clear cuts and agricultural fields increases as foraging habitat, possibly due to prey availability (Korpimäki, 1988; Hayward, 1993). Mature coniferous forests are also used extensively in the breeding season, when the lower density of herbaceous cover also facilitates prey capture (Korpimäki, 1988).
- Cavity trees in stands adjacent to lowland spruce habitat are essential to the survival of the species, as foraging behaviour is directly influenced by roosting location. New roost sites are usually chosen every day, and are widely distributed throughout individual home ranges. Sites may be close to the previous roost or quite distant, ranging from 0m to 6935m. Roosts are never shared, except during times of mating and courtship (Hayward and Hayward, 1993; W. H. Lane, pers. comm).
- In inland Idaho, Boreal Owl roosting sites were (Hayward et. al., 1993):

		Winter	Summer
Canopy Cover (%)		58.5	63.5
Basal Area (m^2/ha)		26.0	29.8
Tree dbh (cm)		27.7	25.7
Tree Density (0-5.2m)	2.5-7.6 cm	797	1380
	7.7-15 cm	561	897
	15.1-23 cm	261	341
	23.1-38 cm	130	181
	>38 cm	35	27
Tree Density (5.2m-	2.5-7.6 cm	864	1233

11.4 m)	7.7-15 cm	641	869
	15.1-23 cm	287	359
	23.1-38 cm	156	199
	>38 cm	38	34
Snag Density (No./ ha)	2.5-15 cm	305	269
	15.1-38 cm	37	49
	>38	2	8

- The average roost tree in Alaska averages 6m high and 36.5 cm dbh (Hayward and Hayward, 1993).
- Summer roosting sites occupy cooler microhabitats, characterized by increased canopy cover, increased basal area and greater tree density (Hayward and Hayward, 1993).
- The Boreal Owl is typically a nocturnal bird of prey, often traveling several kilometers in a foraging bout. Although the total distance traveled may be far from the roost, 'sit and wait' predation is the foraging method used by the Boreal Owl once in the hunting ground. Hunting does occur sporadically in the daylight; however, the success rate is nearly 0%. Daytime foraging attempts account for approximately 2.9% in winter and 7.4% in summer of the total hunting time (Hayward and Hayward, 1993; Hakkarainen et. al., 1997).
- The home range is considered the full extent of the foraging habitat, and is not defended, as the nesting territory is; therefore overlapping ranges are common. Groups of overlapping populations can be considered semi-isolated sub-populations, susceptible to demographic stoichasticity. Several factors contribute to the large home range size such as 1) hetergeneous vegetation types provide optimal habitat 2) limited productivity and cyclic productivity of small mammals. The winter range is approximately 1500 ha, while the summer range is smaller at approximately 1200 ha. The yearly combined home range averages 2000 ha (Hayward, 1993; Lane et. al., 1997b). Some home ranges have been estimated as large as 3400 ha, proving the large amounts of habitat needed in varied locations. Density is usually quite low, as shown in Minnesota, where densities are consistently below 0.1 individuals/ km^2 (Hayward and Hayward, 1993; Hayward and Verner, 1994; Lane et. al., 2001).
- Although the winter range is generally the same as the breeding range, irruption does occur, especially due to cyclical vole populations (Korpimäki, 1986; Hayward and Hayward, 1993; Korpimäki, 1993; Boutin et. al., 1995 Lane et. al., 1997).

- A model built for boreal coniferous forests in western Alberta in winter includes the following variables (Heinrich et. al., 1999):
  - Deciduous trees/conifer snags (stems/ ha ≥35 cm dbh) (S_1): 0= 0.0; ≥30 = 1.0
  - Tree canopy closure (S_2): ≤20% = 0.0; ≥50% = 1.0
  - Conifer canopy height (S_3): ≤5m = 0.0; ≥14m = 1.0
  - Weighted conifer in canopy (% spruce + % fir + 0.25(%pine) (S_4): ≤30% = 0.0; ≥50% = 1.0
    - HSI = S_1 x S_2 x S_3 x S_4
- Fragmentation of habitat makes this species susceptible to forestry harvest (Imbeau, et. al, 2001).
- It is assumed that water is not limiting (Heinrich et. al., 1999).

Reproduction

- Individuals are seldom found together, except during the courtship rendezvous at the proposed nesting location (Hayward and Hayward, 1993).
- Breeding typically occurs April to June (Hayward and Hayward, 1993).
- The typical clutch is 4 to 6 eggs with incubation averaging 26 to 29 days, (Salt and Salt, 1976; Semenchuk, 1992; Konig, et. al., 1999).

Nesting Habitat

- The Boreal Owl is an obligate secondary-cavity nesting species, using cavities initially excavated by Pileated Woodpeckers or Northern Flickers , although some cup nests may be used in northern latitudes (Salt and Salt, 1976; Semenchuk, 1992; Hayward and Hayward, 1993). Nesting habitat is unlike foraging habitat, where preferred sites are mature to old Aspen or Aspen-mixedwood forests (Hayward and Verner, 1994; Heinrich et. al., 1999). Older, upland mixed forests are used more than available in Minnesota and regenerative stands were used less than available for courtship activities (Lane et. al., 1997a; Lane et. al, 1997b; Lane et. al., 2001).
- Nest territory size is approximately 0.8-1.3 ha in Aspen stands and 1.6-14 ha in coniferous stands (Hayward and Hayward, 1993).
- Nesting sites are seldom close to other Boreal Owl nesting sites, (Hayward and Hayward, 1993).

- Males choose a nesting site and than sing to attract a mate, while protecting a nesting territory. Usually, the minimum distance between nests is100m and 500m (Hayward and Hayward, 1993).
- In inland Idaho, Boreal Owl singing sites were (Hayward et. al., 1993):
  - tree density (#/ ha)
    - 2.5-7.6 cm dbh = 387
    - 7.7-15 cm dbh = 284
    - 15.1-23 cm dbh = 204
    - 23.1-38cm dbh = 176
    - 38.1-53 cm dbh = 43
    - > 53 cm dbh = 11
  - snag density (#/ ha)
    - 2.5-38 cm dbh = 111
    - >38 cm dbh = 13
  - basal area (m^2/ ha)
    - tree > 30.5 cm dbh = 14.7
  - tree canopy cover (%)
    - 0-1m = 8
    - 1.1-2m = 8
    - 2.1-4m = 12
    - 4.1-8 = 22
    - >8m = 28
  - shrub canopy cover = 14%
  - forb cover = 7%
  - grass cover = 14%
  - subshrub cover = 7%
- In inland Idaho, Boreal Owl nesting sites were (Hayward et. al., 1993):
  - tree density (#/ ha) within 5.2 m
    - 2.5-7.6 cm dbh = 174
    - 7.7-15 cm dbh = 98
    - 15.1-23 cm dbh = 114
    - 23.1-38cm dbh = 136
    - 38.1-68 cm dbh = 60
    - > 68 cm dbh = 11
  - tree density (#/ ha) between 5.2 m-11.4m
    - 2.5-7.6 cm dbh = 242
    - 7.7-15 cm dbh = 178
    - 15.1-23 cm dbh = 124
    - 23.1-38cm dbh = 130
    - 38.1-68 cm dbh = 51
    - > 68 cm dbh = 10
  - snag density (#/ ha)
    - 2.5-38 cm dbh = 79
    - >38 cm dbh = 10
  - basal area (m^2/ ha) = 33.7
  - canopy cover = 55%
  - distance to water = 201m
  - slope = 28%

- The conservation of cavity trees and stands with cavity trees is essential to the survival of the species (Pers. comm., W. H. Lane).
- When nesting structure is limited within mature/old sites, nesting boxes may be used by Boreal Owls (Pers comm, W. H. Lane).

Community Structure

- Variation within vole populations, dramatically affect Boreal Owl population density and breeding success (Korpimäki and Hakkarainen, 1991; Korpimäki, 1992; Hakkarainen, et. al.,1997). As well, Boreal Owls have a significant effect on small mammal population dynamics (Hayward and Hayward, 1993).
- The American Marten is the most important nest predator (including incubating females). Predators of adults include Cooper's Hawk, Northern Goshawk, and the Great Horned Owl (Hayward and Hayward, 1993).
- When threatened by a predator or disturbance, the Boreal Owl will tend to shift nest holes (Hakkarainen, et. al., 2001).

Management Implications

- Due to large home ranges and low population density, management areas should be quite large, up to $1000km^2$.
- Since nesting occurs in Pileated Woodpecker excavations, large Aspen retention and snag retention will affect the Boreal Owl.
- Large tracts of clear cut logging have a negative impact on the Boreal Owl and should be limited within optimal habitat.
- Assess habitat quality by identifying breeding occupancy and prey abundance
- Habitat fragmentation may be detrimental to population persistence with respect to the metapopulation., and therefore its effect should be limited
- Short rotation, even-aged management can be detrimental to populations.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

37. Habitat suitability associations
38. Effects of anthropogenic disturbance on nesting presence/ absence
39. Association between the Boreal Owl, other secondary cavity nesters and primary cavity nesters.
40. Nesting characteristics
41. Local population dynamics and perhaps metapopulation dynamics if applicable.
42. The effects of harvest on prey populations affects Boreal Owls, and optimal post-harvest vole habitat should be ascertained to contribute to Owl success.

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Canada Lynx

Lynx lynx canadensis

Introduction

The Canada Lynx is a common year-round resident of Alberta. Unique coloration and vocalization, as well as its large size make this species easily identifiable in Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Canada Lynx is rated yellow B (may require special management) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000 and S4 (apparently secure in Alberta) by the Heritage status ranks The Canada Lynx is strongly associated with the Snowshoe Hare, and population fluctuations result from the cyclic nature of the hare. Pursuit of the hare leads the Lynx to utilize younger forests, where Snowshoe Hares are prevalent. Females, however, choose old coniferous stands to rear young. The Lynx is important both in the natural ecosystem and through human utilization, such as with trapping for fur needs.

Food

- The main prey item of the Lynx, the Snowshoe Hare, changes in abundance in accordance to a cyclic ten year pattern (Forsyth, 1985; Boutin, 1995; Sulzle, 1995; O'Donoghue, 1997; Mowat and Slough, 1998; O'Donoghue, 1998). When hare populations peak, diet composition is ≈ 50% hares, ≈35% squirrels, and ≈11% small mammals (O'Donoghue, 1998).
- When hare population density is low, the Lynx utilizes the Red Squirrel to a greater extent (O'Donoghue, 1998).

- Lynx are specially adapted to hunt snowshoe hares; however, the Lynx is opportunistic and will prey upon many available species, as densities fluctuate. Supplemental dietary items include small mammals, birds, fish, ungulates and carrion (Koehler and Aubrey, 1994).
- More hares are killed than energetically required when the hare cycle is at its peak (O'Donoghue, 1998).
- Lynx will occasionally hunt in groups, especially when Snowshoe Hare density is low (O'Donoghue et. al., 1998).

Foraging Habitat

- Xeric coniferous and coniferous mixedwood forest stands, of low topographic relief are preferred by the Lynx. This is due to the presence of suitable thermal cover, security cover, stalking cover, and abundant prey biomass. All successional stages of forest may be used; however, old spruce stands are the most utilized habitat, comprising 35-43% of yearly usage (Koehler and Aubrey, 1994; Murray et. al., 1994; Poole et. al., 1996). Early successional coniferous mixedwood forest stands (with high stem growth) provide optimal habitat for the preferred prey, the Snowshoe Hare. The resultant increase in prey biomass draws the Lynx into these very important hunting grounds. Open areas tend to be avoided, especially while hunting, although the kill/chase success rate is not correlated with habitat (Koehler, 1990; Koehler and Brittell, 1990; Koehler and Aubrey, 1994; Murray et. al., 1994; Slough, 1999; Buskirk et al., 2000). In the northern boreal forests, however, older regenerating stands (≥20 years) are preferred over younger stands that are over-concentrated with young stems making hunting very difficult (Murray et. al., 1995; Mowat et. al., 2000).
- Vegetative cover affects Lynx hunting tactics. Sparse vegetation induces stalking, whereas ambush was used when a dense forest was used (Murray et. al., 1995
- Areas exhibiting wetland, lake complexes, shrublands, open Black Spruce, or other open habitat were consistently avoided (Murray et. al., 1994; Poole et. al., 1996).
- Although factors which influence the size and shape of the home range are not completely understood, sex, season, and especially cyclical Snowshoe Hare populations may elicit a behavioural response by the Lynx; therefore, the size and extent home ranges is flexible (Ward, 1985; Koehler and Aubrey, 1994; Mowat et. al., 2000). Male home ranges vary 15 km^2 in good hare years to 150km^2 in poor Hare years. Females ranges are typically smaller and vary from 15 km^2 to 250 km^2

(Mech, 1980; Carbyn and Patriquin, 1983; Ward, 1985; Koehler, 1990; Poole, 1994; Slough and Mowat, 1996).

- The average home range in southern Yukon increased three fold during the trough of the cycle, when hare abundance dropped from 14.7 hares/ ha to 0.2 hares/ ha. Some individuals apparently abandon home ranges and become nomadic when densities fall below 0.5 hares/ ha. This change completely overshadowed any other changes due to sex, age, season, or existing home range (Ward, 1985; Slough and Mowat, 1996).
- The average overlap of male-male home ranges ≤10%; female-female home ranges ≤25%; and male-female home ranges ≤22.0%; however, when considering the core range only, overlap is quite limited (Mech, 1980; Carbyn and Patriquin, 1983; Ward, 1985; Poole, 1995).
- Densities of Lynx are variable and are dependant on prey resources. During the trough of the Snowshoe Hasre cycle Lynx density average below5 individuals/ 100 km^2. When adequate food resources are available, density may peak at as many as 50 individuals / 100 km^2 (Koehler, 1990; Mowat, 1993; Poole, 1994; Slough and Mowat, 1996).
- Lynx may disperse up to 1000km during Snowshoe Hare population lows (Ward, 1985; Poole, 1995; Poole, 1997)
- Lynx may find optimal habitat in coniferous and mixedwood boreal forests, where disturbance (by fire or harvest) is common, but not overly abundant. Although immediate utilization is not common, Snowshoe Hares typically invade the disturbed area once woody plants have become established, thus drawing the local Lynx population to the area as well (Quinn and Thompson, 1987; Koehler, 1990; Koehler and Britton, 1990
- Lynx tend to avoid open areas and will not cross areas greater then 100m (Koehler, 1990).
- Lynx beds were located in closed spruce cover with abundant understory and overhead cover, such as rock ledges, windfall, low branches, or rootwads (Banfield, 1974; Murray et. al., 1995).
- In areas where fragmentation of the boreal forest is common, old forests may be an important stabilizing agent, where prey (hares) may occur in smaller densities, but be more stable and thus reliable (Buskirk et al., 2000).

Reproduction and Development

- Lynx are solitary animals, except during the breeding season (between March and April) (Mowat and Slough, 1998).
- Gestation time is usually between 60 to 65 days (Forsyth, 1985).
- Litter size is typically 2 or 3 (Forsyth, 1985).
- Kittens are typically born mid-May to late June to fully mature adult mothers, whereas juvenile mothers tend to give birth only in late June (Mowat et. al., 1996; Mowat and Slough, 1998; Slough, 1999).
- Adult litter size in good hare years averages 4-5, while in poor hare years the average size drops to 2-3 kittens. Juvenile litter size is typically between 3-5in good hare years, while poor hare years elicit 0-1 kittens. Although rare, females may have as many as eight kittens in one season (Sulzle, 1995; Mowat et. al., 1996; Mowat and Slough, 1998).
- Female kittens show affinity to the natal site, and will remain on the mother's home range as long as possible (Mowat and Slough, 1998).
- Litter size for adult females averaged more kittens when born in the spring/summer, rather than in the winter (Mowat, 1993).

Denning Habitat

- Denning sites are not located in optimal hunting grounds, but rather in dense climax forests in mesic areas with a well developed shrub layer and high density of downed woody debris (Banfield, 1974; Koehler, 1990; Koehler and Brittell, 1990; Koehler and Aubrey, 1994; Slough, 1999; Mowat et. al., 2000). Coarse woody debris, either in mature forest or in recently burned areas is the limiting structural component of den sites (Koehler, 1990; Slough, 1999).
- Other components of suitable denning habitat include minimal human disturbance, proximity to foraging (young forest) areas, and suitable stands that are at least 1 ha. Small denning stands (0.4-2 ha), however, are usually joined to other dense stands by travel corridors (Koehler and Brittell, 1990).

- When available, dens in Southeastern Yukon were predominantly placed in areas which were burned and subsequently regenerated. These areas were preferred over old coniferous stands due to the abundance of coarse woody debris left and thus the increased availability of denning sites (Slough, 1999). In the boreal forest, optimal denning habitat appears to be stands 15-30 years post fire (Poole et. al., 1996; Slough, 1999).
- Dens are seldom used in subsequent years, however, the female shows denning site affinity, and will den in the same vicinity each year (Slough, 1999).
- Dens have been located within 300m of other denning females (Slough, 1999).
- Maternal dens used until kits are 6-8 weeks pf age (Slough, 1999).
- The aspect of most dens in cooler climates is south to southwest (Slough, 1999), while in warmer climates, the entrance faces north to northwest (Koehler, 1990).

Community Structure

- Harvest data for the High Level area 1985-1989, as collected from volunteer submissions (AB Fish and Wildlife Div, 1990).

Lynx harvested	1984/1985	1985/1986	1986/1987	1987/1988	1988/1989
Map sheet 84 - E	107	53	109	27	29
Map sheet 84 – F	47	29	36	11	5
Map sheet 84 – G	25	40	34	14	8
Map sheet 84 – J	24	23	17	11	11
Map sheet 84 – K	17	9	14	8	7
Map sheet 84 – L	46	39	42	12	7
Map sheet 84 – M	36	17	14	8	6
Map sheet 84 – N	25	22	19	7	11
Map sheet 84 - O	36	25	33	6	10

- When prey numbers increase, Lynx populations respond in a similar increase (Koehler and Aubrey, 1994; Murray et. al., 1994; Murray et. al., 1995; Boutin et. al., 1995; Mowat et. al., 1996; O’Donoghue et. al., 1997)

- Predators include the coyote, wolf, large owls, eagles, and man (Forsyth, 1985).
- The Lynx is a top level predator, but through the Snowshoe Hare, is connected in a complex food web with many other species (Boutin et. al., 1995).

Management Implications

- As denning sites are typically in old or burned forests, these areas should be maintained. The Lynx will use small patches, but only if small patches are connected with travel corridors.
- Downed woody debris is an important attribute of Lynx habitat suitability and should be maximized throughout harvest areas.
- Replanted sites are initially used less then unplanted harvest blocks
- Cutblocks should be less then 100m across, or extremely irregular so that ample points less then 100m are available. Lynx may be limited in blocks which are greater than 100m from one edge to the other edge within the block.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

43. Habitat suitability associations
44. Denning location and attributes
45. Local population dynamics
46. Effects of harvest on demographics
47. Optimal retention practices for ideal den site use

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Canadian Toad

Bufo hemiophrys hemiophrys

Canadian Toad (W. Roberts)

Introduction

The Canadian Toad (Dakota Toad) is a small amphibian, generally limited to the eastern portion of the province, from the prairies through to the Northwest Territories. Although very limited, there have been confirmed sightings of this species in the eastern portion of Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Canadian Toad is rated red (species is at risk) by the Alberta Wildlife Act, at risk by the General Status of Alberta Wild Species 2000, and S4 (apparently secure in Alberta) by the Heritage status ranks. The preferred diet of the Canadian Toad consists of worms, beetles, ants and other small invertebrates. Typically breeding is confined to aquatic areas; however, upland areas (generally less then 100m, but up to 1 km away) are utilized during the summer and for winter hibernating habitat. The species is vulnerable, as most amphibians, to slight environmental changes; however, the most significant threat to Canadian Toad persistence within the FMA area is disturbance of winter hibernacula.

Food

- The Canadian Toad feeds on a variety of invertebrates, including worms, beetles, and ants, generally obtained at or very close to ground level (Stoyke, 1994; Takats, 1997; Ab. Sust. Res. Dev., 2002; Nature North, 2002).
- Vertebrates are rarely taken by the Canadian Toad, which are generally characterized by avoiding relatively large prey (Cook and Cook, 1982).

Reproduction

- Males Emerge from hibernacula first, congregate at breeding areas, and await females to enter the breeding chorus. Breeding occurs from late April to late June in the shallows of lakes, ponds, ditches, marshes, and other intermittent bodies of water (Tester and Breckenridge, 1964; Russell, 1993).
- Several hundred to several thousand eggs are laid (Russell and Bauer, 1993; Takats, 1997).
- Eggs hatch from early May to late June, over 3-12 days (Takats, 1997; Ab. Sust. Res. Dev., 2002).
- Metamorphosis completed from mid-May to mid-August, six to seven weeks after hatching (Takats, 1997; Ab. Sust. Res. Dev., 2002).

Breeding/Summer Habitat

- The distribution is essentially the eastern portion of the province, including the eastern portions of Tolko Industries Ltd FMA area (Russell, 1993; K. Morton, Pers comm.).
- The Canadian Toad is active from April to September, within the boreal forest and aspen parkland, which supply optimal habitat. Suitable habitat exists within the FMA area, with several confirmed sightings recently near the town of Fort Vermillion (Russell, 1993; K. Morton, Pers comm).
- Generally, river valleys and sandy lake shores are preferred (Ab. Sust. Res. Dev., 2002).
- Wetland utilization occurs only for approximately two months, after which individuals move to upland habitat (Hamilton, et. al., 1998).
- Individuals can frequently be found in meadows and willow bogs in northeast Alberta boreal forest regions. Aspen parkland is also preferred habitat, when below elevations of 1200m (Hamilton, et. al., 1998; Ab. Sust. Res. Dev., 2002).
- The Canadian Toad is thought to be more aquatic in nature than other toads, occupying areas with limited aquatic vegetation and increased water action (waves or current). Mudflats with shallow marginal zones, thick sedge, floating mats of weeds and algae, and a thin rim of vegetation surrounding the waterbody are positively correlated to Canadian Toad presence and abundance, although the actual mudflats themselves are seldom used by the Canadian Toad (Breckenridge and Tester, 1961; Henrich, 1968; Roberts and Lewin, 1979).

- Permanent water bodies are better suited habitat for the Canadian Toad as they are less likely to diminish and desiccate eggs. Substantial mortality of larvae and partially transformed individuals result from early pond drying, which is increased in open or partially canopied forests, and thus not suitable habitat (Roberts and Lewin, 1979; Waldwick, et. al., 1999).
- Individuals routinely travel within 40m of water in summer, however, >95% of individual travel is within 10m. Abundance declines gradually after 40 m. The presence of individuals after approximately 60 m is relatively low (Breckenridge and Tester, 1961; Roberts and Lewin, 1979).
- Females remain at breeding pond only long enough to mate and lay eggs. After successfully depositing eggs, individuals tend to move to upland habitats. The range in the remainder of summer is larger than in the breeding season. Individual dispersal distance from wet areas averages 170 - 385m, however, some individuals have been found hunting up to 1000m from water, although very rare (Breckenridge and Tester, 1961; Tester and Breckenridge, 1964; Stoyke, 1994).
- Densities may exceed 50 toads per hectare (Nature North, 2002).
- Usually diurnal and burrows at night. If temperature is adequate, individuals may be nocturnally active (Russell, 1993).

Hibernation

- Winters are spent in burrows beneath the frost line, as this species is not tolerant of freezing temperatures (Storey and Storey, 1986; Hamilton et. al., 1998).
- Hibernacula are usually located in upslope areas with sand being the major soil component, rather than clay or silt-based mud (Breckenridge and Tester, 1961; Tester and Breckenridge, 1964; Kuyt, 1991).
- Movements to hibernacula in Alberta and the Northwest Territories typically occur early to mid-September (Breckenridge and Tester, 1961; Kuyt, 1991; Timoney, 1996).
- Individuals show high site fidelity as >90% of individuals returned to hibernacula each year for a total of three years in Minnesota (Kelleher and Tester, 1969).
- Emergence from hibernation is completely dependant on weather (Breckenridge and Tester, 1961).
- The average bury depth is dependant upon local climate (Breckenridge and Tester, 1961).

- The availability of suitable hibernacula sites is the critical habitat variable affecting the presence/abundance of Canadian Toads (Kuyt, 1991).
- A large communal hibernacula exists near Fort Smith, NWT, containing several hundred individuals in a loose exposed hillside presumably produced by road construction (Kuyt, 1991; Timoney, 1996).
- Hibernacula in northern boreal sites were surrounded by Trembling Aspen, White Spruce, Black Spruce, and Jack Pine (Kuyt, 1991). The presence of this species of tree does not signify use per se, as exclusive direct use of dry sandy soil in Jack Pine forests is avoided (Roberts and Lewin, 1979).
- Hibernacula are often found within several hundred meters of permanent water, with associated larch, willow, alder, and sedges (Kuyt, 1991).

Community Structure

- Canadian Toads and Boreal Toads will interbreed when ranges overlap, however, the hybrid offspring tend to have lowered reproductive success (Eaton, et. al., 1999)
- Range overlaps occur in central Alberta (Ab. Sust. Res. Dev., 2002).
- Adult toads are unpalatable to most species; however, many species of aquatic invertebrates, fish, birds, and mammals will eat the larvae (Nature north, 2002).

Management Implications

- As winter survival is critical to the persistence of the Canadian Toad, areas suitable for hibernacula (sandy soils, associated with Trembling Aspen, White Spruce and Black Spruce) should be identified and conserved.
- Suitable habitat is typically within 200m of aquatic habitat; therefore, areas of known habitat require management of Aspen, Spruce, and Willow, understory vegetation, ground-level vegetation and debris, to maintain habitat integrity.
- Hillsides with sandy, loose soil should be maintained as extensively as possible, due to the possible presence of hibernacula

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

48. Habitat suitability associations
49. Breeding pond use adjacent to harvest block
50. Range, presence and abundance within the FMA area

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Cougar

Felis concolor missoulensis

Puma concolor

Cougar (USFWS)

Introduction:

The Cougar is an uncommon year-round resident of Alberta. This unique species is easily identifiable and is a high profile species, throughout Alberta, including Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Cougar is rated yellow B (special management may be required) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000 and S3 (vulnerable in Alberta) by the Heritage status ranks. The Cougar preys on a variety of animals, but its primary prey includes ungulates (adult and young) and medium sized mammals, such as beaver and Porcupine. The Cougar is confined to remote wooded areas, where both prey and potential denning sites are available. The Cougar is known by several other names, primarily due to its extensive distribution throughout North America. These include Puma, Mountain lion, and Panther.

Food

- The cougar will eat almost any animal that it can catch, including insects, mice, hares, birds, elk and cattle, although the preferred prey are mule deer and white-tailed deer (Wrigley and Nero, 1982; Ackerman et. al., 1984; Forsyth, 1985).
- Male and female cougars may use different habitat types due to differences in prey taken. Females predominantly prey upon larger, typically adult prey, while males concentrate hunting to ungulate calves (Jalkotzy et. al., 1999).

- Although cougar habitat attributes are extremely important, modeling prey habitat is also vital in determining overall habitat suitability for the cougar in southwestern Alberta (Jalkotzy et. al., 1999).
- The presence of cougars almost always coincides with the presence of deer or other ungulates (Wrigley and Nero, 1982).
- Cougars are solitary hunters which usually prey upon animals larger than themselves, occasionally resulting in death of the cougar (Ross et. al., 1996).
- Cougars remain at the kill site for up to a month, or store kills in a larder hoard (food cached all in one site), gradually feeding on the carcass (Holt, 1994; Thompson and Stewart, 1994).

Foraging Habitat

- Although generally associated with mountainous terrain, the Cougar is able to adapt to a multitude of habitats where suitable cover and prey abundance exist. Foraging habitat, therefore, tends to follow prey habitat requirements, particularly that of White-tailed Deer and Mule Deer. This adaptability leads to a range that extends across North America, with local populations known under alternate names such as the Puma, Panther, and Mountain Lion. The present optimal habitat in Alberta exists in the forests of the Rocky Mountains. Northwest Alberta does not exhibit typical highly variable rocky habitats for the cougar (Fish Wild. Div., 1992), although individuals are present within northwestern Alberta, with several sightings reported annually within Tolko Industries Ltd (HLLD) FMA area. These extralimital sightings usually occur in major river valleys, where more adequate cover and prey base exist. River valleys are preferred also due to increased slope, where > 20^{o} is preferred (Banfield, 1974; Logan and Irwin, 1985; Fish Wild. Div., 1992; Lindzey et. al., 1994; Tesky, 1995; Pattie and Fisher, 1999; Wright, 2002; Pers comm., Kim Morton).
- Larder site characteristics in Montana are (Holt, 1994):
  - 22m from game trail
  - 15m coniferous tree (at base)
  - 22.6 cm dbh
  - 76.0% canopy cover
  - 3.5 – 4 m from cougar bedding site

- Important habitat attributes, in southwestern Alberta, are varied at different levels, in different seasons, and for alternate sexes (Jalkotzy et. al., 1999). Attributes, in order of importance are as follows:

1 = most important variable 6 = least important variable empty cells = not significant in modeling in southwestern Alberta			Stalking Cover	Slope	Terrain Ruggedness	Aspect	Elevation	Distance to Quality Prey Habitat	Prey Availability	Distance to High-Use Human activity	Distance to High Use Roads	Distance to High Use Trails
Female	**Summer**	Landscape Level	**3**		**4**	**5**	**1**			**2**		
		Local Level	**3**		**1**		**2**			**4**		
	Winter	Landscape Level	**3**		**1**		**5**	**2**				**4**
		Local Level			**1**		**4**	**3**			**2**	
		Kill Location	**3**		**1**		**2**					
Male	**Summer**	Landscape Level	**2**		**3**	**4**	**5**		**6**			**1**
		Local Level					**2**					**1**
	Winter	Landscape Level	**1**		**4**	**5**	**2**		**6**			**3**
		Local Level			**2**	**3**	**1**					**4**
		Kill Locations	**5**	**1**	**4**		**3**	**2**				

data based on all habitat complement, except local level male data which relates used/unused habitat

- The average adult home range size for cougars in Southwestern Alberta changes with several variables. Females generally have smaller home ranges than males occupying the same area. Younger and juvenile individuals have larger ranges than older, mature, territorial, adults. Winter ranges tend to be smaller, not due to reduced mobility, but rather concentration of potential prey in winter yards. Lastly, habitat suitability is important in determining range. The less suitable the habitat, the larger the range. Female home ranges, throughout the distribution, tend to exhibit extensive overlap; however, male ranges overlap very little throughout the foraging range (Logan et. al., 1986; Van Dyke et. al., 1986; Fish Wild. Div., 1992; Ross and Jalkotzy, 1992; Spreadbury et. al., 1996).

Annual home range sizes (km^2) as reported in Fish Wild. Div., 1992.	Alberta	Utah	Idaho	California	British Columbia
Male	365	826	453	152	151
Female	158	685	268	66	55

- Environmental features other than prey abundance determine habitat suitability. When prey availability and abundance increase, associated Cougar density remain the same. In western North America population densities average 0.3-9.2 individuals/ 100km^2 (Ross and Jalkotzy, 1992; Lindzey et. al., 1994; Wright, 2002).
- Juvenile male dispersal typically occurred at 15 to 18 months, and resulted in a movement of 30-155km. All individuals typically required ‘corridors’ in fragmented habitat (Ross and Jalkotzy, 1992; Beier, 1995).
- Cougars ultimately choose habitat that is characterized by an absence of timber harvest, lower-than-average road density, and little permanent human disturbance (Van Dyke et. al., 1986).
- Populations are limited by prey abundance, suitable hunting areas, and social structure (Wright, 2002).
- Cougars have limited homing skills and site fidelity when removed from original home range; however, injection of an individual into an occupied habitat proves to be harmful (Ross and Jalkotzy, 1996).

Reproduction

- Cougars are generally solitary animals, only associating during the breeding season. When in heat, the female searches out the male or occasionally, the male searches out the female (Wrigley and Nero, 1982; Wright, 2002).
- Gestation time is typically 90-96 days (Forsyth, 1985; Wright, 2002).
- Cougars are polygamous and breed throughout the year; therefore, parturition is variable as well. Most litters, however, are born in the spring and early summer (Wrigley and Nero, 1982; Tesky, 1995; Pattie and Fisher, 1999; Wright, 2002).
- Litter size is usually 3 or 4, but may be as many as six (Wrigley and Nero, 1982; Forsyth, 1985; Tesky, 1995; Pattie and Fisher, 1999; Wright, 2002).
- Where slope is minimal and rock outcroppings are limited, dens are formed under fallen logs, root wads, or in dense thickets (Tesky, 1995; Wright, 2002).

Community Structure

- Young are vulnerable to predation by Wolves, Bears, Eagles, large Hawks, and large Owls (Forsyth, 1985; White and Boyd, 1989).
- Predators of adults are limited, although Wolves, Bears and Humans contribute to mortality (Forsyth, 1985; Boyd and Neale, 1992).
- Both Black and Grizzly Bears will displace Cougars from kills they have made (Murphy et. al., 1998).
- In 1992, there were approximately 685 cougars in Alberta, with likely very few in northwestern Alberta (Fish Wild. Div., 1992).

Management Implications

- Cougars are adversely affected by timber harvest, and require large tracts of land associated with natural conditions.
- Smaller harvest blocks are recommended.

- Areas with above average Cougar habitat attributes, such as rocky outcroppings, old growth, and areas with sloping topography should be conserved.
- Maintaining ungulate habitat needs should help conserve Cougar populations.
- River valleys are important habitat areas in the northwestern portion of the province, due to suitable habitat and prey abundance. As cougars tend not to traverse large open areas, harvesting from waterbody to upland would be detrimental. In these areas, harvest blocks may be better placed parallel to the water body rather then perpendicular, leaving areas to avoid the block, without leaving the valley breaks.
- Cougar populations are generally stable, however, the low population size (estimated ≈ 650 in Alberta) may be limiting, thus, all efforts should be made to conserve Cougar habitat.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

51. Habitat suitability associations
52. Habitat use in relation to industrial use
53. Local population dynamics

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Dark-eyed Junco

Junco hyemalis

Dark-eyed Junco (B. Israel)

Introduction

The Dark-eyed Junco is a very common summer resident of Alberta. A member of the sparrow family, the Dark-eyed Junco is readily observed throughout Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small decrease of 1%/ year (Sauer et. al., 2001). Provincially, the Dark-eyed Junco is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S3 (vulnerable in Alberta) by the Heritage status ranks The Dark-eyed Junco forages mainly on insects, through a variety of hunting tactics, although vegetative matter is also consumed. Studies from different geographical areas show the variety of habitat used by this species. Birds in Alberta chose young and old coniferous and coniferous-mixed stands. Nesting occurs on the ground under heavy overhead cover, such as grasses, small stems, rootwads or rock outcrops. There is commonly at least four subspecies residing in Alberta during the breeding season, including the Oregon Dark-eyed Junco (*Junco hyemalis thuberi*) and the Pink-sided Dark-eyed Junco (*Junco hyemalis* mearnsi).

Food

- Diet consists of mostly Coleoptera, but also includes other arthropod prey and vegetative material. This may include berries and seeds, on or close to the ground (Otuos and Stark, 1985; Fisher and Acorn, 1998).
- Social rank determines diet composition (Langen and Rabenold, 1994).

Foraging and Roosting Habitat

- The Dark-eyed Junco is a highly versatile species of bird. In most areas, individuals utilize deciduous and deciduous mixed stands; however, within Alberta old coniferous and coniferous mixed stands are preferred. The age of forest stands is also variable throughout the range. Within Alberta, both young (Farr, 1992) and old forests (Schieck and Roy, 1995) are continually chosen, although mature forests will be used as well. Optimal habitat is not directly correlated with age, but rather with canopy closure, explaining the variability between stand composition and stand age used for foraging habitat. Optimal habitat suitability is typically found in old forest stands with 0-39% canopy closure. Suitable habitat includes young shrub/sapling forest and mature forest with 40-69% canopy closure (Sanderson et. al., 1980; Verner, 1980; Scott and Crouch, 1988a; Farr, 1992; Semenchuk, 1992; Smith, 1992; Schieck and Roy, 1995; Haney, 1999).
- Other habitat areas include shrublands, clearings, montane ecosystems, deciduous stands, burns, regenerating harvested stands and wooded urban environments, although all require abundant edge habitat to provide suitable habitat (Semenchuk, 1992; Smith, 1992; Fisher and Acorn, 1998
- The preferred foraging micro-habitat exists in low shrubs and at ground level, where an open understory and a relatively dense herb layer are prevalent (Holmes and Robinson, 1988; Semenchuk, 1992; Schieck and Roy, 1995).
- Increased density of low shrubbery has a dramatically negative effect on habitat suitability. As well, mature forest with 70-100% canopy closure is considered marginal habitat for the Dark-eyed Junco (Verner, 1980; Hagar, et. al., 1996).
- Prey are taken primarily from the litter layer and from foliage. Litter = 37.4%; foliage = 34.6%; herb layer = 18.7%; air = 4.7%; bark = 4.6% (Holmes and Robinson, 1988 in New Hampshire).
- Dark-eyed Juncos usually direct their insect attacks at ground level, with decreasing incidence of foraging at higher vegetative height. 0-0.2m = 63.8%; 0.3-2m = 20.4%; 2.1-8m = 12.5%; 8.1-14m = 3.1%; >14m = 0.2% (Holmes and Robinson, 1988 in New Hampshire).
- Dark-eyed Junco's foraging techniques vary, although gleaning is most commonly used. Glean = 62.7%; jump/hover = 20.5; probe = 6.9%; hover = 5.7%; and hawk = 4.2% (Holmes and Robinson, 1988 in New Hampshire).
- Territories are based on reproductive requirements. Breeding pairs defend nesting territories, which typically average less then five ha per mating pair (Haney, 1999).

- Densities typically vary between 20 and 40 individuals/ 40 ha, although populations may exist in densities as high as 150 individuals/ 40 ha (Beedy, 1981; Scott and Crouch, 1988b).
- The Dark-eyed Junco is more abundant in commercially thinned forests then in un-thinned forests, due to the requirement for reduced canopy cover. The most common post-harvest stage is regenerating harvested mature forest (Thompson and Capen, 1988; Hagar et. al., 1996).
- In harvested, rather than thinned stands, Dark-eyed Junco density on six to ten year old cutblocks appears to be unaffected by the cutblock, when the size of the block is relatively small. A preference for unscarified blocks is, however, evident (Scott et. al., 1982; Scott and Crouch, 1988b; Stelfox et. al., 2000):
  - 1.76 ha harvest area = 21 individuals/ 40 ha
  - 3.56 ha harvest area = 14 individuals/ 40 ha
  - 5.64 ha harvest area = 35 individuals/ 40 ha
- Population density, for the Dark-eyed Junco was almost double in managed blocks as compared to old growth stands (Mannan and Meslow, 1984).
- The best correlate for habitat suitability after fire disturbance is the presence and density of large diameter live and dead trees. The Dark-eyed Junco utilizes early and mid-successional burned areas, typically from the time herbaceous cover is established; however, individuals show no preference for burned or unburned forest stands (Apfelbaum and Haney, 1981; Raphael et. al, 1987; Hutto, 1995).

