

Species Risk Assessment for Fur-bearers in DMI's Forest Management Areas

FINAL REPORT

Prepared for:

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Prepared by:

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Date

Mr. Jim Witiw
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Dear Mr. Witiw:

**Re: Species Risk Assessment of Fur-bearers in DMI Forest Management Areas –
DRAFT REPORT**

At your request, Fiera Biological Consulting Ltd. has completed a Species Risk Assessment for 8 fur bearing species identified as species of interest in the DMI FMA. We are pleased to provide you with the final report for your consideration. If you have any questions or comments regarding this report or its conclusions, please contact the undersigned at your convenience.

Sincerely,
FIERA BIOLOGICAL CONSULTING LTD.

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1. ACKNOWLEDGEMENTS

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2. EXECUTIVE SUMMARY

Eight fur-bearing species were identified as species of interest by Daishowa-Marubeni International Ltd. (DMI) in consultation with its public advisory committee (PAC) and Aboriginal (First Nations, Metis) discussions, including: American marten, beaver, coyote, fisher, lynx, red squirrel, snowshoe hare, and wolf. The purpose of this document is to assess risk (low, medium, high) to these species under DMI's current forest management strategies as outlined in their existing Detailed Forest Management Plan (DFMP).

The report includes (by species):

- a literature review summarizing life history characteristics and habitat requirements, including a summary of forestry impacts.
- assessment of risk to species as a result of DMI's current forest management strategies.

Conclusions

Overall, of the 8 species of interest only 2 species (marten and fisher) are of direct management concern because current forest management practices may not substantially mitigate risk to their populations and/or habitat. Both these species were assessed at moderate risk as a result of DMI's current forestry strategies. Marten and fisher depend on contiguous areas of mature/old forest at the landscape scale, and/or habitat structure typically available in mature/old forest (e.g. large trees, snags, CWD, structural complexity) at the stand level to meet life requisites. Partial harvesting systems may mitigate risk to both these species but this question needs to be further addressed in Alberta boreal forests. Red squirrels are also associated with mature/old forest to meet life requisites; however, stand and landscape level management strategies that retain habitat structure, and in particular, large conifer (spruce) trees and large patches of mature coniferous forest will mitigate risk to red squirrel populations over the long-term. Therefore, these species are considered low risk as a result of DMI's current forest management practices. The remaining species are either associated with early seral regenerating forest (beaver, lynx, snowshoe hare) or are not directly impacted by harvesting (coyote, wolf); these species were therefore assessed as low risk as result of forestry practices.



3. INTRODUCTION

Eight fur-bearing species were identified as species of interest by Daishowa-Marubeni International Ltd. (DMI) in consultation with its public advisory committee (PAC) and Aboriginal (First Nations, Metis) discussions, including: American marten, beaver, coyote, fisher, lynx, red squirrel, snowshoe hare, and wolf. The purpose of this document is to assess risk (low, medium, high) to these species under DMI's current forest management strategies as outlined in their existing Detailed Forest Management Plan (DFMP).

The report includes (by species):

- a literature review summarizing life history characteristics and habitat requirements, including a summary of forestry impacts.
- assessment of risk to species as a result of DMI's current forest management strategies.

Explanation of Risk

Risk to the eight fur-bearing species was subjectively assessed as low, medium, or high based depending on a number of factors. The general risk categories are defined in Table 1.

Table 1. Definition of risk categories for fur-bearing mammals

Category	Definition	Potential Management Response
Low Risk	<ul style="list-style-type: none"> • Species not at risk and/or no evidence of population decline. • Species not directly impacted by company activities, or species habitat requirements adequately addressed by full suite of DMI coarse/fine-filter strategies (i.e. Ground Rules, DMI DFMP) 	<ul style="list-style-type: none"> • No action required – maintain current practices.
Moderate Risk (stand and landscape level)	<ul style="list-style-type: none"> • Species not at risk and/or no evidence of population decline. • Species habitat may be <u>inadequately</u> addressed by current practices at the stand level. Additional specific protection measures may be required. • Species habitat needs may be <u>inadequately</u> addressed by current practices at the landscape-level. Cumulative effects at the landscape –scale may require an integrated (cross-sector) management approach. 	<ul style="list-style-type: none"> • Design new forest-sector specific measures in addition to existing strategies, rules and processes. • Maintain or seek-out participation in collaborative integrated efforts and landscape-scale strategies.
High Risk (stand and landscape level)	<ul style="list-style-type: none"> • Species at risk (e.g. threatened, endangered) and/or evidence of population decline. • Species habitat <u>inadequately</u> addressed by current practices at the stand level. Additional specific protection measures required. • Species habitat needs <u>inadequately</u> addressed by current practices at the landscape-level. Cumulative effects at the landscape –scale may require an integrated (cross-sector) management approach. 	<ul style="list-style-type: none"> • Design new forest-sector specific measures in addition to existing strategies, rules and processes. • Maintain or seek-out participation in collaborative integrated efforts and landscape-scale strategies. • Government led management plan likely required.



4. AMERICAN MARTEN

4.1 SUMMARY OF RISK

Traditionally, marten have been considered a late successional species dependant on coniferous forest types; they have also been considered an indicator of these conditions. However, there is increasing evidence that marten do not require old-growth forest per se, nor do they require coniferous forest to meet their life requisites. Instead, marten depend on structural complexity (i.e. CWD, snags, ground cover) to minimize predation risk, and provide resting and denning sites, habitat for prey species, and subnivean access points. While these attributes may be found in a variety of forest types and of stand ages, marten prefer mature/old conifer forest and avoid clearcuts with little or no structure. In particular, coarse woody debris is critical to meet martens' requirements for resting, denning and foraging although it is unknown what CWD characteristics are needed to provide high quality habitat. Marten appear to have a threshold of 30% cleared area which they can incorporate into their home range, above which habitat becomes unsuitable. However, marten have been observed to use young stands (e.g. partially harvested stands, stands defoliated by the spruce budworm, fire regenerating stands) provided advanced regeneration of conifers is protected and adequate structure is maintained. At the landscape level, a target of 30-40% mature forest retention in a matrix of regenerating stands across the forest management unit has been suggested to minimize population risk. Retention patches should be at the size of 5 to 10 marten home ranges to provide an adequate breeding population.

There are several forest harvesting strategies that mitigate the negative effects of clearcutting on marten, such as: variable retention, understory (conifer) protection, and CWD retention. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to marten populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including large areas of core old-growth stands in the long-term.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.
- Downed woody debris (DWD) management through retention of 'in-situ' dead debris after harvest and black tree retention during wildfire salvage.

In general, stand and landscape level management strategies that retain habitat structure, and in particular, large CWD, sources of large CWD, ground cover, and large patches of mature coniferous forest will mitigate risk to marten populations over the long-term.

Assessed risk to marten on DMI's FMA as a result of forestry practices – Moderate

4.2 SPECIES INFORMATION

Status

Provincial: S5 Secure

Federal: N5

Global: G5

Description



The American marten (*Martes americana*) is a carnivorous mammal with a long thin body (49 to 65 cm), a long bushy tail (14 to 20 cm), and short limbs with semi-retractable claws. Their fur is tan to black with an irregular throat patch ranging from cream to orange in colour. Marten weigh between 0.6 and 1.3 kg, with males weighing 1.5 times more than females (Buskirk and Ruggiero 1994).

Provincial Distribution

Marten are year round residents in deciduous, mixedwood and, most commonly, coniferous forests in Alberta (Natureserve 2009). They are absent from the southeastern portion of the province.

Life History

Diet and Foraging Behaviour

Marten are dietary generalists eating mammals, birds, carrion, as well as seasonally available birds' eggs, insects and fruit. Up to 80% of a martens diet is animal prey particularly in the winter when other food sources are scarce; red backed voles are common prey for marten in Alberta (Andruskiw et al. 2008).

As their dietary requirements change from a summer generalist to a winter carnivore, foraging behaviour adjusts accordingly. In the winter marten choose foraging habitat with dense and complex structures near the forest floor (<3 m) including branches, logs and coarse woody debris (Hargis and McCollough 1984, Buskirk 1992). Marten use the logs and CWD as sensory cues and to access hunting sites under varying snow depths, increasing their predation efficiency (Hargis and McCollough 1984; Andruskiw 2008). In Alberta, although red backed voles were at the same density in recently logged and mature forest marten had higher hunting success in mature/old forest (Andruskiw 2008).

Marten are active up to 16 hours of the day and spend the remainder of their time resting in trees. As temperatures get colder, marten will spend less time hunting, especially at night and may even den up for several days. Marten are known for their constant movement and searching for forage. Marten will criss-cross and zigzag back and forth across their home range in search of food. In one day marten may cover a distance more than their entire territory in search of food.

Breeding Biology

Breeding season occurs from late June to early August but implantation is delayed between 193 and 237 days. The actual gestation period is 27 days with litters of 1 to 5 young (average 2.9 kits/litter) being born in late March or April (Buskirk and Ruggiero 1994). Female martens raise their kits without any male parental involvement. The kits wean in 2 to 3 months and the mother will leave between 3 and 4 months of age. Females reproduce after 15 to 17 months of age (Banfield 1974). Thereafter female marten produce litters only once a year and may not reproduce at all if they are under sufficient environmental stress (Buskirk and Ruggiero 1994).

Site Fidelity

Individual martens generally show high site fidelity from one year to the next although moderate home range shifts can occur (O'Doherty et al. 1997; Philips et al 1998). Site fidelity of juveniles is somewhat lower than adults before they settle on a home range (O'Doherty et al. 1997). Females are more likely than males to abandon their home range, possibly because they are limited by body size in the area of home range they can defend or as a result of the energetic costs of reproduction (Philips et al. 1998). In winter marten have higher site fidelity to denning/resting sites compared to the spring (Wilbert et al. 2000). Adults have higher site fidelity to resting, denning, and subnivean access points associated with CWD than juvenile marten (Buskirk et al. 1989).

Home Range

Marten display intrasexual territoriality as female and male home ranges overlap, as do adult and juvenile home ranges; however, there is no overlap between adult male home ranges. Male home ranges are approximately 1.9 times larger than female home ranges (Buskirk and McDonald 1989).



Actual home range sizes vary considerably throughout their distribution ranging from 200 to 3000 hectares in Canada. There is no obvious geographic pattern in marten home size; home range is also not correlated with latitude or mean temperature. However, home ranges may be larger in suboptimal habitat (Buskirk and McDonald 1989; Gosse et al. 2005). For example, marten may increase the size of their home range because of: decreased prey abundance (Fredrickson 1990; Fryxell et al. 1999; Gosse et al. 2005; Thompson and Colgan 1987); increased logging pressure (Godbout and Ouellet 2008); loss of forest cover and understory (Poole et al. 2003); increased road density (Godbout and Ouellet 2008) and; vacancies in nearby home ranges (Philips et al. 1998).

Movements and Dispersal

Juvenile marten disperse in August to October to establish a home territory; adults disperse when food is limited. Marten do not normally disperse more than 10 km; for example, in black spruce forests in Ontario, juvenile marten dispersed an average of 5 km (median = 1.77 km) (Broquet et al. 2006). However, dispersal distances of greater than 100 km have been recorded (Banfield 1974; Thompson and Colgan 1987; Slough 1989). Both adult and juvenile marten preferentially settle in old forests and avoid younger, regenerating forests although these younger stands can be incorporated into their home range (Fredrickson 1990; Fryxell et al. 2008).

The extent to which long distance movements of marten is limited by openings is unknown. In their daily movements, marten show a strong avoidance of openings (e.g. clearcuts, pipeline right-of-ways) with edges seemingly functioning as travel corridors (Heinemeyer 2002; Marklevitz 2003). Marten rarely cross clearcuts; if they do the clearcut is often smaller than average with residual structure remaining (Heinemeyer 2002). Openings above approximately 70 m appear to pose a significant barrier to marten movements (Heinemeyer 2002; Marklevitz 2003). However, marten have been noted to traverse larger openings (up to 2 km) provided forest patches were present (Banfield 1974; Steventon and Major 1982; Hargis and McCullough 1984; Fredrickson 1990; Potvin et al. 1999).

4.3 HABITAT

Marten are generally considered an old-forest specialist that is highly and negatively affected by forest harvesting (Chapin et al. 1998; Potvin et al. 2000; Gosse et al. 2005; Prioux 2006). However, recent research suggests that marten can live in a variety of forest types and stand ages provided there is enough horizontal and vertical structure to meet their needs regarding forest cover, such as: coarse woody debris, snags, understory and ground cover (Chapin et al. 1998; Potvin et al. 2000; Payer and Harrison 2000, 2003; Poole et al. 2003; Nams and Bourgeois 2004; Porter et al. 2005; Godbout and Ouellet 2008).

Structural stage/seral stage

Marten occur at their highest densities in old forest throughout their range, including Alberta (Chapin et al. 1998; Potvin et al. 2000; Gosse et al. 2005; Prioux 2006). Higher habitat quality results in mature/old forest because the increased structural complexity (e.g. increased volume of coarse woody debris, overstory/understory cover, high tree density), and increased availability of important prey species relative to younger forests (Andruskiw et al. 2008; Godbout and Ouellet 2008). Clearcuts with little or no structure remaining on site are clearly avoided by marten (Thompson and Harestad 1994; Hargis et al. 1999; Huggard 1999; Payer and Harrison 2000; Poole et al. 2004; Bull et al. 2005; Fryxell et al. 2008), with marten densities potentially reduced for several decades in harvested areas (Thompson and Harestad 1994). However, marten will use clearcuts and partially harvested stands (Steventon and Major 1982; Potvin et al. 2000; Fuller and Harrison 2005), as well as stands defoliated by the spruce budworm (Chapin et al. 1998; Potvin et al. 2000) and stands regenerating following fire (Paragi et al. 1996), provided advanced regeneration of conifers is protected and adequate structure is maintained. Young (<40 year old) deciduous-dominated forests can also support marten populations (Poole et al. 2004).

While young and/or partially harvested stands may be used by marten, one concern is the habitat quality of these stands relative to mature stands, particularly in the winter. For example, Fuller and Harrison



(2005) found that while partially harvested stands were adequate for foraging during the summer, they were not in the winter. Marten living in partially harvested stands shifted their home ranges to include more second-growth forest and increased their home range size to meet their life requisites during the winter. Therefore, it cannot be assumed that regenerating or partially harvested stands will be of similar habitat quality compared to closed-canopy forest. Specific habitat attributes likely need to be maintained at certain thresholds at the stand-level in order to maintain habitat quality for marten.

Landscape-scale effects

At the landscape-scale, marten have been found to exist in extensively clearcut landscapes (Chapin et al. 1998; Hargis et al. 1999; Fryxell et al. 2008). However, marten are highly affected by low levels of canopy cover and generally select home ranges with more than 60% cover, in landscapes with less than 40% of harvested area (Thompson and Harestad 1994; Chapin et al. 1998; Hargis et al. 1999; Potvin et al. 2000; Mullen 2006). It would appear that marten have a maximum threshold of approximately 30% clearcut area that they can incorporate into their home range, above which habitat becomes unsuitable (Chapin et al. 1998; Hargis et al. 1999; Potvin et al. 2000). This pattern consistent in Alberta as Mullen (2006) found that marten were unsuccessful in areas with >36% area developed by forestry, mining and/or other industrial activities. Marten living in partially harvested stands shift their home ranges to include more second-growth forest and increase their home range size to have enough prey and denning sites during the winter (Fuller and Harrison 2005).

One of the most significant fragmentation effects felt by marten as a result of clearcutting is the sizes of residual forest patches remaining and isolation of these patches (Chapin et al. 1998; Hargis et al. 1999; Mullen 2006); small, isolated residual forest patches are less likely to be used than larger, well connected patches. For example, Snyder and Bissonette (1997) captured on 5 of 51 marten in residual forest stands <15 ha in size. In Maine, the median patch size used by marten in mixedwood/deciduous forests was 27 ha compared to 1.5 ha for unused patches (Chapin et al. 1998). Further, the home ranges of all resident marten was associated with one large residual patch (i.e. 247 ha for males, and 150 ha for females) which made up at least 50% of the individual marten's home range. Therefore, at the landscape-scale it appears that large contiguous tracts of residual forest that maintain some level of connectivity to other forested tracts will help maintain marten in the landscape.

Important habitats

Stand types

As mentioned above, marten are generally considered to be coniferous old-forest specialists and as such, have been highlighted as an indicator of late successional coniferous forest conditions (Bull et al. 2005). However, these stand type associations appear to be strongest in the western United States and for some areas of the boreal forest (Thompson 1994; Sturtevant et al. 1996; Bull et al. 2005; Gosse et al. 2005; Mowat 2005; Godbout and Ouellet 2008). In other areas, marten have shown more flexibility in their use of stand types, depending on the habitat structure available to them. For example, in eastern portions of their range, marten select mixedwood stands and deciduous-dominated stands that have a dense coniferous understory layer (Chapin et al. 1997; Potvin et al. 2000; Payer and Harrison 2003). Young (<40 year old) deciduous-dominated forests are also used as moderate marten densities were observed in these stand types in northeastern boreal forests of British Columbia (Poole et al. 2004).

While marten show more flexibility in their use of different forest types than previously thought, the presence of conifers still seems to critical to their success; the presence of conifers is one of the best predictors of marten habitat at the stand level (Nams and Bourgeois 2004; Baldwin and Bender 2008; Godbout and Ouellet 2008). This is also true for marten in Alberta as marten home ranges contain a minimum of 20% conifer forest (Mullen 2006).