Reproduction

- Clutch size averages 3-6 eggs (Semenchuk, 1992; Fisher and Acorn, 1998).
- Incubation time is between 11-13 days (Semenchuk, 1992; Fisher and Acorn, 1998).

Nesting Habitat

- Nests are typically constructed on, or very near the ground (<0.5m), where optimal foraging habitat occurs. Typically, the nest is built in a depression under heavy-concealing vegetation, beside rocks, stumps, roots, logs or windfall (Semenchuk, 1992; Schieck and Roy, 1995; Fisher and Acorn, 1998; Marcum et. al., 1998).

- The nest is constructed of grass, rootlets, moss, and hair (Semenchuk, 1992).
- Reproductive behaviour is greatest in young stands where vegetative cover is extremely high, and thus reproductive success is ultimately increased (Rangen et. al., 2000).

Migratory Behaviour

- Spring migration brings birds into Alberta in March and April (Semenchuk, 1992).
- Fall migration occurs late August to early October, although some individuals may overwinter in Alberta, especially in urban areas (Semenchuk, 1992; Fisher and Acorn, 1998).

Community Structure

- The Dark-eyed Junco showed no change in density after a spruce beetle induced mortality of local spruce stands in Alaska (Matsuoka et. al., 2001).
- Dark-eyed Junco habitat needs (black spruce and jack pine dominant) are the same as Nashville warbler, Palm warbler, Gray Jay, Hermit Thrush, Veery, Black and White Warbler, Black-throated Blue Warbler, Black-capped Chickadee and the Ruby-Crowned Kinglet (Thompson and Capen, 1988; Hobson and Bayne, 2000),
- Habitat preference (upland coniferous) in Alberta, is different then the Brown-headed cowbird (deciduous riparian), resulting in fewer parasitized Dark-eyed Junco nests (Tewksbury et. al., 1998; Tewsbury, et. al., 1999).
- European Starlings may have a negative effect on native bird nesting and breeding, by displacing individuals from breeding territories (Weitzel, 1988; Fisher and Acorn, 1998).

Management Implications

- The use of burned-over areas is prevalent and thus during salvage logging operations structure should be retained, including standing stems.
- Large-diameter snags should be retained in harvested areas.

- Understory and ground cover is very important for the Dark-eyed Junco and should be preserved in harvest areas, especially in larger retention areas.
- Old coniferous forests are utilized, and should therefore be maintained
- Mature stands, typically unsuitable for the Dark-eyed Junco, may be minimally harvested, thereby producing suitable habitat.
- Unscarified blocks are preferred over scarified blocks; therefore, some area should remain untreated for silvaculture purposes.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

54. Habitat suitability associations
55. Nesting efficiency as related to edge (both natural and anthropogenic)
56. Use of insect-infested stands and how to manage for insect control, Dark-eyed Junco management and infected timber extraction.

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Great Gray Owl
Strix nebulosa nebulosa

Introduction

The Great Gray Owl, the largest of all North American owls, is an uncommon year-round resident of Alberta. It's striking appearance, large size, and use of forest clearings make this an easily identified species of Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Great Gray Owl is rated yellow B (warrants management attention) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000 and S4 (apparently secure in Alberta) by the Heritage status ranks. The Great Gray Owl forages mainly on small mammals, dependent on forest clearings. General habitat use consists of a mosaic of forest types, although mature to old deciduous stands, close to edge habitat, are preferred. Nesting occurs in old raptor, or corvid (ravens and crows) nests. The Great Gray Owl occupies a niche similar to other species in the community such as the Great Horned owl.

Food

- The great gray owl utilizes a variety of species for food, from small mammals and birds, to amphibians and large insects. Small mammals, such as voles, mice and shrews, are the predominant food source, particularly during the breeding season (Bull and Duncan, 1993; Fisher and Acorn, 1998, Konig et. al., 1999, Bull et. al., 1989, Franklin, 1988, Hayward and Verner, 1994).
- Many small mammal species prefer open habitat. The type of opening, natural or anthropogenic, affects the availability and abundance of prey species. Species which tolerate drier conditions than the surrounding forest will be available in harvested areas that remain dry. Natural openings have a

higher percentage of moisture dependant species, such as the Southern Red-backed Vole (Franklin, 1988).

- Great Gray Owls can detect prey items under 45 cm of snow at a distance of 45 m (Salt and Salt, 1976).

Foraging and Roosting Habitat

- Habitat requirements are similar throughout the year (Hayward and Verner, 1994). Mature to overmature coniferous, deciduous or mixedwood stands with 40% or greater canopy closure are preferred. Suitable stands are typically associated with open areas that provide suitable foraging habitat (Harris, 1984; Godfrey, 1986; Campbell et. al., 1990; Semenchuk, 1992; Bull and Duncan, 1993; Fisher and Acorn, 1998; Stepnisky, 1997; Sanderson et. al., 1980; Verner, 1980; Smith, 1992).
- Young pine stands tend to be avoided (Whitfield and Gaffney, 1997).
- Suitable habitats are correlated to edge abundance (Stepnisky, 1997), with portions of cutblocks greater than 30 m from an edge appear to be of little value to Great Gray owls (Hayward and Verner, 1994).
- Juvenile Great Gray owls usually perch at least 15m from an edge and perch sites had less understory canopy and higher basal areas than that of adults (Whitfield and Gaffney, 1997).
- Great Grey Owls can benefit from the early stages of forest fragmentation including clearcuts and other natural openings, with 20-30% fragmentation throughout their home range appears to be optimal (Whitfield and Gaffney, 1997, Bull and Duncan, 1993).
- Home range average in Oregon is 67.3 km^2 for adults and up to 167 km^2 for juveniles (Bull et. al., 1988; Bull and Duncan, 1993) with minimal territorial behavior during the winter period (Brunton and Pittiway, 1971). Territorial aggression is most observed in the breeding season (Bull and Duncan, 1993).
- The highest density recorded is 1.88 pairs/km^2 (Duncan, 1987).
- Mating pairs will commonly roost close to one another, especially prior to egg laying. Males will travel up to 3.2 km from the nest to hunt during the breeding season (Bull and Duncan, 1993).
- Owlets tended to remain in harvested forests with at least 60% canopy closure (Whitfield and Gaffney, 1997).

- Irruptive movements may be limited when a wide selection of alternative habitats are available; however, irruptions likely still occur when vole populations crash (Bull and Duncan, 1993; Collister, 1997; Nero and Copeland, 1997).
- A habitat model built for western Alberta winter habitat (Piorecky et. al., 1999):
  - density of deciduous trees ≥35 cm dbh (S_1) (5/ha = 1; 0/ha = 0)
  - mean dbh of deciduous canopy trees (S_2) (≥25 cm = 1; ≤17 cm = 0)
  - mean dbh of coniferous canopy trees (S_3) (≥25 cm = 1; ≤17 cm = 0)
  - distance to open habitat (S_4) (150m =1; 0m = 0.5)
  - tree canopy closure (S_5) (≥35% =1; ≤5% = 0)
  - shrub/sapling cover (S_6) (≤40% = 1; ≥80% = 0)
  - distance to treed area (S_7) (≤15m = 1; ≥50m = 0)
    - HSI (nesting) = (S_1, S_2,0.5S_3) x S_4 x S_5
      - S_1, S_2,0.5S_3 (only the variable with the highest value is chosen, thereby making the equation complete with only three variables, and not five)
    - HSI (foraging) = S_6 x S_7

Reproduction

- The actual timing of reproductive events is dependant on prey abundance and availability (Voous, 1988).
- The average clutch size is 2-5 eggs (Franklin, 1988; Semenchuk, 1992; Tishechkin et. al., 1997; Whitfield and Gaffney, 1997; Konig et. al., 1999) with incubation typically taking 28-32 days (Bull and Duncan, 1993).
- Pair bonds are formed for the breeding season, but do not persist throughout the winter. However, if both birds return to the previous years nest area, they will breed again (Bull and Duncan, 1993)
- Females abandon the young between 3-6 weeks, when the males provide care and food.
- Great Gray Owls show some degree of fidelity to nest site (Bull et. al., 1988).
- Sexual maturity is reached the second season (Konig, et. al., 1999).

Nesting Habitat

- Great Gray Owls use a variety of habitat types for nesting (Tishechkin et. al., 1997), 'recycling' nests of other large birds such as ravens, crows and hawks (Semenchuk, 1992; Tishechkin et. al., 1997) and often re-use the same nest for several years (Bull et. al., 1988; Franklin, 1988).
- Nesting habitat ranges from coniferous to deciduous stands, with snags used for nesting when available (Whitfield and Gaffney, 1997; Bull and Duncan, 1993). In Alberta, mixedwood stands are preferred, with nests typically built in Aspen (Stepnisky, 1997).
- The adult male establishes his territory by vocalizing near the potential nest site, but only defends the territory in the vicinity of the nest (Bull and Duncan, 1993). Pairs will nest as close as 0.5 km from other nesting pairs of Great Gray owls.
- Canopy closure above the nest provides thermal protection as well as safety from predators. Whitfield and Gaffney (1997) observed nest abandonment in areas with less than 48.1% canopy closure. Nests used prior to forest harvest in the area, tended not to be used again.
- The typical height of nests in Canadian boreal forests is between 4.5 to 15m in either deciduous or coniferous trees (Godfrey, 1986).
- In central Alberta, nesting habitat was: (Stepnisky, 1997).
  - average patch size = 29.6 ha
  - edge/area ratio of nesting habitat is 81.7
  - distance from nearest adjacent patch = 40m
  - percent of forested area in home range = 55%
- Breeding ranges, which were harvested to an average of 49.3% of the total area, were completely abandoned. Areas where harvest totaled 20.8% were relatively unaffected. Areas which were not harvested, allowing openings to decrease to below 15%, showed declines in breeding populations (Whitfield and Gaffney, 1997).
- Nesting will readily occur in artificial nesting structures (Hayward and Verner, 1994; W. Lane, pers. comm.).

Community Structure

- Great Gray Owls are generally solitary animals; however, congregations may form in late winter, perhaps in relation to the commencement of the breeding season (Voous, 1988).
- Despite its large size, the Great Gray Owl may compete for prey more directly with smaller birds of prey, especially during population lows (Bull and Duncan, 1993).
- Competition for nest sites may be severe when prey abundance is high and raptor diversity and abundance is great. When other raptors irrupt, Great Gray Owl success is increased (Voous, 1988; Hayward and Verner, 1994).
- Great Horned Owls nest earlier than Great Gray Owls and thus choose the best nesting sites (Voous, 1988).
- During years of low hare and grouse populations, the Northern Goshawk preys frequently on owlets (Bull and Duncan, 1993).
- Predators include Red-tailed Hawks, Black Bear, Fisher, Canada Lynx , and other larger mammalian carnivores, although adults are generally tolerant of their presence (Bull and Duncan, 1993).
- Food supply and pre-existing nest structures affect population size (Duncan, 1997).

Management Implications

- Vegetation surrounding natural meadows should be conserved when possible.
- Known nest sites should be conserved, with a vegetative buffer to a distance of at least 300m. This would leave a surrounding patch approximately 30 ha. Selective harvest within this buffer may be an option, providing canopy closure remains above 50%.
- Nesting sites depend on available suitable habitat for other large birds; therefore, management of nesting sites should be considered.
- Large residual trees should be left to supply roosting and hunting perches.
- Great Gray Owls may benefit from some forest harvest within their home ranges, with the creation of short-term openings. To maximize effectiveness of harvest areas, cutblocks should be relatively small (10 ha or less), irregularly shaped, and have suitable woody debris retention for prey species within the cutblock.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

57. Habitat suitability associations
58. Effects of anthropogenic disturbance on success (type and amount of disturbance).
59. Associations between Great Gray Owls and other large birds of prey
60. The effects of harvest on prey populations and optimal post-harvest vole habitat should be ascertained to contribute to Owl success.

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Grizzly Bear

Ursus arctos

Grizzly Bear (L Fullerton, SRD)

Introduction

The Grizzly Bear is an uncommon year-round resident of Alberta, with low densities throughout the province. Its formidable size and unique features make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Grizzly Bear is rated blue (may be at risk) by the Alberta Wildlife Act, may be at risk by the General Status of Alberta Wild Species 2000 and S3 (vulnerable in Alberta) by the Heritage status ranks. The Grizzly Bear diet consists of a variety of items including plants, insects, carrion, and live animals. Historically a prairie dwelling animal, the Grizzly Bear has been forced into remote forested habitat by humans and associated development. Denning occurs throughout the winter months in a variety of structures, depending on availability. The Grizzly Bear is a species which requires special management due to its depleted population, and sensitivity to disturbance.

Food

- Grizzly Bears feed on grasses, flowers, forbs, sapwood, roots, bulbs, tubers, corms, berries, invertebrates (typically insects), fish, and mammals (Forsyth, 1985; Herrero, 1985; Hamer et. al., 1991).
- Food can be divided into five main categories, making up most of the diet, including graminoids; forbs/roots, berries/pine seeds, mammals, and insects (Kansas, 2002).
- Seasonal diet changes occur throughout the Grizzly Bear range, with a general pattern consistent for most areas. Roots, graminoids and forbs are the most common food eaten in April and early May;

forbs comprise the majority of the diet in May-July; and fruits, roots and ungulates comprise the autumn diet (Servheen, 1983; McLellan and Hovey, 1995; Kansas, 2002). Food availability changes throughout the season, with herbage comprising approximately 60% of the spring forage. As summer approaches, the seeds, nuts and berries become the main component of the diet, making up approximately 65% at this time (Herrero, 1985). Roots and bulbs used for food are generally only found in streamside habitat in boreal regions (Kansas, 2002).

- Food items such as meat (especially in both spring and autumn) may be chosen due to quality, such as digestible energy and available protein, rather than abundance (McLellan, 1995; Hilderbrand, et. al., 1999; Rode et. al., 2001).
- Many animal species compose the diet of the Grizzly Bear, including army cutworm moths (White, et. al., 1998a; White, et. al., 1998b; Blodgett, et. al., 2000); ants (Swenson, et. al., 1999); birds (Henson and Grant, 1992); and mammals (Larsen et. al., 1989; Hamer and Herrero, 1991
- An important source of food for the Grizzly Bear is ants, especially Carpenter ants (*Camponotus spp*), and Red Forest Ants (*Fomica spp*). Utilization of ants is not due to their abundance, but rather availability of other foods (Swenson, et. al., 1999).
- Grizzly Bears will occasionally kill and consume Black Bears (*Ursus americanus*) (Boyd and Heger, 2000).
- Diet tends to parallel that of sympatric Black Bears (Jacoby et. al., 1999).
- Grizzly Bears will burrow in capturing small subterranean mammals (Britton and Graves, 1985).

Summer Habitat

- The main factor influencing Grizzly Bear movements is the search for food (which occur in small microsites), although cover, bedding areas, den site areas, and mating areas also contribute to movements throughout the year (Herrero, 1985; McLellan, 1995; Waller and Mace, 1997a; Waller and Mace, 1997c; Hilderbrand, et. al., 1999; Swenson, et. al., 1999; Rode et. al., 2001; Kansus, 2002).
- Unlike the Black Bear, which requires forested habitat, the Grizzly Bear is a habitat generalist and can utilize open areas in addition to utilization of forested habitat; however, ideal home range habitat is comprised of >80% secure, extremely dense cover habitat in relation to entire usable habitat area

(Herrero, 1985; Hood and Parker, 2001). Historically, preferential habitat included open grasslands and shrublands of the prairies (Banfield, 1974).

- Grizzly Bears in Montana were associated with forests with ≤40% overstory canopy cover (Mace and Waller, 1997a).
- In Yellowstone NP, Grizzly Bears showed no preference for different seral stage Lodgepole Pine stands in general, however different classes were used more heavily for different life processes. Recently disturbed areas were used primarily for travel and feeding, while mixed/non-forest areas, young stands and old stands were used only for feeding (Mattson, 1997).
- Spring use preference is for low elevation wet riparian zones, fens, natural springs, and disturbed areas, usually associated with mature spruce forests. Open agricultural areas are typically avoided, when other suitable habitat is available. Summer use of natural springs increased, due to an increase in cover, allowed by the lush vegetation, as well as increased forbs, ferns, horsetails and other dense understory vegetation. Shrub-dominated areas and regenerating harvest blocks are selected, while upland, mature coniferous forests were used less in this time. Autumn use of lowland riparian areas, springs, and natural rock outcroppings were preferential. Shrub-dominated areas and regenerating harvest blocks are selected, while upland, mature coniferous forests were used less in this time. Females in south-western Alberta tended to avoid male-occupied habitats. Males chose 5-50 year pine forests with increased forage availability, while females shifted to seemingly less optimal habitats as males encroached (Wielgus and Bunnell, 1994).
- Grizzly Bears require variety in their home range habitat, so that seasonal food may be found when available (Kansus, 2002). Male home range size average between 10 000 and 100 000ha. Female home range size averages are generally smaller, and average between 10 000 and 50 000ha ((Ballard et. al., 1982; Servheen, 1983; Waller and Mace, 1997c; Clark, 2000). Home ranges tend to overlap in both time and space, throughout the geographical range, although individuals tend to be fairly aggressive towards other non-family members when encountered). Ranges overlap averages 24% for female/female and 29% for female/male, while male/male overlap may be limited (Mace and Waller, 1997b; Mace and Waller, 1997c). Dispersal from maternal range involved several years to migrate to new home range. This process creates many potential overlaps in range, and the possibility of metapopulation relationships between family members and groups (McLellan and Hovey, 2001).

- The highest concentrations of bears occur in fall, when highly desired food sources are found concentrated into specific habitats (Servheen, 1983).
- Grizzly Bears showed no preference to caribou calving grounds, but rather were opportunistically utilized when present. Predation rates on Caribou calves vary among age and sex class (Young and McCabe, 1997; Young and McCabe, 1998).
- The greatest impact of timber harvest may be the alteration of the food supply available for consumption. Variations are site-specific, as shown in Montana, where some harvest blocks were not used for over forty years post-harvest, while some blocks were used soon after harvest (Waller and Mace, 1997b).
- Industrial disturbance near denning sites elicited variable responses, but typically resulted in abandonment, significantly increasing the rate of cub mortality (Linnell et. al., 2000).
- Grizzly Bears appear to become habituated towards roads, but habitat use is more dependent upon forage abundance and quality. Roads are however a means of habitat fragmentation (Yost and Wright, 2001).
- Adult males tend to approach human-disturbed areas more readily than do females and juvenile individuals (Gibeau et. al., 2002).
- Grizzly Bears do not require as much cover as Black Bears, and therefore will venture into open spaces (Herrero, 1985).
- Bedding areas are variable with weather conditions, time of day, and the time of the year (Herrero, 1985).
- Mostly confined to the western portions of Tolko Industries Ltd FMA area and managed under Grizzly Bear Management Areas 01 and 02A (from Kansas, 2002).
- The density of bears over time may be a more useful indicator of habitat selection than individual location data (Mace et. al., 1996).

Winter Denning

- In the Rocky Mountains, Grizzly Bears den on steep, north-eastern facing slopes, with typically heavy snow accumulations (Kansas, 2002).

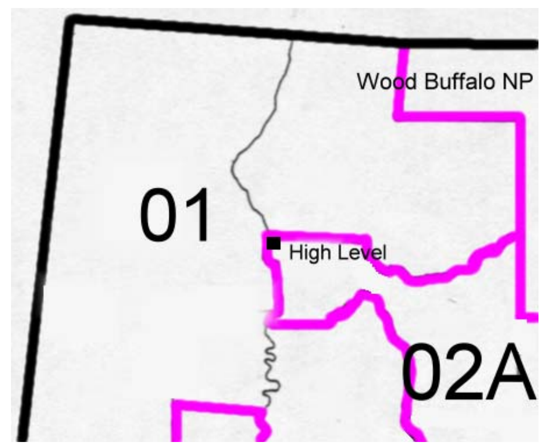
- Bears tend to enter the winter den in mid to late October, probably as a response to lacking food availability, rather than refuge from the cold (Ballard, et. al. 1982; Herrero, 1985; Mace and Waller, 1997b).
- Dens built on sloped terrain are usually associated with rocky outcroppings, while dens built on level areas are usually selected below a stand of willows or alders in loose soil, which partially obscure the opening and also acts as a barrier to snowfall (Britton and Graves, 1985; Herrero, 1985; Mace and Waller, 1997b).
- Time inside the den is dependant on the sex and age class of the occupant. Males spent an average of 148 days in the den, while females with cubs denned the longest at 177 days (Mace and Waller, 1997b).

Reproduction

- Average litter size tends to be two-three cubs per season, although up to six bears are possible. 'Adopted' cubs are also a possibility of large family sizes (Forsyth, 1985; Wilk et. al., 1988; Wielgus et. al., 1994; Case and Buckland, 1998).
- Breeding behaviour occurs late May to late June (Ballard et. al., 1982; Britton and Graves, 1985; Forsyth, 1985). Distinctive mating areas are not prevalent; however feeding in mating areas appears not to be critical as the abundance/ availability of food items is very low in the vicinity (Herrero, 1985; Hamer and Herrero, 1990).
- The mean age of the first parturition averaged 7-9 years, when females tend to average small litters of 1.5 young/ year. More mature females average 2.8 young per year and are able to produce consecutive-year litters as long as suitable food supplies exist (Ballard et. al., 1982; Dean et. al., 1992; Wielgus et. al., 1994; Case and Buckland, 1998).
- Gestation time is 180-266 days, leading to parturition within the confines of the winter den (Forsyth, 1985).

Community Structure

- Females will kill conspecifics if population density becomes too great within an area. This can especially be seen in highly productive, but concentrated areas (Hessing and Aumiller, 1994). Occasionally, cannibalization occurs (Frederick et. al., 1986).
- Although rare, Grizzly Bears will occasionally kill and consume Black Bears (*Ursus americanus*) (Boyd and Heger, 2000).
- Grizzly Bears will displace Cougars and wolves, and subsequently consume their kill (Hornbeck and Horejsi, 1986; Murphy et. al., 1998).
- Population trends are most sensitive to the survival of females (McLellan et. al., 1999).
- There are an estimated maximum of 1100 bears in the boreal plains region of the Grizzly Bear range, with an estimated 134 individual Grizzly Bears within BMA-1 (an increase from 82 in 1988) (McLellan and Banci, 1999; Kansus, 2002). It is estimated that 18% of Alberta's population reside north and west of the Peace River
- The Grizzly Bear has no natural predators, other than man, wolves, and killing by conspecifics (Forsyth, 1985; Kehoe, 1996).



Modified from McLellan and Banci, 1999

- Resource extraction and the associated access roads create problems of habitat degradation, habitat fragmentation, and habitat loss, but also create areas of increased forage (McLellan, 1988; Mace et. al., 1996).
- Grizzly bear predation on calves can limit Caribou population success (Adams et. al., 1995).

Management Implications

- Grizzly Bears can become habituated to human disturbances, with females being most impacted. Habitat usage, however, depends on the degree to which human involvement is still present; therefore, management plans should be developed to address new accesses, as well as upgraded accesses involving remote areas and otherwise suitable habitat

- To manage for females, sub-optimal foraging areas must be included into management plans.
- Den sites should be protected when discovered by a wide vegetative retention patch.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

61. Habitat suitability associations
62. Denning efficiency as related to edge (both natural and anthropogenic)
63. Population dynamics, population size , and distribution in the local area, due to its low population size
64. Den habitats in the boreal region are poorly understood.
65. Disturbance threshold at local and landscape levels.

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Mink

Mustela vison lacustris

Mustela vison energumenos

Mink (Ducks Unlimited Canada)

Introduction

The Mink is a very common year-round resident of Alberta. Essentially an aquatic weasel, the Mink is sleek, dark brown or black, with a large bushy tail This makes it easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Mink is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Mink is a ferocious predator, feeding on a variety of species, although Muskrats are the main prey item. General habitat varies between coniferous, deciduous, and shrubby areas; however, the main habitat variable is the presence of water. Denning is also variable, but is always in close proximity to water, such as a beaver lodge, log jam, or bank burrow. The Mink occupies its niche as a specialized riparian carnivore, unlike many other furbearing species.

Food

- The diet of the Mink is varied and includes small mammals, birds, fish, reptiles, amphibians, and arthropods. Mink typically utilize birds and mammals while in riverine habitats, whereas fish, waterbirds and aquatic invertebrates are utilized near lake habitat. The Muskrat is regarded as one of the most important prey species for the Mink (Erlinge, 1969; Burgess and Bider, 1980; Gilbert and Nancekivell, 1982; Forsyth, 1985; Proulx, 1987; Lodé, 1993; Viljugrein et. al. 2001).

- In northern Alberta, Mink have a varied diet including fish, mammals, birds, and invertebrates. The primary food items were the Brook Stickleback (27.9%), Muskrat (21.4%), Northern Pike (21%), and Snowshoe Hare (19.3%) (Gilbert and Nancekivell, 1982).
- Some seasonal changes in diet occur due to availability of prey species. Fish are the main prey item during the spring, with mammals and invertebrates second most utilized. Summer diet is diverse with mammals and invertebrates increasing in abundance and the occurrence of fish decreasing markedly. Autumn diet is varied as well, with bird prey decreasing and fish increasing. The winter diet is dominated by fish (Gerell, 1967; Proulx, 1987).
- Mink and Muskrat dynamics are very similar to that of the Lynx and Snowshoe Hare dynamics. Throughout most of Canada, the Mink cycle is approximately 8-9 years, and tends to be 1-2 years behind that of the Muskrat (Viljugrein et. al. 2001).
- Food is cached within or in close proximity to dens (Pattie and Fisher, 1999).

Foraging Habitat

- Mink are essentially wetland weasels inhabiting streams, lakes, and other aquatic habitats, especially those with adjacent riparian Aspen woodlands. Other areas used by the Mink include mixed shrubs, weeds, and marsh-grasses (Gerell, 1970; Banfield, 1974; Forsyth, 1985; Arnold and Fritzell, 1990; Pattie and Fisher, 1999). When available, however, Mink forage extensively on woody marshes, rather then grassy marshes, with little incursion on the surrounding habitat (Lodé, 1993; Sullivan, 1996).
- The highest number of mink occur on medium-sized rivers (11-15m wide and 1.5-3m deep), with the least number occurring on the smallest (1-5m wide and <1m deep) (Sidorovich et, al., 1996).
- The critical habitat feature for the Mink is water, where individuals are positively correlated with aquatic perimeter, shore-line development, wetland permanence, wetland cover type, and water level (Arnold and Fritzell, 1990; Sullivan, 1996).
- Mink generally avoid open areas and extensive grassy meadows which do not provide suitable cover habitat. Home ranges, thus, are larger when vegetative cover is diminished in quantity and/or quality such as forested habitat compared to grassland (Mitchell, 1961; Gerell, 1970; Allen, 1984).
- Mink travel throughout their habitat range in a circuit, moving back and forth along shorelines and riparian areas in search of food. Holes, crevices and other hiding places, such as overhanging

vegetation, floating wood, and log jams are extensively searched for potential prey. (Melquist et. al., 1980; Forsyth, 1985).

- Home ranges are centered along aquatic habitat; with the average yearly range being 2-3km of shoreline, and rarely more then 10 km. Males tend to show the largest home ranges, with females exhibiting smaller ranges and juveniles occupying the smallest ranges. Seasonal variability also occurs with summer ranges being larger than winter (Schladweiler and Storm, 1969; Gerell, 1970; Forsyth, 1985; Arnold and Fritzell, 1990; Lodé, 1993; Sidorovich et, al., 1996).
- Riparian areas associated with streams are used most often in summer months, where the Mink hunts up to 64% of its time, but never more than 200m from the associated waterbody (Melquist et. al., 1980; Allen, 1984; Sullivan, 1996).
- Foraging habitats vary slightly through the year. In late summer to early winter, Mink foraged for approximately 50% on logjams, 25% stream bank (water to high water mark), and 25% in riparian vegetation (beyond high water mark) (Melquist et. al., 1980).
- A model built for year-round, inland wetland habitat throughout the range includes the following variables (Allen, 1982):
  - Percent tree , shrub, and/or emergent herbaceous canopy(V_1): 0% = 0.0; ≥75% = 1.0
  - Percent of year with surface water present (V_2): ≤25%=0.0; ≥75% = 1.0
  - Percent of wetland dominated by emergent vegetation (V_3): 0%= 0.1; 50-75% = 1.0; 100% = 0.8
  - Percent tree and/or shrub canopy closure within 100m (V_4): 0% = 0.1; ≥75% = 1.0
  - Shoreline development (length/2(√Area x pi) (V_5): 1.0 = 0.2; 3.0 = 1.0
    - HSI food/cover in forested/shrub wetlands < 405 ha = $V_2[(V_1 + V_4) \div 2]$
    - HSI food/cover in forested/shrub wetlands ≥405 ha = $(V_1 \times V_2)^{1/2}$
    - HSI food/cover in herbaceous wetlands = $V_2[(4V_3 + V_4) \div 5]$
    - HSI food/cover in lacustrine habitat = $(V_4 \times V_5)^{1/2}$
    - HSI food/cover in riverine habitat = $(V_2^2 \times V_4)^{1/3}$
- Mink are excellent swimmers, but are also quite agile on land (Viljugrein et. al. 2001).
- In winter, Mink travel under ice, utilizing pockets of trapped air (Banfield, 1974).
- There is a high correlation between beavers and mink presence (Sidorovich et, al., 1996).
- Mink are more nocturnal than diurnal (Melquist et. al., 1980).

Reproduction

- Mating typically occurs February to April (Allen, 1986).
- Due to delayed implantation, the actual gestation time is 28-30 days (total = 39-76 days), with parturition usually occurring between late April and early May (Banfield, 1974; Forsyth, 1985; Pattie and Fisher, 1999).
- Mink usually only have one litter each season, with an average of 5 kits produced (Banfield, 1974; Viljugrein et. al. 2001).
- Juveniles disperse between July and August along watercourses until finding suitable, uninhabited areas. Although distances vary and are typically short, the longest distance recorded is 45km from the natal site (Gerell, 1970).

Denning Habitat

- Dens are typically located in Muskrat houses/burrows, Beaver lodges, under stream-side tree roots, stumps or hollow logs within the adjacent forest. Abundant woody debris, dense vegetation, and other thick, tangled complex cover is available within these areas. In addition, dens are always within 200m of open water (Marshall, 1936; Schladweiler and Storm, 1969; Banfield, 1974; Eagle and Sargeant, 1985; Sullivan, 1996). (Schladweiler and Storm, 1969).
- Mink select den sites based on the location of suitable feeding areas, however as Mink utilize terrestrial prey, dens may be some distance from water. In late summer to early winter, den sites were: logjam = 53.5%, brush/debris = 19%, rock crevices = 17.5%, stream bank = 9%, and beaver lodges = 1% in Idaho (Melquist et. al., 1980).
- The average number of dens in the home range is three, and the distance between these average between 388 and 544m (Schladweiler and Storm, 1969; Gerell, 1970).

Community Structure

- The Mink is responsible for the destruction of many small duck nests (*Anus spp*) (Opermanis et. al., 2001).

- Harvest data for the High Level area 1985-1989, as collected from volunteer submissions (AB Fish and Wildlife Div., 1990).

Mink harvested	1984/1985	1985/1986	1986/1987	1987/1988	1988/1989
Map sheet 84 - E	25	44	85	100	43
Map sheet 84 – F	19	30	72	89	61
Map sheet 84 – G	74	90	155	225	121
Map sheet 84 – J	119	149	315	544	260
Map sheet 84 – K	41	46	120	277	135
Map sheet 84 – L	97	108	161	290	223
Map sheet 84 – M	35	52	108	207	128
Map sheet 84 – N	120	140	351	556	229
Map sheet 84 - O	16	23	60	147	57

- Predators include large owls, foxes, coyotes, wolves, bears, and humans (Forsyth, 1985; Sullivan, 1996).
- Mink and otter occupy similar habitat throughout their range and may compete for food items during different seasons (Melquist et. al., 1980).
- The Mink is tolerant of human activity and will utilize sub-optimal habitats, but only if an adequate food source exists (Allen, 1984).

Management Implications

- Waterbodies should be managed to include riparian areas, and associated forest up to 200m from the high-water level.
- Old growth forest should be maintained near waterbodies.
- Large retention patches should be employed to provide optimal prey habitat near waterbodies. Outside of retention patches, in-block structure should be maximized as much as possible. Coarse woody debris, understory, and ground-level plants should provide suitable prey habitat as well as security cover from potential predators.

- Winter ice crossings should avoid Muskrat houses, rootwads, log jams, and other large material which may provide suitable denning habitat.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

92. Habitat suitability associations
93. Use of coarse woody debris left in harvest blocks
94. Local population dynamics
95. Displacement from home range due to winter access construction
96. Harvest effects on trapper success

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Moose

Alces alces andersoni

Moose (USFWS)

Introduction:

The Moose is a very common year-round resident throughout Alberta. The Moose is unique in description, and is relatively easily identified within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Moose is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Moose forages mainly on woody vegetation, supplemented with aquatic vegetation in the summer months. Generally associated with the northern coniferous forest, the Moose utilizes a variety of habitat types. Through hunting and predation, the Moose is an important member of the community in North-western Alberta.

Food

- The Moose is primarily a browser, consuming twigs and bark in the winter and foliage, submerged aquatic plants, forbs and grasses in the summer (Banfield, 1974; Forsyth, 1985; MacCracken et. al., 1993; Heikkilä, 1996). Important consumable species include the buds of highly nutritious Feltleaf Willow (*Salix alaxensis*), Diamondleaf Willow (*Salix plantifolia*), Littletree Willow (*Salix arbusculoides*), Grayleaf Willow (*Salix glauca*), and Balsam Poplar saplings (Risenhoover, 1989; Ballard et. al., 1991; Collins and Helm, 1997; Geist. 1999). Although Moose prefer deciduous species, aquatic and coniferous species are also utilized in the diet (Geist. 1999; Pattie and Fisher, 1999).

- Browse species important in Alberta included Aspen saplings, Paper Birch, Willow species, Rose, Beaked Hazel, Alder, Saskatoon, Chokecherry, and Red-osier Dogwood (Stelfox et. al., 1995; K. Wright, pers. comm.).
- High preference browse species in the Lake Superior region, include Aspen, Willow, Mountain Ash, Mountain Maple, Red Maple, Juneberry, Cherry, Paper Birch, and Bush Honeysuckle. Moderate preference species include Hazel, Green Alder, Red Osier Dogwood, Yellow Birch, High-bush Cranberry, and Balsam poplar. Low preference species include Speckled Alder, Thimbleberry, Raspberry, Blueberry, Elderberry, Canadian Honeysuckle, and bog shrubs (Allen et. al., 1987).
- Consumption rates are reflective of the season. During summer, food is relatively abundant and easily digestible; therefore, individuals may fulfill their daily nutrient requirements relatively quickly. Winter forage is less abundant and not as energetically advantageous, causing individuals to feed for longer periods of time (Renecker and Hudson, 1986).
- Sodium is required, especially after winter, when the diet consists almost entirely of woody vegetation. Required minerals are obtained from natural mineral licks, where Moose will drink the associated water, or consume the mineral laden mud. In aquatic habitats, Moose forage on emergent and submerged vegetation as a source of sodium (MacCracken et. al., 1993; Bechtold, 1996).
- Moose may exhibit population cycles dependant on salt requirements (Forsyth, 1985).

Summer and Security Cover Habitat

- Moose prefer young Poplar forests with sparse Alder and Willow stands for security cover, while early successional stands with adjacent old growth stands provide optimal foraging habitat. This segregation of habitat is not observed when Willow density is high, providing optimal security and browsing habitat together. (Collins and Helm, 1997; Cole et. al., 1999). Moose are least correlated with overstory development, and most correlated with shrub biomass and height (Jenkins and Wright, 1988). Edge habitats are used extensively by Moose due to the interspersion of browse species and coniferous forest, allowing for the maximum quantity and quality of browse with adjacent escape cover available (McNicol and Gilbert, 1980; Brusnyk and Gilbert, 1983).
- Differences between individuals at different latitudes are likely due to seasonal changes in forage quality and distribution (Risenhoover, 1986).

- Habitat segregation appears prevalent in the summer and autumn between male and female Moose, with females using less-steep slopes, lower elevation, and areas closer to aquatic feeding habitat. Winter habitat usage is comparable among the sexes (Miller and Litvaitis, 1992). Males used mixedwoods more often than females who typically used pure coniferous in the summer months in northern Maine (Leptich and Gilbert, 1989). During summer months in Alaska, female Moose use aquatic habitats, tall shrub, and deciduous/spruce mixed forests, while avoiding low shrub habitats. Males use aquatic habitats and tall shrub, while avoiding low shrub and deciduous/spruce mixed forests (Gasaway et. al., 1985). The time of day also influenced habitat use by moose in Maine (Leptich and Gilbert, 1989).
- Moose are attracted to stands younger than twenty years, as well as coniferous stands greater than twenty years, but with less than 50% canopy cover in winter (Puttock et. al., 1996).
- Moose in northern Montana and southern Alberta showed a preference for (Jenkins and Wright, 1988):
  - hydric shrub [poorly drained forest with extremely sparse conifer canopy (1%), sparse shrub layer, and well developed ground cover]
  - Lowland Spruce [climax forest on floodplains and other mesic areas with dense canopy (70%), moderate shrub layer and moderate ground cover]
  - Mature to old forest [climax forest on xeric sites with dense coniferous canopy (70%), sparse shrub layer, and moderate ground cover], was used extensively during extremely harsh winters.
  - Regenerating harvest block [10-40 regeneration with sparse canopy, moderate shrub layer and well developed ground cover] was used extensively during mild winter conditions.
- During the summer months in Idaho, Moose habitat preference is for even-aged pole timber stands and open areas, including natural breaks, lakes, and clearcuts. Habitat use in Idaho (Pierce and Peek, 1984).
  - winter ≈ 50% mature mixed; 40% old coniferous; 5% pole timber; 5% open
  - spring ≈ 50% old coniferous; 30% mature mixed; 15% pole timber; 5% open
  - summer ≈ 15% old coniferous; 50% mature mixed; 25% pole; 10% open
  - autumn ≈ 55% old coniferous; 30% mature mixed; 10% open and 5% pole timber
- To avoid hyperthermia, resting sites under Willows and White Spruce increased, due to the dense crown closure, offering a high degree of ground-level shade (Demarchi and Bunnell, 1995; Collins and Helm, 1997).