Important habitat features

Stand characteristics



Most research on marten has focused on structural attributes required for resting and denning. However, some general quantification of stand-level forest structure requirements of marten has occurred. Adequate canopy closure is required to meet marten life requisites for resting, denning, foraging and travel habitat (Strickland and Douglas 1999; Potvin et al. 2000). Marten can meet their life requisites under different levels of cover ranging from <20% cover to 100% (Spencer et al. 1983; Hargis and McCollough 1984; Paragi et al. 1996; Hargis and Bissonette 1997; Chapin et al. 1997; Chapin et al. 1998; Potvin et al. 2000; Gosse et al. 2005; Mullen 2006). However, marten appear to have a minimum threshold of 30% cover required during all seasons, below which marten home ranges shift or marten may disperse. Marten usually avoid habitats which threshold cover including bogs, fens, grasslands, natural openings, and recently cleared, partially thinned or burned areas due to decreased prey availability and increased predation risk (Hargis and McCollough 1984; Fredrickson 1990; Bissonette et al. 1997; Hargis et al. 1999; Gosse et al. 2005; Godbout and Oulette 2008).

Tree densities differ between forest types and seral stages. Coniferous stands generally have higher basal area and mean tree densities relative to mixedwood or deciduous stands and thus provide more cover for marten which may increase habitat quality for marten in these conifer stands. While threshold density and basal area of trees is unknown for marten, Fryxell et al. (2008) found that marten densities were highest in coniferous and mixedwood forests of 15 trees per 20 m² compared to deciduous forests of 12 trees per 20 m². In Maine, marten used stands with a mean basal area of coniferous and deciduous trees of 27 m²/ha (Payer and Harrison 2003) and 18 m²/ha (Payer 1999 cited in Payer and Harrison 2003; Fuller and Harrison 2005).

Finally, coarse woody debris is a critical structural component for marten; habitat suitability of stands may be limited by the volume of large diameter CWD and stumps which have higher thermoregulatory properties compared to smaller pieces. Mature coniferous forest, has the highest amount of coarse woody debris among the forest cover types which increases the habitat suitability of this forest type for marten (Buskirk et al. 1989; Etcheverry et al. 2005). A mean maximum diameter of at least 22 cm with some pieces at least 40 cm are the recommended levels of CWD to be retained in forest stands (Payer and Harrison 2003).

Resting/ Denning

Marten select for subnivean rest sites in the winter and above-ground resting and denning sites in the summer (Steventon and Major 1982; Chapin et al. 1997; Gilbert et al. 1997; Raphael and Jones 1997; Bull and Heater 2000). Although dens can be found in a wide variety of structures, natal and maternal dens are often found in large-diameter structures (CWD, snags, and trees) characteristic of late successional forests (Buskirk and Ruggiero 1994; Ruggiero et al. 1998; Bull and Heater 2000).

Winter resting/denning sites

Marten have a high surface area to volume ratio; this, in combination with their relatively thin fur and limited fat reserves make them highly susceptible to heat loss. Marten use resting and denning sites to conserve heat in the winter (Buskirk et al. 1989; Thompson and Colgan 1994). Winter rest sites are usually located in subnivean spaces because of the severe energetic constraints experienced by marten in the winter (Buskirk et al. 1989; Gilbert et al. 1997; Raphael and Jones 1997; Chapin et al. 1997; Bull and Heater 2000). Partially decayed CWD, including logs, root masses/tip-up mounds, and large-diameter stumps and snags are important winter resting microhabitats. Marten also use squirrel middens as den sites; the source of heat provided by organic decay provides thermal relief for marten the winter (Buskirk 1984; Buskirk et al. 1989; Sherburne and Bissonette 1993; Pearson and Ruggiero 2001).

Summer resting/denning sites

In contrast to winter denning and resting sites, summer denning and resting sites are located above ground in a variety of structures, such as: large trees and snags, tree platforms, witches broom, CWD, root wads/tip-up mounds, stumps, rock outcrops, slash piles, and animal burrows (Hargis and McCollough



1984; Chapin et al. 1997; Gilbert et al. 1997; Raphael and Jones 1997; Bull and Heater 2000). These sites may be cooler than ambient temperature in some cases, such as rock outcrops or tree platforms.

Natal/maternal denning sites

Maternal dens used in the spring and summer are often found in the largest diameter trees and snags (e.g. >40 cm) that can be found in a stand (Gilbert et al. 1997; Raphael and Jones 1997; Ruggiero et al. 1998; Bull and Heater 2000). It has been suggested that females are more selective of habitats than males because of their greater energetic requirements as a result of reproduction (Buskirk and Ruggiero 1994).

Foraging

Subnivean spaces used by marten in the winter may be selected just as much for their access to prey as for their thermal advantages (Coffin et al. 1997; Phillips et al. 1998; Potvin et al. 2000); therefore, foraging sites often have similar microhabitat characteristics to winter resting sites. Marten tend to forage in areas with increased volumes of deadwood, and consequently, increased subnivean access (e.g. Gilbert et al. 1997; Heinemeyer 2002; Porter et al. 2005). Coarse woody debris is positively associated with abundance of small mammals and marten use CWD as a sensory cue to the presence of prey access as well as access points to subnivean levels (Andruskiw et al. 2008). Marten have been found to have greater hunting efficiency in structurally complex forest compared to regenerating forests regardless of prey abundance because of increased volumes of CWD (Andruskiw 2008). Marten found more prey and had higher kill rates in mature forest compared to the regenerating stands due to higher levels of CWD in mature stands (Fryxell et al. 2008).

4.4 RISK ASSESSMENT

There are three main threats of forestry activities to marten populations. First, forest harvesting removes large structural attributes (e.g. CWD, snags, canopy and understory cover) that are important to meet marten life requisites, with short rotation ages limiting their replacement. Second, increased fragmentation may affect marten movement in the landscape as well as make resources more difficult to procure. Finally, forest harvesting improves access to areas that may have been previously inaccessible thus increasing trapping pressure on marten.

Given that marten are forest dwelling species and are negatively affected by clearcut harvesting, the key to minimizing risk to marten is the protection, maintenance and recovery of forest habitats. Currently, DMI forestry operations include several strategies at the stand and landscape level that will mitigate risk to marten populations on their operational landbase, including (but not limited to):

- Variable retention target of 0 to 30% at the block level including 7.5% as large patches greater than 2 ha.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including old-growth stand representation in perpetuity.
- Natural-disturbance regime based strategy to maintain ‘large areas’ of old core forest in the long-term on the landscape.
- Variable retention landscape-average target of 15% to provide widespread structural complexity in the long-term across the landscape, and that by design is inherently well-distributed across the landscape. This distribution of structure is ‘in addition to’ structure associated with buffers and all other voluntary (passive) reserves.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.



- Downed woody debris (DWD) management through retention of ‘in-situ’ dead debris after harvest and black tree retention during wildfire salvage.

Given marten’s dependence on mature/old (conifer) forest to meet life requisites, risk to this species as a result of DMI’s existing forestry practices was assessed as moderate. Generally, the effects of forestry on marten will depend on the scale and intensity of harvesting activities. Marten respond positively to silviculture that provides habitat attributes and higher conifer content (Thompson et al. 2008). Partial harvesting systems appear to be effective at mitigating negative effects of forestry on marten on some parts of their range, but this question needs to be further addressed in Alberta boreal forests in the short and longterm. The quality of this habitat in the winter also needs further investigation. Given their large home ranges and avoidance of landscapes with >30% area recently harvested, marten habitat requirements must be considered at the landscape-scale as well. Landscapes for marten are generally defined as 5 to 10 home ranges which may range as low as 1000 ha to 30,000 ha; therefore, landscape-level risk is at the scale of forestry operations. However, given marten’s avoidance of linear features, an integrated cross sector approach may be beneficial to mitigate risk to this species.

Assessed risk to marten on DMI’s FMA as a result of forestry practices – Moderate

4.5 LITERATURE CITED

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5. BEAVER

5.1 SUMMARY OF RISK

The beaver is an easily recognizable semi-aquatic rodent that has historic economic importance in North America; it is currently considered “Secure” provincially. Beavers require aquatic habitats such as lakes or slow-flowing streams with an adequate food supply of deciduous trees and shrubs in close proximity to the water’s edge to meet their life requisites. Because of these aquatic requirements, the beaver is generally restricted to riparian habitats within 100 m of water bodies. Aspen of all age and size classes is a preferred food throughout the range; beavers reach peak densities in riparian areas with abundant early successional aspen. Disturbance as a result of logging or natural processes may be important for the maintenance of beaver habitat in the boreal forest because it promotes aspen regeneration. The beaver is capable of dramatically altering terrestrial and aquatic habitats through its tree-felling and dam-building activities, potentially benefiting a variety of wildlife including: birds, waterfowl, other aquatic furbearers, amphibians, and fish.

Generally, forest harvesting practices are compatible with maintaining beaver habitat. The practice of leaving residual buffers of at least 20 m on permanent water bodies has been demonstrated to result in no measurable effects in the density of beaver in the short-term (2 years post-cut) or the long-term (10 years). Forest harvesting within the riparian zone could potentially improve beaver foraging habitats approximately 10 years post-cut by promoting aspen regeneration at the stand-level, but in the short term, makes habitat unsuitable for beaver. Therefore, current management strategies should maintain beaver habitat on the landbase, as long as deciduous and mixedwood riparian forests are not converted to conifer-dominated stands following harvest, and provided that riparian areas are given some level of protection.

Currently, DMI’s forestry operations include riparian buffer/protection zones on several classes of streams and waterbodies which will mitigate risk to beaver populations as a result of forestry operations. At the landscape level, the creation of a continuous reserve network which includes consideration of the ecological and hydrological connectivity between protected areas, wetland complexes, and permanent buffers will also help to minimize risk to beavers.

Assessed risk to beavers on DMI’s FMA as a result of forestry practices – Low

5.2 SPECIES INFORMATION

Status

Provincial: S5

Federal: N5

Global: G5

Description

The American beaver (*Castor canadensis*) is the largest rodent in North America; ranging in mass from 16 to 32 kg and measuring up to 1.2 m in length (including the tail) (Hill 1982). Beavers are characterized by physical features highly adapted to their aquatic environment such as: a broad, flat, hairless, paddle-like tail; and a heavily muscled body with short legs; small ears, and; webbed feet (Hill 1982). Beavers use oil from their anal gland to waterproof a yellowish brown to black, dense, and highly insulated coat. The teeth of beavers are adapted for gnawing wood; they have four prominent incisors with hard orange enamel on the front surface, which continue to grow over their 10 year (average) life span (Hill 1982).

Provincial Distribution

Beavers range throughout Alberta in proximity to freshwater and woody vegetation (Pattie and Fisher 1999).

Life History



Diet and Foraging Behaviour

Beavers are generalized herbivores feeding on the leaves, twigs, and cambium of woody vegetation as well as herbaceous and aquatic vegetation (Jenkins 1975; Jenkins 1979; Allen 1983). While beavers utilize many different food items they exhibit a strong foraging preference seasonally (Aleksiuk 1970; Müller-Schwarze and Sun 2003) and between years, based on variation in the nutritional value of food sources (Jenkins 1979). Where available, beavers prefer herbaceous vegetation to woody vegetation in all seasons (Jenkins 1979; Müller-Schwarze and Sun 2003). For example, in the Mackenzie Delta in July and August, beavers fed almost exclusively on the high protein leaves and shoots of willow; whereas throughout the rest of the year, their diet was composed entirely of tree bark (Aleksiuk 1970). The seasonal variation in food choice in the Mackenzie Delta appears to follow the availability of high protein food sources and is thought to be typical of beaver at northern latitudes. Conifers are primarily used during late winter and spring when other vegetation may be largely unavailable and spring sap flows improve their palatability and nutritional value (Jenkins 1979; Svendsen 1980; Müller-Schwarze and Sun 2003). Beavers shift from a woody diet to a primarily herbaceous diet as new growth appears in the spring.

Beavers are “central place foragers” with foraging centered near the lodge and generally restricted to the forest within 20 to 30 m of the water’s edge (Orians and Pearson 1979 in Gallant et al. 2004; Thompson 1988; Barnes and Mallik 2001; Martell and Foote 2006); however, they will forage up to 200 m from the water (Allen 1983). Beavers tend to be selective in the size and species of tree they harvest, with selectivity increasing with increasing distance from the pond. Beavers extend their foraging radius for preferred species (aspen); furthermore, as distance from the pond increases beavers in high quality habitats select for fewer, but larger trees (Gallant et al. 2004). The size of tree harvested also appears to be related to the relative palatability of the tree species; beavers only cut smaller specimens of less preferred trees, while all size classes of preferred trees are harvested (Müller-Schwarze and Sun 2003). The maximum stem diameters cut by beaver in Minnesota and Ontario was 43.5 cm and 45.3 cm respectively, with the average stem diameter cut ranging from 10 to 15 cm (Johnston and Naiman 1990; Donkor and Fryxell 1999).

Beavers are believed to assess the nutritional value of trees by sampling each tree (i.e. biting into tree) before eating (Jenkins 1978 in Müller-Schwarze and Sun 2003). In North America, beavers prefer the following tree species in most seasons: aspen, willow, balsam poplar, and alder (Denney 1952 in Allen 1983). Although aspen and willow are highly preferred foods (Jenkins 1981) beaver will inhabit and even thrive in areas where aspen and willow are absent (Jenkins 1975).

At northern latitudes, beavers cache woody stems in the autumn as a food source for the winter months (Wheatley 1997; Müller-Schwarze and Sun 2003). Branches and saplings are piled up in the water near the lodge; low-preference and non-food species are often found in the raft, which floats above the cache to prevent food items from becoming entangled in the ice during winter. The timing of cache construction varies with latitude with construction occurring earlier at more northerly locations (Müller-Schwarze and Sun 2003).

Breeding Biology

Beavers form monogamous breeding pairs (Müller-Schwarze and Sun 2003); within a colony only the adult pair breeds. Mating generally occurs between January and March in northern portions of their range (Hill 1982). The gestation period typically ranges from 98 to 128 days (Hill 1982; Müller-Schwarze and Sun 2003), with most births occurring between late April and late June (Banfield 1974). One litter is produced per year with an average litter size of 3.9 kits (range is 1 to 8 kits per litter)(Banfield 1974). Lactation lasts six to eight weeks (Jenkins and Busher 1979). Parental care of the kits is distributed between the female, male, and yearlings present in the colony. Juveniles remain with the colony until dispersal, which generally occurs just prior to the birth of siblings in the juvenile’s second year. First parturition in beavers usually occurs at three years of age, but may occur at two or four years (Hill 1982). Early sexual maturity is positively related to high-quality habitat (Gunson 1970).



Site Fidelity

Beavers show high site fidelity, spending their entire lives within their home range (Slough, 1977) unless forage species become depleted or their pond dries or becomes silted in (Svendsen, 1989). In these cases they may shift to nearby areas to let food species recover at their original colony or change sites completely. Beavers can utilize marginal habitats without significant costs due to the relative ease of aquatic dispersal.

Home Range

The beaver's home range varies seasonally in the northern portion of the range, averaging from 0.25 ha up to 200 ha, and is often centered on the lodge (Aleksiuk 1968 in Allen 1983; Wheatley 1997). The winter range is restricted to the vicinity of the lodge (average winter range: 0.25 ha), while summer and fall home ranges are more extensive (average summer and fall ranges: 10.34 ha and 3.07 ha, respectively) (Wheatley 1997). Variability in home range size may be related to food availability, habitat types, and habitat quality. Home range size may also be related to age, sex, family group dynamics, and the shape, size, and type of water body upon which the lodge is located (Wheatley 1997).

Beavers are territorial and territory boundaries are defended and marked with scent mounds (Müller-Schwarze and Sun 2003); scent mounds are piles of lake/pond sediment built by beavers which are marked with castoreum and/or anal gland secretions (Müller-Schwarze and Sun 2003). Scent mounds play a major role in the maintenance of territorial rights; the number of scent mounds at any one beaver site is positively correlated with population density (Müller-Schwarze and Sun 2003). At northern latitudes, scent mound marking is restricted to open-water periods (Hill 1982).

Movement and Dispersal

Beaver activities fluctuate with the natural light cycle, air temperature, and season (Müller-Schwarze and Sun 2003). Beavers are generally nocturnal and during the summer at northern latitudes, they remain in their lodges from about 0800 to 2000 hours. Throughout the night they feed and construct or repair dams and lodges. In the winter at northern latitudes, beaver activities are restricted to the vicinity of the lodge (Wheatley 1997). Above ice activity ceases at low temperatures with thresholds ranging from -10°C to -18°C, depending on location (Müller-Schwarze and Sun 2003).

Young beavers typically initiate dispersal at the age of two years, but may also disperse at one or three years of age (Sun et al. 2000). Dispersal occurs prior to the birth of a new litter of siblings and with the onset of snow melt, as ephemeral streams and high water levels created by snowmelt provide enhanced dispersal opportunities (Van Deelen and Plestcher 1996; Müller-Schwarze and Sun 2003). In high quality habitats and/or in habitats with a high density of beavers, young may remain in the family group for longer than two years.

Dispersal distances appear to be related to beaver densities, habitat type and quality, and sex (Müller-Schwarze and Sun 2003). Most dispersal occurs within 10 km of the natal colony (Banfield 1974), but dispersal distances of 81 km have been recorded (Müller-Schwarze and Sun 2003) with females typically dispersing farther than males (Sun et al. 2000). Dispersing juveniles live as transients and may travel for weeks or months before selecting a new site. During dispersal, juveniles may inhabit and even defend temporary, suboptimal territories before moving on; in some cases juveniles may temporarily co-habit with relatives while searching for a suitable site (Müller-Schwarze and Sun 2003).

5.3 HABITAT REQUIREMENTS

Beavers are semi-aquatic; however, they venture into adjacent terrestrial habitats for forage and construction materials. As such, they tend to be associated with riparian areas having a high density of deciduous trees and shrubs (Barnes and Mallik 2001; Martell and Foote, 2006).

Forest Type

In Alberta, beavers are associated with deciduous and/or mixedwood dominated forests in riparian areas.