- The average yearly individual home range overlaps in time and space throughout the species distribution, and is approximately 9-57km^2 in north-eastern Alberta, 4030 ha in southeastern Alaska, 25km^2 in Maine, 4154 ha in Finland; 290-505km^2 in Alaska, 5600 ha in Quebec(Doerr, 1983; Leptich and Gilbert, 1989; Ballard et. al., 1991; Heikkilä, 1996; Potvin et. al., 1999). Range in New Hampshire shown at right (Miller and Litvaitis, 1992). The typical core range averages approximately 10% of the total yearly home range (Heikkilä, 1996).

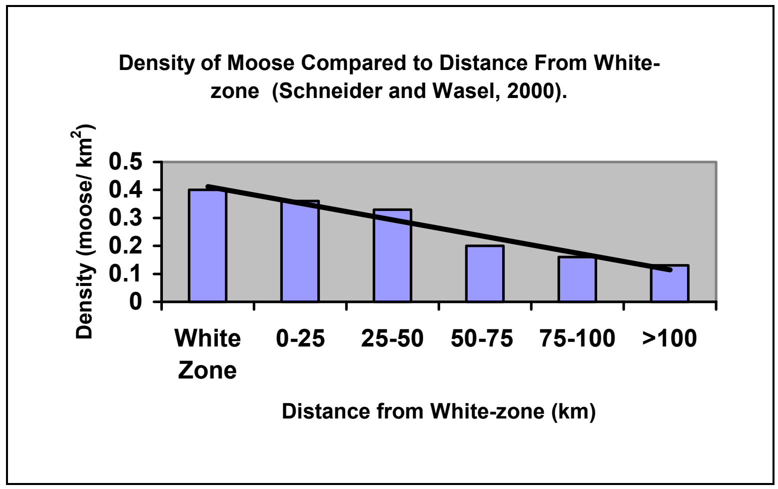
Range in NH	Male (km^2)	Female(km^2)
June 01-Sept 15	41.4	67.3
Sept 15-Dec 31	71.4	81.7
Jan 01-March 31	26.7	3.9

- Moose density is directly related to the density of predators, as well as the degree of fragmentation of the forests. In general, moose density in North America is less than 0.5/km^2. In northern Alberta, densities are estimated at 0.27/ km^2 (Messier, 1995; McKenney, et. al., 1998; Schneider and Wasel, 2000).
- Post-harvest treatments induce varied effects. Deciduous browse biomass decreased (on Glyphosphate-treated clearcuts) 30% by year 1 and 70% by year 2 in Maine. By 7-11 years after treatment, the quantity of browse was 4-5 times greater on the treated areas; therefore a short-term decrease in Moose browse is expected after herbicide application; than followed by an increase in woody browse species (Santillo, 1994; Raymond et. al., 1996). Moose abundance in harvested Alberta forests is dependent on stand species and scarification. Moose abundance, based on pellet group counts, were (Stelfox et. al., 2000):

Year	1	6	9	17	27	32	39	Avg
Scarified Spruce	0	17	30	0	0	0	16	9.0
Unscarified Spruce	17	0	0	0	0	0	8	3.6
Scarified Mixedwood	0	0	75	---	0	0	0	12.5
Unscarified Mixedwood	0	17	15	---	0	0	0	5.3
Scarified Pine	17	0	45	---	40	18	4	20.7
Unscarified Pine	32	0	75	---	50	30	20	34.5

- High densities of moose are associated with a highly fragmented landscape, such as from fire, windfall, insect infestations and timber harvest, when compared with mature and old stands adjacent to disturbance. Blocks tend to be avoided until suitable foraging shrubs emerge, typically the following season (Brusnyk and Gilbert, 1983; Doerr, 1983; Potvin et. al., 1999; Schneider and Wasel, 2000; J. Hallet, Pers. Comm.). Scattered residual cover is preferred by Moose, especially when the retained patches are comprised of dense coniferous growth (McNicol and Gilbert, 1980). Stands tend to decrease in foraging habitat suitability over time, with the lowest value reached after approximately fifteen years (Potvin et. al., 1999).

- Moose appear to become habituated towards roads, cutlines, and cutblocks; however, habitat use is more dependent upon forage abundance and quality. Disturbance areas are a means of habitat fragmentation (Stelfox et. al., 1995; Yost and Wright, 2001).
- In Alberta, there is a linear decrease, in density with increased distances from the white zone, probably due to increased predator (wolf) pressure , as wolves are limited in and adjacent to the White due to increased wolf mortality (Schneider and Wasel, 2000; K. Morton, Pers. comm.).



- Much of the day in summer is spent ruminating in forest cover (Banfield, 1974).

Winter and Thermal Cover Habitat

- Winter habitat needs are generally the same as those of summer; however, coniferous thermal cover is an added requirement during times of extreme cold weather (Forbes and Theberge, 1993).
- Moose density may be correlated with young deciduous mixedwood forests for foraging habitat, with shrub/sapling density and trees 3 -20 cm dbh proving to be ideal indicators of habitat suitability; however, foraging habitat in winter may actually be a result of decreased mobility and broadened preferences. White Spruce stands, shrubland, and bogs are avoided (Rounds, 1981; Crête and Jordan, 1982; Roy, et. al., 1995; Schieck and Roy, 1995; Stelfox et. al., 1995).
- Winter habitats, especially during periods of heavy snow cover, are typically dense forests (with high canopy cover) and abundant forage. From January to March and June through September the preferred habitat is upland aspen and mixed aspen forest greater than ten meters in height. In April

to May, and November through December, the use of bogs, treed muskegs and coniferous lowlands increased. Pine areas are utilized most extensively in autumn and spring, while spruce stands are utilized most in winter. Throughout winter, agricultural clearings, roads, and dwellings were avoided (Rolley and Keith, 1980; Hauge and Keith, 1981; (Crête and Jordan, 1982; Doerr, 1983; Boonstra and Sinclair, 1984; Pierce and Peek, 1984; Heikkilä, 1996).

- The Moose was detected in winter in each age class of aspen mixedwood stands; however, young stands (49%) and old stands (37%) exhibited higher densities than mature stands (14%) (Roy, et. al., 1995).
- Optimal winter habitat includes some water feature and some good thermal cover (conifer or heavy decadent willow) associated with the winter foraging area (K. Wright, pers comm.).
- Winter yards are typically composed of a variety of mature and disturbed stands (2-30 years), but the relative size may represent only a fraction (<15%) of the summer range, leading to yard sizes less than 2ha. The majority of the winter yard is comprised of mixed woods, totaling 51% of total area. Pure stands of coniferous and deciduous occur to a lesser extent in the yards, at 18% and 20% respectively (Proulx and Joyal, 1981; Crête and Jordan, 1982; Doerr, 1983; Forbes and Theberge, 1993).
- The average winter home range size in Northeastern Alberta ranges between 12 and 30km^2 (Hauge and Keith, 1981).
- Moose show a definite preference for unharvested lakeshore habitats during winter in Ontario, especially those with abundant coniferous cover and browse (Brusnyk and Gilbert, 1983).
- During winter in Alaska, Moose spent on average 48.8% of their time ruminating, 24.1% bedding, 20.6% feeding, and 5.8% searching. Moose must ruminate longer during the winter due to the higher fiber content in the woody vegetation consumed (Risenhoover, 1986; Renecker and Hudson, 1989).
- Winter forage availability is not necessarily a limiting factor (Crête and Jordan, 1982).
- Cleared areas may be used by the following winter (K. Wright, pers. comm.).
- A model built for boreal coniferous forests in western Alberta in winter (Romito et. al., 1999):
  - Sapling cover (S_1): 0% = 0.0; ≥25% = 1.0
- A very complex model was built for boreal coniferous forests of the Lake Superior region in winter (Allen et. al., 1987).

Reproduction

- Parturition typically occurs in mid-May, although dates vary depending on age and condition of the female, environmental conditions and predator pressure (Keech et. al., 2000).
- Gestation time is 226 to 264 days (Forsyth (1985).
- The moose usually gives birth to one calf, although 2 or 3 are possible (Forsyth, 1985).
- HSI values for moose calving grounds in the Lake Superior region (Allen et. al., 1987
  - Island = 1.0
  - Peninsula = 0.8
  - Shoreline <100m from water = 0.5
  - Upland 100-500m from water = 0.4
  - Wetland (no open water) = 0.3
  - Upland >500m from water = 0.2

Community Structure

- Moose can be an important food source for the Coyote , Black Bear, Grizzly Bear, Wolverine, Cougar and Wolf , especially when other food sources are scarce or the population density of moose is high (Ballard et. al., 1981; Forsyth, 1985; Larsen et. al., 1989; Samson and Crête, 1997; Keech et. al., 2000). The vulnerability of moose depends mostly on the habitat attributes related to predator, such as ease of travel and proximity to stalking cover (Kunkel and Pletscher, 2000; Yost and Wright, 2001).
- Ticks may be a large contributor to moose death in winter (Pybus, 1999).
- Estimated harvest data for the High Level area 1995, as collected from volunteer submissions (AB Env. Prot, 1997).

Demographic	WMU	524	528	534	535	536	537	540
Male		135	226	23	6	76	53	23
Female		0	0	0	0	0	0	0
Young		0	0	0	0	0	0	0

- Moose will strip bark from Aspen trees when preferred foods are in short supply and in spring when newly-born calves have limited mobility. This stripping generally kills the tree, resulting in standing dead timber (Miquelle and Van Ballenberghe, 1989).

Management Implications

- Small clearcuts, regenerated 5-7 years, or highly convoluted harvest block shapes (increased edge:area ratio), with minimal edge to edge distances can provide ample forage for a high concentration of moose in one area.
- Manage for spruce saw logs, while conserving birch and willow component to increase habitat effectiveness for moose.
- As harvest blocks will become primary browse sites, consideration on placement should be influenced by the location of nearest available, residual, winter thermal cover habitat.
- In areas of high Moose density, small clearings allow for increased forage, possibly increasing the carrying capacity of the local environment.
- Access management should be employed, as logging roads (and other linear disturbances) can lead to increased hunting pressure in areas historically unaccessable.

Research Needs

Some research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

97. Habitat suitability associations within the FMA area
98. Harvest block use during all seasons
99. Harvest block treatment to provide optimal browse habitat, thereby increasing potential utilization, and perhaps decreased herbicide application
100. Optimal harvest-block width to not decrease habitat suitability
101. Harvest effects on hunter success

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Northern Goshawk

Accipiter gentilis atricapillus

Introduction

The Northern Goshawk is an uncommon year-round resident of Alberta, including Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small increase of 1.3% /year; however, information is lacking (Sauer et. al., 2001). Provincially, the Northern Goshawk is rated yellow B (warrants management attention) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and status undetermined by the Heritage status ranks. The Northern Goshawk feeds mainly on small mammals and birds. Habitat associations are defined at three scales including 1) nest site habitat 2) Post-fledging Area (PFA) 3) Foraging Area (Reynolds et. al., 1992; Squires and Reynolds, 1997). Although the Goshawk is considered a habitat generalist, several attributes, such as canopy closure, large trees, and low herbaceous ground cover, are important requisites for suitable habitat. Nests are large stick platforms built high in the canopy and represent the centre of the highly defended territory.

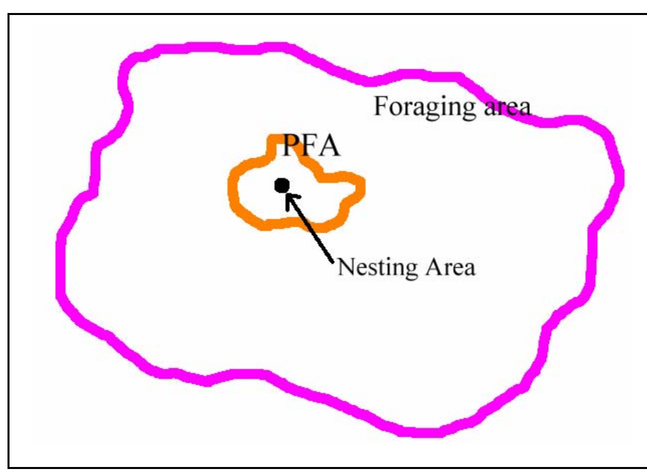
Food

- Due to the distribution of the species and changes in seasonal availability, the prey base is quite large. In any one range, up to fifty species of mammals and birds may be utilized. Grouse, Snowshoe Hares, and Squirrels comprise the majority of species taken (Reynolds et. al., 1992; Semenchuk, 1992; Griffith, 1993; Squires and Reynolds, 1997; Squires, 2000).

- Cyclical changes in prey-species availability (especially grouse and hare), rather than abundance, may cause irruptive movements (Brown and Amadon, 1968; Beier and Dreman, 1997; Squires and Reynolds, 1997), or decreased reproductive success (Erdman et. al., 1998).
- The food requirement of the goshawk is approximately 120g/day to 150g/day (Brown and Amadon, 1968).
- Carrion is not a component of the Goshawk diet (Salt and Salt, 1976).
- Water sources are not a habitat requirement, but are often present near nests (Squires and Reynolds, 1997)

Roosting and Foraging Habitat

- Northern Goshawks are found in a variety of habitat types; however, dense mature mixedwoods, with at least 20% old growth is optimal. The preferred hunting areas within these stands include the transition from bogs, riparian areas, and regenerating areas to the dense mature mixedwoods. These areas typically provide suitable habitat to the largest number of available prey species; therefore, the behaviour and morphology of adult birds is adapted to these areas. Canopy closure also determines habitat suitability. Old forest with 40-69% canopy closure is considered optimal; old forest with 70-100% canopy closure is considered suitable; mature forests with 40-69% canopy closure is considered marginal; all other forest types are considered sub-marginal (Salt and Salt, 1976; Sanderson et. al., 1980; Verner, 1980; Widén, 1989; Reynolds et. al., 1992; Semenchuk, 1992; Griffith, 1993; Doyle and Smith, 1994; Squires and Reynolds, 1997; Tornberg and Colpaert, 2001).
- Closed canopy forests with large trees, on moderate slopes, and with open understories are important habitat attributes, with respect to prey habitat requirements (Reynolds et. al., 1992; Squires and Reynolds, 1997).
- Home range is typically divided into three overlapping concentric areas, focusing on particular life processes. These include the foraging area, the post-fledgling area (PFA), and the nesting area (Shipman, 1997; Daw and DeStefano, 2001).



- The outer ring, representing the foraging area, is dependant on the quality of habitat available, and may be quite variable. Although the foraging area typically occupies approximately 2500 ha, some mating pairs may utilize up to 10 000 ha in sub-optimal habitat, with the males utilizing the more distant portions of the range than the females. When old forest is abundant (>50%), home range sizes are much smaller than areas with <50% old growth; however, old-growth patches greater than 30 ha tend to be avoided. Abundant, delineated edge habitat is also required to facilitate hunting success (Reynolds et. al., 1992; Griffith, 1993; Tornberg and Colpaert, 2001).
- On average in Arizona, goshawk foraging areas had the following characteristics (Beier and Dreman, 1997):
    - 48.3% canopy closure
    - 4.4 large snags/ha
    - 29.6 small snags/ha
    - 17.6 large downed logs/ha
    - 30.8 small downed logs/ha
    - 614 trees/ha <10cm dbh; 761 trees/ha 10-20.3cm dbh; 259 trees/ha 20.4-40.6cm dbh; 52 trees/ha >40.6cm dbh
- With respect to foraging habitat, stand quality is more important than stand quantity (Daw and DeStefano, 2001).
- The area utilized in the rearing of broods is known as the post-fledgling area (PFA), which is smaller, and contained within the foraging area. Due to the protection of reproductive success, the PFA corresponds with the defended portion of the range. Typically, this area varies between 3 and 400 ha (average 150 – 200 ha), and consists of a mosaic of structure and vegetative types. Wet openings, as well as security cover against some predators and siblings within large contiguous forests patches must be provided within the PFA (Reynolds et. al., 1992; Smith, 1992; Boal and Bacorn, 1994; Shipman, 1997; Squires and Reynolds, 1997; Estes et. al., 1999; Daw and DeStefano, 2001).
- At one week post-fledging, young usually stay within 50m of the nest. By 7 weeks, young typically are found between 100 and 400m form the nest (Shipman, 1997).
- The smallest circular habitat area, contained within the PFA is known as the nesting area, and is typically 10-15 ha (Reynolds et. al., 1992; Shipman, 1997; Daw and DeStefano, 2001).

- Some perches, located in close proximity to the nest act as plucking perches, where the adult will strip the prey items of feathers or fur. These perches are usually quite low to the ground and include structure such as downed logs, stumps, or old nests (Squires and Reynolds, 1997).
- Roosting/perching sites tend to be high in the canopy, where the bird will perch alone. Average fledgling perch height is typically 3-4 meters, except during weeks 2-3 (post-fledgling) when the flight feathers are developing. Perching trees are typically Aspen (Shipman, 1997; Squires and Reynolds, 1997).
- The Northern Goshawk prefers unscarified mixedwood harvest areas rather then scarified treatments. The negative effect of timber harvest on the Goshawk is likely due to the altered prey composition, resultant of fragmentation. (Haila, 1984; Stelfox et. al., 2000; Tornberg and Colpaert, 2001).
- While pursuing prey, the Goshawk may chase on foot when vegetation becomes too thick for flight (Griffith, 1993).
- Prey abundance determines winter habitat preferences in the winter, not the actual habitat structure itself. Irruptive movements may be caused by the failure of prey species during the winter months, particularly due to cyclic population fluctuations of the Ruffed Grouse and the Snowshoe Hare (Semenchuk, 1992; Doyle and Smith, 1994; Squires and Reynolds, 1997; (Tornberg and Colpaert, 2001).
- During the breeding season, the average foraging bout never extended to the full extent of the range (Craighead and Craighead, 1969).

Reproduction

- The male builds the nest from bark and twigs; however, the female may supplement with conifer needles after the general structure of the nest is complete (Godfrey, 1986; Semenchuk, 1992).
- Egg laying can take up to sixty days, with eggs being laid every several days (Brown and Amadon, 1968).
- Clutch size is two to five eggs (Salt and Salt, 1976; Godfrey, 1986; Semenchuk, 1992).
- Incubation time is 36-41 days (Reynolds and Meslow, 1984; Godfrey, 1986; Semenchuk, 1992; Shipman, 1997).
- Fledging occurs between 21 and 31 days, while post-fledgling dependence lasts up to 60 more days (Shipman, 1997).

- Pair bonds remain until the death of one occurs (Brown and Amadon, 1968).

Nesting Habitat

- Goshawks can nest in almost any type of forest and have even been observed to nest on the ground; however, the nest is usually built in a deciduous tree (although conifers may be used). Breeding in Alberta most commonly occurs in densely wooded parts of western and northern Alberta old forests with very thick surrounding vegetation. Nests tend to be located on the northern aspect of a slope, usually associated with a drainage (Salt and Salt, 1976; Reynolds et. al., 1982; Reynolds et. al., 1992; Semenchuk, 1992; Griffith, 1993; Shipman, 1997)
- Nesting stand optimal habitat should have a contingent of large trees (>53cm dbh), have good canopy closure (>50%), have between 400-1500 stems/ ha, be closer than 215m from forest openings, and be at least 12 ha in size. (Reynolds, et. al., 1982; Crocker-Bedford, 1990; Siders and Kennedy, 1996; Beier and Dreman, 1997; Squires and Reynolds, 1997; Daw and DeStefano, 2001).
- The large nest (approximately 1m across) is a platform structure, built 6-23m high (16-20m average). Typically, the nest is constructed from twigs and bark, occasionally with sticks broken from live vegetation. Previous-year nests, made by Goshawks, other hawks, and other large birds may be relined and used. The nest tree is usually the largest tree in the area; however, several alternate nests (1-8) will be available in less dominant trees (Salt and Salt, 1976; Reynolds, et. al., 1982; Reynolds et. al., 1992; Semenchuk, 1992; Siders and Kennedy, 1996; Squires and Reynolds, 1997; Fisher and Acorn, 1998).
- The distances between adjacent nests averaged approximately 10 km, however, some nesting sites were as close as 1.6 km in Wisconsin (Erdman et. al., 1998).
- Younger and early mature forests, open canopy forests, and wide woodland industrial roadways were used less than available. Nesting success and survival are not impeded in these areas, but rather utilization is decreased (Squires and Reynolds, 1997; Daw and Destefano, 2001).
- Logging activities within 50-100m of nest can cause abandonment, especially if structure is altered by greater then 30%. Dispersing pairs tend not to exceed 1.5 km from disturbance (Squires and Reynolds, 1997; Penteriani and Faivre, 2001).
- Pairs show a long-term fidelity to nesting sites (Erdman et. al., 1998; Penteriani and Faivre, 2001).
- Suitable nesting habitat is critical to population persistence (Reynolds et. al., 1992).

- Freestanding water is often found in close proximity to nest trees; however, water sources up to 3.5km from the nest have been used. Water distance averaged 119 m from nest in Oregon (Reynolds et. al., 1982; Squires and Reynolds, 1997).

Community Structure

- Territorial behaviour, especially towards other raptors, peaks during the breeding season (Beebe, 1974).
- Occupying a fairly high rank in the food web, the adult Northern Goshawk has few natural predators, except perhaps large avian species, such as the Bald Eagle, Golden Eagle, Great-Horned Owls and Red-tailed Hawks (Griffith, 1993; Squires and Reynolds, 1997; Daw and DeStefano, 2001).
- American Martens and Wolverines may stalk and kill Goshawks, especially while using plucking perches close to the ground (Paragi and Wholecheese, 1994; Doyle, 1995).
- Great Horned Owls, Long-eared Owls, and Cooper's Hawks never nest within 1 km of a Goshawk nest (Crocker-Bedford, 1990).

Management Implications

- Snags and largelive trees should be retained whenever possible, especially within larger retention patches.
- Habitat should be managed in several large areas of 2000 ha blocks (up to 5000 ha). Rotating harvest areas throughout Goshawk habitat management areas may provide a profitable habitat mosaic of multiple large stands with high foliage volume and regenerating young patches throughout the PFA.
- Nesting stands, and therefore PFA's and foraging areas should be associated with watersheds.
- As prey populations are vitally important, management of prey habitat should be achieved by:
  - providing habitat attributes (dense tree cover with developed herbaceous growth)
  - forest openings up to 2 ha in size could be produced
  - patches of dense mature forest scattered throughout
  - majority of forests in mature to older stages

- Nests may be recycled, therefore, suitable nests should be identified and areas of at least 12ha should be retained surrounding the nest tree.

Research Needs

There is little quantitative information in northern Alberta about Northern Goshawk habits and habitats. Future research should be directed towards:

102. Habitat suitability associations.
103. Winter ecology.
104. Predator-prey dynamics.
105. Utilization of harvest blocks and surrounding stands.
106. Maintenance/ promotion of prey habitat and its affect on other species which require large contiguous forest, rather than abundant edge habitat.

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Northern Myotis
(Northern Bat)
Myotis septentrionalis

Northern Myotis (M. Vonhof)

Introduction:

The Northern Myotis (Northern Bat) is a year-round resident of Alberta. Nocturnal habits, similarity throughout the genus and small size make this species difficult to locate and identify within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Northern Myotis is rated blue (may be at risk) by the Alberta Wildlife Act, may be at risk by the General Status of Alberta Wild Species 2000 and S2 (imperiled in Alberta) by the Heritage status ranks. The Northern Myotis forages on insects captured during flight. General habitat use consists mostly of old deciduous and mixed deciduous forests, where suitable roosting and foraging habitat are available. Edges are typically preferred, while dense forest and the centers of openings are avoided. Roosting sites are typically close to foraging sites in deciduous stands. During winter, the Northern Myotis retires to communal hibernacula, typically in rocky caves or old mines. Although designated 'may be at risk,' the Northern Bat may be more common and exhibit more stability than currently observed.

Food

- Diet includes Lepidoptera, Coleoptera, Neuroptera, Diptera, Hemiptera, Homoptera, and Hymenoptera, although different consumption rates will occur in different environments due to altered prey populations (Hayes and Adam, 1996; Caceres, 1998).

- The total biomass and number of small insect prey is significantly larger in harvested areas than in wooded stands, while the opposite is true for larger insects ≥5mm (Hayes and Adam, 1996).
- Feeding generally occurs at dusk and dawn (Pattie and Fisher, 1999).
- Bats feed until insect populations disappear in fall. The recently consumed prey is contained within the digestive tract throughout the winter (Whitaker and Rissler, 1993).

Foraging Habitat

- Commercially overmature Aspen and Aspen-dominated mixedwoods are preferred by the Northern Myotis. Mesic habitat with large trees and decadent standing timber, especially riparian areas, is optimal (Roy, et. al., 1995; Krusic and Neefus, 1996; Caceres and Pybus, 1997).
- Univariate analysis indicate a positive association with basal area, large tree density, canopy closure, and small tree height (Jung et. al., 1999).
- Bat activity is concentrated over ponds, small gravel roads, and lake edges during the summer; however, as autumn approached, confined wetland areas, surrounded by dense, mature forest were avoided, possibly due to the lower temperatures and assumed decrease in insect biomass. There is a distinct male-biased sex ratio, as females move to areas with higher temperatures and presumably higher insect abundances in the summer (Krusic and Neefus, 1996; Zimmerman and Glanz, 2000).
- Myotis species were most commonly detected in regenerating stands when the dominant trees were softwoods; however the harvest of riparian areas may have a devastating effect on bat utilization (Hayes and Adam, 1996; Krusic and Neefus, 1996).
- A negative association is indicated with large gap size and flowing water (Krusic and Neefus, 1996; Jung et. al., 1999).
- Bats are attracted to larger gaps (>20m) for foraging opportunities; however clearings (such as from timber harvest) greater than 30 ha are suitable only near the edge, and are seldom traversed (Crampton, 1995; Crampton and Barclay, 1995; Crampton and Barclay, 1996).

Roosting Habitat

- Mature Trembling Aspen and Balsam Poplar trees greater then 80 years old, as well as in regenerating cutblocks less then 20 years old are very important roosting stands. Dead coniferous trees, with lost branches, no needles, hard to spongy heartwood, and spongy to soft sapwood are used as well, although to a lesser degree. Roost trees are typically associated with edge habitat, often located in wetland areas, with the base of the trees usually submerged to some degree. Therefore stand age, along with structural and compositional variability and insect abundance reflect habitat suitability (Crampton, 1995; Crampton and Barclay, 1995; Crampton and Barclay, 1996; Hayes and Adam, 1996; Vonhof and Barclay, 1996; Foster and Kurta, 1999; Grindal, 1999; Pattie and Fisher, 1999; Vonhof and Hobson, 2001).
- Northern Bats choose to roost in tall living or recently dead trees, with less canopy closure, increased accessibility and close proximity to suitable foraging habitat (typically within 500-600m from roost). Old woodpecker holes, cracked tree trunks, and peeling bark provide suitable roosting sites (Vonhof and Barclay, 1996; Caceres, 1998; Foster and Kurta, 1999; Grindal, 1999).
- Roosts typically average (Crampton, 1995; Sasse and Pekins, 1996; Foster and Kurta, 1999):
  - tree height = 15-25 m
  - roost height = 10m
  - mean dbh = 35-65 cm
  - bark retention (for snags) = 70-80%
  - snag class ≈ 3 (only larger diameter branches >2m intact)
- Roosts tend to be deep (>20cm) in old trees, shallow (1-10cm) in mature stands, and either shallow or under loose bark in young stands. Roosts in northern Alberta tend to be in older trees, due to the need for thermal and security protection. Aspen bark is quite thin, and offers little protection against the local climate (Crampton and Barclay, 1996).
- Roosts in northern Alberta tend to be (Crampton, 1995):
  - in deep crevices in Aspen 20m tall
  - in trees exhibiting early decay
  - limited in clutter (branches, thick understory etc).
- Northern bats tend to roost with other species, averaging 20 individuals in each cavity (Foster and Kurta, 1999; Grindal, 1999).

- Alternate roost trees tend to be clustered within a confined area, as tree roosting bats tend to switch roosts often (≈ every 2nd day) choosing roost sites relatively close to the original roost site; however, new roosts may be up to 1 km away when suitable sites are not available within close proximity (Crampton, 1995; Crampton and Barclay, 1995; Vonhof and Barclay, 1996; Caceres, 1998; Foster and Kurta, 1999).
- Roost sites are three times more prevalent in unharvested forests; however, cutblocks less than 20 years old provide ample sites, but with limited thermal protection. Bat activity in general is minimally affected by harvest. Some areas may produce suitable habitat with adjacent foraging and roosting areas; however, large blocks >30ha will be used primarily at the edge (Crampton, 1995; Grindal, 1999).
- Roost tree abundance may be an important contributing factor in determining Northern Myotis distribution (Crampton and Barclay, 1995).

Reproduction

- Maternity roosts must be large, well insulated and near foraging habitat (Crampton and Barclay, 1995).
- Copulation occurs from July through October, however sperm is stored overwinter. One egg is fertilized in spring, and gestated for approximately forty days. Parturition occurs in early summer; but sometimes later in more northern latitudes (Forsyth, 1985; Caceres and Barclay, 2000).
- Litter size is usually one, although twins do rarely occur (Forsyth, 1985; Pattie and Fisher, 1999).
- Maternal colonies disperse by late August (Grindal, 1999).
- Reproductive roosting sites tend to face south so that radiant heat from the sun warms the nesting cavity (Grindal, 1999).
- Maternal colonies contain up to 30 females (Pattie and Fisher, 1999).
- Young can fly in approximately four weeks (Pattie and Fisher, 1999).

Wintering Hibernacula

- Winter hibernacula tend to be caves or other rocky openings such as abandoned mines, due to a preference for low (0-4 ^{o}C) consistent temperatures, with high humidity and limited air movement. Typically, hibernacula are shared with other *Myotis* species of bats, such as the Little Brown Bat and the Long-legged Bat (Caceres and Pybus, 1997; Caceres and Barclay, 2000).
- There are currently two known hibernacula in Alberta; Cadomin Cave and Wood Buffalo National Park, which are continually reused (Griffin, 1940; Caceres and Pybus, 1997; Caceres and Barclay, 2000).
- The length of hibernation varies with latitude, altitude, and environment, although most are vacated by April or early May. During the summer, hibernacula remain unoccupied, as individuals roost near foraging areas (Griffin, 1940; Caceres and Barclay, 2000).
- Individuals awaken periodically throughout the winter, presumably due to changes in ambient temperature; however movement is limited in order to conserve energy. Bats can also be awakened by non-tactile (ie: sound) disturbance, eliciting a demanding response. This arousal from hibernation can be costly, as it may use up to 75% of the winter energy stores, leading to increased mortality (Whitaker and Rissler, 1992; Thomas, 1995).

Community Structure

- Predators include mustelids, snakes, hawks and owls (Forsyth, 1985).
- Community structure depends on resource availability and competition among species (Krusic and Neefus, 1996).

Management Implications

- Retained old-growth stands should be large (>120ha) and supply:
  - several roost trees (dying or newly dead Populus spp.(preferably aspen) with a minimum 20m in height and 40cm dbh with large scars and/or cracks above 10m
  - alternate roosts throughout old-growth stands

- gaps in understory of contiguous stands between 30-50 m^2 in size to allow for navigation to and from foraging areas
- smaller width cutblocks would allow for uninhibited travel across width
- roost trees retained close to edge of harvest blocks

- Harvest blocks near wet areas should retain many residual trees and snags to be used for roosting substrate.
- Regenerating younger stands may be more preferable if gaps are randomly made throughout the block, especially near residual trees and snags.
- Although unclear of the definitive effects of harvesting near bat roosting areas, newly created edge appears to provide habitat for *Myotis spp*.
- Harvest blocks should be small overall, as the interior of larger blocks provide decreased foraging suitability.

Research Needs

Limited research has been conducted within the northern boreal region of Alberta. The closest studies were conducted in the Aspen Parkland of central Alberta. Future research should be directed towards:

107. Habitat suitability associations
108. Identification of potential winter hibernacula sites
109. Roosting efficiency in harvested areas
110. Local population dynamics
111. Identifying the optimal edge to area ratio to benefit bats
112. Post-harvest treatments to best accommodate the Northern Myotis

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Olive-Sided Flycatcher

Contontopus cooperi

(Contopus borealis) (Nuttallornis borealis)

Olive-sided Flycatcher (D. Eckford)

Introduction

The Olive-sided Flycatcher is an uncommon to common summer resident of Alberta. Cryptic coloration makes location difficult, however perch sites and vocalization make this species identifiable in Tolko Industries Ltd. (HLLD) FMA area. Although somewhat data deficient, the Alberta population has shown a general small increase of 4.1% /year between 1966 to 2000 (Sauer et. al., 2001). Provincially, the Olive-sided Flycatcher is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Olive-sided Flycatcher preys mainly on insects, always captured during flight. General habitat use consists of coniferous forest types, especially close to edge habitat or riparian areas. Tall snags used for foraging perches are essential. Nesting occurs high in a conifer, usually on a branch well away from the trunk.

Food

- The diet is almost exclusively composed of arboreal insects. Hymenopterans (ants, bees, wasps) are the main prey item, however other prey are reported including Diptera (flies), Lepidoptera (moths and butterflies), Orthoptera (grasshoppers), Odonata (dragonflies) and Coleoptera (beetles) (Otuos and Stark, 1985; Altman and Sallabanks, 2000).
- All insect prey taken while in flight, by sallying (Eckhardt, 1979).

- Food caching does not occur with the Olive-sided Flycatcher (Altman and Sallabanks, 2000).

Foraging and Roosting Habitat

- The Olive-sided Flycatcher uses a variety of habitats throughout its range; however, old coniferous stands with relatively open canopies are preferred. In the boreal regions of Canada, upland Spruce-Fir forests, open muskeg and bogs dominated by Spruce and Tamarack, and riparian woodlands are most commonly used (Erskine, 1977; Sanderson, et. al., 1980; Beedy, 1981; Probst and Thompson, 1995; Altman and Sallabanks, 2000; Banner, 2000).
- Structural components required by individuals for foraging and roosting dictate use of particular stands. Water is typically incorporated within optimal habitat as a food source, as insect prey are more abundant in these areas. Snags and open-canopied live trees, which rise above the canopy, are also required as hunting perches within optimal habitat. These perches are used due to unobstructed views and increased variability of flight paths, providing more hunting opportunities. Openings and the associated edge habitat are also utilized by the Olive-sided Flycatcher, where light intensity is at a maximum making prey detection easier (Beedy, 1981; Rosenberg and Raphael, 1984; Godfrey, 1986; Probst and Thompson, 1995; Altman and Sallabanks, 2000; Banner, 2000).
- In the boreal forests, males tend to perch (Wright, 1997):
  - 90% in Spruce trees (61% White Spruce; 29% Black Spruce)
  - 20% in live trees, 26% in dead trees, and 54% in dead-topped trees
  - 17.8 m = average perch height
  - 25.9 cm = average dbh
  - 1.4 = ratio of perch height /canopy
- Optimal habitat in the Sierra Nevada is old forest with 0-39% canopy closure. Suitable habitat includes old forest with 40-69% canopy closure. Marginal habitat includes old forest with 70-100% canopy closure , while all other habitat types are considered sub-marginal and used less frequently by the Olive-sided Flycatcher (Verner, 1980)
- Regenerating, recently burned coniferous forests are also utilized extensively, but only when the required habitat attributes (water, tall snags/residual timber, and abundant edge) are available. When these attributes are abundant, individuals may prefer these disturbed areas (Bock and Lynch, 1970;

Raphael, 1987; Hutto, 1995; Probst and Thompson, 1995; Altman and Sallabanks, 2000; Banner, 2000).

- Attacks are generally less than 10m from perch (Eckhardt, 1979).
- Some regional populations have been found to utilize partially logged forests (over non-harvest/clear cut), where the overstory has been thinned, but many residual trees remain. Densities have been shown to double once harvest is complete; however, harvest blocks will become sink habitats when too great a percentage of trees are removed (Franzreb and Ohmart, 1978; Robinson, 1989; Evans and Finch, 1994; Altman and Sallabanks, 2000).
- Critical habitat variables include (Altman and Sallabanks, 2000; Brandy, 2000):
  - positive association with old growth
  - post fire habitat
  - Positive association in harvest areas
  - Present in young and old, but not usually in even aged mature forests.
  - Natural openings in the canopy.
  - Positive association (home range) with increased snag density and snag dbh, in harvested and unharvested stands.
  - Juxtaposition of seral stages.
  - Decreased productivity in managed areas (habitat sink).
  - Unobstructed air-space within semi-open forest and over-canopy perching sites
- The best correlate for habitat preference after fire is ground cover (Hutto, 1995).
- Males tended to forage farther from the nest site than females (Altman and Sallabanks, 2000).
- When adverse weather conditions (such as wind) are prevalent, arboreal insects are less available in the preferred foraging height. Therefore, foraging birds perch lower (<15 m) and prey on insects close to the forest floor, occasionally in herbaceous shrubbery, sapling trees, slash piles and root wads (Altman and Sallabanks, 2000).
- In Minnesota, Olive-sided Flycatcher abundance was equal in logged areas (0.02 males/ ha) and burned areas (0.02 males/ ha) (Schulte and Niemi, 1998).

Reproduction

- Eggs are laid between May and June (Altman and Sallabanks, 2000).
- Clutches average 3-4 eggs, with incubation times of 15-17 days. Nestlings fledge at 21-23 days (Salt and Salt, 1976; Godfrey, 1986; Semenchuk, 1992; Wright, 1997).
- The nest is presumably built by the female, as a bulky but fragile structure of twigs, mosses, lichens, and fine roots, lined with grasses and rootlets (Dixon, 1920; Phillips, 1937; Semenchuk, 1992).
- The Olive-sided Flycatcher has the lowest reproductive rate of any North American passerine species (Altman and Sallabanks, 2000).