Structural stage/seral stage

Disturbance such as fire and logging may produce high quality habitat for beaver by increasing the presence of preferred food, particularly young trembling aspen (Slough and Sadleir 1977; Thompson 1988). In the boreal forest, beaver densities are at their highest in early successional (10 to 40 years old) naturally regenerating sites (Thompson 1988). In Quebec, short-term and long-term response of beaver to clear-cutting was examined along permanent streams and lakes where 20 m buffers were retained (Potvin et al. 1999; Potvin et al. 2005). Because the majority of beaver foraging occurs within 20 to 30 m of water, cut and uncut blocks maintained similar densities of beaver over the short and long term (Potvin et al. 1999; Potvin et al. 2005). However, silvicultural practices in riparian areas that inhibit deciduous regeneration, like brushing and herbicide applications, may negatively impact beaver densities (Thompson 1988). Further, recent (i.e. <10 years) harvesting in riparian areas produces unsuitable habitat. In the boreal foothills of Alberta, stream reaches located closer to cutblocks were less likely to be occupied by beaver (Stevens 2005). Recent cutblocks (<20 years) may be avoided by beaver, possibly due to a lack of large standing trees preferred for foraging. The age at which cutblocks in the riparian zone become suitable beaver habitat may vary with location and forest type.

The affects of forest fires on beaver populations has been poorly studied. It has been suggested that fires result in early successional forests that should then help support beaver populations. However, repeated prescribed burning of forests surrounding beaver ponds in Elk Island National Park, Alberta, resulted in a dramatic long term decrease in beaver abundance (Hood et al. 2007).

Landscape-scale effects

Beaver abundance is primarily explained by the abundance of suitable water bodies, and as such, can be impacted on a landscape level by practices or events that change or alter hydrology on a landscape level. That said, beavers also exercise a great deal of control over their local aquatic environment through building dams to manipulate local drainage patterns, and thus have some ability to endure droughts and other events that might otherwise impact the availability of water locally or regionally.

Beavers can be limited by the availability of early successional deciduous forests in proximity to suitable aquatic habitat. Management practices that impact or limit such forest types in proximity to water at a large scale, such as large scale intensive logging with narrow or non-existent riparian buffer widths, or repeated prescribed burning, may have large scale effects on beaver abundance.

Important Habitats

Mixedwood stands

Beavers require a deciduous forest component to meet their nutritional requirements; however, a wide variety of tree and shrub species (deciduous and conifer) are utilized by beaver for food and construction activities throughout their range (Allen 1983; Barnes and Mallik 2001; Müller-Schwarze and Sun 2003). Therefore, mixedwood stands provide optimal forage and construction materials throughout the year.

Riparian Areas

Sufficient woody riparian vegetation is required to meet beaver foraging requirements, as well as for the construction of the lodge and dam. As mentioned previously, beavers typically forage within 20 to 30 m of the water's edge (Thompson 1988; Barnes and Mallik 2001; Martell and Foote 2006), but can forage up to 200 m from shore (Allen 1983). Therefore, vegetation beyond 200 m of the shore is of little value. The composition and structure of riparian stands is an important predictor of the location of the lodge and dams, and may be a better predictor of habitat suitability than the availability of food trees (Barnes and Mallik 1997; Stevens 2005). For example, in boreal forests in Ontario, beavers built dams at stream sections with high shoreline densities of woody vegetation ranging in diameter from 1.5 to 4.4 cm (Barnes and Mallik 1997), corresponding with the preferred stem size for dam construction (Barnes and Mallik 1996); whereas the density of aspen, the primary food item, was not significantly different between dams sites and non-dam sites (Barnes and Mallik 1997). Therefore, it is thought that beavers



select for areas with high densities of vegetation suitable for dam construction; the water impounded as a result of dam construction subsequently increases the forage radius and improves access to forage.

Water

Beaver require a stable supply of water year-round to meet life history requirements for foraging, copulating, dispersing, fleeing predators, and protection; therefore, a permanent, stable water body in the form of a stream, river, lake, or pond is the primary habitat requirement for beaver (Müller-Schwarze and Sun 2003). Beaver prefer water bodies with seasonally stable water levels and on small streams, ponds, and lakes, beaver control and manipulate water depths and stability through the construction of beaver dams (Slough and Sadleir 1977). In northern latitudes, sufficient water depths (i.e. 1 to 1.5 m) are also required to prevent water bodies from freezing to the bottom (Thompson 1988). Bank substrates should be sufficiently fine-textured to permit den and lodge construction. Large lakes and rivers in which water depth and water level fluctuations cannot be controlled are generally considered unsuitable for beaver, as are ephemeral water bodies that periodically dry up (Allen 1983). Lakes, marshes, and ponds generally satisfy life requisites for water provided that suitable shelter from wind, wave, and ice action is available. Bays, coves, and inlets may provide adequate shelter on the shores of larger lakes (Allen 1983).

In riverine habitats, stream gradient is the most significant factor in determining the suitability of habitat for beavers (Allen 1983). Beavers prefer slow-moving waters with gradients of 1% or less (Müller-Schwarze and Sun 2003). In the mountains of Colorado, beaver used streams up to a maximum gradient of 15%, above which beavers were absent; the majority of beavers colonized streams with gradients $\leq 6\%$ (Retzer et al. 1956 in Müller-Schwarze and Sun 2003).

Important Habitat Features

Beaver have the ability to actively alter aquatic habitats to better suit their year round needs. Provided that appropriate starting materials and habitat is available, beaver will construct their essential habitat features. The two most important features that beaver require and construct are lodges and dams.

Lodges

The lodge is the principal shelter for a beaver colony, providing thermal cover and protection from predators. A significant proportion of beaver activity occurs within the lodge, including: sleeping, eating, mating, and bearing and rearing of young. There is no specific information available with respect to preferred sizes and types of trees used for lodge construction, but they are likely similar to species and size class preferences exhibited in dam construction.

Dams

Beavers build dams to impound water along streams to create a beaver pond; a colony of beavers may create one or several ponds within a territory (Müller-Schwarze and Sun 2003). The stable water levels associated with impounded water perform several functions. First, dams ensure that the entrances to the lodge are submerged and thus protected from predators. Second, the impounded water permits the floating of logs and branches which enable beavers to more easily construct dams and lodges. Finally, dams increase the circumference of the beaver pond, thus expanding the foraging radius and reducing the need for risky overland foraging.

An average sized beaver dam contains approximately 7000 kg of wood (Johnston and Naiman 1990) and includes logs of varying length and diameter, rocks, grass, and mud. In Ontario, beavers exhibited a preference for stems ranging in size from 1.5 to 3.5 cm (Barnes and Mallik 1996); beavers also appeared to prefer alder species, although this may be a function of the high availability of alder in appropriate size classes adjacent to the water's edge, rather than a preference for species (Barnes and Mallik 1996). Conifers may also be used in dam construction, but are generally avoided (Barnes and Mallik 1996) as are food-tree species (aspen) with diameters >4.5 cm.



5.4 RISK ASSESSMENT

A permanent, stable water body in the form of a stream, river, lake, or pond is the primary habitat requirement for beaver. In addition, forest harvesting practices are generally compatible with maintaining beaver habitat with beavers achieving their highest in early successional (10 to 40 years old) naturally regenerating sites. Currently, DMI's forestry operations includes riparian buffer/protection zones on several classes of streams and waterbodies which will mitigate risk to beaver populations as a result of forestry operations. At the landscape level, the creation of a continuous reserve network which includes consideration of the ecological and hydrological connectivity between protected areas, wetland complexes, and permanent buffers will also help to minimize risk to beavers.

Specific recommendations to mitigate risk to beaver habitat include: maintaining riparian mixedwood and deciduous stands (within 30 m of a permanent water body) with 40% to 60% tree and/or shrub canopy closure (Allen 1983), and; retaining early successional (10 to 40 year old; <15 cm dbh) aspen trees within riparian areas that are associated with permanent water bodies of all sizes (Thompson 1988; Allen 1983). At the landscape level, maintaining adequate amounts of mixedwood/deciduous stands in proximity to preferred water bodies would likely be beneficial although threshold amounts of these forest types is unknown.

Assessed risk to beavers on DMI's FMA as a result of forestry practices – Low

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6. COYOTE

6.1 SUMMARY OF RISK

Coyotes (*Canis latrans*) were originally a canid species of the mid-western United States. However, over the past two centuries coyotes have increased their geographic range, and are now common and widespread across most of North America, including Alberta. Coyotes are considered generalist predators, and have been shown to utilize many different prey species across their range. In northern Alberta, coyotes commonly prey on red squirrels, snowshoe hare, muskrats, various species of microtines, white-tailed and mule deer, and waterfowl and grouse.

Although the effects of forestry practices on coyote have not been well studied, coyotes are known to use fragmented landscapes, suggesting that they may benefit from forest disturbance. Coyotes have been found to select for regenerating cutblocks and mature conifer in winter, likely because of food availability in these habitats at this time of year. In addition, the high human activity associated with logging may reduce interspecific competition between coyotes and wolves which is also beneficial to coyotes. In general, coyotes are competitively excluded by wolves across much of the coyote's northern range; however, human persecution of wolves may release coyote populations from this competitive exclusion. Coyote populations may similarly be negatively impacted where forestry results in increased human access and high persecution or population control of coyotes.

In general, DMI forestry operations are not expected to negatively impact coyote populations, and may indeed benefit them.