Nesting Habitat

- The preferred nesting habitat is in mature to old spruce forest interspersed with numerous bogs, marshes and other opening, especially with water killed snags. Low-ground shrub cover, including *Ledum*, *Salix*, and *Betula nana*, is also preferred. When optimal habitat is not available, or is occupied, nests will be built in mixedwood stands or in stands recovering from fire. Residual, tall coniferous trees and standing water (bog, pond, lake, etc.) must still be present for the habitat to be viable. Unlike foraging habitat, abundant edge is avoided (Smith, 1927; Salt and Salt, 1976; Raphael et. al., 1987; Semenchuk, 1992; Smith, 1992; Wright, 1997).
- Poplar forests were almost completely avoided (Smith, 1927; Wright, 1997).
- Nests are typically high in the tree (10-25m), although the more northern populations tend to nest lower on average. Nests are also typically placed well out on a horizontal branch (Dixon, 1920; Phillips, 1937; Semenchuk, 1992; Fisher and Acorn, 1998).
- Nest site characteristics (Wright, 1997):
  - 95% in Spruce trees (80% of total = Black Spruce
  - 80% in live trees; 0 %in completely dead trees
  - 9.3 m = average nest tree height
  - 10.6 cm = average tree dbh
  - 0.9 = ratio of tree height /canopy

- Territories are typically observed during the nesting period, and tend to be quite large and aligned along a drainage, thereby limiting overlap. Territorial aggression is less frequent, but may occur when range is intruded upon (Altman and Sallabanks, 2000; Wright, 2001).
- Territory sizes are quite variable:

Bock and Lynch, 1970	Raphael et. al., 1987	Marshall, 1988	Wright, 1997
45 ha (Sierra Nevada)	40 ha (Sierra Nevada)	25 ha (Coast Ranges)	18.4 ha (Interior Alaska)

- The distances between nests average around 1000m (Wright, 1997).
- In riparian habitats, density is variable, but estimated between 1pair/ 1-2km of shoreline habitat (Altman and Sallabanks, 2000).
- Nesting pairs tend to be highly intolerant of potential predators (Altman and Sallabanks, 2000).
- Adult birds tended to show nest site fidelity, with 56% (5 of 9) birds in Alaska returning to the same area as the previous year. New nests averaged 271m from previous years nest (Wright, 1997).
- Nests are open cup structures (Altman and Sallabanks, 2000).

Migratory Behaviour

- Individuals depart for the wintering grounds mid August to late September (Semenchuk, 1992; Altman and Sallabanks, 2000).
- Southward migration often goes unnoticed (Salt and Salt, 1976).
- Males arrive in Alaska, from wintering grounds, on average May 24-26, with nearly all males arriving before June. Females usually arrive seven to nine days later (Wright, 1997).

Community Structure

- Although very rarely, the Brown-headed Cowbird does nest parasitize the Olive-sided Flycatcher (Altman and Sallabanks, 2000).
- The Olive-sided Flycatcher showed no change in density after a spruce beetle induced mortality of spruce stands in Alaska (Matsuoka et. al., 2001).

- Beavers provide ideal habitat for the Olive-sided flycatcher by creating numerous snags within the flooded area (Godfrey, 1986; Altman and Sallabanks, 2000).
- Nest predators include the Gray Jay, Squirrel, Northern Flying Squirrel, Stellar's Jay and the Raven (Altman and Sallabanks, 2000).
- There is no evidence of adult predation, but due to their size and affinity to edge habitat, predation by raptors can be assumed (Altman and Sallabanks, 2000).
- European Starlings may have a negative effect on native bird nesting and breeding (Weitzel, 1988).

Management Implications

- Retention of snags and live trees in large non-uniform patches should increase habitat suitability.
- The Olive-sided Flycatcher utilizes naturally disturbed areas, such as from fire and flooding; therefore, emulation of these natural disturbance types should be achieved.
- Pesticide application will affect insect populations, thereby affecting Olive-sided Flycatcher populations.
- Post-fire salvage logging should be minimized to maintain disturbed habitat.
- Habitat suitability models cite ideal habitat as upland coniferous, upland mixed and lowland coniferous/palustrine areas (Banner, 2000).
- Limiting factors include habitat loss, alteration of forests (Forestry), decreased food resources, and increased predation.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

87. Habitat suitability associations.
88. Identifying site fidelity in local area, to protect potential site reuse for subsequent years.
89. The effects of harvest (natural and disturbed) on potential insect prey populations.
90. Assess dynamics of population.
91. Managed timber may be a sink habitat, and different harvest applications should be assessed.

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Orange-Crowned Warbler

Vermivora celata celata

Orange-crowned Warbler (USFWS)

Introduction:

The Orange-crowned Warbler is a common migratory resident of Alberta. Dull olive green plumage along with a faint orange crown make this species difficult to identify within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small increase of 0.5% /year (Sauer et. al., 2001). Provincially, the Orange-crowned Warbler is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Orange-crowned Warbler forages mainly on insects, through a variety of hunting tactics. General habitat use consists mostly of very complex forest and shrub, especially in riparian areas. Nesting occurs on or near the ground in cup nests, covered by overhanging structure. The Orange-crowned Warbler occupies habitat similar to many other species in the community, such as the Connecticut Warbler.

Food

- The main food of the Orange-crowned Warbler consists of insects and other invertebrates, especially larval Lepidopterans (Salt, 1973; Sogge, et. al., 1994; Fisher and Acorn, 1998).
- Some fruits, berries, nectar, and sap are consumed (Sogge, et. al., 1994; Fisher and Acorn, 1998).
- Water is consumed from condensation on leaves (Sogge, et. al., 1994).

Roosting and Nesting Habitat

- In the boreal forests of western Canada, the Orange-crowned Warbler is associated with young and immature brushland forest, typified by tangles of deciduous thickets, willow, and alder. It is usually associated with wet areas, such as associated with beaver ponds. Riparian areas, with moderately dense canopy and moderate undergrowth are also preferred when available (Salt, 1973; Godfrey, 1986; Semenchuk, 1992; Smith, 1992; Sogge, et. al., 1994; Probst and Thompson, 1995).
- Natural edge habitat is used when available in Alberta (Salt, 1973).
- The microhabitat used for foraging is generally the same as the breeding habitat (Sogge, et. al., 1994).
- In contrast to other findings, the highest density of Orange-crowned Warblers in Alberta was found in old forest over any other age stand (Farr, 1992).
- Young birds use riparian corridors quite extensively when dispersing from the nest site (Sogge, et. al., 1994).
- Overly open areas are avoided, leaving individuals in tight cover for the majority of time (Salt, 1973).
- Territorial behaviour shown by males during the breeding season throughout foraging range (Sogge, et. al., 1994).
- As the Orange-crowned Warbler can utilize early successional habitat, it is assumed that it will respond well to disturbance by harvest (Annand and Thompson, 1997).
- The Orange-crowned Warbler is prevalent in regenerating burned areas 10-40 years old, especially when Larch is prevalent (Hutto, 1995).
- Orange-crowned Warbler density increased in a mixed coniferous regeneration block (Franzreb, and Ohmart, 1978).
- Generally a gleaning species, however, will hawk for arboreal insects if perch sites are unavailable (Sogge, et. al., 1994).

Reproduction

- Monogamous mating pairs form at the beginning of the breeding season and continue until the fall migration (Sogge, et. al., 1994).
- Breeding occurs March through July, with eggs laid between the beginning of April through early July (Sogge et. al., 1994).
- Clutch size is approximately 4-6 eggs (Salt, 1973; Semenchuk, 1992; Sogge, et. al., 1994; Fisher and Acorn, 1998).
- The incubation time is 11 to 13 days (Semenchuk, 1992; Sogge, et. al., 1994; Fisher and Acorn, 1998).
- Site fidelity for the breeding range is apparent (Sogge, et. al., 1994).

Nesting Habitat

- Almost all nests are built in wooded habitat with bushy herbaceous cover and large quantities of moss (Sogge, et. al., 1994).
- The small open-cup nest, made of leaves, twigs, roots and other small vegetative matter, is built almost entirely by the female (Semenchuk, 1992; Sogge, et. al., 1994).
- Nests are often well concealed on the ground, or very low in a bush, by overhanging vegetation such as moss to protect the site from potential predators (Salt, 1973; Sogge, et. al., 1994).
- Nest site characteristics are often very similar throughout the same region (Sogge, et. al., 1994).
- Nests are not re-used a second year (Sogge, et. al., 1994).

Migratory Behaviour

- The species is a short-to-medium range migrant (Sogge, et. al., 1994).
- During the spring migration, birds arrive within breeding ranges as early as late April, but usually in early May (Salt, 1973; Semenchuk, 1992; Sogge, et. al., 1994).
- During fall migration, birds depart breeding ranges in September or early October, traveling through Mississippi valley, and arriving on the Atlantic seaboard (Semenchuk, 1992; Sogge, et. al., 1994).

- Some mixed flocking occurs, although flocking is usually confined to individuals of the same species (Semenchuk, 1992).

Community Structure

- The Orange-crowned Warbler showed significant change (almost seven times greater) in density after a spruce beetle induced mortality of local spruce stands in Alaska (Matsuoka et. al., 2001).
- The general similarity in habitat preferences between the Orange-crowned Warbler and the Brown-headed Cowbird lead to a higher incidence of brood parasitism; approximately 30% (Sogge, et. al., 1994; Tewksbury et. al., 1998; Tewksbury et. al., 1999).
- Some species have the same habitat requirements, such as the Song Sparrow (Sogge, et. al., 1994).
- Will commonly join mixed flocks during migration (Sogge, et. al., 1994).
- Many predators exist, including other birds and mammals (Sogge, et. al., 1994).
- European Starlings may have a negative effect on native bird nesting and breeding (Weitzel, 1988).
- Orange-crowned Warblers commonly feed on sap at holes excavated by Sapsuckers (Sogge et. al., 1994).

Management Implications

- Forest practices that preserve the understory benefit the Orange-crowned Warbler.
- Vegetation should be conserved in areas surrounding water.
- The ratio of edge to area should be maximized to provide best possible habitat.

Research Needs

Little research has been conducted within the boreal region, let alone the northern boreal region of Alberta. Future research should be directed towards:

92. Habitat suitability associations
93. Harvest effect on populations
94. Does conserved understory, in open areas of harvest blocks, become utilized?

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Pileated Woodpecker

Dryocopus pileatus abieticola

Pileated Woodpecker (Dennis Eckford)

Introduction

The Pileated Woodpecker (*Dryocopus pileatus)* is the largest and most recognizable member of the North American Woodpeckers (Bull and Jackson, 1995), with a range in Alberta that includes the boreal forest, foothills, Rocky Mountain Natural Regions, and Tolko Industries Ltd. (HLLD) FMA area (Semenchuk, 1992). Although there is some data deficiency, the Alberta population has shown an average increase of 12.1%/year between 1966 and 2000 (Sauer et. al., 2001). Provincially, the Pileated Woodpecker is rated yellow B (warrants management attention) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000, and S4 (apparently secure in Alberta) by the Heritage status ranks. The preferred diet of the Pileated Woodpecker consists of insects, especially carpenter ants. The species is typically considered a mature/old forest obligate due to reliance for decayed nesting and foraging substrate; however, it can be found in a variety of forest types. The impact the Pileated Woodpecker has on community function, such as supplying cavities for other species, affords its designation as a keystone species.

Food

- The main foods of the Pileated Woodpecker are Carpenter Ants (*Camponotus spp*.), wood-boring beetle larvae, and some fruiting bodies when available (Hoyt, 1957; Conner, et. al. 1975; Semenchuk, 1992; Bonar, 1994, Conner, et. al., 1994; Bull and Jackson, 1995; Torgerson and Bull, 1995; Bonar, 2001).

- Carpenter ants comprised 90.6% of the diet in the winter, but declined to 62.5% of the diet in the summer months (Bonar, 2001). This is presumably when late instar budworms, as well as most other species of insect, are in the greatest abundance. Isoptera and Coleoptera are the typical prey in the summer (Bull and Holthausen, 1993; Conner et. al., 1994).
- No food caching is known to occur with this species (Bull and Jackson, 1995).
- Prey is located by sight or sound (Bull and Jackson, 1995).
- Water is taken from all sources (Bull and Jackson, 1995).

Roosting and Foraging Habitat

- The Pileated Woodpecker is most frequently associated with dense canopied older forest with optimum canopy cover of 40-100%, or suitable canopy cover of 0-39%. Younger seral stage forest may be used, albeit at a much lower frequency. Some studies report avoidance (Mannan, 1984; Savignac, et. al., 2000), as its use is relative to high prey densities, typically reliant on standing decadent timber (Hoyt, 1957; Carter, 1967; Verner, 1980; Conner, 1981; Renken and Wiggars, 1989; Bull and Holthausen, 1992; Bonar, 1994; Conner et. al., 1995; Mellen et. al., 1992; Bonar, 2001).
- In Alberta, Pileated Woodpeckers used all seral stages and forest types. Pole and mature upland/mixed spruce were used most often in winter whereas pole and mature Balsam Poplar were used most in the summer, showing alternative use of foraging substrate. Old mixedwood forests were shown to be preferred in other Alberta-based literature (Sanderson et. al., 1980; Schieck and Roy, 1995; Bonar, 2001).
- Regardless of the age of the stand, many large trees in various stages of decay are required for foraging. Trembling Aspen and Balsam Poplar are host to over 100 fungal species in BC, possibly suggesting the susceptibility of decay, and subsequent use by Pileated Woodpeckers during the summer months. Winter diet is found typically in coniferous trees in Alberta (Callan and Ring, 1994; Bonar, 2001).
- Forage habitat use in winter in Alberta consists mainly of coniferous species (79.6%), live trees and snags (84.3%), and hard decay class substrates (86.9%) in the winter months. Increased use of deciduous species (44.7%), stubs, logs and stumps (47.7%), and soft decay substrates (49.0%) occurred in summer (Bonar, 2001). This change in foraging substrates is directly related to the seasonal availability of arthropod prey item.

- The method of foraging also changes throughout the season. During winter in Alberta, 94.1% of foraging is by excavation (usually near the base of the tree). Excavation decreases to 66.8% in the summer while surface gleaning increases to 33.4% (usually in the upper branches, as a result of increased arthropod populations). Foraging incidence increased in downed logs when the end-diameter was greater then 25cm (Bull and Jackson, 1995; Torgerson and Bull, 1995; Bull, 1987; Bonar, 2001).
- Home range (foraging area) is affiliated with critical variables hypothesized as the best prediction method for Pileateds. These variables include coarse woody debris volume , canopy cover, and the density of large snags (≥51cm dbh). Home range is variable with respect to time of year, in that summer range>winter range>breeding range (Hoyt, 1957; Mannan, 1984; Renken and Wiggers, 1989; Bull and Holthausen, 1993; Renken and Wiggers, 1993; Bull and Jackson, 1995; Torgerson and Bull, 1995; Bonar, 2001
- The Pileated Woodpecker home range varies from 257-1464 (average 450 to 550 ha) in studies from the United States (Mannan, 1984; Bull, 1987; Renken and Wiggers, 1989; Mellen, 1992; Bull and Holthausen, 1993). Smaller average home ranges were associated with minimally logged old growth forest (Bull and Holthausen, 1993). In Quebec, home range was 268 ha +/- 69ha (Savignac, et. al, 2000). In Alberta, home range average is 2156.6 ha/ breeding pair (Bonar, 2001).
- Pairs may defend foraging sites in winter, but in an area smaller than the summer range, where pairs defend the home territory at the greatest intensity while nesting. Mating pairs occupy the same range every year. When a mate dies/disappears, the remaining bird will remain and attract another mate to the original home range (Carriger and Wells, 1919; Kilham, 1959; Bonar, 1994; Bull and Jackson, 1995; Bonar, 2001).
- The use of harvested forest blocks may be partly associated with the high degree of mobility shown by the Pileated Woodpecker, or as a method of predator avoidance. Slash and logging debris can be an important foraging substrate in the absence of a large supply of standing dead timber; however, foraging is uncommon more then 50m from the edge of the cutblock (Renken and Wiggers, 1989; Mellen et. al., 1992; Bonar, 1994; Hutto and Young, 1999; Savignac, et. al., 2000; Bonar, 2001).
- Roosts in hollow trees or vacated nesting cavities at night (leaves after sundown and returns before darkness (Bull, 1978) and during times of inclement weather. Roost trees typically contain 1-16 entrance holes in the trunk to facilitate escape from predators (Bull and Jackson, 1995).
- The Pileated Woodpecker is neither migratory nor irruptive (Bull and Jackson, 1995).

Reproduction

- Nesting behaviour occurs primarily between February and May, lasting approximately three to six weeks (Bull and Jackson, 1995; Bonar, 2001).
- Both the male and female excavate the nest (Semenchuk, 1992; Bull and Jackson, 1995).
- Eggs (3-4) are laid from early May to mid-June (Semenchuk, 1992; Bull and Jackson, 1995).
- Incubation time lasts approximately 18 days (Semenchuk, 1992; Bull and Jackson, 1995).
- Young remain with parents until fall, when they disperse (Semenchuk, 1992; Bull and Jackson, 1995).
- Individuals start breeding as early as one year (Bull and Jackson, 1995).
- Many cavities started each year (22/pair/year), however, only 0.2 starts resulted in a cavity suitable for nesting (Bonar, 2000).
- Pair bonds last for life. If the male or female dies, the remaining individual will attract a new mate, which will again remain until death (Carriger and Wells, 1919; Kilham, 1959; Semenchuk, 1992; Bull and Jackson, 1995; Bonar, 2001).

Nesting Habitat

- Nesting habitat, in most studies from the United States, is correlated with broken top coniferous snags (stubs) (most sources). In contrast to most previous literature, Pileated Woodpeckers in Alberta tend to nest in deciduous vegetation. Of 611 cavities located between 1993 and 1998, 74.6% were located in live Trembling Aspen, 11.5% in Trembling Aspen stubs, and 5.9% in Trembling Aspen snags (Bonar, 2000; Bonar, 2001). Mellen, et. al., 1992, found no difference between the relative preference for deciduous or other forest vegetation, as long as available nesting habitat was ≥40 years old
- Nesting habitat appears to be mesic type habitat, with streams averaging 50m from the nest, but never more then 150m (Conner, et. al., 1975; Conner and Adkisson, 1976; Rosenberg and Raphael, 1984; Renken and Wiggers, 1993). Mesic areas tend to produce larger trees in less time then xeric sites (Schroeder, 1983).
- Nesting trees almost always displayed some degree of decay, such as conks, breaks, and scars (Conner, et. al., 1975; Bonar, 2001), and the location of the cavity entrance was correlated with these

decay indicators. When excavations were made in deciduous trees; therefore most evidence within Alberta, a preference was shown for areas of fungal decay (Conner et. al., 1975; Conner and Adkisson, 1976; Bull et. al., 1992; Bonar, 2001).

- All sources report the importance of tree diameter (>35cm dbh), due to size of cavity produced. The opening itself may be greater then 30 cm in length and be so extensive it may cause the tree to break (Bull and Jackson, 1995).
- Although basal area was comparable between different extents of the range, ground-stem density was lower in Alberta, possibly as a mechanism of predator evasion (Bonar, 2001).
- Cavity position is more influenced by distance from canopy, rather then by height from ground as reported for most other studies (Bonar, 2001).
- Comparative nest tree characteristics:

Attribute (avg)	Oregon (Bull, 1987)	Montana(McClelland and McClelland, 1999)	Alberta (Bonar, 2001)
Tree Height	28m	29m	14.1 (stand)
Cavity Height	15m	15.9m	4-10m
Dbh	73.4cm	84cm	45.6cm
% bark	50%	43%	Mostly live trees
Basal Area	$30.8m^2/ha$	XXX (not reported)	37.5m2/ha
Canopy Closure	70%	41%	40.8%

- Nests are rarely used again for the same purpose; however, the mating pair tends to excavate new nests in the same area for many years. The distance between successive nests is typically less than 1.0 km (Carriger and Wells, 1919; Kilham, 1959; Bull and Meslow, 1988).
- Nesting territory is considerably smaller and completely contained within the foraging territory throughout the species distribution (Hoyt, 1959; Renken and Wiggers, 1989; Bonar, 2001). Average nesting territory size for Alberta is 252.1 ha +/-173.5 (Bonar, 2001)
- Pileated Woodpeckers rarely use open habitat for nesting. Pairs may use a logged area remnant snag, but not for many successive years post-harvest. One nest was found in such a harvest block,

located 64m from the edge and with 1 meter vegetation regrowth. The snag had been used previous to harvest, was used for several years after, but was abandoned in subsequent years (Conner, et. al, 1975).

- In Alberta, there is, on average, 1.28 cavity trees/km^2 and 2.20 cavities/km^2 (Bonar, 2000; Bonar, 2001).

Community Structure

- The Pileated Woodpecker is considered a keystone species (Bonar, 2000)
- Considered a primary cavity nester, in that it excavates the initial cavity within the tree (Bonar, 2001).
- The increased consumption of Carpenter Ants (*Camponotus*) may positively affect populations of Western Spruce Budworms (*Choristoneura occidentalis*) (Torgerson and Bull, 1995).
- Known predators of adults include the Northern Goshawk, Cooper's Hawk, Red-Tailed Hawk, Great Horned Owl, American Marten, and Grey Fox (Brooks, 1944; Bull and Jackson, 1995). The most common occurrence of predation, however, is by the Northern Goshawk (Brooks, 1944; Bonar, 2001). Bonar, 2001 showed that 11 of 16 study birds were killed by the Northern Goshawk.
- Several nest predators exist, such as the Marten and Weasels, as well as squirrels (Bull and Jackson, 1995).
- As the nest cavity is seldom used in succession, secondary cavity nesters tend to use the excavations. These include Barrow's Goldeneye, Common Goldeneye, Bufflehead, American Kestrel, Northern Pygmy Owl, Northern Saw-Whet Owl, Boreal Owl, Northern Flicker, Hairy Woodpecker, Three-toed Woodpecker, Northern Flying Squirrel, Red Squirrel, Bushy-tailed Woodrat, American Marten, Little Brown Bat, Big Brown Bat, Silver-haired bat, and the Wasp (*Vespidae spp.*) (Bonar, 2000).
- Hayward, et. al., 1993 noted 18 of 19 cavities used by boreal owls were originally excavated by Pileated Woodpeckers.
- Readily shares nesting tree with Vaux's Swift, Northern Flicker, Williamson's Sapsucker, Red-breasted Nuthatch, Northern Saw-whet Owl, and Mountain Chickadee (Hoyt, 1948; Schemnitz, 1964; Bull and Jackson, 1995)
- The Pileated Woodpecker will sometimes chase away nest-cavity competitors, such as the European Starling, Wood Duck, Eastern Bluebird, and the Great Crested Flycatcher (Kilham, 1979).

- Squirrels occupied three of six cavities in Oregon within eight weeks of fledging (Wilson and Bull, 1977).

Management Implications

- Timber harvest likely has the largest impact on the Pileated Woodpecker. Inhibition of natural disturbance processes, such as fire and insect infestation, as well as removal of woody debris create the largest impact on Pileated Woodpecker ecology.
- Both living and dead vegetative material should be preserved, especially Trembling Aspen infected with fungus and/or showing signs of decay. Damaged vegetation should also be retained.
- Trees which currently have excavations should be retained for future secondary cavity nesting species.
- Optimal habitat for Pileated Woodpeckers should contain an abundance of fallen logs and stumps for use as foraging habitat.
- Optimal habitat should contain larger trees in excess of 7m tall; therefore trees this height should be retained to allow for younger stands to be viable habitats
- Large retention patches should encompass the above attributes, and if possible have a linking corridor to adjacent undisturbed habitat.

Research Needs

Some research has been conducted within the western region of Alberta, particularly by Richard Bonar, in fulfillment of his PhD at the University of Alberta. Future research should be directed towards:

95. Determine if habitat suitability associations made in the Foothills Model Forest are applicable to Tolko Industries Ltd. FMA area.
96. Determine the community dynamics involving secondary cavity nesting species, including cavity-nesting waterfowl.
97. Nesting habitat efficiency as related to edge (both natural and anthropogenic).
98. Population dynamics, including territory size as literature supports a vast range of sizes.

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Pine Grosbeak

Pinicola enucleator leucurus

Pine Grosbeak (J. C. Leupold)

Introduction:

The Pine Grosbeak is an uncommon, partially-migratory resident of Alberta. Unique coloration and habituation to human activity make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general increases of 6.3%/year, although the data appears to be somewhat deficient (Sauer et. al., 2001). Provincially, the Pine Grosbeak is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5N (secure for non-breeding population in Alberta) and S3B (vulnerable for breeding populations in Alberta) by the Heritage status ranks. The Pine Grosbeak forages primarily on a variety of vegetative matter. General habitat use is typically restricted to old growth coniferous forest. Nesting occurs, as well, confined to coniferous trees. The Pine Grosbeak occupies a niche similar to other coniferous-dependant species.

Food

- The Pine Grosbeak eats primarily pine seeds and available fleshy fruits; although deciduous seeds, weed and grass seeds, berries, buds, mast and insects are also consumed. The yearly average diet consists of approximately 99% vegetative material (Semenchuk, 1992; Adkisson, 1999; Koenig and Knops, 2001).
- The Pine Grosbeak drinks water or eats snow daily (Adkisson, 1999).
- The young are fed primarily insects and spiders (typically taken near the ground on the trunk of the tree) interspersed with vegetative matter (Adkisson, 1999)

- Buds and newly grown needles are taken from all parts of the tree; however, late summer feeding includes ground-foraging for fallen seeds and ripening forbs (Adkisson, 1999).
- Insects are taken near the ground, typically on the trunk of the tree (Adkisson, 1999).
- In winter, Grosbeaks feed on seeds, buds and fruits, from a variety of deciduous and coniferous species (Cook and Littlefield, 1945).

Foraging and Roosting Habitat

- In Alberta, Pine Grosbeak density was highest in old forests, while young were the next most dense, and mature forests showed the least population density. Typically, spruce, Pine and Fir forests are chosen when available (Sanderson et. al., 1980; Scott and Crouch, 1988; Farr, 1992; Fisher and Acorn, 1998).
- Openings both natural and anthropogenic are also required by the Pine Grosbeak (Adkisson, 1999).
- Foraging microhabitat is highly variable, where individuals will utilize an entire tree from top to bottom (Adkisson, 1999).
- Irruptions occur when a good seed-crop year is followed by a poor seed-crop year, or rather based on population size and an inadequate food supply to support the entire population. Long distances may be traveled during periods of irruption, but typically, only as far as to find a new food supply (Adkisson, 1999; Koenig and Knops, 2001).
- Males are extremely territorial towards other males and females are also territorial against other females. Males defend an area of about 400 m in diameter (12.6 ha), from the top of a coniferous tree (French, 1954; Fisher and Acorn, 1998; Adkisson, 1999).
- Home range data is strongly lacking (Adkisson, 1999).
- Strong evidence of winter and summer site fidelity (Adkisson, 1999).
- During the breeding season, mating pairs feed together, while during the rest of the year, pairs join into small flocks of 5-15 birds (Cook and Littlefield, 1945; Adkisson, 1999).
- The Pine Grosbeak is a pioneer species (Cook and Littlefield, 1945).

Reproduction

- Clutch size is usually 3 or 5 eggs, rarely more, rarely less (Semenchuk, 1992; Adkisson, 1999).
- Incubation time is 13-14 days (Semenchuk, 1992; Adkisson, 1999).

Nesting Habitat

- Breeding habitat includes open coniferous forests, generally white or black spruce (Adkisson, 1999).
- Nest-building occurs in late May (Adkisson, 1999).
- Nesting microhabitat data is generally lacking, due to the general remoteness of nesting sites. The density of nesting pairs, however, seems to be related to moist, open coniferous forests, with Spruce preferred (Adkisson, 1999).
- Nests are generally concealed in dense foliage near the trunk of coniferous trees, and less then 6m high in the tree (Semenchuk, 1992; Fisher and Acorn, 1998; Adkisson, 1999).
- The female builds the nest alone from conifer twigs, roots, grass, lichens and feathers (Semenchuk, 1992; Fisher and Acorn, 1998; Adkisson, 1999)

Migratory Behaviour

- Although the Pine Grosbeak is not a migratory bird, movements are commonly observed during the winter months, based on changes in food availability and population structure (Semenchuk, 1992; Adkisson, 1999; Koenig and Knops, 2001).
- Small flocks of up to 24 birds are common (Cook and Littlefield, 1945; Semenchuk, 1992; Adkisson, 1999).

Community Structure

- The Pine Grosbeak showed no change in density after a spruce beetle induced mortality of local spruce stands in Alaska (Matsuoka et. al., 2001).
- Winter flocks are not mixed with other species of birds (Adkisson, 1999).

- Although information is lacking, it is assumed that medium-sized hawks, ravens, jays, crows, and squirrels are the main predators (French, 1954; Adkisson, 1999).
- No brood parasitism has been observed (Adkisson, 1999).

Management Implications

- Information gaps should be filled to fully assess the needs of the Pine Grosbeak within Tolko Industries Ltd. (HLLD) FMA area.
- Old coniferous forest needs to be maintained for habitat needs.
- Openings are important, so edge to area ratio should be maximized in cutblocks, especially when harvesting homogenous coniferous stands.

Research Needs

Little research has been conducted on the Pine Grosbeak, let alone within the northern boreal region of Alberta. Future research should be directed towards:

99. Habitat suitability associations
100. Nesting efficiency as related to edge (both natural and anthropogenic)
101. Nesting microhabitat
102. Threshold stand sizes required for suitable habitat.
103. Threshold edge to area ratio required for habitat suitability
104. Predator pressures

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Red-breasted Nuthatch

Sitta canadensis

Red-Breasted Nuthatch (Provincial Museum of Alberta)

Introduction

The Red-breasted Nuthatch is a common year-round resident of Alberta. The feeding habits, coloration and vocalization make this species easily identifiable in Tolko Industries Ltd. (HLLD) FMA area. Although somewhat data deficient, the Alberta population has shown a general small increase of 8.7% /year between 1966 to 2000 (Sauer et. al., 2001). Provincially, the Red-breasted Nuthatch is rated green (breeding) list by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5B/ S3N(breeding individuals secure in Alberta/ non-breeding individuals vulnerable in Alberta) by the Heritage status ranks. The Red-breasted Nuthatch diet changes throughout the year, but includes vegetable and animal matter. Habitat use is quite variable depending on location. Foraging, perching and nesting occur on both deciduous and coniferous substrate, although in Alberta, coniferous species tend to be preferred. The Red-breasted Nuthatch occupies a niche similar to many other species in the community, such as the Boreal Chickadee. Other names include Canada Nuthatch and the Red-bellied Nuthatch (Ghalambor and Martin, 1999).

Food

- During the breeding season the main foods taken are adult and larval arboreal arthropods, especially beetles. Other prey species include butterflies and moths, spiders, ants, leaf bugs, and flies. The main food sources outside of the breeding season are conifer seeds, sedges, angiosperms, and occasionally fruiting bodies (Grubb and Waite, 1987; Ghalambor and Martin, 1999; Koenig and Knops, 2001).

- Northern populations tend to rely heavily on cached cones in the winter (Ghalambor and Martin, 1999).

Foraging and Roosting Habitat

- The Red-breasted Nuthatch typically prefers old (greater than 80 years old) coniferous-mixed forests, (pure coniferous less preferred) especially over young forests. The main foraging substrate throughout the year is large living coniferous trees, but individuals will use hardwoods such as Aspen when available. Optimal foraging layer exists within the shrub layer and the canopy (Sanderson et. al., 1980; Farr, 1992; Semenchuk, 1992; Schieck and Roy, 1995; Kirk et. al., 1996; Fisher and Pattie, 1998; Ghalambor and Martin, 1999; Haney, 1999; Weikel and Hayes, 1999; Hobson and Bayne, 2000). In other portions of the distribution, individuals will utilize deciduous stands, showing the adaptability of the species (Scott et. al. 1982; Scott and Crouch, 1988a; Scott and Crouch, 1988b). When Aspen mixedwood forests are chosen in Alberta, the Red-breasted Nuthatch was most commonly detected (89%) in old stands over other seral stages (Schieck and Nietfeld, 1995).
- Optimal habitat is old forest with 70-100% canopy closure. Suitable habitat includes old forest with 40-69% canopy closure and mature forest with 40-100% canopy closure. Marginal habitat includes old and mature forest with 0-39% canopy closure, while all other habitat types are considered sub-marginal and are used less frequently by the Red-breasted Nuthatch (Verner, 1980).
- Disturbed habitat (including burned stands and timber harvest blocks) tend to be avoided by the Red-breasted Nuthatch. Areas surveyed before and after disturbance noted a drastic decline in abundance. The Red-breasted Nuthatch is negatively associated with abrupt edge habitat; however, Red-breasted Nuthatches responded positively to subtle edges with an abundant conifer component with a closed canopy, suggesting that it may respond well to a mosaic-type habitat rather then homogenous structure throughout the forest (Scott et. al. 1982; Raphael and White, 1984; Rosenberg and Raphael, 1984; Hawrot and Niemi, 1996; Scott and Crouch, 1988b).

- Foraging by the Red-breasted Nuthatch occurs mainly on live coniferous trees, with about 10% of feeding occurring on snag surfaces. Foraging microhabitat variables include larger diameters (older trees), which tended to increase the surface area of the crown, bole, and branches. Foraging takes place on all parts of the tree, but the majority occurred on long, dead limbs. Distal branches are favoured in the breeding season, while proximal branches and the trunk are favoured in the winter. Prey is located while the Red-breasted Nuthatch moves along the branches and/or the trunk, probing crevices, holes, and cracks. Less common prey capture strategies include flycatching and ground foraging (Mannan and Meslow, 1984; Adams and Morrison, 1993; Ghalambor and Martin, 1999; Weikel and Hayes, 1999).
- Habitat attributes which are deemed most important are conifer density, tree density (>20 cm dbh), birch density, and shrub/sapling density, as well as shrub species richness (Schieck and Nietfeld, 1995)
- Red-breasted Nuthatches will occasionally cache seeds in the ground. If the seed is viable, the seed may germinate, resulting in dispersal of that tree species (Hendricks, 1995).
- Territory size averages 25ha/breeding pair, which may be defended year-round by the Nuthatches; however, pairs tend to join into mixed flocks during the winter. Densities typically average between 10-30 birds/40ha in optimal habitat, but may be as high as 116 birds/ 40 ha (Beedy, 1981; Ghalambor and Martin, 1999; Haney, 1999).
- Population density for the Red-breasted Nuthatch is more than double in old growth stands as compared to managed blocks that were recently harvested. Thinned stands do not create as drastic changes in suitability; therefore, thinned stands may represent useable habitat, as long as sufficient residual timber remains within the harvest area. Three hectares is the estimated minimum useful patch size, however, the minimum is probably much larger in forested landscapes (Franzreb, and Ohmart, 1978; Mannan and Meslow, 1984; Hagar, et. al., 1996; Steeger and Hitchcock, 1998; Weikel and Hayes, 1999).
- The probability that Red-breasted Nuthatches will cross a gap (cutblock and agricultural found to have same effect) is directly related to the gap's width (Desrochers and Hannon, 1997), although any gap less than 30 meters is assumed to have no effect.

Width of Gap (m)	Probability of Crossing
20	0.80

40	0.70
60	0.50
80	0.30
100	0.15

- Increased saw timber and pole timber cover are negatively associated with red-breasted nuthatch habitat requirements (Hagar, et. al., 1996).
- The best correlate for habitat suitability after fire disturbance is Lodgepole Pine cover (Hutto, 1995); however, the Red-breasted Nuthatch shows a preference for unburned habitat typically more than burned /logged habitat (Raphael et. al. 1987; Schulte and Niemi, 1998).
- The Red-breasted Nuthatch winters mostly within its breeding range, although irruptive movements typically occur every 2-4 years when conifer cone production is limited on the breeding ground (Ghalambor and Martin, 1999; Koenig and Knops, 2001).

Reproduction

- Eggs are generally laid between April and July, with the majority from early May to early July (Semenchuk, 1992; Ghalambor and Martin, 1999).
- Females excavate the nest cavity, although, unpaired males will excavate several cavities and then sing to attract a female to the pre-formed nests (McCowan, 1988; Ghalambor and Martin, 1999).
- Clutch size is typically six eggs, with an incubation time of 12-13 days (Salt and Salt, 1976; Semenchuk, 1992; Ghalambor and Martin, 1999).
- The Red-breasted Nuthatch has elaborate courtship behaviour, including variable songs and visual displays (Kilham, 1973).

Nesting Habitat

- Breeding range is typically composed of mature and diverse stands of coniferous forest (Salt and Salt, 1976; Adams and Morrison, 1993; Campbell et. al., 1997).

- The Red-breasted Nuthatch is closely tied to the coniferous forest and rarely uses pure deciduous stands. Nesting sites for the Red-breasted Nuthatch are often in old growth stands with a greater density of large snags (>31cm dbh), greater number of trees 11-30cm dbh, and lack of hard edge habitat. Nesting did occur within managed stands, but since the surrounding microhabitat in old growth did not resemble that of the harvested block 'island,' it is assumed that the main criterion for nest site is the presence of a suitable excavation location (Flack, 1976; Mannan and Meslow, 1984; Smith, 1992).
- This species excavates its own nesting cavities; therefore, it is deemed a primary cavity nester, although it will use partially complete excavations thereby seeming to be a secondary-cavity nester. Nests are typically excavated in large (>51cm dbh) snags, usually with some degree of damage to the crown. Infection by Armillaria Root Disease, which lives as parasites on living host tissue, or as saprophytes on dead, woody material provides preferred habitat attributes (Mannan and Meslow, 1984; Martin, 1993; Schieck, and Roy, 1995; Hawrot and Niemi, 1996; Fisher and Pattie, 1998; Steeger and Hitchcock, 1998; Williams et. al., 2000).
- Territoriality and aggression peak at the height of the nesting/breeding season, when males will chase away any other species of bird which approaches the nest cavity (Ghalambor and Martin, 1999).
- Dead trees and decayed wood are, thus, the preferred habitat components of these cavity nesters (Mannan and Meslow, 1984; Harestad and Keisker, 1989; Steeger and Hitchcock, 1998).
- Sticky pitch (resin) is applied to the rim of the nest entrance for protection, especially from ants (Kilham, 1973; Fisher and Pattie, 1998).
- The Red-breasted Nuthatch nests in Aspen 100% of the time (in the interior western United States) at an average 8.4 m high, in an average tree height of 15.9 m, with average 40 cm dbh (Scott et. al., 1980).

Migratory Behaviour

- The Red-breasted Nuthatch is not typically migratory; however, some birds may make irruptive movements, typically when coniferous cone production is limited. Irruptive birds arrive back in Alberta in April and depart by September (Salt and Salt, 1976; Fisher and Pattie, 1998; Ghalambor and Martin, 1999; Koenig and Knops, 2001).

- Birds will join into mixed flocks with other small birds, especially Black-capped Chickadees (Salt and Salt, 1976; Ghalambor and Martin, 1999).

Community Structure

- Many avian predators exist for the Red-breasted Nuthatch including the Sharp-shinned Hawk, Cooper's Hawk, Merlin, and Northern Pygmy Owl. Mammalian predators include Red Squirrels and weasels (Ghalambor and Martin, 1999).
- European Starlings may have a negative effect on native bird nesting and breeding (Weitzel, 1988).
- Pairs may maintain territory year-round; however, birds may join into flocks/mixed species flocks for the winter months (Ghalambor and Martin, 1999).
- Red-breasted Nuthatch habitat needs are the same as the American Crow, Black-Throated Green Warbler, Swainson's Thrush, and the Tennessee warbler (Hobson and Bayne, 2000).

Management Implications

- Retention of 1 hard and 1 soft snag per hectare is necessary for maximum nesting. Trees exhibiting signs of root disease also should be retained.
- Old growth patches should be maintained throughout the managed forest. As well, snags of all classes should be saved within harvested areas.
- Habitat islands should be formed around snags.
- Forest operations should leave large standing live trees to act as islands when the surrounding forest is maturing around it, for a rotation long enough to produce large diameter trees.
- Harvest blocks should be oblong, have limited width, and allow for suitable habitat to cross the gap.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

106. Habitat suitability associations
107. Nesting efficiency as related to edge (both natural and anthropogenic)
108. The effects of logging on the persistence of Red-breasted Nuthatch populations

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Ruffed Grouse

Bonasa umbellus umbelloides

Bonasa umbellus yukonensis

Ruffed Grouse (B. Israel)

Introduction

The Ruffed Grouse is a very common year-round resident of Alberta, and is the most wide-spread Gallinaceous bird in North America. Its abundance, habits and unique plumage make this species an easily identifiable species in Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown a general decrease of 6.2% /year (Sauer et. al., 2001). Provincially, the Ruffed Grouse is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The adult Ruffed Grouse forages mainly on vegetative matter, while young birds feed on insects. Although varied habitat is used, young deciduous stands are optimal and sought out. Nesting occurs in depressions in the ground in more open habitat. The Ruffed Grouse is important prey for many species, such as mammalian carnivores, raptors, and humans.

Food

- Summer forage consists of seeds, buds, catkins, leaves, fruits, berries, and limited insects, although the exact composition is variable and dependant by region (Semenchuk, 1992).
- Aspen buds and twigs comprised 50% of the winter diet. This forage can be consumed quickly, allowing individuals to return to protective cover (Doerr et. al., 1974; Thompson and Dessecker, 1997; Rusch et. al., 2000).

- Food acquisition is more important than cover in the autumn, when individuals are commonly associated with fruit/berry-producing trees and shrubs (Rusch et. al., 2000).
- Insects, especially Hymenoptera, Coleoptera, Lepidoptera, Homoptera, and Diptera, are the prime staple of young birds up to two weeks, when vegetation becomes the dominant dietary intake (Semenchuk, 1992; Hollifield and Dimmick, 1995; Thompson and Dessecker, 1997).
- Arthropod abundance can be twice as great on old logging roads, than in adjacent interior (Hollifield and Dimmick, 1995).
- Due to the high concentration of water in most food items, the Ruffed Grouse may survive indefinitely without a water source (Johnsgard, 1973).

Foraging and Roosting Habitat

- Ruffed Grouse are early successional forest specialists, using even-aged young deciduous stands (5-15 years old) approximately 85% of the time when available. Aspen and mixed Aspen stands are preferred, especially when a conifer component of 10-15% is available, especially Spruce. These habitat areas, however, are typically only available for ten years, because of successional changes. (Stauffer and Peterson, 1985; Semenchuk, 1992; Schieck and Nietfeld, 1995; Schieck and Roy, 1995; Thompson and Dessecker, 1997; Rusch et. al., 2000; Dessecker and McAuley, 2001).
- Early successional forests provide the necessary structural components needed within the home ranges. Trees and woody stems of saplings less then 20 cm dbh, as well as shrubs, are required in densities up to 25,000 stems per hectare to provide adequate overhead cover from avian predators. The resultant shade also inhibits the growth of ground-level vegetation increasing the detection of mammalian predators. (Schieck and Nietfeld, 1995; Thompson and Dessecker, 1997; Dessecker and McAuley, 2001).
- The presence of small clearing may provide optimal habitat, although larger, contiguous blocks of upland deciduous stands are preferred over smaller isolated or fragmented woodlots (Sharp, 1963; Rusch et. al., 2000).
- Ruffed Grouse show a negative association with hard edge habitat (although soft edge is used occasionally), grasslands, and areas with very thick low-ground vegetative cover. These do not provide suitable security cover, which is a primary habitat suitability determinant. Due to the sedentary nature of the Ruffed Grouse, all food and shelter requirements must be met within a small

home range within Aspen-dominated mixed stands (Bump et. al., 1947; Rosenberg and Raphael, 1984; Smith, 1992; Rusch et. al., 2000; Dessecker and McAuley, 2001).

- Foraging and roosting areas in the winter are similar to summer habitat requirements, with Aspen and Poplar being dominant; however, coniferous density tends to be higher (approximately 20-25%of total stem count). Canopy cover in winter tends to be quite high (≈85-90%), albeit quite low in height, at an average of 1.5m high. Coniferous trees with dense canopies are utilized in cold winter weather to provide thermal protection. These roosts may provide microclimates 5-10^{o}C warmer then ambient temperature. Evergreens, however, provide limited, low quality food, and thus, individuals must return to deciduous feeding areas. During extremely cold weather individuals burrow into the snow to take advantage of the insulation provided, possibly raising the temperature as much as 20^{o}C. Winter roosting sites, either in coniferous trees or in snow burrows, are seldom re-used. Dispersal is more common in winter then in summer, as shown in Alberta where juvenile females tended to move the greatest distances (mean = 2 686m) over the winter, while territorial males moved the least distance (mean = 198m) (Doerr et. al., 1974; Fisher and Keith, 1974; Pietz and Tester, 1982; Thompson and Fritzell, 1988; Semenchuk, 1992; Thompson and Dessecker, 1997).
- Ruffed Grouse broods tend to use the same general habitat as adults; however, due to different dietary requirements, subtle differences in suitability do exist. Small open areas, with substantial shrubbery, more open canopy, and a high concentration of herbaceous growth is optimal, as it provides security cover adjacent to ideal foraging areas, with high concentrations of insect prey. Broods will also utilize low-lying wet areas comprised of willow and alder, also due to the abundance of insects (Palmer, 1963; Boag and Sumanik, 1969; Stauffer and Peterson, 1985; Thompson and Dessecker, 1997; Rusch et. al., 2000; Dessecker and McAuley, 2001).
- As the Ruffed Grouse utilize early successional habitat created by fire, insects, and wind, it is assumed that populations will respond well to emulated disturbance by deciduous and deciduous-dominant mixed-wood harvest. Optimal habitat is not usually available, however, until the herbaceous layer returns and is well established, typically occurring several years post disturbance. Once suitable habitat is available, the area becomes preferred over undisturbed areas, as well as naturally burned stands. These disturbed stands were used more often in spring and summer, whereas winter use is somewhat limited (Sharp, 1963; Thompson and Fritzell, 1989; Annand and Thompson, 1997; Thompson and Dessecker, 1997; Schulte and Niemi, 1998; Kurzejeski and Thompson, 1999; Potvin et. al., 1999; Dessecker and McAuley, 2001).

- Small harvest units (1-2 ha) on a 40 year rotation is likely the most beneficial to the Ruffed Grouse (Dessecker and McAuley, 2001).
- Nests in highly fragmented landscapes are more likely to be depredated (Yahner and Mahan, 1997), although managed woodlots exhibit increased Ruffed Grouse production (Hollifield and Dimmick, 1995).
- The Ruffed Grouse prefers scarified harvest areas rather than unscarified (Stelfox et. al., 2000).
- A year-round model built for Aspen forests throughout the range (Cade and Sousa, 1985):
  - Average circle radius encompassing 20 mature ♂Aspen (V_1): <90m = 1.0; >183m =0.25
    - HSI winter food = V_1
  - Equivalent stem density coefficient for conifers (V_2): ≤0.90m = 4.0; 4.6m+ = 1.0
    - 4.0 = 1.0 when comparing coniferous trees to deciduous trees
  - Total equivalent stem density (V_3): < ≈4375 = 0.0; 4 900-14 800 = 1.0; > ≈21 250= 0.0
    - V_3 = (# deciduous trees/ ha) + 0.25(# deciduous shrub stems) + (equivalent coniferous stem density x number of coniferous trees/ ha)
  - Average height of woody stems (V_4): <1.5m = 0.0; > 4.6m = 1.0
    - May be weighted by : $\sum_{i=1}^{3}\left[V_{4(i)} \times [(\text{equivalent stems/ ha})_i \div 4900/\text{ ha}]\right]$
  - Percent conifers (V_5): 0% = 1.0; 100% = 0.25
    - Where the conifer component is a curvilinear relationship
    - HSI (fall to spring cover) = V_3 x weighted V_4 x V_5
- A model built for boreal coniferous forests in western Alberta in winter includes the following variables [(S_1xS_2xS_3)] (Schaffer et. al., 1999).
  - Deciduous in canopy (S_1): 0% = 0.0; ≥20% = 1.0
  - Percent tree canopy closure (S_2): <6% = 0.0; ≥6% = 1.0
  - Deciduous Canopy Height (S_3): ≤2m =0.0; ≥10m = 1.0
- When observed in more open habitat, the Ruffed Grouse is usually traveling between habitat patches or briefly feeding on an attractive food item (Thompson and Dessecker, 1997).

Reproduction

- Males drum during the breeding season to 'mark' territory, as well as to attract a mate. Dense, young forests with thick, soft edges are required to conceal males while drumming. Suitable drumming logs, however, must be present. Drumming logs (1-2/ territory) are typically large diameter (>25 cm), partially decayed, downed logs greater then three meters in length. Drumming sites are usually 150m apart, and tend to be re-used in subsequent years(Rusch and Keith, 1971a; Rusch and Keith, 1971b; Thompson and Dessecker, 1997; Rusch et. al., 2000).
- Drumming sites in Wyoming averaged (Buhler and Anderson, 2001):
  - Conifer canopy cover = 73%
  - Total canopy cover = 86%
  - Vertical foliage 0.3-1.0m = 95%
    1-2m = 90%
    2-3m = 90%
  - Quaking Aspen dbh = 48.3 cm
  - Quaking Aspen snag dbh = 38.6 cm
- Home ranges are dependant upon sex, season, and habitat suitability. Males defend territories averaging approximately 2 ha during the mating season. Drumming logs represent the centre of defended territories, although the surrounding vegetation (heavy understory with shrub-cover near drumming platforms)is the critical variable. Females do not defend their larger (2-10 ha), overlapping territories (Boag and Sumanik, 1969; Semenchuk, 1992; Rusch et. al., 2000).
- Ruffed Grouse density is also dependant upon sex, season, and habitat suitability. Some populations exhibit very low densities of less then 5 individuals/ 100 ha within fragmented marginal habitat. Alternately, densities may exceed 40 males or 100 individuals/ 100ha in optimal habitat. The average density in central Alberta was between 20 and 60 birds/ 50 ha (Fisher and Keith, 1974; Cade and Sousa, 1985; Small et. al., 1991; Kurzejeski and Thompson, 1999; Lovallo et. al., 2000; Dessecker and McAuley, 2001).
- Eggs are typically laid April to May (Rusch et. al., 2000).
- Clutch size is approximately 8-14 eggs (Fisher and Keith, 1974; Semenchuk, 1992).
- Incubation time is approximately 24 days (Semenchuk, 1992).
- Females will breed again if initial clutch is lost (Semenchuk, 1992).

- The family group breaks up after approximately 12 weeks, when juveniles disperse approximately 1.6 km. with a maximum distance of 12 km (Johnsgard, 1973; Semenchuk, 1992).
- A hen on the nest is well camouflaged (Thompson and Dessecker, 1997).

Nesting Habitat

- The nest is built on the ground, often under or near a downed log, tree, rock, or brushpile. Typically, the nest is constructed of grass and leaves (Semenchuk, 1992; Schieck and Roy, 1995; Thompson and Dessecker, 1997).
- Nesting cover is usually in pole-sized (or larger) deciduous stands, typically close to protective cover and suitable brood habitat to allow for increased visibility and predator detection, as well as rearing young (Thompson and Dessecker, 1997; Rusch et. al., 2000).
- Low nests are disturbed less frequently then arboreal nests (Yahner and Cypher, 1987).
- Nest success is dependant on degree of fragmentation (Yahner and Scott, 1988).

Community Structure

- Estimated harvest data for the High Level area 1995, as collected from volunteer submissions (AB Env. Prot, 1997).

WMU	524	528	534	535	536	537	540
Number hunted	741	400	105	26	26	0	64

- Flocks of 2-10 birds form in winter (Rusch et. al., 2000).
- Young are preyed upon by jays and crows (Yahner and Vogtho, 1989).
- Edge contrast does not affect the rate of nest predation (Yahner et. al., 1989).
- Adults prey upon by many species including Owls and Hawks (Small et. al., 1991.)
- Predation creates cyclical population trends (Hewitt et. al., 2001).
- In Alberta, winter flock size was variable; 2 birds (42%), 3 birds (25%), 4 birds (16%), 5-9 (max) (17%) (Doerr et. al., 1974).

- Populations are preyed upon more dramatically when Snowshoe Hare populations crash (Rusch et. al., 2000).

Management Implications

- Even-aged harvest will benefit the Ruffed Grouse to the greatest extent. Smaller harvest units are more advantageous than larger units (1-2 ha); however, this would be impractical. Highly variable edges, (leading to a high edge: area ratio) and large amounts of residual structure could mimic the response to small blocks.
- Selective harvest at perimeter could create the potential for less abrupt edge effects as block regenerates (0% retention on harvest block side of perimeter, 25% retention at 5m, 50% retention at 10m, 75% retention at 15m for example)
- Large diameter downed logs are needed for drumming logs and should be retained, if not purposely placed in blocks.
- Young Aspen and Poplar stands are optimal for the Ruffed Grouse; therefore, some shorter rotation (40 year) small harvest blocks may be beneficial.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

109. Habitat suitability associations
110. Nesting efficiency as related to edge (both natural and anthropogenic)
111. Local population dynamics
112. Small clearing effectiveness
113. Identify limiting factors
114. Impact of harvesting operations on hunter success

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Sharp-tailed Grouse

Tympanuchus phasianellus caurus

Introduction

The Sharp-tailed Grouse is an uncommon year-round resident of Alberta; however in the High Level area, the species appears to be somewhat common in clumped distributions. Its wide range of habitat tolerance and conspicuous behaviours make detection easy in Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown a general decrease of 6.5% /year (Sauer et. al., 2001). Provincially, the Sharp-tailed Grouse is rated yellow A (may require special management) by the Alberta Wildlife Act, sensitive by the General Status of Alberta Wild Species 2000 and S4 (apparently secure in Alberta) by the Heritage status ranks. The Sharp-tailed Grouse forages on a variety of vegetative matter and invertebrate prey. General habitat use is varied, including open agricultural fields, peatlands, and forested habitat. Breeding behaviour is quite pronounced, with males forming social lekking colonies. The Sharp-tailed Grouse occupies a niche similar to other species which use grassland and open forest habitat, such as the White-tailed Deer.

Food

- Adults feed on a variety of vegetative matter, including buds, seeds, forbs, fruiting bodies, grasses and insects (mostly *Acrididae* and *Coleoptera* (Harris, 1967; Evans and Dietz, 1974; Mitchell and Riegert, 1994; Connelly et. al., 1998)

- From spring through autumn, insects comprise 30% of the diet, when abundance is greatest. During winter, as insects are generally absent, vegetative matter comprises ≈100% of the diet (Harris, 1967; Marks and Marks, 1988).
- The juvenile diet consists primarily of insects until twelve weeks of age, when the diet than becomes more like the yearly averaged adult diet; approximately 90% vegetative matter (Kobriger, 1965).

Foraging and Roosting Habitat

- Habitat types include prairie, shrubland, sandhills, deciduous forest, coniferous forest, openings, muskegs and bogs (Moyles, 1981; Godfrey, 1986). Dense herbaceous cover and deciduous trees (adjacent to grasslands) are considered optimal for feeding, roosting and escape cover opportunities in these areas, including northern Alberta (Johnsgard, 1973; Moyles, 1981; Connelly et. al., 1998; Dasgupta and Alldredge, 2000).
- Spring and summer foraging habitat includes early successional stage forests where forb and grass density is high. Range use at this time is generally restricted to areas in or adjacent to the lekking area (Kobriger, 1965; Connelly et. al., 1998).
- In summer, primarily grassland and tall shrub communities were used, although an increase in wetland meadows may also occur at night in summer (Moyles, 1981; Gratson, et. al. 1990). Individuals may stay within summer habitat until first autumn snow, at which time a movement towards upland habitat occurs (Connelly et. al., 1998).
- In winter, (November 16 to March 31) riparian areas, deciduous hardwood shrubs, and open deciduous or coniferous forests, and wetlands were used for feeding, roosting, and security/thermal cover approximately 30%. The use of these types of habitat increase home range to include distant areas up to 1.5 km away. Grassland habitat, however, is still preferred (Kobriger, 1965; Moyles,1981; Swenson, 1985; Marks and Marks, 1988; Connelly et. al., 1998; Dasgupta and Alldredge, 2000).
- Quality foraging habitat, with abundant forbs and insects, is very important to broods (Connelly et. al., 1998).
- Overnight roosting takes place on the ground and not in trees (Johnsgard, 1973); however, winter roosting in Aspen trees is quite common (Moyles, 1981).

- Fire and other disturbance, which induces early succesional habitat, is beneficial to Sharp-tailed Grouse, for increased food abundance and decreased predator stalking cover (Buss, 1984; Smith, 1992; Tesky, 1994).
- In the western boreal forests of Canada, an affinity for burned or logged habitat exists (Smith, 1992).
- The sharp-tailed grouse is a land bird and does not migrate; however, during periods of heavy snow, timber harvest, or fire individuals may move up to 34 km to wooded habitat (Connelly et. al., 1998).
- In the High Level area, the Sharp-tailed Grouse has a very low overall population density; however, due to clumped distributional patterns, they are readily encountered and observed. In general, distribution is east of High Level, ranging from peatlands in the Caribou mountains through to pasture lands in the south. Ground cover and nearby tree cover is prevalent throughout these areas (K. Morton, pers. comm.).
- A complex model was built for the year-round historical range (Prose, 1987).

Reproduction

- Leks form the hub of the breeding habitat and are typically associated with elevated areas of diminished vegetation, including dry grassland, wet meadows, and naturally or anthropogenically disturbed areas (Hanson, 1953; Kobriger, 1965; Baydack, 1988; Tsuji, 1992 K. Morton, pers comm.).
- The location of leks is generally stable from one year to the next, except if naturally disturbed by snow or water (Baydack, 1988; Tsuji, 1992).
- The amount of aspen cover, within a radius of 0.8km, is inversely related to the number of lekking males (ie. Lek sites are less populated in areas with a higher percentage of aspen cover) (Moyles, 1981).
- In Manitoba, Leks had the following average characteristics (Baydack, 1988):
  - Closet neighbouring lek—2.2km
  - Orientation—Nw to SE
  - Area—446m^2
  - Area/ displaying male—50m^2
  - Surrounding Terrain—Flat to undulating (lek at highest elevation)
  - Slope—≤1% over display area

- Vegetation height in spring—10.4cm
- Ground cover in spring—70% grasses
- Visibility—unrestricted in all directions
- Distance to escape cover—≤ 500m
- Distance to perching trees—≤ 400m

- The habitat distribution necessary to sustain a population within 1km of a lek includes (Berger and Baydack, 1992):
  - <44% closed aspen forest
  - ≅15% open forest
  - ≥ 23% prairie
  - ≅15-17% shrub
- Leks consist of at least two males; 5-16 in Manitoba (Gratson et. al., 1991), 2-30 in Saskatchewan (Pepper, 1972), and 12-40 in Alberta (Rippin and Boag, 1974b).
- Leks are the site of tremendous behavioural responses, whereas limited agnostic responses are exhibited in other habitats, and in different times of the year. Holders of central territories often occupied the lek the previous year, and have greater reproductive success than those less dominant males at the periphery and outside of the lek (Nitchuk and Evans, 1978; Sexton, 1979; Gratson et. al., 1991; Tsuji et. al., 1992; Tsuji, et. al., 1995; Connelly et. al., 1998). When a male near the center of the lek does not survive, all other individuals 'rotate' inwards (Rippin and Boag, 1974a; Moyles and Boag, 1981). The height of male displaying occurs in the spring (Marks and Marks, 1988).
- Sharp-tailed Grouse have a strong affinity towards lek sites. With disturbance, individuals vacate the lek area, but return at a later time. Males seldom retreated more than 400m from the individual lekking territory; however the effect of females is unknown. Disturbance of leks does however appear to limit reproductive opportunities for both sexes (Baydack and Hein, 1987).
- Distances between males at leks is dependant upon the size of the lek itself, although will generally be consistent for the majority of the year, as males may display for up to ten months, as long as weather conditions permit (Moyles and Boag, 1981; Connelly et. al., 1998). Spacing among leks varies from 1.6 to 3.5 km (Kirsch et. al., 1973; Rippin and Boag, 1974a; Connelly et. al., 1998).
- Female territoriality is not documented, but is thought to be related to the periphery of the lek itself, where females will aggregate before entering the lek, usually in stands of mature Aspen (Connelly et. al., 1998).

- No pair bonding, except during display than copulation. The male will breed with as many females that will enter his lekking territory (male-dominant polygyny); however not all males will breed in a season, and most will only breed once. In southern Manitoba 49% did not breed and 23% only bred once (Gratson et. al., 1991; Connelly et. al., 1998). Females may visit a lek 1-10 times in a season and may even attend alternate leks, where polyandrous behaviour is also common (Tsuji et. al., 1996; Connelly et. al., 1998).
- The distributional pattern of leks indicates the appearance of a functional meta-population, and lek densities provide an estimate of populations and indirectly reflect changes in habitat quality (Rippin and Boag, 1974b; Cannon and Knopf, 1981; Connelly et. al., 1998).
- Physical disturbance to a lek is often tolerated, as long as there is no threat. Individuals may vacate the lek, but will return within five minutes of the removal of the disturbing agent (Wedgwood, 1992).
- Populations respond well to habitat management practices which increase or protect food sources. Leks should be managed for land within and including >20 ha, but preferably a 2km radius around the lek (Berger and Baydack, 1992; Connelly et. al., 1998).
- The average clutch size is between 11.3 and 12.3 eggs (Tesky, 1994; s*ummary in* Connelly et. al., 1998).
- Incubation time is 21-24 days (Godfrey, 1986; Connelly et. al., 1998).
- Currently, several active lek sites are located within Tolko Industries Ltd (HLLD) FMA area (K. Morton, pers. comm.).

Nesting Habitat

- Breeds in central Alberta (Semenchuk, 1992), as well as northern Alberta (Salt and Salt, 1976; Godfrey, 1986)
- Structural diversity, including grassed, shrubs and forbs, is considered high quality nesting habitat Connelly et. al., 1998).
- The ground-nest is made of moss, grasses, sedges, herbaceous plants and leaves, and than lined with female breast feathers (Godfrey, 1986; Connelly et. al., 1998).
- The nest is only used once (Connelly et. al., 1998).
- Females often nest close to lek sites (C. Broatch, pers. comm.).

Community Structure

- The species is highly social and is grouped together in flocks of variable size up to 100 individuals (Salt and Salt, 1976; Connelly et. al., 1998).
- The flocks break up by March when males return to lekking grounds (Salt and Salt, 1976).
- Tolerance shown for other species, however, always confrontational with other Gallinaceous birds (Sharp, 1957).
- Estimated harvest data for the High Level area 1995, as collected from volunteer submissions (AB Env. Prot, 1997).

WMU	524	528	534	535	536	537	540
Number hunted	25	277	25	21	0		

- Mallards may parasitize Sharp-tailed Grouse nests Saskatchewan (Leach, 1994).
- Predators of eggs include many different species of mammals and birds (Connelly et. al., 1998).
- Predators of adults include large individuals including Coyote, Mink, Weasel, Red Fox, Red-tailed Hawk, Northern Goshawk, Peregrine Falcon, Gyrfalcon, Great Horned Owl, Long-eared Owl, and the Northern Harrier (Connelly et. al., 1998).

Management Implications

- Populations respond well to practices which preserve and/or protect food sources close to food sources. Lekking areas should be managed (jointly when on private land) to keep habitat ratios consistent. Lekking areas could be managed for 0.5 open area, 0.3 lowland area, and 0.2 wooded area.
- Lek sites identified within the FMA should be managed in conjunction with timber harvest, to maintain functional values for nesting and security cover.
- Populations are presently concentrated in the eastern portions of Tolko Industries Ltd. (HLLD) FMA area; however, due to the use of peatland habitats, other areas surrounding High Level may be suitable habitat as well, when forested stands have intermittent openings greater than 4 ha.
- Habitat units should comprise the area surrounding the lek site, up to a 2km radius.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

115. Habitat suitability associations
116. Edge use near lekking areas (both natural and anthropogenic)
117. Use and/or non-use of harvest areas
118. Local population dynamics, presence/abundance, and distribution

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Song Sparrow

Melospiza melodia juddi

Song Sparrow (D. Eckford)

Introduction

The Song Sparrow is a very common summer resident of Alberta. Although somewhat dull in appearance, the Song Sparrow's melodic array can identify this species within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown general stability with only a small increase of 2.4% /year (Sauer et. al., 2001). Provincially, the Song Sparrow is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) for breeding individuals by the Heritage status ranks. Overwintering individuals however are classed S1 (critically imperiled) by the Heritage status ranks. The Song Sparrow utilizes both insects and vegetative matter in diet. General habitat use consists of a variety of forest types, although complexity in structure, such as shown in young stands, appears to be important. Nesting occurs near the ground, typically under thick vegetation. The Song Sparrow, due to its varied habitat use occupies a niche similar to many other species in the community, including small mammals, a highly utilized prey group.

Food

- The Song Sparrow consumes a variety of foods, including weed seeds, cutworms, beetles, grasshoppers, and ants (Semenchuk, 1992; Fisher and Acorn, 1998).
- Foraging typically involves searching through the leaf litter (Semenchuk, 1992).

Roosting and Foraging Habitat

- Preferred foraging and roosting habitat includes many habitat types including shrub-sapling forest, shrub-wetland areas, and very young/regenerating deciduous forests, where densities are typically twice as large as mature forest and four times as large as old forest. Optimal habitat thus has an increased degree of complexity (Sanderson, et. al., 1980; Niemi and Hanowski, 1984; Rosenberg and Raphael, 1984; Greenburg, 1989; Smith, 1992; Probst and Thompson, 1995; Kirk et. al., 1996; Canterbury and Blockstein, 1997; Fisher and Acorn, 1998; Sanders and Edge, 1998; Larison et. al., 2001).
- Song Sparrows are very abundant in spruce/tamarack forests (Ewert, 1982).
- The Song Sparrow favours continuous mesic shrub, tolerates discontinuous mesic shrub, and completely avoids herbaceous xeric shrub (Sanders and Edge, 1998).
- The favored habitat in Alberta consists of shrubby-riparian areas, woody openings, small forest patches with an abundance of edge (Semenchuk, 1992).
- Old forests and open habitats are not typically incorporated as suitable habitat (Sanderson, et. al., 1980).
- The habitat layers used for foraging by the Song Sparrow include the understory, the shrub midstory, and the canopy (Short and Williamson, 1984).
- Males defend territories year round, through song, except during molting. All Song Sparrow territories contained at least 70 shrubs/ ha, although this does not contribute to territory size. Song repertoire size of all individual within area, trying to establish territories, is the determinant of territorial range. More individuals and/or less suitable habitat yields larger ranges, thus a greater expenditure of energy (Degraaf, 1989; Wingfield and Hahn, 1994; Beecher et. al., 2000; Soma et. al., 2000; Soma and Wingfield, 2001).
- The song sparrow is positively associated with recently disturbed areas, including those by burning and from forest harvesting. Sites under ten years had the highest density than all other ages. Edge habitat is often used to a much greater extent than the forest interior (Scott et. al., 1982; Morrison and Meslow, 1983; and Crouch, 1988; Annand and Thompson, 1997; Schulte and Niemi, 1998).
- Song sparrow density on six to ten year old cutblocks decreases as the size of the cutblock increases. In SW Colorado(Scott and Crouch, 1988):

- 1.76 ha = 104/ 40 ha
- 3.56 ha = 76/ 40 ha
- 5.64 ha = 48/ 40 ha

- The Song Sparrow is a habitat generalist and will successfully colonize different habitats throughout its range (Greenburg, 1989).

Reproduction

- The average clutch size is approximately 3-6 eggs (Semenchuk, 1992; Fisher and Acorn, 1998).
- Clutch size in recently disturbed stands is significantly lower then in forest stands with very high structural complexity (Larison et. al., 2001).
- Incubation time is usually 12-14 days (Semenchuk, 1992; Fisher and Acorn, 1998).
- Sometimes, up to three broods are raised each year (Semenchuk, 1992).
- Pair bonds may persist for several years (Semenchuk, 1992).

Nesting Habitat

- Nests are almost always built on the ground, or within one meter of the ground in a low bush or in a small tree (Semenchuk, 1992; Larison et. al., 2001).
- The nest is constructed from grass, weeds, bark and leaves (Semenchuk, 1992).
- The nest is usually well hidden under thick vegetation or large woody debris (Semenchuk, 1992).
- Foliage cover near the nest averaged 67.8% (Larison et. al., 2001).
- Song Sparrow nesting territories in Pennsylvania had (Greenburg, 1988).
    - grass cover = 22.8%
    - forb cover = 59.4%
    - rush cover = 7.1%
    - total ground cover = 92.1%
    - bramble cover = 2.7%
    - ground-cover height = 0.75m

- *Vibernum* density (Cranberry spp) = 0.09 stems/3.14m^2
- *Spiraea* density (Meadowsweet) = 0.12 stems/3.14m^2
- *Cornus* density (Bunchberry and Dogwood) = 0.25 stems/ 3.14m^2
- total shrub density = 0.59 stems/ 3.14m^2
- water depth = 5.5m (associated water body near territory)
- water cover = 13.2%
- water + moisture cover = 15.9%

- Nests in Iowa had the following characteristics (Stauffer and Best, 1986):
  - nest height = 0.1m
  - support structure height = 0.8m
  - relative nest height = 11.2%
- The habitat layers used for nesting include the understory and the shrub midstory (Short and Williamson, 1984).

Migratory Behaviour

- Song Sparrows are not flocking birds (Semenchuk, 1992).
- Birds arrive in mid-April (Semenchuk, 1992; Fisher and Acorn, 1998).
- Winter migration occurs by early October (Semenchuk, 1992; Fisher and Acorn, 1998).
- Some individuals may overwinter in urban areas, however overwintering survival rate is very low (Semenchuk, 1992; Fisher and Acorn, 1998; Natureserve, 2001).

Community Structure

- Females show aggression towards other females during the nesting season (Elekonich, 2000).
- The song sparrow may be only slightly parasitized by the brown-headed cowbird, due to a general lack of similarity in preferred habitat; however, when nest is built in areas of low structural complexity and density, parasite pressure may become as high as 60% (Tewksbury et. al., 1998; Tewksbury et. al., 1999)
- Male song repertoire ranges from 6-11 songs (Nordby et. al., 1999).

Management Implications

- Complexity in both habitat layers and species composition should be maintained
- Snags should be preserved, including relatively intact ones, which will persist as young growth matures in the surrounding area.
- Burning the forest floor may allow for optimal habitat regeneration.
- Increase spatial heterogeneity in and surrounding logged areas, perhaps by thinning at edge, resulting in complex, 'soft' edge, rather then abrupt, 'hard' edge habitat.
- Harvest blocks should intensify edge/area ratio, offering more suitable habitat for the Song Sparrow.
- Oblong harvest blocks, with limited traversing distance would best serve the Song Sparrow.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

119. Habitat suitability associations
120. Nesting efficiency as related to edge (both natural and anthropogenic)
121. Optimal edge to area ratio within harvest block.

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Southern Red-backed Vole

Clethrionomys gapperi athabascae

Red-backed Vole (RTI, UWash and WSU)

Introduction

The Southern Red-backed Vole is a very common year-round resident of Alberta. It is likely that this species could be found in leaf litter in every suitable forest stand within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Southern Red-backed Vole is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The omnivorous Southern Red-backed Vole forages on a variety of items. Unlike its eastern counterpart, the western ecotype prefers lichens and fungi. Habitat requirements include mesic coniferous forests with ample downed woody debris. As with most other rodents, the reproductive rate is high, with mature adults producing 3-4 litters throughout the year. The Southern red-backed Vole occupies an important place in the community as it is a valued prey item for many species.

Food

- The diet is dominated by lichens and fungi (ectomycorrihazae) which comprise >80% of the diet. Leaves, forbs, shoots, berries, seeds, petioles, buds, bark, stems insects, and mouse carcasses are also consumed (Banfield, 1974; Maser et. al., 1978; Martell, 1981; Forsyth, 1985; Wolff and Dueser, 1986).
- May feed on seedlings in some patch-cuts (Sullivan and Sullivan, 2001).
- Southern Red-backed Voles require a large amount of water daily (Buckmaster et. al., 1999).

Foraging and Security Habitat

- The Southern Red-backed Vole prefers old, moist deciduous, mixed and coniferous stands throughout its range. Trembling Aspen, Spruce and Spruce/Fir mixedwood forests are the most used stand type. Habitat is not chosen based solely on stand type, but on microhabitat attributes. Typically, natural springs, brooks, or bogs are associated with optimal stands, as moist microclimates are required to meet a high moisture demand because of low water economy, and suitable growing habitat for main food items (Banfield, 1974; Vickery, 1981; Allen, 1983; Forsyth, 1985; Wolff and Dueser, 1986; Clough, 1987; Nordyke and Buskirk, 1991; Roy, et. al., 1995; Schieck and Roy, 1995; Gillis and Nams, 1998; Pearson and Ruggiero, 2001). The optimal habitat in central Alberta is mainly young (used 34%) and old (used 50%) mixed deciduous stands; however in southern Alberta the Southern Red-backed Vole was found to use coniferous forest much more frequently then deciduous forests (Morris, 1983; Bondrup-Nielsen, 1987; Roy, et. al., 1995).
- A uniform distribution of understory saplings and shrubs, such as Lowbush Cranberry (*Viburnum edule*), Bracted Honeysuckle (*Lornicera involucrate*), and Rose (*Rosa spp.*) are required, for security protection from predators. Ground cover, if present at all, is typically limited to sparse grass. Large deciduous trees (>40cm dbh) provide for optimal, closed canopies (> 60%), thereby shading the ground level, reducing plant growth and retaining moisture. Snags (>20cm dbh) and downed woody debris (accounting for greater than 20% of the forest floor area), with associated moss, shrubs, leaf litter and exposed tree roots are also important habitat variables. These provide optimal food growth, as well as complex structure used for nest sites, temporary shelters and refuge against predators. Conifers are utilized in the winter for thermal and security cover, although feeding opportunities are limited. Overall habitat use is likely selected for optimal conditions, rather then predator avoidance (Vickery, 1981; Yahner, 1982; Allen, 1983; Yahner, 1983; Forsyth, 1985; Bondrup-Nielsen, 1987; Clough, 1987; Nordyke and Buskirk, 1991; Roy, et. al., 1995; Schulte-Hostedde and Brooks, 1997; Simon et. al. 1998; Mech and Hallett, 2001).
- The Southern Red-backed Vole is affected by altered microhabitat attributes. Sites with an overabundance of lichens are generally avoided. Edge habitat is also avoided due to the lack of adequate forage supply. Due to the high water demand of the Vole, xeric sites are typically avoided. Areas with dense forb cover obstruct feeding behaviour, as well as decreasing ground-level predator detection. Some studies, particularly in central Alberta show young coniferous stands to be least

desirable (Yahner, 1982; Yahner, 1983; Bondrup-Nielsen, 1987; Roy, et. al., 1995; Bayne and Hobson, 1998; Simon et. al., 1998; Kingston and Morris, 2000).

- Females acquire defended territories to maximize reproductive success. This is done by limiting resource utilization. Males on the other hand, are not territorial. Home range is approximately a 60-70 m (0.28 ha –0.38 ha) diameter area, although the range may be as large as 1.4 ha in the summer. Home range in winter is typically one tenth of summer range (Banfield, 1974; Mihok, 1981; Perrin, 1981; Gillis and Nams, 1998).
- Southern Red-backed Voles are slightly affiliated with squirrel middens (Pearson and Ruggiero, 2000).
- Due to requirements of uncut forest (ectomycorrhizal fungi, mesic conditions, and heavy ground cover), the Southern Red-backed Vole are likely to disappear from large harvested areas for a period of at least ten years, due to changes in habitat suitability and predator success. Smaller, patch-cut blocks may elicit less dramatic responses. Large retention patches, leaving 60-70% of the basal area may provide suitable habitat, providing optimal microsite conditions are provided; however, this may be difficult due to the minimum viable habitat size of approximately 2 ha. These areas may prove to be a habitat sink, as overall population density tends to decline until habitat suitability increases. Individuals readily navigate across cleared patches that are less then 20 m across (Martell and Radvanyi, 1977; Maser et. al., 1978; Allen, 1983; Martell, 1983; Morris, 1983; Gillis and Nams, 1998; Hayward et. al., 1999; Sullivan et. al., 1999; Sullivan and Sullivan, 2001).
- Shelterwood harvest methods have a positive impact for habitat quality for the Southern Red-backed Vole. Population density increased 3 times when 50% of shelterwood was removed, while population density increased 4 times when 30% was harvested (Von Treba et. al., 1998).
- Southern Red-backed Vole density was highest on uncut stands in British Columbia (from 1988-1992), with a density of 11.74/ ha. Upon clearcutting, density declined to 0.60/ ha, and a combined cut/burn elicited a decrease to 0.02/ ha (Sullivan et. al., 1999).
- Small-sized corridors within the forest structure may lead to increased genetic variability within a metapopulation (Mech and Hallett, 2001).
- Harvest blocks treated with minimal amounts of herbicide may have little long-term effect on populations of the Southern Red-backed Vole; however, extreme changes in habitat and food supply may limit the Vole from harvest blocks for longer periods of time, when herbicide application is extensive (Santillo et. al., 1989; Sullivan et. al., 1998)

- Water is very important, and individuals are seldom far from a water source (Banfield, 1974).
- Individuals will climb trees and burrow through snow to access arboreal lichens (Allen, 1982; Pattie and Fisher, 1999).
- There is no preference between downed and elevated logs. As well, woody material is used in the same manner regardless of the stage of decomposition (Davis and Christian, 2001).
- A model built for the western United States populations throughout the year (Allen, 1983):
  - Average dbh of overstory trees (V_1): 0 cm = 0.0; ≥30 cm = 1.0
  - Percent of ground surface with CWD (V_2): 0%=0.0; ≥20% = 1.0
  - Percent grass canopy cover (V_3): ≤10% = 1.0; ≥80% = 0.0
  - Percent canopy closure (coniferous) (V_4): 0% = 0.05; ≈20% = 0.1; ≥50% = 1.0
    - HSI (food/cover) = $(V_1 \times V_2 \times V_3)^{1/3} \times V_4$
- A model built for year-round, boreal coniferous forests in western Alberta (Buckmaster et. al., 1999).
  - Coniferous Canopy Height (S_1): 0m = 0.0; ≥10m = 1.0
  - Percent black spruce and larch in canopy (S_2): 0% = 0.0; ≥80% = 1.0
  - Moss Cover (S_3): 0% =0.0; ≥50% = 1.0
  - Weighted canopy closure (S_4): 0% = 0.0; ≥50% = 1.0
    - = Tree canopy closure x [0.05(%deciduous in tree canopy) + 0.25(%pine + %white spruce + fir in tree canopy)]
  - Coarse woody debris (S_5): 0% = 0.0; ≥5% = 1.0
  - Shrub cover (S_6): 0 = 0.0; ≥30% = 1.0
  - Tree canopy closure (S_7): 0 = 0.0; ≥10% = 1.0
    - HSI (year-round) = max $[S_1 \times S_2 \times S_3 \times S_4 \times (S_5 \times S_6)^{1/2}]$
- Populations of the Red-backed Vole decrease in areas affected by fire (Martell, 1984).