Assessed risk to coyotes on DMI's FMA as a result of forestry practices – Low

6.2 SPECIES INFORMATION

Status

Provincial: S5 Secure

Federal: N5

Global: G5

Description

Coyotes (*Canis latrans*) are a North American member of the dog family. They vary geographically in size, with the eastern coyote being much larger than the western coyote (Elbroch 2003; Way 2007). Generally, they are approximately 109 to 134 cm in length (including tail) and weigh between 9 and 22 kg (Bekoff 1977; Burt and Grossenheider 1980). The coyote's pelt is usually grey or reddish grey, with rusty legs, feet, and ears, the throat and belly are usually white, and the tail is heavily furred with a black tip (Bekoff 1977; Burt and Grossenheider 1980). Coyotes are primarily, though not exclusively, nocturnal.

Provincial Distribution

The coyote is a permanent resident throughout Alberta (Natureserve 2009).

Life History

Diet and Foraging Behaviour

Coyotes are opportunistic foragers. They commonly prey upon small mammals, such as mice, voles, shrews, squirrels, and hares, but also prey on deer and other wild ungulates (particularly young), domestic sheep, various bird species, amphibians, lizards, and invertebrates (Nellis and Keith 1976; Bekoff 1977). In addition, they eat carrion, berries, grain plants, and human refuse and garbage (Nellis and Keith 1976; Bekoff 1977). In Jasper National Park, Alberta, rodents and neonatal cervids were the major summer foods for coyotes, while in winter large ungulates were the primary food (Bowen 1981). In general,



protein makes up about 90% of the coyote's diet (Bekoff 1977), with the use of plant matter, such as berries, being highest in the autumn (Tremblay et al. 1998).

Coyotes have keen hearing, an acute sense of smell, and excellent eyesight and are able to locate prey even when it is scarce (Bekoff 1977). Coyotes can be seen hunting alone, in pairs or in packs at any time of the day, although they tend to be most active at night (Tremblay et al. 1998). They can move distances of 30 km or more in a single night, although distances of about 10 to 15 km per night are more normal (Burt and Grossenheider 1980; Way et al. 2004; Young et al. 2006).

Coyotes use a number of different strategies when hunting. For small mammals such as mice and voles they usually pounce, while for larger prey such as ungulates they use some combination of locating, stalking, encountering, and chasing (Ozoga and Harger 1966; Ogle 1971; White 1973). Coyotes often hunt individuals within a population that are the most vulnerable to predation, particularly young of the year or old weak animals that are less able to cope with environmental conditions such as deep snow (Bekoff 1977).

Breeding Biology

Mating takes place between late-January and late-March depending primarily on latitude. Dens may be located in a number of different habitats, but are commonly located near stream banks or ravines. Five to ten pups are born in April or May after a gestation period of about 60 days (Burt and Grossenheider 1980). An average litter size of 6.3 has been reported for central Alberta (Nellis and Keith 1976). Coyote pups open their eyes at about 2 weeks and are usually weaned from their mother's milk at about 5 to 7 weeks. Both sexes help with the rearing of young.

Juvenile coyotes may disperse as young as 6 months of age; however, males usually disperse as yearlings, while females may remain with the family group longer (Bekoff 1977). Coyote mortality is highest in the first year (Nellis and Keith 1976; Bekoff 1977). Although captive coyotes have been reported to live to 18 years, wild coyotes are unlikely to live past 10 years (Bekoff 1977; Young et al. 2006).

Site Fidelity

Coyote social systems consist of territorial pairs or groups, as well as transient animals (Andelt and Gibson 1979). Territorial pairs and groups tend to show strong fidelity to home ranges (Gese 1998); however, while they remain faithful to one range (i.e., boundaries remain similar over a period of years) the use of the habitat within the range may change temporally (Kitchen et al. 2000). Factors such as human disturbance or interspecific strife with species such as wolves may cause territory abandonment (Arjo and Pletscher 1999; Switalski 2003).

Home Range

Breeding pairs and groups of coyotes most often defend their home ranges. Defended home ranges or territories vary greatly in size across North America and may be as large as 100 km² or more (Andelt and Gibson 1979; Litvaitis and Shaw 1980; Crête et al. 2001). An average territory size of about 12 km² has been reported in central Alberta (Roy and Dorrance 1985). Factors such as latitude, group size, prey size, abundance and distribution, as well as the number of points used to define the territory all influence coyote territory size (Bekoff 1977; Mills et al. 2006). Home ranges are often situated along landscape features such as roads, fence lines, and rivers (Gese et al. 1996a; 1996b).

Coyotes tend to den in the core of their range, which usually has good protective cover (Neale et al. 2007). Mortality is highest near the edges of their home range (Young et al. 2006; Chamberlain and Leopold 2005). Coyotes may have overlapping home ranges with other coyotes, lynx, bobcat, or fox (Chamberlain and Leopold 2005); however, wolves usually competitively exclude coyotes where the two species occur together (Fuller and Keith 1981; Crabtree and Sheldon 1999). Transient coyotes tend to avoid established home ranges, and live and feed in the matrix surrounding occupied habitat (Messier and Barrette 1982). They may make long distance dispersals (e.g. 544 km; Carbyn and Paquet 1986) as they search for mates or available territories.



Movements and Dispersal

Most coyotes disperse from their family groups. Movements are motivated primarily by food, mating opportunities, and the possibility of locating an available territory. Coyotes usually disperse as yearlings between July to November (53%) or January to March (33%); however, some juveniles may remain with the family group longer (Bekoff 1977; Roy and Dorrance 1985; Harrison 1992; Gese et al. 1996a). Dispersals may consist of one or more exploratory forays before permanent dispersal (Harrison et al. 1991). Dispersal distances range from 40 to 342 km, and juveniles may be transients for a 1 year or more before establishing a territory (Harrison 1992; Kolbe and Squires 2004).

6.3 HABITAT

Coyotes utilize a variety of habitats throughout their range. As they are considered habitat generalists and opportunistic feeders, habitat use and selection (particularly in the absence of human persecution) is largely determined by the distribution, abundance, and relative vulnerability of food resources (Bekoff 1977).

Structural stage/seral stage

Limited data exists on coyote use of successional stages of forest stands; however, as coyotes are known to occur in fragmented landscapes they may benefit from forest disturbance (Fisher and Wilkinson 2005). Coyotes have been found to select regenerating cutblocks of >10 years, likely because of the high food availability in this habitat (Parker and Maxwell 1989). Indeed disturbances, such as forestry, may result in increased ungulate populations (particularly deer), a factor that could result in increases in coyote populations (Cumming 1992). In addition, anthropogenic features associated with forestry may result in easier travel for coyotes (Way and Eatough 2006).

Important Habitats

Coyotes are found in most types of habitat within their range, including the Great Plains of the United States, the forests of Alaska, and the jungles of Central America (Gompper 2002). Originally excluded from much of their current range by wolves, coyotes are currently able to exist in most habitats so long as they have sufficient food, and are not too heavily persecuted by humans (Gompper 2002). Within Alberta, the prairie and aspen parkland agricultural regions appear to be particularly good coyote habitat, while densities tend to be lower in the boreal forest in the north of the province (Fuller and Keith 1981; Roy and Dorrance 1985). During periods of deep snow, coyotes may use thick cover where snow is shallower (Crête and Larivière 2003; Murray et al. 2005). Coyotes commonly den near stream banks or other nearby water bodies (Gier 1968; Bekoff 1977; Way et al. 2001). Similarly, coyotes often use watercourses as travel corridors, likely because of high prey availability near these features (Kays et al. 2008).

6.4 RISK ASSESSMENT

Given that coyotes are a widespread, common predator species, including in Alberta, they are a species of low conservation concern. Although there is little information on how forestry practices may affect coyote populations, it is widely accepted that they are well adapted to landscapes that have been highly fragmented by anthropogenic practices (Fisher and Wilkinson 2005). Accordingly, it is also assumed that coyotes may benefit from logging, possibly because of higher prey densities associated with logged landscapes (Cumming 1992).

The greatest threat to coyote populations in Alberta is human persecution. Coyotes are one of the top three furbearers harvested in the province, with almost 25,000 pelts taken in Alberta per year (ASRD 2001). In addition, hunting, collisions with motor vehicles, and population control account for a substantive proportion of coyote population mortality (Kamler and Gipson 2004; Van Deelen and Gosselink 2006). However, despite the high numbers of coyotes harvested in Alberta each year, coyote populations remain high and widespread (ASRD 2001).



DMI forestry practices that include buffer zones around active dens, riparian zone conservation and harvest strategies that maintain a variety of successional stages, are likely to be beneficial to coyote populations. Overall, this generalist predator is unlikely to be negatively impacted by DMI's forestry operations.

Assessed risk to coyotes on DMI's FMA as a result of forestry practices – Low

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7. FISHER

7.1 SUMMARY OF RISK

Fisher (*Martes pennanti*) are a medium-sized member of the weasel family that are found primarily in extensive mixed hardwood forests in Canada and the mountainous regions of the western United States. They use a wide variety of foods, such as small mammals, birds, carrion, fruits and fern tips, and are one of the few predators to specialize on porcupines. This species uses dense coniferous stands with closed canopies and mixed-wood forests for a number of life requisites. Because fisher home ranges are relatively large (approximately 10 to 30 km²) and the species is considered sensitive to some forestry activities, careful consideration should be given to forest harvest strategies.