Reproduction

- The breeding season is exceptionally long, from April to early October. The female is polyestrous, typically leading to three or four litters each year (Banfield, 1974; Forsyth, 1985; Pattie and Fisher, 1999).

- Litter size is usually 4 to 6, (may vary between one and eight) with 3-4 litters per year (Banfield, 1974; Forsyth, 1985).
- Gestation time is, on average, 17-19 days (Banfield, 1974; Forsyth, 1985).
- Juveniles first successfully mate between two and four months (Banfield, 1974; Pattie and Fisher, 1999).
- Nests are typically a round ball of shredded plants under a stump or fallen log, although nests may occur in tree cavities (Forsyth, 1985; Pattie and Fisher, 1999).
- Winter nests are subnivean (Pattie and Fisher, 1999).

Community Structure

- The Southern Red-backed Vole is a very important prey species. Predators include hawks, owls, mustelids, canids, felids, and even other rodents (Banfield, 1974; Forsyth, 1985).
- Pinus species require ectomycorrhizal fungi for normal growth. As this fungus is a major component of the diet, the Southern red-backed Vole is closely associated with Pine-dominated stands (Maser et. al., 1978).
- The Southern Red-backed Vole may exhibit cyclical patterns, depending on geographic variability:
    - Red-backed Vole populations peak 2-3 years after Snowshoe Hare population crashes (Boutin et. al., 1995).
    - The Vole population cycle only affects the Hawk Owl (Boutin et. al., 1995).
    - The Southern Red-backed Vole tends not to exhibit population cycles (Bondrup-Nielsen, 1987).

Management Implications

- May or may not react to forest harvesting.
- When applying herbicide, could do so with intentional skip areas, which can provide for vole habitat.
- Management of the Southern Red-backed Vole will provide habitat for many other animals requiring mature/old growth.
- Conservation of coarse woody debris is important, especially within retention patches. Wide-spread distribution of coarse woody debris may increase Vole habitat suitability.

- Harvest may be conducted to allow maximum amount of shade to fall upon the block to allow for decreased soil moisture evaporation.
- Selective thinning may provide the best habitat outcome for the Southern Red-backed Vole, as canopy cover remains relatively abundant.

Research Needs

Some research has been conducted within northern Alberta; however no studies have been conducted within the northwest boreal region. Future research should be directed towards:

122. Habitat suitability associations
123. Harvest block usage and attributes which may increase habitat suitability in blocks (ie: edge to edge distances)
124. Local population dynamics
125. Usage of retention patches and retained woody material; are slash piles useful habitat, or would the debris be more useful spread across harvest block?

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Warbling Vireo

Vireo gilvus swainsonii

Introduction

The Warbling Vireo is a common summer migratory resident of Alberta. Microhabitat use, drab coloration and similarity to other species makes this species difficult to identify within Tolko Industries Ltd. (HLLD) FMA area. From 1966 to 2000, the Alberta population has shown a general increase of 3.9% /year (Sauer et. al., 2001). Provincially, the Warbling Vireo is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The Warbling Vireo forages almost exclusively on invertebrates, (especially caterpillars), generally by gleaning. A preference towards mature deciduous stands is noted, with riparian areas used as well. Nests are typically constructed in the upper canopy of deciduous trees. There are two subspecies in Alberta, although these may eventually be considered separate species once more information is confirmed; however, the two are almost identical in the field.

Food

- The main food of this species is insects (95%), especially Lepidopteran larvae. Foliage is gleaned for invertebrates, but occasionally methods of hovering and plucking are employed in prey capture as well. Some fruits are taken in winter, while in migratory wintering grounds (Fisher and Acorn, 1998; Gardali and Ballard, 2000).
- This species is not known to cache food (Gardali and Ballard, 2000).

Foraging and Roosting Habitat

- The Warbling Vireo resides throughout the FMA area of Tolko Industries Ltd. HLLD (Salt and Salt, 1976; Gardali and Ballard, 2000).
- Breeding habitat preference towards mature and young deciduous dominant mixedwoods, especially when the associated tree species is Trembling Aspen. Lowland stands, incorporating riparian areas (including marsh, bog and other wetland habitat) are preferred when available. Both forest edge habitat and interior forests are utilized (Salt and Salt, 1976; Godfrey, 1986; Scott and Crouch, 1988a; Semenchuk, 1992; Smith, 1992; Probst and Thompson, 1995; Fisher and Acorn, 1998; Gardali and Ballard, 2000). In Alberta, the highest density of Warbling Vireos was found in early successional sites, while the lowest density occurred in old stands (Farr, 1992).
- Foraging substrate is quite variable, although a preference for the upper, peripheral canopy (at an average of 10m) is shown. Typically a preference for low canopy closure (<40%) is observed. Food was almost always taken from the leaf surface or adjacent small twigs by one of several methods. Gleaning or hovering is used most often, followed by stalking, with hawking used least (Hamilton, 1962; James, 1976a; Airola and Barrett, 1985).
- Optimal habitat in the Sierra Nevada is mature and old forest with 0-39% canopy closure. Suitable habitat includes mature and old forest with 40-69% canopy. Marginal habitat includes mature and old forest with 70-100% canopy closure, while all other habitat types are considered sub-marginal and are used less frequently by the Warbling Vireo (Verner, 1980).
- Rarely is this bird found in pure coniferous forest, or in areas dominated by large-bole trees (James, 1971; Gardali and Ballard, 2000).
- As the Warbling Vireo can utilize early successional habitat, it is assumed that it will respond well to human and natural disturbance. Thinned forest stands offer the most suitable habitat, post harvest, due to the relative abundance of retained structure. In stands harvested more liberally, the Warbling Vireo avoids the interior of the harvest block; however, the total abundance and density tends to increase within the newly created edge habitat, especially when the original stand was coniferous mixedwood forest. The effects from fire are assumed to be much like disturbance by harvest. The best correlate for habitat suitability after fire disturbance is deciduous cover (Franzreb, and Ohmart, 1978; Scott and Crouch, 1988b; Hutto, 1995; Hagar, et. al., 1996; Annand and Thompson, 1997; Ward and Smith, 2000; Tittler et. al., 2001).

- A model built for boreal coniferous forests in western Alberta in winter includes the following variables (Banks et. al., 1999).
  - Deciduous canopy height (S_1): ≤10m = 0.0; ≥15m = 1.0
  - Percent deciduous in tree canopy (S_2): 0% = 0.0; ≥30% = 1.0
  - Tree canopy closure (S_3): 0% =0.0; ≥50% = 1.0
  - Shrub and sapling cover (S_4): 0m = 0.0; ≥50% = 1.0
    - HSI (nesting cover) = S_1 x S_2 x S_3
    - HIS (foraging cover) = S_4
    - HIS (overall) = nesting habitat requires 0.5 suitable foraging habitat within 100m of nest

Reproduction

- Solitary foraging, except in breeding season when mating pairs will feed together (Gardali and Ballard, 2000).
- The species is apparently monogamous, with no records of multiple-partner mating (polygamy or polyandry) (Gardali and Ballard, 2000).
- Mating pair remains together in the breeding season, possibly to protect the female while she builds the nest and incubates the eggs (Gardali and Ballard, 2000).
- Nest building commences within a week of pair formation (Gardali and Ballard, 2000).
- Clutch size is approximately four eggs per season (Salt, 1973; Peck and James, 1987; Semenchuk, 1992; Gardali and Ballard, 2000).
- Incubation time is 12-14 days (Semenchuk, 1992; Gardali and Ballard, 2000).
- No data is available for the period between hatching and fall season (Gardali and Ballard, 2000).

Nesting Habitat

- Tall, deciduous-dominant forests are a necessary habitat requirement for the nest-site. The nest is placed in the periphery of a tree or shrub canopy approximately 80% of the time; therefore the canopy trees must be well developed; however the overall canopy cover tends to be low (<40%) (Bent, 1950; James, 1971, Salt, 1973; James, 1976a; Salt and Salt, 1976; Walsberg, 1981; Marzluff and Lyon, 1983; Godfrey, 1986; Peck and James, 1987; Semenchuk, 1992; Gardali and Ballard, 2000).

- The nest is a cup structure supported from the top. Typically the nest is constructed from grasses and bark, obtained from distances over 70m, including previous nest sites. Nest height can be up to 12 m; however, the average nest is below 3 m in Alberta (Salt, 1973; Salt and Salt, 1976; Semenchuk, 1992; Gardali and Ballard, 2000).
- Nests of the Warbling Vireo were seldom further then 200m from edge habitat (either natural or anthropogenic) (Salt, 1973; Tewksbury et. al., 1998).
- Territory sizes are small, and approximately the same size (1-2 ha/pair) throughout the range and throughout different habitats. Males typically establish territories, where he will sing to attract a mate (Gardali and Ballard, 2000).
- Although the territory is chosen by the male, the actual nest location is chosen by the female (Gardali and Ballard, 2000).
- Males will actively chase non-vireo intruders from territory, although some closely-related species, such as the Red-eyed Vireo or Yellow-throated Vireo, are tolerated (James, 1976aGardali and Ballard, 2000).
- The higher the nest, the lower the risk of brown-head cowbird parasitism (Salt, 1973).

Migratory Behaviour

- The Warbling Vireo is a medium to long distance, nocturnal migrant, wintering in western Central America (Gardali and Ballard, 2000).
- Spring migration occurs in early May (Salt and Salt, 1976; Semenchuk, 1992).
- Most birds have left by late August (Salt and Salt, 1976; Semenchuk, 1992).

Community Structure

- Like many other neo-tropical birds, the Warbling Vireo will join into mixed species flocks outside of the breeding season (Hutto, 1980; Hutto, 1987).

- Very little information about adult, juvenile, or nest predators is known, although it is assumed that common predators (hawks, jays, small mammals) do prey upon the Warbling Vireo and its nests (Gardali and Ballard, 2000).
- The similarity of preferred habitat between the Warbling Vireo and the Brown-headed Cowbird (riparian deciduous) lead to increased rates of brood parasitism, especially in areas of increased agricultural activity and human-induced disturbance. In fact the Warbling Vireo is one of the most utilized hosts of the Brown-headed Cowbird, at rates greater than 60%. A higher incidence of human presence increases the density of Brown-headed Cowbirds. This brood parasite can be detrimental to the Warbling Vireo, such that some small populations may become extinct. The Warbling Vireo therefore avoids the human induced high-density-cowbird areas, lowering the occurrence of parasitism and loss of clutch (Tewksbury, et. al., 1998; Tewksbury et. al., 1999; Gardali and Ballard, 2000; Ward and Smith, 2000; Banks and Martin, 2001).
- European Starlings may have a negative effect on native bird nesting and breeding (Weitzel, 1988).
- Two subspecies may be present, although *Vireo gilvus swainsonii* is likely more prevalent then *Vireo gilvus gilvus* (Godfrey, 1986; Gardali and Ballard, 2000).

Management Implications

- As nesting and foraging occur primarily in deciduous stands, these stands should be managed for the Warbling Vireo.
- Retention patches of tall mature trees should be retained for nesting and foraging.
- Riparian areas should be retained as secondary habitat.
- Degradation of riparian habitat is of concern for the Warbling Vireo, as well as succession of forest to coniferous stages.
- Nests must have suitable foraging habitat within 100m; therefore both habitats must be managed concurrently.
- Increased edge to area ration should be achieved.

Research Needs

Little research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

126. Habitat suitability associations
127. Nesting efficiency as related to edge (both natural and anthropogenic)
128. Minimum retention patch size to accommodate nesting behaviour
129. Shape of harvest block and its effect on populations, with respect to edge:area ratio, as well as harvest block width

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White-tail Deer

Odocoileus virginianus dacotensis

Introduction

The White-tailed Deer is a common year-round resident of Alberta. Deer are easily identified within Tolko Industries Ltd. (HLLD) FMA area; however, Mule Deer and White-tailed Deer are very similar and may be confused. Provincially, the White-tailed Deer is rated green (breeding) by the Alberta Wildlife Act, secure by the General Status of Alberta Wild Species 2000 and S5 (secure in Alberta) by the Heritage status ranks. The White-tailed Deer forages mainly on leaves, twigs, and other shrubby bush in winter, while summer forage concentrates on grasses and other herbaceous growth. Habitat use is very generalized, with individuals using most habitat types; however, open habitat with adjacent aspen stands are preferred, as well as riparian stands. The White-tailed Deer is important in the community as a major prey item, as a recreationally harvested animal, and also in its disruptive effects on herbaceous and deciduous vegetation.

Food

- Buds and twigs of shrubs and saplings comprise the majority of the diet. Young grass shoots are typically utilized early in the spring. The summer diet is quite diverse, including grasses, fruits, forbs, evergreen needles, foliage, nuts, flowers, lichen and fungi. The autumn diet is similar to the summer diet; however, berries consumption increases dramatically. Winter browse consists of deciduous buds and twigs, and evergreen needles from mature trees. Red-Osier Dogwood (*Cornus stolonifera*), Pussy Willow (*Salix discolor*), and White Ash (*Fraxinus amreicana*) comprise >90 of the winter diet (Banfield, 1974; Forsyth, 1985; Hodgman and Bowyer, 1985; Brown and Doucet, 1991; Johnson, et. al., 1995; Swihart, 1998).

- Litterfall may be an important dietary component, for mature and juvenile individuals, especially during winter months, with low browse availability (Ditchkoff and Servello, 1998).
- White-tailed Deer consume water and/or mud from natural mineral springs. Individuals use licks as a source of minerals, particularly sodium and bicarbonate. When available, all deer with a natural lick in their home range will visit a lick daily. Deer without licks within their home range, travel several kilometers to access the essential minerals (Wiles and Weeks, 1986; Bechtold, 1996).

Summer Habitat

- Optimal habitat is composed of a naturally highly fragmented forest stands, with a mixture of open areas near cover. This increases foraging opportunities and increases predator detections, while still remaining close to both security and thermal cover habitat. Riparian areas, grassland, shrubland, shelterbelts, deciduous dominant mixedwood forest are used most extensively (Compton et. al., 1988; McCullough et. al., 1989; Beier and McCullough, 1990; Bell et. al., 1992; Pattie and Fisher, 1999; Stewart, et. al., 2000).
- The White-tailed Deer utilizes each age class of Aspen mixedwood forests, although young stands are used most frequently. Old stands are used slightly less than young stands, while mature stands are used significantly less. Young stands provide abundant forage with tender young shoots of regenerating deciduous trees. Forests greater than 40 years old also provide good forage with the quantity of catkins and the quantity and variety of fruiting bodies of herbaceous shrubs (Johnson, et. al., 1995; Roy et. al., 1995; Schieck and Roy, 1995).
- White-tailed deer in northern Montana and southern Alberta showed a preference for (Jenkins and Wright, 1988):
  - Spruce dominated mixed stands (succeeds from populus/picea community, showing sparse deciduous canopy (25%) and moderate coniferous canopy (50%), with a sparse shrub layer)
  - Mature to old forest (climax forest on xeric sites with dense coniferous canopy (70%), sparse shrub layer, and moderate ground cover)
  - Lowland Spruce (climax forest on floodplains and other mesic areas with dense canopy (70%), moderate shrub layer and moderate ground cover)

- Other variables associated with habitat-suitability include shrub species richness, tree (>20 cm dbh), shrub/sapling density, natural openings with intermediate biomass, and adequate concealment cover (Stelfox et. al., 1995; Stewart, et. al., 2000)
- White-tailed Deer typically avoid extensive mature to old coniferous forest (although used for thermal cover in winter), with a moderate coniferous canopy (≈50%), due to large-scale disturbance, stands with a sparse shrub layer, and stands with well developed ground cover (Banfield, 1974; Jenkins and Wright, 1988).
- Unforested areas are generally used during crepuscular and nocturnal hours (Compton et. al., 1988).
- The distance between seasonal ranges is variable. Summer habitat can be considered approximately ten times as large as the winter yards, and can be approximately calculated by: summer range = (winter yard size) x (10) x (percent forest cover). For example, a 20 km^2 winter yard with adjacent-80% forest cover would yield a potential summer range of 250 km^2 (Root, et. al., 1990; Broadfoot et. al., 1996).
- Home range for White-tailed Deer is dependent on several variables: older individuals tend to have smaller home ranges with males having larger average yearly ranges. The typical core home range, when in optimal habitat, is approximately 100ha; however 100% home range may include several hundred square kilometers (Ozoga and Verme, 1986; Mooty et. al., 1987; Leach and Edge, 1994). Dispersal and spatial overlap are lowest in the fawning season (McCullough et. al., 1989). White-tailed deer average density (Sept, 1991) in north-western Alberta was <1.5/ 10 km^2, with a total population of 13 120 in deer management area 9. When density exceeds 25 deer/ 100 ha, the availability and quality of browse declines such that the population will decrease as well (AB. Env. Prot., 1995; Swihart et. al., 1998). As a method of territorial marking, White-tailed Deer Bucks rub their antlers on trees. The abundance of markings indicates the abundance of mast crops in the area. Rubs are less common on coniferous trees and in very young growth areas (Miller et. al., 1987).
- The chief method of predator avoidance by fawns involves hiding, dispersal of doe/fawn pairs, and alternation of bedding sites. Fawns chose bed-sites which displayed more woody cover and less medium-to-short ground cover, resulting in better concealment and more stable thermal environment. On cooler days, south-facing slopes were preferred, whereas average and hotter than average days showed a general avoidance of the south-facing slopes (Huegel et. al., 1986; Ozoga and Verme, 1986).

- Deer will use clear-cut openings due to the increased quantity of forage. These areas have greater biomass and a greater density of high nutrient foods, but as a stand increases with age, the availability of forage decreases. Where coarse woody debris is not limiting, the optimal opening size is approximately 24ha; however, the use of clear-cuts is avoided until vegetation heights exceed 0.3m. The use of harvest blocks peak in spring, then gradually decline into summer, as young shoots become less abundant. Variables in relation to deer use in clears-cuts include:
  - regenerative growth height
  - slash depth
  - depth of CWD in forest adjacent to the cut-block
  - size of the opening
  - cover quality of the adjacent forest (Lyon and Jensen, 1980; Sweeney, 1984; Johnson et. al., 1995; Secord et. al., 1999).
- Deer abundance in harvested Alberta forests is dependent on stand species and scarification. Deer abundance, based on pellet group counts, in (Stelfox et. al., 2000):

Year	1	6	9	17	27	32	39	Avg
Scarified Spruce	17	17	30	107	375	160	210	130.9
Unscarified Spruce	0	32	0	588	162	246	102	161.4
Scarified Mixedwood	0	67	30	---	0	8	8	18.8
Unscarified Mixedwood	17	67	45	---	10	46	0	30.8
Scarified Pine	0	0	0	---	0	48	18	11.0
Unscarified Pine	0	0	0	---	80	138	28	41.0

- Unlogged riparian habitats are preferred in the summer (Leach and Edge, 1994).
- Deer will bed-down in a shallow depression in leaves or snow in times of inactivity. These beds may be reused; however, individuals tend to have multiple beds (Pattie and Fisher, 1999).
- Chemical removal of shrubs, especially in the summer, may have detrimental effects on Deer browse abundance (Stewart, et. al., 2000).

Winter Habitat

- In northern areas where snow accumulation is great, White-tailed Deer aggregate in the winter in shelter-providing deer yards. These small components of the home range represent a vital area for deer, where winter browse is available and snow is not exceptionally deep. Deer yard availability compared to total forest area showed the greatest significance with respect to habitat suitability. The relationship is linear with forest patches >400 ha provided deer ample cover, while tracts <100 ha required >50% yard habitat to support deer populations (Banfield, 1974; Nixon et. al., 1988; Brown and Doucet, 1991).
- Winter habitat use is typically low elevation, Aspen dominated mixedwood forests, although the composition of deciduous and coniferous trees is variable, due to the utilization of both. All age classes are utilized, albeit old growth forests are typically preferred, being used 50-60% of the time. Young ands mature stands are used approximately 20-30% each. (Mooty et. al., 1987; Roy, et. al., 1995; Stelfox et. al., 1995; Secord et. al., 1999).
- Predicted White-tailed Deer use of forest can be attributed to accumulated snow. Pole sized timber is used greatest (≈ 0.8 at 0 cm) with the least amount of snow accumulation. Mature timber is used greatest when accumulation is moderate (≈ 0.5 at 20-40 cm). Old forest stands are utilized when accumulation is extreme (≈ 0.8 at >30 cm) (Pauley et. al., 1993).
- Optimal cover habitat exists in stands with ≥50% conifers, ≥70% canopy closure, ≥10m tree height, in an area within 140m of foraging habitat (Gould et. al., 1999).
- Optimal foraging habitat must be within 140m of thermal cover and have >50% shrub growth (Gould et. al., 1999).
- Winter habitat correlations include a strong association with tree (>20cm dbh) density, tree height (≥ 24m canopy), closed canopy (≈75%), birch density, snag (>20 cm dbh) density, shrub species richness, and coniferous density (Pauley et. al., 1993; Roy, et. al., 1995; Stelfox et. al., 1995).
- A strong negative correlation is shown for small tree (3-20 cm dbh) density, as well as overly open areas (Roy, et. al., 1995; Stelfox et. al., 1995; Secord et. al., 1999).

- Habitat attribute analysis in coniferous forest in Idaho (Pauley et. al., 1993):

	Mean dbh (cm)	Canopy height (m)	Canopy cover (%)	Basal area (m^2/ha)	Stand age (yrs)	Total mature tree density (/ha)	Shrub cover (%)	Shrub Height (cm)	Herbaceous Cover (%)	Elevation (m)	Slope (%)	Aspect NE (% use)	Aspect SW (%use)
Spring-Autumn	20	21	66	28	102	535	25	76	13	797	10	26	74
Early Winter		24	74			694				759	5		
Mid-winter	35	31	87	49	238		6	37	6	762		7	93
Late Winter		25	74			650				778	9		

- White-tailed Deer winter bedding sites in central Ontario were on average (Armstrong et. al., 1983)

Variable	Day	Night
Coniferous composition (%)	11.3	76.2
Distance to nearest tree (m)	1.7	0.9
Diameter of nearest tree (cm)	17.5	23.3
Distance to nearest live branch (m)	2.1	2.4
Distance to nearest dead branch (m)	1.9	1.2
Depth of bed (cm)	18.7	22.0
Overhead Cover (%)	12.8	84.7
Snow Depth (cm)	75.7	35.9
Vegetation volume (%)	4.1	58.8

- Many of the bedding sites are used repeatedly, even in successive years (Armstrong et. al., 1983)
- With the inception of spring, open habitats increase in use, as snow depths decrease (Secord et. al., 1999).

- A significant relationship exists between deer predation and clearcuts, where a higher percentage of individuals were killed, compared to forested densities, possibly due to differences in snow depth (Patterson and Messier, 2000).
- A model built for boreal coniferous forests in western Alberta in winter (Gould et. al., 1999).
  - Tree canopy closure (S_1): ≤30% = 0.0; ≥70% = 1.0
  - Tree canopy height (S_2): <4m = 0.0; ≥10m = 1.0
  - Pine, spruce, and fir in tree canopy (S_3): 0% =0.5; ≥50% = 1.0
  - Distance of cover from food (S_4): <140 m = 1.0; ≥220m = 0.0
    - HSI (cover) = S_1 x S_2 x S_3 x S_4
  - Deciduous sapling cover ≤2 m in height and shrub cover (S_5): 0% = 0.0; ≥50% = 1.0
  - Distance from cover (S_6): ≤140m = 1.0; ≥220m = 0.0
    - HSI (foraging) = S_5 x S_6

Reproduction

- The rut typically occurs mid October through to December (Banfield, 1974).
- Gestation length is 195-212 days (Forsyth, 1985). Parturition typically occurs in a well-sheltered area between April and September, leading to one or two fawns born each season (Banfield, 1974; Forsyth, 1985)
- Typically, juvenile females mate at one year (Banfield, 1974).

Community Structure

- White-tailed Deer may be considered a keystone species due to their impact on woody vegetation, herbaceous vegetation and predator dynamics (Waller and Alverson, 1997).
- The initial removal of riparian deciduous vegetation by beavers, coupled with the subsequent foraging on deciduous regrowth, leads to the increased rate of succession as coniferous species are allowed to flourish under the open habitat (Barnes and Mallik, 2001; Liang and Seagle, 2001).
- Coyotes prey upon White-tailed Deer, but choose to pursue Mule Deer if given the choice between the two (Samson and Crête, 1997; Lingle and Wilson, 2001).

- Although quite closely related, White-tailed Deer and Mule Deer occupy different habitats (Lingle and Wilson, 2001).
- Unlike Mule Deer, White-tailed Deer tend to flee upon detection of predators (Lingle and Wilson, 2001).
- Estimated harvest data for the High Level area 1995, as collected from volunteer submissions (AB Env. Prot, 1997).

Demographic	WMU	524	528	534	535	536	537	540
Male		19	42	19	132	4	4	13
Female		0	6	0	27	0	0	0
Young		0	0	0	0	0	0	0

- Tolko Industries Ltd (HLLD) FMA area is entirely within Deer management area 9 (Ab. Env. Pro, 1995).

Management Implications

- A formula for calculating summer range size is (winter yard size)x(10)x(percent forest cover). For example, a 20 km^2 winter yard with adjacent-80% forest cover would yield a potential summer range of 250 km^2 (Broadfoot et. al., 1996). If winter yards are found within the FMA area, management should be employed to maintain 80% forest cover.
- Cuts within winter habitats will further fragment existing forested stands and will be at the expense of critical thermal cover.
- Cuts should be a maximum of 280m across.
- The optimal opening size for White-tailed Deer is approximately 24 ha; therefore to maximize habitat suitability this size may be utilized in areas of unsuitable, marginal, and suitable habitat to maintain, create, or enhance existing habitat.

Research Needs

Limited research has been conducted within the northern boreal region of Alberta. Future research should be directed towards:

130. Habitat suitability associations
131. Utilization of harvest blocks and the ideal harvest method to allow for optimal habitat
132. Local predator/population dynamics
133. Harvest effects on local hunter success

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Wolverine

Gulo gulo luscus

Introduction

The Wolverine is the largest mustelid in Alberta and an uncommon year-round resident. Its unique coloration and size make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area; however, the probability of observation is low. Provincially, the Wolverine is rated blue (may be at risk) by the Alberta Wildlife Act, May be at Risk by the General Status of Alberta Wild Species 2000 and S3 (vulnerable in Alberta) by the Heritage status ranks The Wolverine is primarily a scavenger in the winter feeding on carrion; however, large ungulates will be preyed upon if conditions, such as snow depth provide an adequate advantage to the Wolverine. During summer, the Wolverine relies more on hunting small mammals, birds, and foraging on berries. Habitat use consists of a variety of forest types, although mature to old stands are preferred. Likely the most important variable in Wolverine success is the lack of human disturbance. Dens are typically located under snow, with an abundance of buried structure, where tunnels and passages are excavated in close relation. The Wolverine is very sensitive to disturbance, as well as very limited in numbers, giving any operation in forested areas the potential to degrade habitat.

Food

- Wolverines are generally considered opportunistic omnivores in the summer and scavengers in the winter. Winter diet is less varied due to decreased diversity, availability and abundance. Prey items include Snowshoe Hare, Porcupine, Squirrels, birds, small mammals, Beaver/Muskrat, Carrion (caribou, moose, fat/flesh/bone), and fish. Summer diet includes ungulates, Squirrels, birds, small mammals, Beaver, fish, Porcupines, Marmot, roots, berries, and eggs, (Banfield, 1974; Forsyth, 1985; Banci, 1994; Pattie and Fisher, 1999).

- The availability of large animals to provide carrion in the winter months determines the distribution of the Wolverines. Wolverine distribution has changed in northern Saskatchewan in response to changes in Barren Ground Caribou distribution, and the same is expected for Alberta (Johnson, 1990; W. Runge, pers. comm.., as cited in Banci, 1994).
- Wolverines will cache food items on the ground, in crevasses, or in trees (Banci, 1994; Banci, 2002).
- Females rely on small mammals when small kits are present, due to limited hunting efficiency, lack of long-distance movements, and the need for an abundance of food (Banci, 2002).

Foraging Habitat

- Wolverines are largely restricted to remote boreal forests, distant from human and associated development, although ranges are generally defined by changing food availability throughout the year. Mature to old coniferous (fir, spruce, pine - in order of importance) stands are preferred; however, habitat use is very similar to habitat available, making the Wolverine a habitat generalist (Hornocker and Hash, 1981; Banci and Harestad, 1990; Banci, 1994; Lofroth et. al., 2000; Banci, 2002).
- Young-successional forests, burned-over areas, harvested areas, and wet meadows were used least often (Hornocker and Hash, 1981; Lofroth et. al., 2000).
- Although long-distance movements are quite common, individuals show fidelity to distinct portions of their range, dependant on prey availability and abundance (Hornocker and Hash, 1981; Banci, 2002). Throughout their distribution, adult males use much larger home ranges than females. Home ranges vary between 200 and 2000km^2, although average size appears to be 250-750km^2 (Hornocker and Hash, 1981; Banci and Harestad, 1990; Banci, 1994; Peterson, 1997; Landa et. al., 1998; Lofroth et. al., 2000; Inman et, al., 2001; Banci, 2002).
- Lactating females tend to have much smaller ranges (Hornocker and Hash, 1981).
- Territories are established by both males and females, where marking is achieved with urine, feces, and glandular secretions. Marking may signal reproductive status, rather than defensive-

territoriality, as territories overlap quite extensively (Koehler et al. 1980; Hornocker and Hash, 1981; Banci 1994).

- Wolverine densities throughout northwest North America are estimated to average between 1/40km^2 to 1/1000km^2 (Banci, 2002). Actual densities modified from Peterson, 1997 (highlighted items not included in this document):

	Northern British Columbia (Quick, 1935)	Montana (Hornocker and Hash, 1981)	NW Alaska (Magoun, 1985)	Alaska (Becker et. al., 1992)	Yukon (Banci and Harestad, 1990)	NWT (Lee and Niptanatiak, 1993)
Density	1/207km^2	1/65 km^2	1/139 km^2	1/213 km^2	1/177 km^2	1/136-226 km^2

- Females may not feel secure near low-level human disturbances, especially when accompanied by young (Johnson, 1990; Magoun and Copeland, 1998).
- Different variables can be considered limiting, including home range habitat, denning habitat, topography, and kit-rearing habitat; however, food availability is quite possibly the determining factor (Banci, 1994)
- The Alberta population is likely less than 1000 individuals in the province (Pattie and Fisher, 1999).
- The adult population in Scandinavia is estimated at only 413 (+/- 71) individuals (Landa et. al., 1998).

Reproduction

- The breeding season occurs late April to early September (Wright and Rausch, 1955; Banfield, 1974).
- Gestation time is 215-273 days (Forsyth, 1985); however, Wolverines exhibit delayed implantation so the active period of gestation lasts 30 to 40 days (Wright and Rausch 1955; Banci, 2002).
- Parturition usually occurs between February and May (Banfield, 1974; Banci, 2002).

- Litter size varies between 2 and 5, however, the Wolverine breeds every second or third year, reducing the total potential population size (Banfield, 1974; Forsyth, 1985; Banci, 2002).
- Cubs remain with the mother for the first winter and then disperse the following spring, when the juveniles become sexually active (Banfield, 1974).
- Females may not reproduce if food sources are limited (Banci, 2002).
- Females appear to be polygamous, but only come into heat once a year (Wright and Rausch 1955; Rausch and Pearson, 1972)
- Monitoring population through wolverine reproduction could provide an important management tool (Landa, et. al., 1998).

Denning Habitat

- Maternal and natal dens are usually located in river drainages associated with Spruce forests. Typically, dens are excavated under deep snow cover, with associated complex ground structure. The length of dens may be quite extensive, averaging as long as 40m (Pulliainen, 1968; Magoun and Copeland, 1998).
- Reproductive dens are typically occupied from 5 to 65 days, with parturition occurring mid-February to early May. Dens are abandoned in response to periods of increased temperature and arrival of spring melting. In subsequent periods of inclement weather, temporary dens may be used (Landa, et. al., 1998; Magoun and Copeland, 1998).
- When females have produced kits in the maternal/natal dens, the effective size of range around the den site is only approximately 4-7% of the usual home range (Lee and Niptanatiak, 1996).
- Dens may be used for many subsequent breeding seasons. If not used however, the female shows extreme site fidelity and new dens will be constructed within a few kilometers of the original denning location (Lee and Niptanatiak, 1996).
- Juvenile (0-1 years) home ranges tend to match the natal denning ranges, typically less than 100km^2 (Vangen et. al., 2001).
- Maternal dens are typically within a few km of the natal den sites, if not part of the natal den structure (Magoun and Copeland, 1998).
- A possible population estimator may be a natal den index (Landa, et. al., 1998).

Community Structure

- Although predators are limited for the adult Wolverine, individuals are occasionally killed by Wolves, Bears and Cougars while in conflict for food (Boles, 1977; Banci, 1994).
- Wolverine kits are preyed on by large mammalian carnivores, as well as large birds of prey such as the Golden Eagle (Magoun and Copeland, 1998).
- Due to the very low densities of the Wolverine, their impact on community function and structure can be considered minimal (Banci, 1994).
- Harvest data for the High Level area 1985-1989, as collected from volunteer submissions (AB Fish and Wildlife Div, 1990).

Wolverine harvested	1984/1985	1985/1986	1986/1987	1987/1988	1988/1989
Map sheet 84 - E	9	9	5	4	4
Map sheet 84 – F	4	3	3	3	0
Map sheet 84 – G	0	4	1	3	2
Map sheet 84 – J	2	1	0	0	2
Map sheet 84 – K	6	0	2	1	1
Map sheet 84 – L	9	12	5	13	3
Map sheet 84 – M	4	6	9	6	3
Map sheet 84 – N	5	3	6	4	0
Map sheet 84 - O	3	4	1	2	1

- Tolko Industries Ltd. (HLLD) FMA area is entirely within Fur Management Zone 1 (Peterson, 1997).

Management Implications

- Large tracts of minimally disturbed coniferous forest should be set aside as habitat for Wolverine, acting as corridors to facilitate movement throughout range.
- Management for ungulates (important winter food source) should benefit Wolverines.

- Although the Wolverine is usually a habitat generalist, some studies show the preferred use of spruce stands. In mixed-coniferous harvest areas, thinning the less-optimal stand types such as pine, while retaining as much Spruce as possible, could be beneficial.
- Residual structure could be preserved as much as possible to allow for future denning sites.
- Harvest blocks should be narrow, minimizing impact on travel.
- Harvest blocks should retain coniferous corridors to rivers and/or other wetland habitat.
- Denning sites should be monitored to evaluate population

Research Needs

Little research has been conducted within the northern boreal region of Alberta; however, studies have been completed in the Northwest Territories, particularly in montane regions. Future research should be directed towards:

134. Habitat suitability associations
135. Denning requirements in habitat without rocky structure
136. Local population dynamics, and monitoring population through wolverine reproduction
137. Use of blocks before and after harvest.
138. Use of slash piles in relation to edge of block and size of pile
139. Harvest effects on local trapper success

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Wood Bison

Bison bison athabascae

Introduction:

The Wood Bison is a common year-round resident of Alberta. Unlike many other wild species in Alberta, Wood Bison are easily identified within Tolko Industries Ltd. (HLLD) FMA area. Provincially, the Wood Bison is rated red (at risk) by the Alberta Wildlife Act, at risk by the General Status of Alberta Wild Species 2000 and S1 (critically imperilled in Alberta) by the Heritage status ranks. The Wood Bison forages on various vegetative matter, including grasses, sedges, fobs and other wetland plants. Habitat use is very generalized, with individuals using most habitat types; however, open grassy habitat with adjacent aspen stands are preferred. The Wood Bison is an integral component of the community. In and surrounding Tolko Industries FMA area are some of the largest remaining concentrations of Wood Bison, limited not by hunting or predation, but rather mostly by disease.

Food

- The bison is considered a grazer, taking grasses, forbs, sedges, and other ground forage. Various plants (mostly grasses, sedges and forbs) comprise the diet of the Bison, including species such as Wheat Grass (*Agropyron spp*), June Grass (*Koeleria cristata*), Wild Oats (*Avena hookeri*), Blue, Spear, and Fowl Meadow Grass (*Poa spp*), Broom Grasses (*Bromus spp*), Purple oat Grass (*Schizachne purpurascens*), Wild Rye (*Elymus innovatus*), Feather Grass (*Stipa richardsonii*), Vanilla Grass (*Hierochloe odorata*), Vetch (*Vicia americana*), Pea-vine (*Lathyrus ochroleucus*), Goose-grass (*Equisetum pratense*), Baltic Rush (*Juncus balticus*), Reed-grass (*Calmagrostis inexpansa*), Salt Grass (*Distichlis spicata*), Squirrel-tail Grass (*Hordeum jubatum*), Alkali Grass

(*Puccinella airoides*), Cord-Grass (*Spartina gracilis*), Blue-Joint (*Calamagrostis canadensis*), Reed Meadow Grass (*Glyceria grandis*), Water and Meadow Sedge (*Carex spp*.), and fine deciduous matter (incl. *Salix* and *Populus*). *Carex atherodes* is typically the preferred forage throughout the northern distribution of the Wood Bison, comprising approximately 50% of the winter diet and up to 75% of the spring/summer/autumn diet (Soper, 1941; Banfield, 1974; Forsyth, 1985; Keith and Reynolds, 1994; Larter and Gates, 1994; Reynolds and Peden, 1997; Larter, et. al., 2000; Wright and Markiewicz, 2000):

- Occasionally mosses, berry shrubs and lichens will also be consumed. Lichens, such as *Cladina mitis*, found in mostly forested areas, are consumed in the autumn due to their digestibility, low fiber content, and possible ability to help digest other forages in the diet (Soper, 1941; Larter and Gates, 1991; Wright and Markiewicz, 2000).

Foraging and Security Habitat

- Habitat use is primarily determined by forage availability cover. Major plant species on the primary winter range include *Calamagrostis Canadensis* and *Carex atherodes*. Major plant species on the primary spring, summer, and autumn range include *Trifolium hybridum*, *Bromus inermus*, *Pheleum pretense*, *Agropyron trachycaulum*, and *Hordeum jubatum.* The Peace-Athabasca range in Alberta has ample, widely dispersed patches of suitable foraging habitat, such as the Hay-Zama complex, and the associated Hay River drainage (Larter and Gates, 1994; Wright and Markiewicz, 2000).
- The Wood Bison uses many habitat types when available (Soper, 1941):
  - Pine parkland on sandy soil, clean floor and/or shrub mat, thickets of willow and alder – used for wallowing.
  - White spruce with dense moss cover and little shrub cover – used during winter storms.
  - Mixedwoods with increased diversity – used frequently, especially for summer feeding.
  - Deciduous forest with herbaceous plants and shrubs with intermixed grasses – used as the primary summer feeding grounds, especially in upland areas.
  - Burned stands with some regrowth – used somewhat for forage, but mostly as travel corridors.
  - Rock hills with open areas and carpet moss under scattered treed bluffs – rarely used.
  - Black spruce/tamarack bogs – used only rarely in the winter.
  - Open muskeg – used only rarely in the winter.

- Upland meadows with brackish standing water, surrounded by grasses, sedges, low shrubbery, willows, alders then forest – used as optimal forage areas in winter.
- Salt plains with stunted herbage – used regularly in summer as a source of ingestible salt.
- Lowland flood plains with high shrubbery and abundant grasses – used heavily in winter.

- The Hay-Zama herd was reintroduced to the area in 1984, through an initiative involving the Alberta Fish and Wildlife Division, the Dene Tha' First Nation, and the Canadian Wildlife Service. Forty-eight animals escaped the confines of the fenced-in compound in 1993, and, as of March, 2002, the population increased dramatically to an approximate total of 250 animals, indicating the abundance of high-quality habitat. Total population numbers in Wood Buffalo National Park appear to be decreasing. The Wentzel herd consists of approximately 50 animals, while the Wabasca/Mikkwa River herd consists of approximately 60 animals, as of February, 2002. All three populations are likely changing due to a drive towards equilibrium, with respect to carrying capacity (Nudds, 1993; Morton, 2002a; Morton, 2002b; Wright and Markiewicz, 2000).
- Summer habitat use is typified by open mesic areas and associated shrub-lands where increased plant biomass, open space, and water exist. Bison forage heavily on upland willows (as much as 90%), possibly as an avoidance behaviour towards insect harassment or high temperatures. These upland areas typically become buffalo wallows (Soper, 1941; Gainer, 1985; Waggoner and Hinkes, 1986; Calef and Van Camp, 1987; Reynolds and Peden, 1987; Melton et. al., 1989; Larter and Gates, 1991; Tesky, 1995; Wright and Markiewicz, 2000; Bergman et. al., 2001).
- Bison are unlike other ungulates in that their foraging strategy is dependant on time, not abundance of forage. In other words, bison will eat as the herd moves throughout the territory rather than seeking out abundant food sources and remaining to utilize entire supply (Bergman et. al., 2001).
- Winter habitat use in the Hay-Zama complex is more variable than summer and utilizes the adjacent forest. When interspersed with sedge meadows, these areas provide adequate winter cover as well as a sufficient food source. Winter is seldom a problem for the Bison as the winter coat, as well as the heavy mane, protect the individual from cold and wind (Keith and Reynolds, 1994; Wright and Markiewicz, 2000).
- Movement of herds and changes in demographics are possibly a result of density dependent processes, such as intraspecific competition for food. Herds are highly mobile and are considered partially migratory creating permanent trails throughout the range. Individuals from Wood Buffalo

National Park may utilize the northern and eastern aspects of Tolko Industries Ltd FMA area in winter, especially near the Peace river Valley (Soper, 1941; Banfield, 1974; Larter, et. al., 2000).

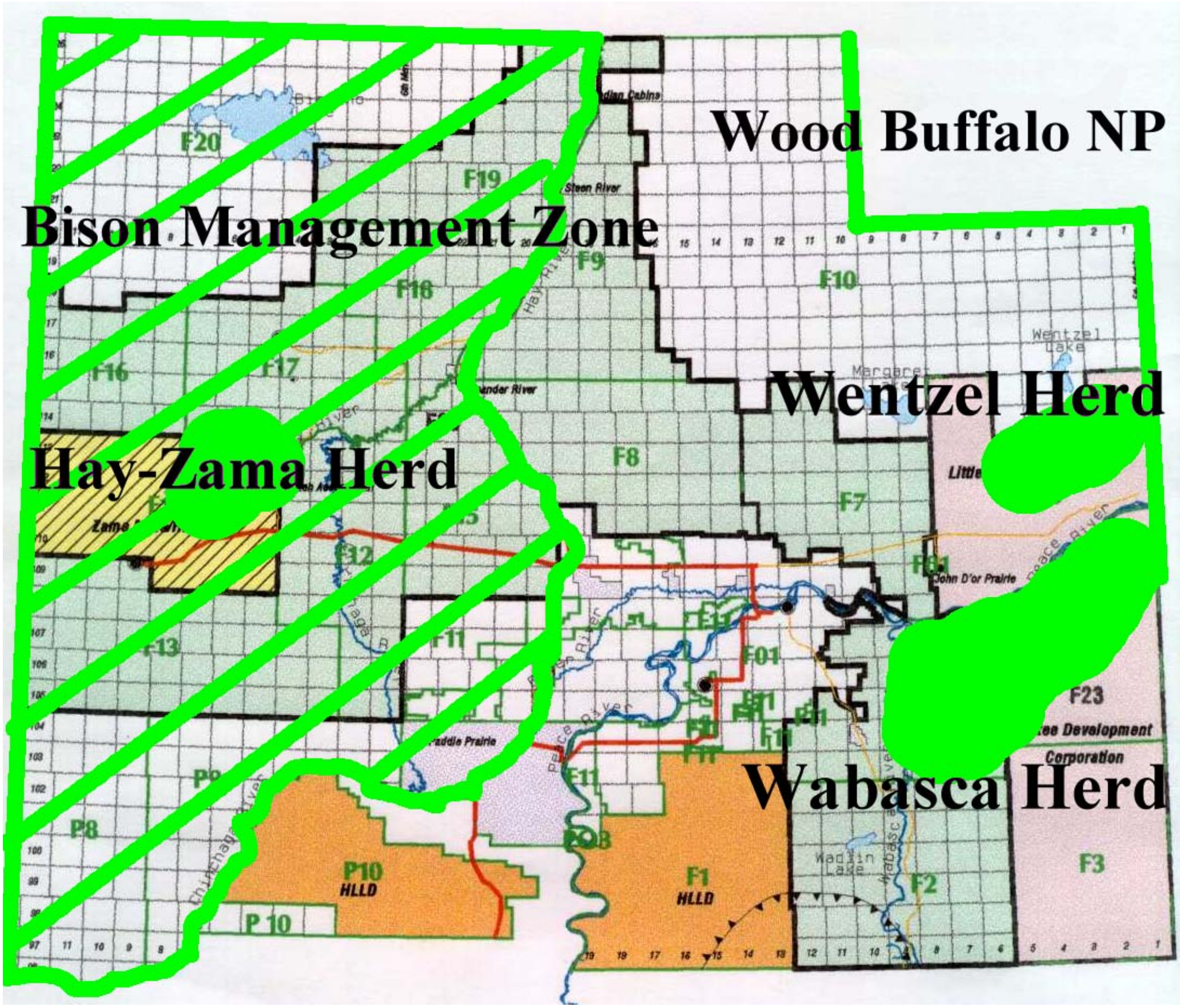
- The mean density of animals in Wood Buffalo National Park is approximately 0.37/ 100 ha (Nudds, 1993).
- Home ranges in the MacKenzie Bison Sanctuary (Larter and Gates, 1994):
  - young of the year = 712.2km^2
  - immature males = 706.0km^2
  - adult females = 1240.5km^2 (poor forage quality/quantity)
  - adult females = 397.8km^2 (good forage quality/quantity)
  - mature adult males = 434.5km^2
  - older adult males = 170.1km^2
- Death after falling through ice is a main contributor to mortality (Keith and Reynolds, 1994).

Reproduction

- The rut occurs in early July to late September (majority in mid-August), when bulls become aggressive towards other males. In Wood Buffalo National Park, the peak of the rut is typically between August 10th and 20th, although conception may occur at any time of the year (Soper, 1941; Fuller, 1962; Banfield, 1974; Calef and Van Camp, 1987; Melton et. al., 1989).
- Gestation time is 270-300 days, with parturition occurring mid April to early June. The average calving date in Alberta is mid-May (Soper, 1941; Banfield, 1974; Forsyth, 1985; Keith and Reynolds, 1994).
- The sexes are generally separated throughout the year, except for the summer months when the cows are joined by the bulls (Banfield, 1974).
- Cows tend to calve in a cyclic nature where successful breeding occurs for two years and not for the third year. In the fourth year the cycle typically starts again (Banfield, 1974; Forsyth, 1985).
- Sexual maturity occurs between two and four years of age (Tesky, 1995).
- Bison concentrated on large open prairie areas during calving and post-calving periods in southern Northwest Territories (Calef and Van Camp, 1987).

Community Structure

- Insect harassment causes Bison to roll on the ground producing wallows, typically without vegetation and occasionally stripped of topsoil. Wallows fill with water in spring and may provide habitat for amphibians and, depending on the size, may provide habitat for waterbirds (Soper, 1941; Keith and Reynolds, 1994; Tesky, 1995; Joly and Messier, 2000).
- Cowbirds rely on the Bison as a source of insect food (Soper, 1941).
- Predators include Grizzly Bears, Black Bears, Wolves and Cougars (Soper, 1941; Fuller, 1962; Forsyth, 1985; Van Camp, 1987; Keith and Reynolds, 1994; Larter, et. al., 2000; Mitchell and Gates, 2002).
- After calf predation, herds continue to flee for many kilometers, resulting in a dramatic displacement (Carbyn, 1997).
- Tuberculosis, Brucellosis, and Anthrax are all problematic with Bison herds, and are a major limiting factor. At present the Hay-Zama herd appears to be disease free, but the eastern populations (Wabasca and Wentzel populations) may be infected (Broughton, 1987; Keith and Reynolds, 1994; Wright and Markiewicz, 2000; Mitchell and gates, 2002; K. Morton Pers comm.)
- Summer herds generally consist of cows, calves, juveniles and one mature bull and thus are quite small. With the onset of the rut and winter, herds aggregate into larger herds. Herds are typically between 5-50 individuals, however, herds up to 90 individuals have been observed near Habay in the Hay-Zama complex (Soper, 1941; Banfield, 1974; K. Morton, Pers. comm).
- Once stripped of alpha status, older bulls depart and become solitary until death (Soper, 1941).
- A bison management zone exists in the northwest corner of the province, from the Chinchaga River/Hay River to the British Columbia and Northwest Territories' Border. Bison which are not within the Bison Protection Area or Wood Buffalo National Park are not considered wildlife by the Alberta Government, and not protected from hunting (Mitchell and Gates, 2002).
- Bison have been observed throughout the FMA area of Tolko Industries Ltd.; with, the majority of individuals concentrated into three separate herds. The Hay-Zama population is concentrated in the Hay-Zama-Lakes Complex. The Wentzel population is located at the eastern border of the FMA, north of the Peace River. The Wabasca population ranges from the Wabasca River east and south from the Peace River (Mitchell and Gates, 2002).



Bison Distribution and Management Zone (from Mitchell and Gates,2002)

Management Implications

- Harvesting increases the potential forage area for the bison, however, it also creates large ecosystem changes throughout. One possible effect is that new dispersal routes, may play a role in the spread of disease.
- The main cause of bison mortality within the Hay-Zama complex herd (and plausible in other ranges) may be due to vehicular traffic between Highway 58 and Zama City; therefore, reduced

speed should be a priority in this area. As well, highly visable signage should be erected to 'remind' drivers to travel slow and be aware of Bison.

- Controlled burns of roadside ditches will deter Bison from foraging on road allowance.

Research Needs

As with the Woodland Caribou, the Wood Bison has become a high profile species within the northern boreal region of Alberta. Several studies have been completed, and present monitoring is carried out by the Alberta Conservation Association and Alberta Sustainable Resource development. Future research should be directed towards:

140. Habitat suitability associations
141. Utilization of harvest blocks and the ideal harvest method to allow for optimal habitat
142. Local population dynamics
143. Information acquisition of the Wentzel herd, as present data is lacking.

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Woodland Caribou

Rangifer tarandus caribou

Woodland Caribou (K. Morton)

Introduction

The Woodland Caribou is a unique year-round resident of northern Alberta. Its size and unmistakable features make this species easily identifiable within Tolko Industries Ltd. (HLLD) FMA area. Sightings are rare, however, as the Caribou prefers remote muskeg and is sensitive to disturbance. Provincially, the Woodland Caribou is rated on the blue (may be at risk) list by the Alberta Wildlife Act, at risk by the General Status of Alberta Wild Species 2000 and S2 (imperilled in Alberta) by the Heritage status ranks. The Woodland Caribou is dependant on terrestrial lichens, and some populations are dependant on arboreal lichens, while other vegetative growth is consumed at a lower rate. General habitat use consists of a variety of types as local movements occur, although wetland areas, such as bogs, fens, and marshes are preferred. The Woodland Caribou has become a high profile species as of late, due to the increased industrial presence throughout its range and its decreasing success. Its endangered classification has prompted special management guidelines for industrial activity in Caribou range.

Food

- Lichens are the mainstay of the Caribou diet. Caribou tend to prefer ground lichens (frequently umbilicate or foliose), rather then terrestrial lichens above the snow-pack; thus, individuals must dig through the snow by a process called 'cratering.' All caribou tend to prefer *Bryoria* species when available during the winter, possibly due to a higher protein content and greater degree of digestibility. Caribou within Tolko Industries Ltd. (HLLD) FMA area, however, tend to prefer

Cladina and *Cladonia* species, which provide greater than 70% of the total diet. Winter additions include dried horsetails, sedge, willow twigs and birch twigs. The summer diet is more varied and includes mushrooms grasses, sedges, forbs, twigs and leaves of willow, and fruits (Banfield, 1974; Forsyth, 1985; Brown and Theberge, 1990; Rominger et. al., 1996; Morton and Wynes, 1997; Johnson et. al., 2001; Pharo and Vitt, 2000; Rominger et. al., 2000).

- Lichens are found primarily in old-growth forests or sparse Black-spruce bogs thereby typifying Caribou use (Morton and Wynes, 1997; Dzus, 2001).
- In late autumn, the use of Horsetails (*equisetum* spp) increased, while concurrently, the use of sedges decreased (Morton and Wynes, 1997).
- Consumption of antler may occur as a response to mineral requirements (Banfield, 1974).

Summer Habitat and Security Cover

- In north-eastern and north-western Alberta (including Tolko Industries Ltd. (HLLD) FMA area), a year-round preference for old black spruce/tamarack dominated peatland complexes is observed, primarily due to the presence of an adequate food source in lichens. Upland coniferous/ deciduous stands (Aspen, White Spruce, Paper Birch, and Balsam Fir) are typically used only as a travel corridor between optimal peatlands (Fuller and Keith, 1981; Boonstra and Sinclair, 1984; Bradshaw et. al., 1985; Morton and Wynes, 1997; Stepaniuk, 1997; Stuart-Smith et. al., 1997; Brown et. al., 1998; Anderson, 2000; Dzus, 2001).
- The presence of older stands does not signify the presence of Caribou, as site specific conditions delegate the availability and abundance of terrestrial lichens (Stepaniuk, 1997).
- Woodland Caribou strongly preferred treed bogs, treed fens and open fens over other wetland classes, such as swamps, marshes, open water, upland forests, and human disturbance in the Red Earth Creek area (Brown et. al., 1998).
  - treed bogs = 0.29
  - treed fens = 0.20
  - open fens = 0.16
  - open swamp = 0.08
  - treed swamp = 0.07
  - anthropogenic = 0.05
  - open shallow water = 0.05
  - upland = 0.04
  - swamp fen = 0.02
  - open marsh = 0.02
  - forested bog = 0.02

- Caribou in southern Manitoba showed affinity to upland coniferous forests between May and September (Darby and Pruitt, 1984).
- Critical Caribou habitat variables for the Selkirk herd in Southeastern British Columbia differed throughout the seasons (Servheen and Lyon, 1989):
  - Early winter = western hemlock and 10-25% canopy cover
  - Late winter = 2.3-17.2 m^2/ ha basal area, 26-50% canopy cover, and <30%understory
  - Spring = <1% lichen abundance, 4-15% lichen abundance, and > 90% understory
  - Calving = # of different stands and km roads/ km^2
  - Summer = % slope, and 61-80% understory
  - Rut = >247 snags/ ha, stem diam. > 25cm, km roads/ km^2
- Home ranges are smaller in summer than in the winter for both male and females. Herds in west-central Alberta had varied average home ranges, throughout three consecutive years of study, at 951km^2, 985km^2, and 858km^2. The average yearly home range size for herds of the Athabasca River in north-east Alberta is 711.44km^2. The mean annual home range size, for bulls in north-eastern Alberta was 1196km^2, whereas female range was 539km^2 (Fuller and Keith, 1981; Stuart-Smith et. al., 1997; Smith et. al., 2000).
- Dispersal into smaller groups in the summer may be attributable to decreased detection rates by the wolf. The mean size of groups in NE Alberta was between 1.2 and 5.4, with the density of caribou in northeastern Alberta is between 4.1 and 12.3 Caribou/ 100km^2 (Fuller and Keith, 1981; Morton and Wynes, 1997; Stuart-Smith et. al., 1997; Dzus, 2001).
- Seasonal movements, although relatively small compared to other herds of caribou, peaks in early spring during calving, and early autumn during the rut. In north-eastern Alberta, the longest movement was 48km (Fuller and Keith, 1981; Morton and Wynes, 1997; Stuart-Smith et. al., 1997; Dzus, 2001).
- Caribou appear to become habituated towards roads, but habitat use is more dependent upon forage abundance and quality. Roads are, however, a means of habitat fragmentation, which may have a detrimental effect on the demographics of the affected populations. This could be due to avoidance of otherwise suitable habitat or appearance of large carnivores into the now more easily accessible habitat. Clear cuts are not utilized and Caribou tend to become increasingly intolerant of harvest blocks through succession. Blocks may be avoided by Caribou by over a kilometer. Linear corridors in Caribou range may allow for ease of movement, and some increased availability of

forage. Wolf use of linear corridors also increases, possibly leading to higher rates of successful caribou predation (Morton and Wynes, 1997; Stepaniuk, 1997; Rominger et. al., 2000; Smith et. al., 2000; Kinley and Apps, 2001; Yost and Wright, 2001).

- Phase 3 Timber inventory (canopy closure, stand height, stand origin, species composition) is inadequate for mapping Caribou habitat, due to the inaccuracies in predicting lichen abundance (Stepaniuk, 1997).
- Road building and forestry activity may act as barriers for inter-population mixing. As well, these areas create patches of younger forest, increasing other large ungulates populations, leading to increased predator (primarily wolves) density (Rettier and Messier, 1998).
- Loud noise disturbance increased the Caribou's rate of movement, however, the total linear disturbance was not substantial (Bradshaw et. al., 1997).

Winter Habitat and Thermal Cover

- Habitat use is likely very similar between summer and winter for the boreal ecotype (Stuart-Smith et. al., 1997).
- Areas of discontinuous permafrost may provide suitable microhabitat for lichen. Mature and old forests are also typically preferred due to the presence of lichens, the primary winter food source. The presence of *Cladina mitis* and *Cladonia* spp are a determinant of feeding sites, when snow does not hamper their harvest. Herds choose feeding sites based on above-snow clues, thereby maximizing forage density and minimizing effort from trenching or cratering. When factors limited the use of terrestrial lichens, such as snow depth, density and hardness, Caribou feed on arboreal lichens (*Bryoria* spp) (Darby and Pruitt, 1984; Brown and Theberge, 1990; Bradshaw et. al., 1995; Morton and Wynes, 1997; Dzus, 2001; Johnson et. al., 2001).
- Caribou in north-eastern Alberta preferred forest/open-fen complexes (non-patterned minerotrophic fen peatlands >50%, dominated by *Carex* spp., *Salix* spp. *Betula* spp, and *Ericaceae*) and open and forested bogs (Forested ombrotrophic bogs or oligotrophic peatlands 85-100%, dominated by *Picea mariana*) while tending to avoid upland areas (mineral soils) and non-patterned fens of 15-50% peatland coverage. Caribou may be associated with fens due to lack of range overlap with Moose, decreased predator pressure, and forage abundance. Although fens are therefore used extensively, the edge between fens and the associated upland are typically avoided. Upland use is similar to

summer use. These areas are typically used for travel between optimal habitats. During winter, however, the use of upland areas as refuge from difficult snow conditions is prevalent, and perhaps required (Bradshaw et. al., 1995; Morton and Wynes, 1997; Stuart-Smith et. al., 1997).

- The slightly increased use of upland areas in winter is dependant on the onset of snowpack increase, as well as increased abundance and availability of food (Fuller and Keith, 1981).
- During winter, in the Selkirk Mountains, Caribou chose sites with moderate slopes, higher elevation, less canopy cover, less basal area, and greater density of lichen-bearing windthrown trees than random sites (Rominger and Oldmeyer, 1989).
- Caribou in southern Manitoba showed affinity to lowland bog and wetland/lake habitat between October and April, where open habitat provides 'sunning' areas (Banfield, 1974; Darby and Pruitt, 1984).
- Winter range habitat deficiency may lead to decreased calf production (Post and Klein, 1999).
- A high abundance of lichens are present in all seasonal habitats, although lichen use is highest in winter and post-calving seasons. Nutritional demands and the availability of forage determine habitat usage for calving females, rather then predator avoidance (Servheen and Lyon, 1989; Morton and Wynes, 1997; Young and McCabe, 1998).
- Caribou may congregate into small (66km^2) winter 'yards' similar to White-tailed Deer (Cumming and Beange, 1988).
- Timber stands must be substantially older than usual forest harvest rotation lengths to provide high lichen biomass (Rominger et. al., 1996).
- Disturbance can cause a greater energy cost to the Caribou, especially in winter (Bradshaw et. al., 1997).
- A distinct cyclic pattern is evident throughout the year when observing herd size. During the calving season, animals tend to be solitary. As autumn approaches, individuals form herds of 7-8 animals. The typical maximum herd in northern Alberta is approximately 25 individuals (Morton and Wynes, 1997).

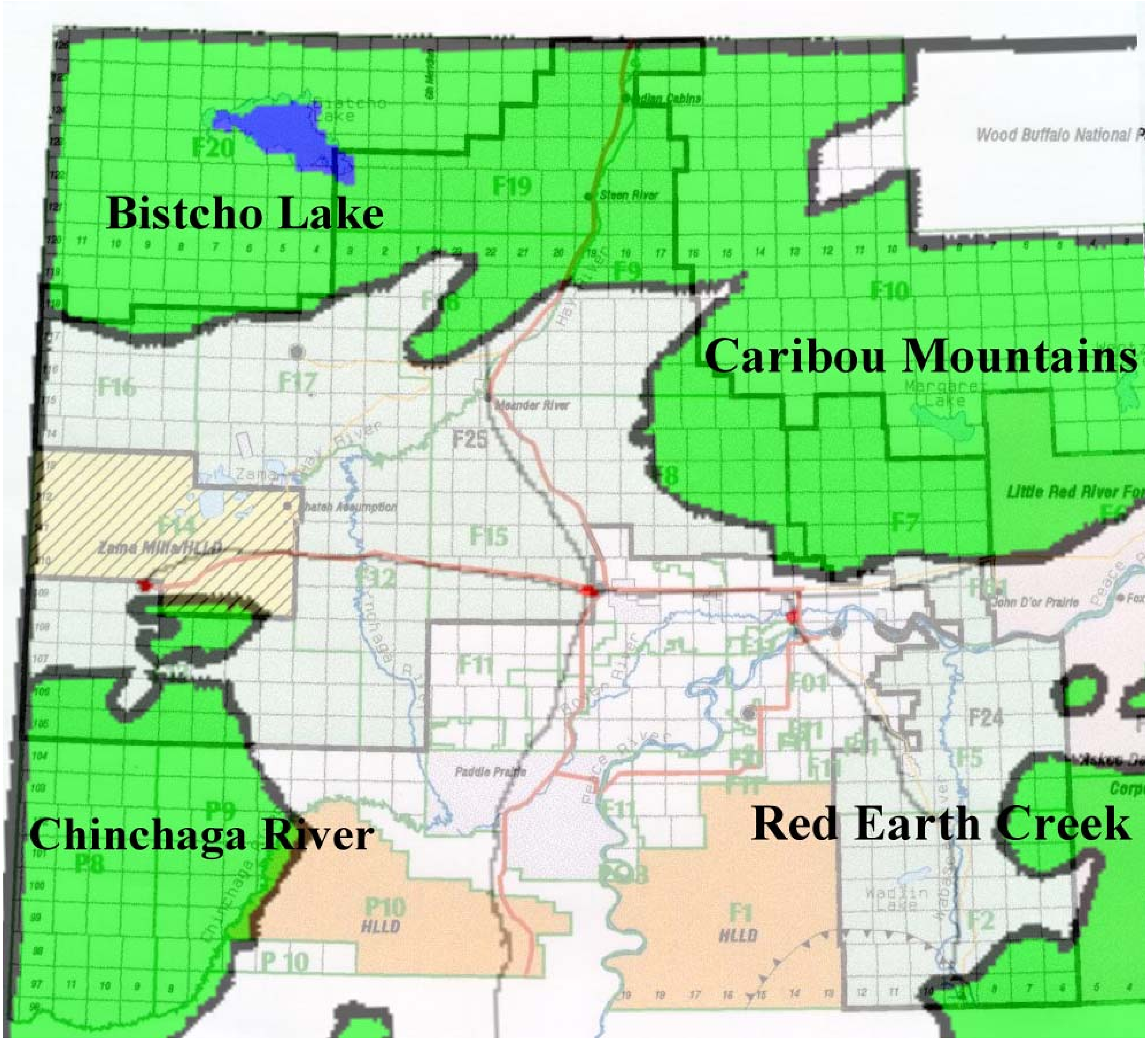
Reproduction

- Bucks collect harems, in the breeding season, of approximately twelve to fifteen does (Banfield, 1974).

- Rutting behaviour begins in early September in northern Alberta. Differential timing of the rut leads to varied parturition dates (Banfield, 1974; Fuller and Keith, 1981; Morton and Wynes, 1997).
- Gestation length is 215-240 days, with calves observed as early as May 7, but typically, mid-late May is the norm in upland boreal regions (Banfield, 1974; Forsyth, 1985; Rettie and Messier, 1998).
- Single fawns are typical, although twins do occur (Banfield, 1974; Forsyth, 1985).
- Poor nutrition and/or body condition may result in increased abortion rates or increased calf mortality post partum (Bradshaw, et. al., 1998; Rettie and Messier, 1998).
- Disturbance can create energetic imbalances leading to lowered production and increased mortality (Bradshaw, et. al., 1998).
- Parturition typically occurs in black spruce stands (Morton and Wynes, 1997).
- Although the boreal ecotype is considered non-migratory, some dispersal does occur during the calving season, although the total distances are, not substantial (Fuller and Keith, 1981; Morton and Wynes, 1997; Stuart-Smith et. al., 1995)
- Females and calves tend to show fidelity to calving sites (Brown and Theberge, 1990l, Morton and Wynes, 1997).

Community Structure

- Tolko Industries Ltd's FMA covers parts of several ranges, including Chinchaga, Bistcho, Caribou Mountains, and Red Earth (Alberta, Env., 1997; Dzus, 2001; K. Morton, Pers comm).
- Animals tend to be solitary in the summer and communal in the winter (Morton and Wynes, 1997; Rettier and Messier, 1998).
- Several predators include bears, cougars, and wolverines, whose predation may limit population success (Adams et. al., 1995; Kinley and Apps, 2001).
- A method of predator avoidance involves low densities, such as those in northern Alberta where the average density is approximately 0.03-0.12 Caribou/ km^2 (Dzus, 2001).



Caribou Protection Areas (modified from Alberta Environment, 1997 and Dzus, 2001).

Management Implications

- As Woodland Caribou are dependant on terrestrial lichens, these should be preserved when possible. Due to their growth in old forests, these stands should be conserved as a method of caribou preservation.

- Forestry planning, when in areas of Caribou habitat, should manage harvest blocks to not enhance other ungulates habitat variables, such as increased browse; therefore, in Caribou-sensitive areas, minimize block edge/area ratio.
- Loud noise disturbance, especially in winter may seriously affect Caribou populations. Operations could be grouped, to minimize current impact, as well as overall long-term disturbance impact.
- Although Caribou habitat areas are delineated in governmental publications, it should be assumed that individuals (and herds) will use areas not designated Caribou protection areas, where suitable habitat exists.
- Maintain adequate old growth coniferous forest within or bordering Caribou ranges. This cover provides relief for feeding and movements during periods of difficult snow conditions, such as deep or crusted snow.

Research Needs

Unlike most other species in north-west Alberta, research projects continue to be initiated, progressed, and completed; however, there are still gaps in knowledge As population sizes are limited and growth rates are negative in many ranges, information is necessary to define impacts to Caribou herds. Future research should be directed towards:

144. Habitat suitability associations
145. Effects of Black Spruce harvest within ranges
146. Local population dynamics
147. Preservation of lichen biomass through different post-harvest treatments
148. Reclamation of cutblocks and access routes, with respect to lichen productivity

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Appendix 1

Vertebrates of Alberta

Amphibians

Long toed Salamander	Ambystoma macrodactylum	Sensitive
Tiger Salamander	Ambystoma tigrinum	Secure
Western Toad	Bufo boreas	Sensitive
Great Plains Toad	Bufo cognatus	May be at risk
Canadian Toad	Bufo hemiophrys	May be at risk
Plains Spadefoot	Spea bombifrons	May be at risk
Boreal Chorus Frog	Pseudacris maculata	Secure
Northern Leopard Frog	Rana pipiens	At Risk
Wood Frog	Rana sylvatica	Secure
Columbia Spotted Frog	Rana luteiventris	Sensitive

Reptiles

Painted Turtle	Chrysemys picta	Sensitive
Short-horned Lizard	Phrynosoma hernandesi	May be at risk
Western Hognose Snake	Heterodon nasicus	May be at risk
Bullsnake	Pituophis catenifer	Sensitive
Western Terrestrial Garter Snake	Thamnophis elegans	Sensitive
Plains Garter Snake	Thamnophis radix	Sensitive
Common Garter Snake	Thamnophis sirtalis	Sensitive
Western rattlesnake	Crotalus viridis	May be at risk

Fish

Arctic Lamprey	Lampetra japonica	Secure
Prickly Sculpin	Cottus asper	Not Assessed
Mottled Sculpin	Cottus bairdi	Not Assessed
Slimy Sculpin	Cottus cognatus	Secure
Shorthead Sculpin	Cottus confusus	May be at risk
Spoonhead Sculpin	Cottus ricei	May be at risk
Deepwater Sculpin	Myoxocephalus thompsoni	Undetermined
Lake Sturgeon	Acipenser fulvescens	Undetermined
Goldeye	Hiodon alosoides	Secure
Mooneye	Hiodon tergisus	Secure
Cisco	Coregonus artedi	Secure
Lake Whitefish	Coregonus clupeaformis	Secure
Shortjaw Cisco	Coregonus zenithicus	May be at risk
Golden Trout	Oncorhynchus aguabonita	Exotic/alien
Cutthroat Trout	Oncorhynchus clarki	Secure
Rainbow Trout	Oncorhynchus mykiss	Secure
Sockeye Salmon	Oncorhynchus nerka	exotic/alien
Pygmy Whitefish	Prosopium coulteri	May be at risk
Round Whitefish	Prosopium cylindraceum	Undetermined
Mountain Whitefish	Prosopium williamsoni	Secure
Brown Trout	Salmo trutta	Exotic/alien
Bull Trout	Salvelinus confluentus	Sensitive
Brook Trout	Salvelinus fontinalis	Exotic/alien

Dolly Varden	Salvelinus malma	Exotic/alien
Lake Trout	Salvelinus namaycush	Sensitive
Arctic Grayling	Thymallus arcticus	Sensitive
Northern Pike	Esox lucius	Secure
Lake Chub	Couesius plumbeus	Secure
Western Silvery Minnow	Hybognathus argyritis	May be at risk
Brassy Minnow	Hybognathus hankinsoni	Undetermined
Emerald Shiner	Notropis atherinoides	Secure
River Shiner	Notropis blennius	Undetermined
Spottail Shiner	Notropis hudsonius	Secure
Northern redbelly Dace	Phoxinus eos	Sensitive
Finescale dace	Phoxinus neogaeus	Undetermined
Fathead Minnow	Pimephales promelas	Secure
Northern Pikeminnow	Ptchocheilus oregonensis	Sensitive
Longnose Dace	Rhinichthys cataractae	Secure
Redside Shiner	Richardsonius balteatus	Secure
Pearl Dace	Margariscus margarita	Undetermined
Flathead Chub	Platygobio gracilis	Secure
Quillback	Carpiodes cyprinus	Undetermined
Longnose Sucker	Catostomus catostomus	Secure
White Sucker	Catostomus commersoni	Secure
Largescale Sucker	Catostomus macrocheilus	Sensitive
Mountain Sucker	Catostomus platyrhynchus	Secure
Silver Redhorse	Moxostoma anisurum	Undetermined
Shorthead Redhorse	Moxostoma macrolepidotum	Secure
Stonecat	Noturus flavus	Undetermined
Trout-perch	Percopsis omiscomaycus	Secure
Burbot	Lota lota	Secure
Mosquitofish	Gambusia affins	Exotic/alien
Sailfin Molly	Poecilia latipinna	Exotic/alien
Brook Stickleback	Culaea inconstans	Secure
Threespine Stickleback	Gasterosteus aculeatus	Exotic/alien
Ninespine Stickleback	Pungitius pungitius	Undetermined
Smallmouth Bass	Micropterus dolomieu	Exotic/alien
Iowa Darter	Etheostoma exile	Secure
Logperch	Percina caprodes	Undetermined
Yellow Perch	Perca flavescens	Secure
Sauger	Stizostedion canadense	Sensitive
Walleye	Stizostedion vitreum	Secure
African Jewelfish	Hemichromis bimaculatus	Exotic/alien

Birds

Red Throated Loon	Gavia stellata	Secure
Common Loon	Gavia immer	Secure
Yellow-billed Loon	Gavia adamsii	Accidental
Pacific Loon	Gavia pacifica	Secure
Pied-billed Grebe	Podilymbus podiceps	Sensitive
Horned Grebe	Podiceps auritus	Sensitive
Red-necked Grebe	Podiceps grisegena	Secure
Eared Grebe	Podiceps nigricollis	Secure
Western Grebe	Aechmophorus occidentalis	Sensitive
Clark's Grebe	Aechmophorus clakii	Sensitive
American White Pelican	Pelecanus erythroryhnchos	Sensitive
Double-crested Cormorant	Phalacrocorax auritus	Secure
American Bittern	Botaurus lentiginosus	Sensitive

Great Blue Heron	Ardea herodias	Sensitive
Great Egret	Ardea alba	Accidental
Snowy Egret	Egretta thula	Accidental
Little Blue Heron	Egretta caerulea	Accidental
Tricolored Heron	Egretta tricolor	Accidental
Cattle Egret	Bubulcus ibis	Accidental
Green Heron	Butorides virescens	Accidental
Yellow-crowned Night-Heron	Nyctanassa violacea	Accidental
Black-crowned Night-Heron	Nycticorax nycticorax	Sensitive
White-faced Ibis	Plegadis Chihi	Sensitive
Tundra Swan	Cygnus columbianus	Secure
Trumpeter Swan	Cygnus buccinator	At Risk
Greater White-fronted Goose	Anser albifrons	Secure
Snow Goose	Chen caerulescens	Secure
Ross's Goose	Chen rossii	Secure
Brant	Branta bernicla	Accidental
Canada Goose	Branta canadensis	Secure
Wood Duck	Aix sponsa	Secure
Green-winged Teal	Anas crecca	Secure
American Black Duck	Anas rubripes	Secure
Mallard	Anus platyrhynchos	Secure
Northern Pintail	Anus acuta	Secure
Garganey	Anas querquedula	Accidental
Blue-winged Teal	Anas discors	Secure
Cinnamon Teal	Anas cyanoptera	Secure
Northern Shoveler	Anas clypeata	Secure
Gadwall	Anas strepera	Secure
Eurasion Wigeon	Anas penelope	Accidental
American Wigeon	Anas americana	Secure
Canvasback	Aythya valisineria	Secure
Redhead	Aythya americana	Secure
Ring-necked Duck	Aythya collaris	Secure
Tufted Duck	Aythya fuligula	Accidental
Greater Scaup	Aythya marila	Secure
Lesser Scaup	Aythya affinis	Secure
King Eider	Somateria spectabilis	Accidental
Common Eider	Somateria mollissima	Accidental
Harlequin Duck	Histrionicus histrionicus	Sensitive
Long-tailed Duck	Clangula hyemalis	Secure
Black Scoter	Melanitta nigra	Accidental
Surf Scoter	Melanitta perspicillata	Secure
White-winged Scoter	Melanitta fusca	Sensitive
Common Goldeneye	Bucephala clangula	Secure
Barrow's Goldeneye	Bucephala islandica	Secure
Bufflehead	Bucephala albeola	Secure
Hooded Merganser	Lophodytes cucullatus	Secure
Common Merganser	Mergus merganser	Secure
Red-breasted Merganser	Mergus serrator	Secure
Ruddy Duck	Oxyura jamaicensis	Secure
Turkey Vulture	Cathartes aura	Secure
Osprey	Pandion haliaetus	Sensitive
Bald Eagle	Haliaeetus leucocephalus	Sensitive
Northern Harrier	Circus cyaneus	Secure
Sharp-shinned Hawk	Accipiter striatus	Secure
Cooper's Hawk	Accipiter cooperii	Secure
Northern Goshawk	Accipiter gentilis	Sensitive