In general, fishers tend to avoid early-seral habitat and forest openings such as recently harvested or burned areas. It has been suggested that the removal of more than 40% of mature late-successional forest results in an absence of fisher from the landbase. In addition, fishers also require an abundance of large coarse woody debris (CWD) for resting, denning, and foraging.

Typically, these structural elements are found in late-successional mature forests. Forestry practices which retain mature and structurally diverse stands on the landbase may benefit fisher populations. Additionally, mature or old forest (ideally near streams) connectivity should be maintained to aid juvenile dispersal.

Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that may mitigate risk to fisher populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including large areas of core old-growth stands in the long-term.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.
- Downed woody debris (DWD) management through retention of ‘in-situ’ dead debris after harvest and black tree retention during wildfire salvage.

Assessed risk to fishers on DMI’s FMA as a result of forestry practices – Moderate

7.2 SPECIES INFORMATION

Status

Provincial: S4

Federal: N5

Global: G5

Description

The fisher (*Martes pennanti*) is a medium-sized carnivore belonging to the weasel (mustelid) family. They have long slender bodies, short legs, and a triangular shaped head which features a prominent muzzle and distinct, large, rounded ears. Fishers weigh between 2 and 7 kg, and are about 80 to 100 cm in length. In general, females are about 10 to 15% smaller than males (Ruggiero et al. 1994; Hatler et al. 2003). Fishers are variable in color, but they generally have grey, gold or black backs, and dark brown



legs and tails (Eder and Pattie 2001). The coat may be grizzled in appearance. Like other mustelids, fishers have five toes on each foot and their claws are retractable but not sheathed.

Provincial Distribution

The fisher, a permanent resident of Alberta, is distributed across the northern half of the province in the Boreal, Rocky Mountain and Foothills Natural Regions of the province (Pattie and Fisher 1999; Natureserve 2009).

Life History

Diet and Foraging Behaviour

Fishers are dietary generalists and forage on a variety of animal, plant, and fungal species (Arthur et al 1989a; Guiliano et al 1989; Zielinski et al 1999; Zielinski and Duncan 2004). Major prey species include snowshoe hare, squirrels, mice and porcupine (Zielinski et al 1999). Other prey items include beaver, muskrat, squirrels, voles, mice, shrews, birds, carrion, and fruit (Arthur et al. 1989a; Guiliano et al. 1989). Snowshoe hare and porcupine have been reported as particularly important prey species for fisher during winter (Raine 1986; Powell 1994). Although there is little variation in the diet of fisher populations within regions, younger individuals appear to hunt birds and consume fruits more frequently than older individuals (Guiliano et al. 1989).

Fishers exhibit two distinct hunting behaviours when foraging for snowshoe hare and porcupines. Fishers travel in a zig-zag pattern across the landscape when hunting snowshoe hares looking for potential hiding spots. In contrast, fishers tend to travel in straight lines when hunting porcupine in deciduous dominated uplands (Powell 1994).

Breeding Biology

Fishers are solitary except during the March to April mating season. Females are sexually mature and breed at one year of age; however, gestation lasts for nearly a year because of delayed implantation (Arthur and Krohn 1991). Delayed implantation may allow females to give birth at favorable times and maximize offspring development before their first winter (Arthur and Krohn 1991). Birth rates ranging from 50% to 75% are lower than copulation rates suggesting that some pregnancies are unsuccessful (Arthur and Krohn 1991). Females are receptive to mating approximately one week after giving birth. Mean litter size is three. Kits are weaned from milk between 8 and 10 weeks, but remain dependent on adults for food until approximately 4 months of age. Kits remain in their mother's territory into the winter, disperse in mid-August and attempt to establish their own home ranges by one year of age (Arthur et al. 1993).

Site Fidelity

Females show strong fidelity to their home ranges across seasons and years. Similarly, males show strong fidelity to their home ranges for most of the year but abandon their territories between February and April to search for mating opportunities; males attempt to reestablish their territories post-mating (Arthur et al. 1989b). Males show less annual fidelity to home ranges than females (Arthur et al. 1989b).

Home Range

Fisher home ranges are intrasexually exclusive; that is, home ranges do not overlap with those of the same sex except during the breeding season (February to April) when males travel extensively (Arthur et al. 1989b). Average home range estimates vary between sexes and studies. However, female home ranges are about 2 to 16 km², while male home ranges are about 5 to 30 km² (Arthur et al. 1989b; Boroski et al. 2002; Koen et al. 2007). Similarly, fisher densities vary across their range. For example, in north-central British Columbia fisher densities have been estimated at about 1 per 100 km² (Weir and Corbould 2006). In contrast, fisher densities in eastern North America have been found to be much higher, ranging from about 20 to 30 per 100 km² (Arthur et al. 1989b; Powell 1994; Fuller et al. 2001; Koen et al. 2007).

Movements and Dispersal



Fishers are generally solitary, and with the exception of the males during the breeding season, they remain on their home territory year round. Males moved approximately 2 to 4 km per day during the breeding season (Arthur and Krohn 1991). Fishers are primarily crepuscular, although they may be active at any time of the day or night (Arthur and Krohn 1991). Fishers are more active in summer than winter, possibly because of winter temperatures and deep snow that may restrict their movements (Raine 1981; Arthur and Krohn 1991).

Most juveniles disperse between 9 months and one year of age (Arthur et al. 1993). Mean juvenile dispersal distances in Maine were 10.8 km (range: 4.1-19.5 km) and 11.2 km (range: 5-18.9 km) for males and females, respectively (Arthur et al. 1993). However, greater dispersal distances have been recorded, e.g., a female in British Columbia traveled 74 km in a straight line distance in 8 days (Hatler et al. 2003).

7.3 HABITAT

Fisher inhabit a wide range of habitats and forest types across their range. Because of differences in vegetation composition, stand structure, and spatial characteristics, it is difficult to generalize habitat specific requirements of fisher. Further, fisher habitat requirements in western North America and in Alberta in particular have been little studied. In general, fishers require structurally complex habitat typically available in mature/old forest to meeting life requisites for foraging, denning, resting, security cover, and thermal cover. There appears to be the greatest selection for resting and denning sites which are critical habitat components for fisher.

Forest type

Fishers are a forest-dwelling species that utilize primarily mature to mid-seral stage conifer and mixed-wood forests, particularly near riparian areas (Arthur et al. 1989a; Raine 1981; Powell 1994; Weir and Harestad 2003; Aubry and Raley 2006; Tully 2006). Deciduous forests are used less than expected based on availability (Arthur et al. 1989a), except where deciduous stands contained complex structural diversity (Tully 2006). In western North America, fishers are most commonly found in late-successional coniferous forests (Zielinski et al. 2004a, 2004b). Fishers likely select habitat based on cover-type, prey availability, thermoregulation, and snow interception (Raine 1981; Kilpatrick and Rego 1994; Weir and Harestad 2003).

Structural stage/seral stage

In general, fishers do not use early-seral forests and tend to avoid open habitats such as recent cutblocks and burns (Raine 1981; Tully 2006). Complex structural habitat attributes appear to be important for resting and denning sites (Weir and Harestad 2003). The structural elements that appear to be of greatest importance are large coarse woody debris, large diameter standing live and dead trees, and multiple layers of overhead vegetation (Weir and Harestad 2003; Zielinski et al. 2004a, 2004b; Zielinski et al. 2006). In western North America, dense stands of late-successional conifer are most frequently used to fulfill these requirements (Weir and Harestad 2003; Zielinski et al. 2004a, 2004b; Zielinski et al. 2006). In eastern North America, fishers do not appear to be restricted to late-successional coniferous forests and are often found in mid-seral mixed-wood and deciduous stands (Arthur et al. 1989a; Weir and Harestad 2003).

Landscape-scale effects

Fisher abundance is positively correlated with the proportion of forested landscape (Lanscaster 2008). Consequently, it may be problematic to maintain viable fisher populations where suitable habitat patches are small and widely spaced as juvenile dispersal may be impeded (Arthur et al. 1993). Other landscape features such as mountain ranges and open grasslands may further impede dispersal (Raine 1981; Arthur et al. 1993; Weir and Harestad 2003). British Columbia Furbearer Management Guidelines recommend maintaining forest patches of ≥ 2 ha and 30 to 45% mature and old forest with productive understories that support diverse prey species (Hatler et al. 2003). Further, landscape connectivity should be maintained by corridors of mature forest ideally close to riparian habitat (Hatler et al. 2003).