Broad-winged Hawk	Buteo playpterus	Sensitive
Swainson's Hawk	Buteo swainsoni	Sensitive
Red-tailed Hawk	Buteo jamaicensis	Secure
Ferruginous Hawk	Buteo regalis	At Risk
Rough Legged Hawk	Buteo lagopus	Secure
Golden Eagle	Aquilla chrysaetos	Sensitive
American Kestrel	Falco sparverius	Secure
Peregrine Falcon	Falco peregrinus	At Risk
Merlin	Falco columbarius	Secure
Gyrfalcon	Falco rusticolus	Secure
Prairie Falcon	Falco mexicanus	Sensitive
Gray Partridge	Perdix perdix	Exotic/alien
Ring-necked Pheasant	Phasianus colchicus	Exotic/alien
Spruce Grouse	Falcipennis canadensis	Secure
Blue Gouse	Dendragapus obscurus	Secure
Willow Ptarmigan	Lagopus lagopus	Secure
White-tailed Ptarmigan	Lagopus leucurus	Secure
Ruffed Grouse	Bonasa umbrellus	Secure
Greater Sage Grouse	Centrocercus urophasianus	At Risk
Greater Prairie Chicken	Tympanuchus cupido	Extirpated
Sharp-tail Grouse	Typanuchus phasianellus	Sensitive
Wild Turkey	Meleagris gallopavo	Exotic.alien
Yellow Rail	Coturnicops noveboracnesis	Undetermined
Virginia Rail	Rallus limicola	Undetermined
Sora	Porzana carolina	Secure
American Coot	Fulica americana	Secure
Sandhill Crane	Grus canadensis	Sensitive
Common Crane	Grus grus	Accidental
Whooping Crane	Grus americana	At Risk
Pacific Golden Plover	Pluvialis fulva	Accidental
Black-bellied Plover	Pluvial squatarola	Secure
American Golden Plover	Pluvialis dominica	Secure
Mongolian Plover	Charadrius mongolus	Accidental
Snowy Plover	Charadrius alexandrinus	Accidental
Spotted Redshank	tringa erythropus	Accidental
Semipalmated Plover	Charadrius semipalmatus	Secure
Piping Plover	Charadrius melodus	At Risk
Killdeer	Charadrius vociferus	Secure
Mountain Plover	Charadrius montanus	Sensitive
Black-necked Stilt	Himantopus mexicanus	Sensitive
American Avocet	Recurirostra americana	Secure
Greater Yellowlegs	Tringa melanoleuca	Secure
Lesser Yellowlegs	Tringa flavipes	Secure
Solitary Sandpiper	Tringa solitaria	Secure
Willet	Catoptrophorus semipalmatus	Secure
Wandering Tattler	Heteroscelus incanus	Accidental
Spotted Sandpiper	Actitis macularia	Secure
Upland Sandpiper	Bartramia longicauda	Sensitive
Eskimo Curlew	Numenius borealis	Extirpated
Black Turnstone	Arenaria melanocephala	Accidental
American Whimbrel	Numenius phaeopus	Secure
Long-billed Curlew	Numenius americanus	May be at Risk
Hudsonian Godwit	Limosa haemastica	Secure
Marbled Godwit	Limosa fedoa	Secure
Ruddy Turnstone	Arenaria interpres	Secure
Surfbird	Aphriza virgata	Accidental

Red-necked Stint	Calidris ruficollis	Accidental
Little Stint	Calidris minuta	Accidental
Red Knot	Calidris canutus	Secure
Sanderling	Calidris alba	Secure
Semipalmated sandpiper	Calidris pusilla	Secure
Western Sandpiper	Calidris mauri	Secure
Least Sandpiper	Calidris minutilla	Secure
White-rumped Sandpiper	Calidris fuscicollis	Secure
Baird's Sandpiper	Calidris bairdii	Secure
Pectoral Sandpiper	Calidris melanotos	Secure
Sharp-tailed sandpiper	Calidris acuminata	Accidental
Dunlin	Calidris alpina	Secure
Curlew Sandpiper	Calidris ferruginea	Accidental
Stilt Sandpiper	Calidris himantopus	Secure
Spoonbill Sandpiper	Eurynorhynchus pygmeus	Accidental
Buff-breasted Sandpiper	Tryngites subruficollis	Secure
Ruff	Philomachus pugnax	Accidental
Short-billed Dowitcher	Limnodromus griseus	Undetermined
Long-billed Dowitcher	Limnodromus scolopaceus	Secure
Common Snipe	Gallinago gallinago	Secure
Wilson's Phalarope	Phalaropus tricolor	Secure
Red-necked Phalarope	Phalaropus lobatus	Secure
Red Phalarope	Phalaropus fulicaria	Accidental
Pomarine Jaeger	Stercorarius pomarinus	Accidental
Parasitic Jaeger	Stercorarius parasiticus	Accidental
Long-tailed Jaeger	Stercorarius longicaudus	Accidental
Franklin's Gull	Larus pipixcan	Secure
Little Gull	Larus minutus	Accidental
Bonaparte's Gull	Larus philadelphia	Secure
Mew Gull	Larus canus	Secure
Ring-billed Gull	Larus delawarensis	Secure
California Gull	Larus californicus	Secure
Herring Gull	Larus argentatus	Secure
Thayer's Gull	Larus thayeri	Secure
Iceland Gull	Larus glaucoides	Accidental
Lesser Black-winged Gull	Larus fuscus	Accidental
Glaucous-winged Gull	Larus glaucescens	Accidental
Slaty-backed Gull	Larus schistisagus	Accidental
Glaucous Gull	Larus hyperboreus	Secure
Great Black-backed Gull	Larus marinus	Accidental
Black-legged Kittiwake	Rissa tridacyla	Accidental
Ivory Gull	Pagophila eburnea	Accidental
Sabine's Gull	Xema sabini	Secure
Caspian Tern	Sterna caspia	Sensitive
Common Tern	Sterna hirundo	Secure
Arctic Tern	Sterna paradisea	Secure
Forster's Tern	Sterna forsteri	Sensitive
Black tern	Chlidonias niger	Sensitive
Black Guillemot	Cepphus grylle	Accidental
Long-billed Murrelet	Brachyramphus perdix	Accidental
Ancient Murrelet	Synthliboramphus antiquus	Accidental
Rock Dove	Columba livia	Exotic/alien
Band-tailed pigeon	Columba fasciata	Accidental
White-winged Dove	Zenaida asiatica	Accidental
Mourning Dove	Zenaida macroura	Secure
Passenger Pigeon	Ectopistes migratorius	Extirpated

Black-billed Cuckoo	Coccyzus erythropthalmus	Undetermined
Yellow-billed Cuckoo	Coccyzus americanus	Accidental
Barn Owl	Tyto alba	Accidental
Eastern Screech-Owl	Otus asio	Accidental
Western Screech-Owl	Otus kennicottii	Accidental
Great Horned Owl	Bubo virginianus	Secure
Snowy Owl	Nyctea scandiaca	Secure
Northern Hawk Owl	Surnia ulula	Secure
Northern Pygmy Owl	Glaucidium gnoma	Sensitive
Burrowing Owl	Athene cunicularia	At Risk
Barred Owl	Strix varia	Sensitive
Great Gray Owl	Strix nebulosa	Sensitive
Long-eared Owl	Asio otus	Secure
Short-eared Owl	Asio flammeus	May be at Risk
Boreal Owl	Aegolius funereus	Secure
Northern Saw-whet Owl	Aegolius acadicus	Secure
Common Nighthawk	Chordeiles minor	Sensitive
Common Poorwill	Phalaenoptilus nuttallii	Undetermined
Black Swift	Cypseloides niger	Undetermined
Vaux’s Swift	Chaeture vauxi	Accidental
White-throated Swift	Aeornautes saxatalis	Accidental
Green Violet-ear	Colibri thalassinus	Accidental
Ruby-throated Hummingbird	Archilochus colubris	Secure
Black-chinned Hummingbird	Archilochus alexandri	Accidental
Anna’s Hummingbird	Calypte anna	Accidental
Costa’s Hummingbird	Calypte costae	Accidental
Calliope Hummingbird	Stellulat calliope	Secure
Rufous Hummingbird	Selasphorus rufus	Secure
Belted Kingfisher	Ceryle alcyon	Secure
Lewis’s Woodpecker	Melanerpes lewis	Secure
Red-headed Woodpecker	Melanerpes erythrocephalus	Accidental
Yellow-bellied Sapsucker	Sphyrapicus varius	Secure
Red-breasted Sapsucker	Sphyrapicus ruber	Accidental
Williamson’s Sapsucker	Sphyrapicus thyroideus	Accidental
Red-naped Sapsucker	Sphyrapicus nuchalis	Undetermined
Downy Woodpecker	Picoides pubescens	Secure
Hairy Woodpecker	Picoides villosus	Secure
Three-toed Woodpecker	Picoides tridactylus	Secure
Black-backed	Picoides articus	Sensitive
Northern Flicker	Colaptes auratus	Secure
Pileated Woodpecker	Dryocopus pileatus	Sensitive
Olive-sided Flycatcher	Contopus cooperi	Secure
Western Wood-Pewee	Contopus sordidulus	Secure
Yellow-bellied Flycatcher	Empidonax flaviventris	Undetermined
Alder Flycatcher	Empidonax alnorum	Secure
Willow Flycatcher	Empidonax trailii	Secure
Least Flycatcher	Empidonax minimus	Secure
Hammond’s Flycatcher	Empidonax hammondii	Secure
Dusky Flycatcher	Empidonax oberholseri	Secure
Pacific-slope Flycatcher	Empidonax difficilis	Undetermined
Cordilleran Flycatcher	Empidonax occidentalis	Undetermined
Eastern Phoebe	Sayornis phoebe	Secure
Say’s Phoebe	Sayornis saya	Secure
Great Crested Flycatcher	Myiarchus crinitus	Sensitive
Western Kingbird	Tyrannus forficatus	Accidental
Eastern Kingbird	Tyrannus tyrannus	Secure

Gray Flycatcher	Empidonax wrightii	Accidental
Scissor-tailed Flycatcher	Tyrannus forficatus	Accidental
Horned Lark	Eremophilia alpestris	Secure
Purple Martin	Progne subis	Sensitive
Tree Swallow	Tachycineta bicolor	Secure
Violet-Green Swallow	Tachycineta thalassina	Secure
Northern Rough-winged Swallow	Stelgidopteryx serripennis	Secure
Bank Swallow	Riparia riparia	Secure
Cliff Swallow	Petrechelidon pyrrhonota	Secure
Barn Swallow	Hirundo rustica	Secure
Gray Jay	Perisoreus canadensis	Secure
Steller's Jay	Cyanocitta stelleri	Secure
Blue Jay	Cyanocitta cristata	Secure
Clark's Nutcracker	Nucifraga columbiana	Secure
Black-billed Magpie	Pica hudsonia	Secure
American Crow	Corvus brachyrynchos	Secure
Common Raven	Corvus corax	Secure
Black-capped Chickadee	Poecile atricapilla	Secure
Mountain Chickadee	Poecile gambeli	Secure
Boreal Chickadee	Poecile hudsonica	Secure
Chestnut-backed Chickadee	Poecile rufescens	Accidental
Red-breasted Nuthatch	Sitta canadensis	Secure
White-breasted Nuthatch	Sitta carolinensis	Secure
Pygmy Nuthatch	Sitta pygmaea	Accidental
Brown Creeper	Certhia americana	Undetermined
Rock Wren	Salpinctes obsoletus	Secure
Carolina Wren	Thryothorus ludovicianus	Accidental
House Wren	Troglodytes aedon	Secure
Winter Wren	Troglodytes troglodytes	Secure
Sedge Wren	Cistothorus platensis	Sensitive
Marsh Wren	Cistothorus palustris	Secure
American Dipper	Cinclus mexicanus	Secure
Golden-crowned Kinglet	Regulus satrapa	Secure
Ruby-crowned Kinglet	Regulus calendula	Secure
Blue-gray Gnatcatcher	Poloptila caerulea	Accidental
Northern Wheatear	Oenanthe oenanthe	Accidental
Eastern Bluebird	Sialia sialis	Secure
Western Bluebird	Sialia mexicana	Secure
Mountain Bluebird	Sialia currucoides	Secure
Townsend's Solitaire	Myadestes townsendi	Secure
Veery	Catharus fuscescens	Secure
Gray-cheeked Thrush	Catharus minimus	Undetermined
Swainson's Thrush	Catharus ustulatus	Secure
Hermit Thrush	Catharus guttatus	Secure
Wood Thrush	Hylocichla mustelina	Accidental
Bendire's Thrasher	Toxostoma bendirei	Accidental
Curve-billed Thrasher	Toxostoma curvirostre	Accidental
American Robin	Turdus migratorius	Secure
Varied Thrush	Ixoreus naevius	Secure
Gray Catbird	Dumetella carolinensis	Secure
Northern Mockingbird	Mimus polyglottos	Secure
Sage Thrasher	Oreoscoptes montanus	Undetermined
Brown Thrasher	Toxostoma rufum	Secure
American Pipit	Anthus rubescens	Secure
Sprague's Pipit	Anthus spragueii	Sensitive
Bohemian Waxwing	Bombycilla garrulus	Secure

Cedar Waxwing	Bombycilla cedrorum	Secure
Northern Shrike	Lanius excubitor	Secure
Loggerhead Shrike	Lanius ludovicianus	Sensitive
European Starling	Sturnus vulgaris	Exotic/alien
Blue-headed Vireo	Vireo solitarius	Secure
Warbling Vireo	Vireo gilvus	Secure
Philadelphia Vireo	Vireo philadelphicus	Secure
Red-eyed Vireo	Vireo olivaceus	Secure
Cassin's Vireo	Vireo cassinii	Undetermined
Tennessee Warbler	Vermivora peregrina	Secure
Orange-crowned Warbler	Vermivora celata	Secure
Nashville Warbler	Vermivora ruficapilla	Secure
Northern Parula	Parula americana	Accidental
Yellow Warbler	Dendroica petechia	Secure
Chestnut-sided Warbler	Dendroica pensylvanica	Secure
Magnolia Warbler	Dendroica magnolia	Secure
Cape May Warbler	Dendroica tigrinia	Sensitive
Blue-winged Warbler	Vermivora pinus	Accidental
Golden-winged warbler	Vermivora chrysoptera	Accidental
Black-throated Blue Warbler	Dendroica caerulescens	Accidental
Yellow-rumped Warbler	Dendroica coronata	Secure
Black-throated Gray Warbler	Dendroica nigrescens	Accidental
Townsend's Warbler	Dendroica townsendi	Secure
Black-throated Green Warbler	Dendroica virens	Sensitive
Blackburian Warbler	Dendroica fusca	Sensitive
Pine Warbler	Dendroica pinus	Accidental
Palm Warbler	Dendroica palmarum	Secure
Bay-breasted Warbler	Dendroica castanea	Sensitive
Blackpoll Warbler	Dendroica striata	Secure
Black and White Warbler	Mniotilta varia	Secure
American Redstart	Setophaga ruticilla	Secure
Ovenbird	Seiurus aurocapillus	Secure
Northern Waterthrush	Seiurus noveboracensis	Secure
Kentucky Warbler	Oporornis formosus	Accidental
Connecticut Warbler	Oporornis agilis	Secure
Mourning Warbler	Oporornis philadelphia	Secure
MacGillivray's Warbler	Oporornis tolomiei	Secure
Common Yellowthroat	Geothylypis trichas	Secure
Hooded Warbler	Wilsonia citrina	Accidental
Wilson's Warbler	Wilsonia pusilla	Secure
Canada Warbler	Wilsonia canadensis	Sensitive
Yellow-breasted Chat	Icteria virens	Secure
Summer Tanager	Piranga rubra	Accidental
Scarlet Tanager	Piranga olivacea	Accidental
Western Tanager	Piranga ludovicana	Sensitive
Green-tailed Towhee	Pipilo Chlorurus	Accidental
Eastern Towhee	Pipilo erythropthalmus	Accidental
Northern Cardinal	Cardinalis cardinalis	Accidental
Rose-breasted Grosbeak	Pheucticus ludovicianus	Secure
Black-headed Grosbeak	Pheucticus melanocephalus	Secure
Lazuli Bunting	Passerina amoena	Secure
Indigo Bunting	Passerina cyanea	Accidental
Painted Bunting	Passerina ciris	Accidental
Dickcissel	Spiza americana	Accidental
Spotted Towhee	Pipilo maculatus	Secure
Cassin's Sparrow	Aimophilia cassinii	Accidental

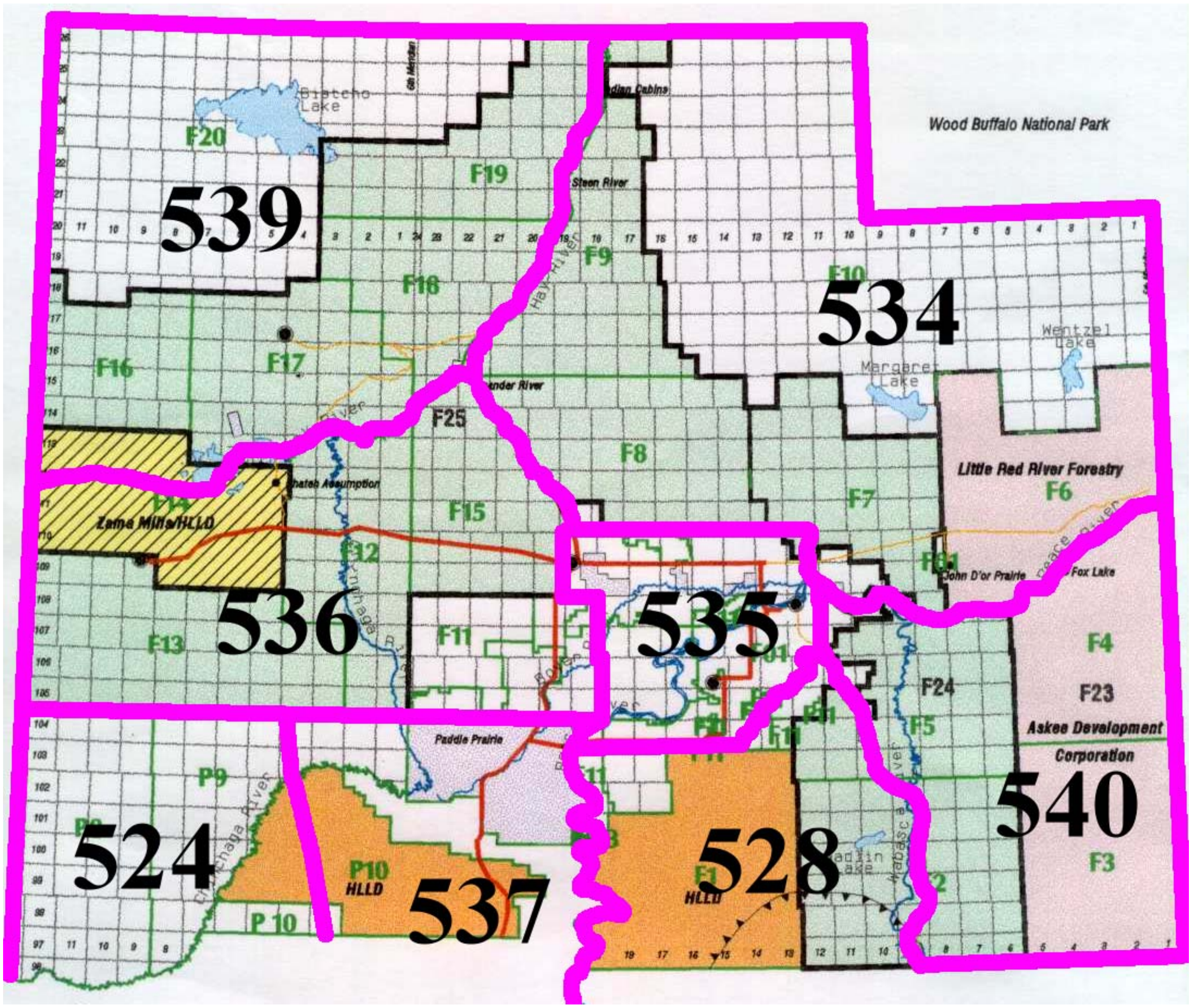
Field Sparrow	Spizella pusilla	Accidental
American Tree Sparrow	Spizella arborea	Secure
Chipping Sparrow	Spizzella passerina	Secure
Clay-colored Sparrow	Spizella pallida	Secure
Brewer's Sparrow	Spizella breweri	Sensitive
Vesper Sparrow	Pooecetes grammacus	Secure
Lark Sparrow	Chondestes grammacus	Secure
Black-throated Sparrow	Amphispiza bilineata	Accidental
Lark Bunting	Calamospiza melanocorys	Sensitive
Savannah Sparrow	Passerculus sandwichensis	Secure
Baird's Sparrow	Ammodramus bairdii	Sensitive
Grasshopper Sparrow	Ammodramus savannarum	Sensitive
Le Conte's Sparrow	Ammodramus leconteii	Secure
Nelson's Sharp-tailed Sparrow	Ammodramus nelsoni	Secure
Fox Sparrow	Passerella iliaca	Secure
Song Sparrow	Melospiza melodia	Secure
Lincoln's Sparrow	Melospiza licolnii	Secure
Swamp Sparrow	Melospiza geogiana	Secure
White-throated Sparrow	Zonotrichia albicollis	Secure
Golden-crowned Sparrow	Zonotrichia atricapilla	Secure
White-crowned Sparrow	Zonotrichia leucoprys	Secure
Harris's Sparrow	Zonotrichia querula	Secure
Dark-eyed Junco	Junco hyemalis	Secure
McCown's Longspur	Calcarius mccownii	Secure
Lapland Longspur	Calcarius lapponicus	Secure
Smith's Longspur	Calcarius pictus	Secure
Chestnut-collared Longspur	Calcarius ornatus	Secure
Snow Bunting	Plectophenax nivalis	Secure
Bobolink	Dolichonyx oryzivorus	Sensitive
Red-winged Blackbird	Agelaius phoeniceus	Secure
Eastern Meadowlark	Sturnella magna	Accidental
Western Meadowlark	Sturnella neglecta	Secure
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	Secure
Rusty Blackbird	Euphagus carolinus	Secure
Brewer's Blackbird	Euphagus cyanocephalus	Secure
Common Grackle	Quiscalus quiscula	Secure
Brown-headed Cowbird	Molothrus ater	Secure
Baltimore Oriole	Icterus galbula	Secure
Bullock's Oriole	Icterus bullockii	Undetermined
Brambling	Fringilla montifringilla	Accidental
Gray-crowned Rosy-Finch	Leucosticte tephrocotis	Secure
Pine Grosbeak	Pinicola enucleator	Secure
Purple Finch	Carpodacus purpureus	Secure
Cassin's Finch	Carpodacus cassinii	Secure
House Finch	Carpodacus mexicanus	Secure
Red Crossbill	Loxia curvirostra	Secure
White-winged Crossbill	Loxia leucoptera	Secure
Common Redpoll	Carduelis hornmanni	Secure
Hoary Redpoll	Carduelis hornemanni	Secure
Pine Siskin	Carduelis pinus	Secure
American Goldfinch	Carduelis tristis	secure
Evening Grosbeak	Coccothraustes vespertinus	Secure
House Sparrow	Passer domesticus	Exotc/alien

Mammals

Masked Shrew	Sorex cinereus	Secure
Vagrant Shrew	Sorex vagrans	May be at Risk
Dusky Shrew	Sorex monticolus	Secure
Water Shrew	Sorex palustris	Secure
Arctic Shrew	Sorex arcticus	Secure
Pygmy Shrew	Sorex hoyi	Secure
Hayden's Shrew	Sorex haydeni	Secure
Little Brown Myotis	Myostis lucifugus	Secure
Long-eared Myotis	Myotis evotis	Secure
Long-legged Myotis	Myotis volans	Undetermined
Western Small-footed Myotis	Myotis ciliolabrum	Sensitive
Silver-haired Bat	Lasionycteris noctivagens	Secure
Big Brown Bat	Eptesicus fuscus	Secure
Eastern Red Bat	Lasiurus borealis	Accidental
Hoary Bat	Lasiurus cinereus	Secure
Northern Myotis	Myotis septentrionalis	May be at Risk
American Pika	Ochotona princeps	Secure
Mountain Cottontail	Sylvilagus nuttallii	Secure
Showshoe Hare	Lepus americanus	Secure
White-tailed Jack Rabbit	Lepus townsendii	Secure
Least Chipmunk	Tamias minimus	Secure
Yellow-pine Chipmunk	Tamias amoenus	Secure
Red-tailed Chipmunk	Tamias ruficaudus	Sensitive
Woodchuck	Marmota monax	Secure
Yellow-bellied Marmot	Marmota flaviventris	Secure
Hoary Marmot	Marmota caligata	Secure
Richardson's Ground Squirrel	Spermophilus richardsonii	Secure
Columbian Ground Squirrel	Spermophilus columbianus	Secure
Thirteen-lined Ground Squirrel	Spermophilus tridecemlineatus	Undetermined
Franklin's Ground Squirrel	Spermophilus franklinii	Undetermined
Golden-mantled Ground Squirrel	Spermophillus lateralis	Secure
Eastern Grey Squirrel	Sciurus carolinensis	Exotic/alien
Red Squirrel	Tamiasciurus hudsonicus	Secure
Northern Flying Squirrel	Glaucomys sabrinus	Secure
Northern Pocket Gopher	Thomomys talpoides	Secure
Olive-backed Pocket Mouse	Perognathus fasciatus	Sensitive
Ord's Kangaroo Rat	Dipodomys ordii	May be at Risk
American Beaver	Castor canadensis	Secure
Western Harvest Mouse	Reithrodontomys megalotis	Undetermined
Deer Mouse	Permyscus maniculatus	Secure
Northern Grasshopper Mouse	Onychomys leucogaster	Secure
Bushy-tailed Woodrat	Neotoma cinerea	Secure
Southern Red-backed Vole	Clethrionomys gapperi	Secure
Heather Vole	Phenacomys intermedius	Secure
Meadow Vole	Microtus pennsylvanicus	Secure
Long-tailed Vole	Microtus longicaudus	Secure
Taiga Vole	Microtus xanthognathus	Undetermined
Prairie Vole	Microtus ochrogaster	Undetermined
Water Vole	Microtus richardsoni	Sensitive
Sagebrush Vole	Lemmus sibiricus	Secure
Muskrat	Ondatra zibethicus	Secure
Brown Lemming	Lemmus sibiricus	Undetermined
Northern Bog Lemming	Synaptomys borealis	Secure
Black Rat	Rattus rattus	Exotic/alien

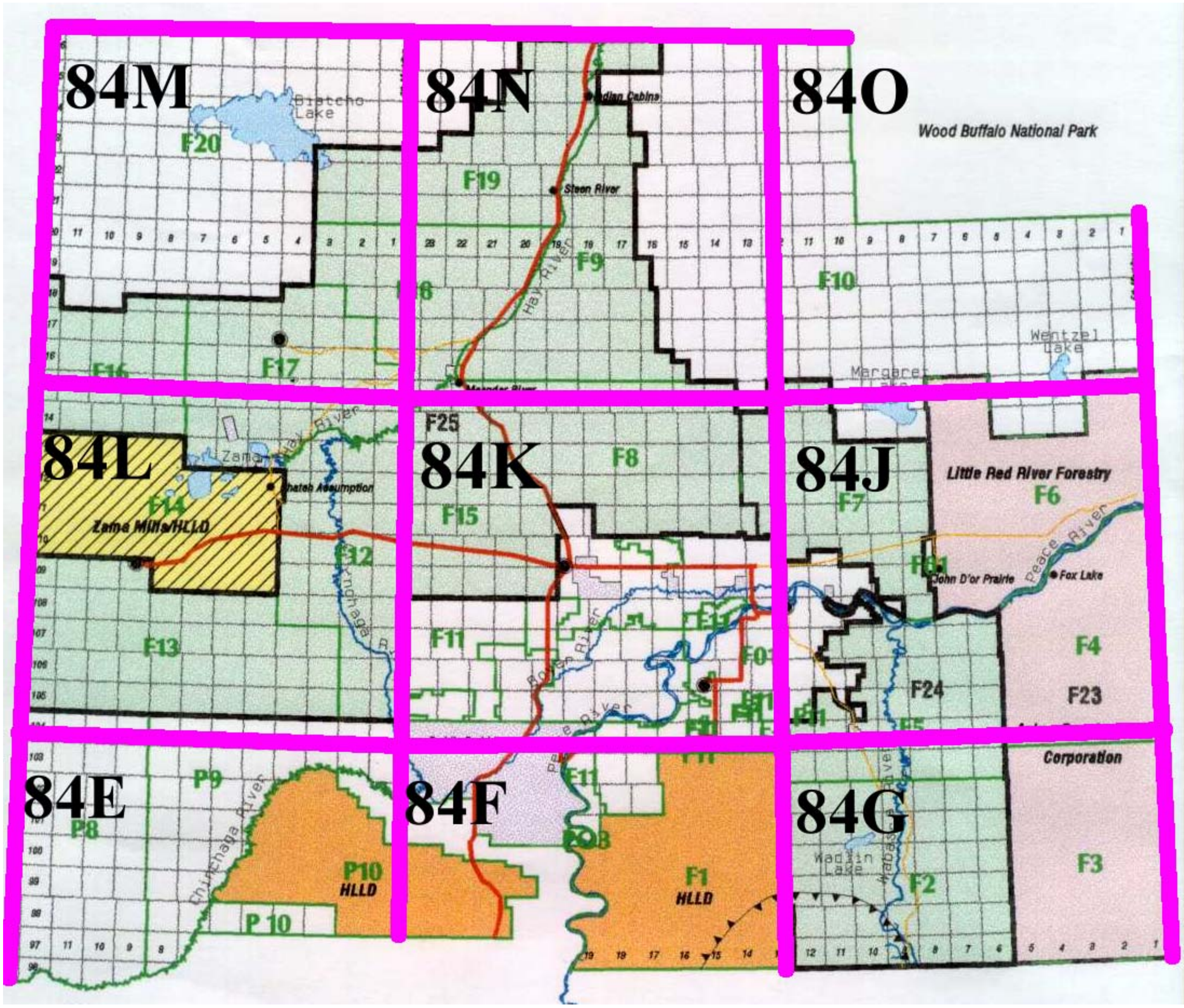
Norway Rat	Rattus norvegicus	Exotic/alien
House Mouse	Mus musculus	Exotic/alien
Meadow Jumping Mouse	Zapus hudsonius	Secure
Western Jumping mouse	Zapus princeps	Secure
Common Porcupine	Erethizon dorsatum	Secure
Coyote	Canis latrans	Secure
Gray Wolf	Canis lupus	Secure
Arctic Fox	Alopex lagopus	Accidental
Red Fox	Vulpes vulpes	Secure
Swift Fox	Vulpes velox	At Risk
Common Gray Fox	Urocyon cinereoargenteus	Accidental
Black Bear	Ursus americanus	Secure
Grizzly Bear	Ursus Arctos	May be at Risk
Common Racoon	Procyon lotor	Secure
American Marten	Martes americana	Secure
Fisher	Martes pennanti	Sensitive
Ermine	Mustela erminea	Secure
Least Weasel	Mustela nivalis	Secure
Long-tailed Weasel	Mustela frenata	May be at Risk
Black-footed Ferret	Mustela nigripes	Extirpated
Mink	Mustela vison	Secure
Wolverine	Gulo gulo	May be at Risk
American Badger	Taxidea taxus	Sensitive
Striped Skunk	Mephitis mephitis	Secure
Northern River Otter	Lutra canadensis	Secure
Cougar	Felis concolor	Sensitive
Canada Lynx	Lynx canadensis	Sensitive
Bobcat	Lynx rufus	Sensitive
Feral Dog	Canis familiaris	Not Assessed
Feral Cat	Felis catus	Not Assessed
Wapiti/Elk	Cervus elaphus	Secure
Mule Deer	Odocoileus hemionus	Secure
White-tailed Deer	Odocoileus virginianus	Secure
Moose	Alces alces	Secure
Caribou	Rangifer tarandus	At Risk
Pronghorm	Antilocapra americana	Sensitive
American Bison	Bos bison	At Risk
Mountain Goat	Oreamnos americanus	Secure
Mountain Sheep	Ovis canadensis	Secure
Wild Boar	Sus scrofa	Not Assessed
Feral Horse	Equus caballus	Not Assessed

Appendix 2



Approximate FMA area in relation to Wildlife Management Zones (from 2001 Wildlife Management Unit Map. Alberta Sustainable Resource Development. 2001). Note, no animal harvest summary included data from WMU 539, as the document source did not have data for this area

Appendix 3



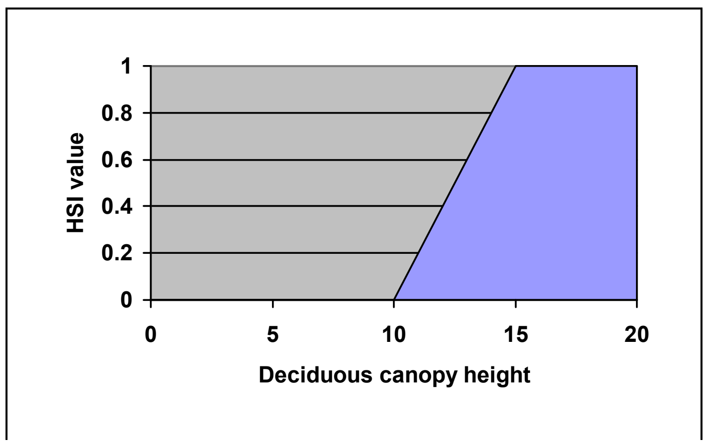
Map sheet 84, showing relative area of Tolko Industries Ltd. (HLLD) FMA area

Appendix 4

Information derived from present HSI models appear to be quite difficult to read; however, an understanding of the formulae simplifies the interpretation of the data. An HSI (Habitat Suitability Index) model attempts to assess different habitat variables, producing a rating of the quality of the habitat. The different variables (labeled V or S) are rated on a scale between 0 (not suitable) to 1 (suitable). The following example can be explained as follows:

- Deciduous canopy height (S_1): ≤10m = 0.0; ≥15m = 1.0
    - the variable discussed is the height of the deciduous canopy
    - the variable is assigned a label S_1
    - canopy less than or equal to 10m has a value of 0.0, and thus is not considered useable habitat
    - canopy greater then or equal to 15m has a value of 1.0 and thus is considered optimal habitat

This data is typically best interpreted (viewed) by a graph.



When all variables are assessed, the total values may be placed into another formula to assess the overall quality of the habitat in question. So for the following:

- HSI (nesting cover) = S_1 x S_2 x S_3

The total quality of nesting cover is thus determined by the three variables assessed

Glossary

- Anthropogenic - pertaining to human-induced processes
- Arboreal – inhabiting or frequenting trees
- Biomass – weight of living material per unit area
- Biome – regional community, typically related to plant formations
- Carnivore – an individual whose diet consists entirely of animal matter
- Carrion – the remaining tissue of a carcass, typically scavenged
- Corm – a short, underground stem without leaves that acts as a reproductive structure
- Crepuscular – the twilight hours of dusk and dawn
- Diurnal – occurring in the day
- Ecosystem – the biotic and abiotic components of a functioning system
- Ecotype – a subspecies or group adapted to regional conditions
- Extralimital – beyond the typical distribution of a selected species
- Fledgling – a developmental stage where young have developed mature feathers, but are still dependant upon the parents
- Forb – a non-woody, broad-leaved plant which dies back at the conclusion of each growing season
- Fragmentation – the division of habitat into smaller units
- Gallinaceous – family of grouse-like birds (Galliformes) includes Partridge, Pheasant and Turkey
- Graminoid – grass or grass-like vegetation
- Herbivore – an individual whose diet consists entirely of vegetative matter
- Herpetofauna – amphibian and reptile species
- Hibernacula – a shelter used for winter survival by a dormant animal
- Hyperthermic – having abody temperature above normal
- Hypothermic – having a body temperature below normal
- Invertebrate – an animal lacking a spinal column
- Irruption (eruption) – the sporadic, often long-distance movements of non-migratory birds, due to local changes, such as cold temperature, lack of prey base, or increased competition
- Lacustrine – relating to standing water, particularly lakes

- Lek – a traditional display area with ‘symbolic’ display territories
- Mesic – moist soil conditions
- Meta-population – a series of multiple micro-populations that live in existence of each other with immigrations and emigrations constantly occurring between them
- Metamorphosis – the change from one body form to another
- Midden – a small pile of ‘refuse’, such as coniferous cone and needle reminants, produced by squirrel activity
- Morphology – the study of the form of an organism
- Mustelid – members of the family Mustelidae (all having anal scent glands) – skunk, weasels, wolverines, otter etc
- Neotropical – relating to songbirds which winter in the biogeographic region that extends south, east, and west from the central plateau of Mexico
- Nocturnal – occurring in the night
- Oligotrophic – a system low in nutrients and/or with low productivity
- Ombrotrophic – a system being supplied only by rainwater
- Omnivore – an individual whose diet consists of both animal and vegetative matter
- Parturition – the separation of fetus from mother (birth)
- Polyandry – mating of one female to multiple males
- Polygyny – mating of one male to multiple females
- Range – area which an individual travels to accomplish life processes
- Rhizome – an underground stem, distinguished from roots by the presence of buds, nodes, and scale-like leaves, which is utilized as a food storage structure
- Riparian – pertaining to the area directly between aquatic habitat and associated uplands; typically highly biodiverse
- Ruminating – chewing and rechewing of food items (typically larger herbivorous mammals)
- Rut – a recurrent state of sexual excitement, typically in the fall for ungulate species
- Salix – genus encompassing willows
- Scarified – to loosen the surface, such as the process prior to reforestation
- Stoichastic – a variable process
- Subnivean – below the snow surface

- Succession – the progressive changes in forest structure and composition through time
- Thermoregulation – the ability to maintain a constant body temperature
- Ungulate – animals having hooves
- Vertebrate – an animal with a spinal column (amphibians, reptiles, fish, birds, and mammals)
- Wallow – a site where Bison roll on the ground producing depressions or scrapes in the soil
- Xeric – dry soil conditions