Important Habitats



Stand Characteristics

In general, fisher select stands with a high level of structural complexity, including large diameter trees, snags, and CWD, to meet life requisites for foraging, resting, and denning (Weir and Harestad 2003; Zielinski et al. 2004a, 2004b; Zielinski et al. 2006). This structural complexity is typically most available in mature to mid-seral stage conifer and mixedwood forests. High prey densities tend to be associated with coarse woody debris, understory shrub cover, forest edges, riparian areas, small wetlands and meadows, and thick conifer and shrub patches (Zielinski et al. 1999; Hatler et al. 2003), and consequently these features should be considered important fisher habitat. In addition, in the winter fisher select mature/old conifer stands with a high degree of canopy closure to provide thermal protection and allow for easier movement due to more moderate snow depths (Raine 1981; Arthur et al. 1989a; Kilpatrick and Rego 1994; Weir and Harestad 2003).

Resting Sites

Fishers use a variety of structures for resting sites and rarely re-use these sites. Resting structures most commonly used are trees, snags, and CWD but rock piles, brush piles, and holes in the ground may also be used (Zielinski et al. 2004a). Resting sites in wood structures i.e. trees, snags, and CWD, are larger than the average available within stands. Further, the area around resting sites is also characterized by greater than average tree size and volume, as well as increased canopy closure (Zielinski et al. 2004a).

Maternal Dens

Tree cavities are particularly important for breeding females because they provide protection for themselves and their kits from male fishers as well as other predators. Dens typically occur in the largest diameter deciduous trees available in a stand (Weir and Harestad 2003; Zielinski et al. 2004a). Because maternal dens may be a limiting factor for fisher populations in some regions, and denning trees often occur in riparian habitat, riparian buffers which maintain large diameter trees may be an important management consideration for fishers (Hatler et al. 2003).

7.4 RISK ASSESSMENT

Given that fishers have been shown to select for mature to mid-seral stage conifer and mixed-wood forests with high structural complexity, the key to minimizing risk to fishers is to maintain enough of this habitat at the stand and landscape levels. The impacts of forestry and variable retention strategies on fishers have been understudied. Variable retention, understory (conifer) protection, CWD retention, and riparian buffer retention are strategies that likely mitigate risk to fisher populations as a result of harvesting. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that may mitigate risk to fisher populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including large areas of core old-growth stands in the long-term.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.
- Downed woody debris (DWD) management through retention of ‘in-situ’ dead debris after harvest and black tree retention during wildfire salvage.



Like marten, fisher's requirement for mature/old (conifer) forest to meet life requisites results in a risk assessment to this species as a result of DMI's existing forestry practices as moderate. Overall, stand and landscape level management strategies that retain habitat structure, particularly closed canopy forests with high structural diversity, including retention of large diameter (deciduous) trees, snags, and CWD will mitigate risk to fisher populations. Similarly, corridors focused around riparian areas which connect mature forest stands may be of further benefit. However, there are many unknowns around the effectiveness of these strategies at mitigating risk to fisher populations over the short and long term resulting in the moderate risk designation.

Assessed risk to fishers on DMI's FMA as a result of forestry practices – Moderate

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8. LYNX

8.1 SUMMARY OF RISK

Canada lynx (*Lynx canadensis*) are a primarily nocturnal and solitary member of the cat family. Lynx are found throughout the northern and boreal forests of North America. They range widely, using their extremely large feet to enable easier travel in deep snow. Lynx prey primarily on snowshoe hare, and show population fluctuations that peak every 8 to 11 years. Other rodent species and birds further supplement lynx diet. Interspecific competition between lynx and coyotes for food has been recorded.

Lynx foraging habitat requirements closely follow snowshoe hare habitat requirements. In particular, early-successional stands with dense understories that provide foraging and cover opportunities for snowshoe hare are preferred foraging habitats for lynx. Lynx also require high densities of large woody debris for den sites and corridors that provide suitable cover for travel between den sites and foraging areas.

There are several forest harvesting strategies that mitigate the negative effects of clearcutting on snowshoe hare (and therefore lynx), in particular variable retention and understory (conifer) protection. In addition, CWD retention and landscape-level connectivity of forested stands will further mitigate risk to lynx. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to lynx populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Downed woody debris (DWD) management through retention of ‘in-situ’ dead debris after harvest and black tree retention during wildfire salvage.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

Assessed risk to Canada lynx on DMI’s FMA as a result of forestry practices – Low

8.2 SPECIES INFORMATION

Status

Provincial: S4

Federal: N5

Global: G5

Description

The Canadian Lynx, *Lynx canadensis*, is a medium-sized member of the cat family that occurs throughout the northern and boreal forests of North America. They have a short tail, long legs, very large feet, a facial ruff, and prominent ear tufts (Pattie and Fisher 1999; Mowat et al. 2000). The winter coat of the lynx is yellowish grey to grizzled grey-brown on the back, and greyish-white to buff-white on the belly, legs, and feet; in the summer the coat is short with a reddish brown hue (Koehler and Aubry 1994). Lynx exhibit sexual dimorphism, with males being 10 to 25% larger than females. On average, males are about 85 cm long and weigh 10 kg, and females are 82 cm long and weigh 8.5 kg (Koehler and Aubry 1994; Mowat et al. 2000).



Provincial Distribution

Canadian lynx are a permanent resident of northern, boreal and mountain regions of Alberta; they are not found in the prairie region in the southeast of the province (Natureserve 2009).

Life History

Diet and Foraging Behaviour

Canadian lynx are considered snowshoe hare specialists because hares make up 33 to 97% of the prey items consumed by lynx (Koehler and Aubry 1994; Squires and Ruggerio 2007). Consequently, lynx abundance is directly related to snowshoe hare abundance. Snowshoe hare populations in the northern boreal forest are highly cyclical, with amplitudes over two orders of magnitude and periods of hare scarcity occurring every 8 to 11 years (Brand and Keith 1979; Koehler and Aubry 1994; O'Donoghue et al. 1998). At northern latitudes, lynx populations follow the same fluctuations as snowshoe hare populations, but lag 1 to 2 years behind (Brand et al. 1976; Brand and Keith 1979). Due to their dependence on hare as a primary prey species, lynx have developed morphological adaptations for hunting snowshoe hares in deep snow, most notably long legs and large, hairy paws (Murray and Boutin 1991; Koehler and Aubry 1994). Lynx hunt snowshoe hare by stalking and rushing, or ambushing from “ambush beds” established near the trails of prey (Murray et al. 1995).

While lynx populations are highly dependent on snowshoe hare in the winter, lynx will switch to other prey during the summer and fall, and during periods of snowshoe hare decline (Koehler and Aubry 1994). During these periods, lynx also prey on red squirrels, mice and voles, flying squirrels, ground squirrels, beaver, muskrat, grouse, ptarmigan and other bird species (Koehler and Aubry 1994; Mowat et al. 2000). When snowshoe hare densities are low, the red squirrel is one of the most important alternate prey species in northern Canada (O'Donoghue et al. 1998), while grouse appear to be the main alternate prey species for lynx in Alberta (Brand et al. 1976).

Breeding Biology

Females ovulate between late-March and early-April, and give birth in late-May after a gestation period of approximately 60 to 70 days (O'Connor 1986; Quinn and Thompson 1987). Most females reproduce for the first time at about 22 months of age (van Zyll de Jong 1963; Parker et al. 1983), although females as young as 10 months of age have been reported to breed under optimal conditions (Brand et al. 1976). Male lynx do not breed in their first year (Quinn and Thompson 1987). Kittens stay with their mothers through their first winter until they are 9 to 10 months of age (Brand et al. 1976; Parker et al. 1983). Family groups begin to break down in early-March and natal dispersal begins in late-April or early-May (Mowat et al. 2000).

Lynx recruitment is highly influenced by snowshoe hare abundance; high snowshoe hare abundance positively influences lynx recruitment, and declining abundance negatively influences lynx recruitment. For example, during the increase and peak phase of the snowshoe hare cycle, average litter size of adult lynx ranges from 4 to 5 (Mowat et al. 1996) and kitten survival is high (50 to 83%) (Brand et al. 1976; Poole 1994; Slough and Mowat 1996). Large litters, in combination with high rates of kitten survival, result in a rapid increase in lynx populations during periods of snowshoe hare abundance (Slough and Mowat 1996). In contrast, birth rates of yearling and adult lynx begin to decline during the spring following a snowshoe hare peak (Poole 1994; Slough and Mowat 1996) and kitten survival declines to nearly zero (Brand et al. 1976; Parker et al. 1983). During periods of low hare abundance, adult lynx continue to breed but few live litters are born (Mowat et al. 2000). Near zero levels of lynx recruitment can persist for 3 to 4 years during periods of low hare abundance (Brand and Keith 1979). Decreased recruitment during times of hare scarcity are likely a result of decreased kitten survival, decreased reproductive rates of yearling females, and decreased litter sizes for females of all age classes (Brand and Keith 1979; Koehler and Aubry 1994).

Site Fidelity



Both male and female lynx appear to show a degree of philopatry to their home ranges over several years; however, home range shifts and abandonment are also common (Poole 1994; Slough and Mowat 1996).

Home Range

Factors influencing the size and shape of lynx home ranges are not well understood; however, it appears that home range varies by area, season, sex, and by cyclical phase of the hare cycle (Mowat et al. 2000). Due to the plasticity of home ranges and differences in the methods used to calculate home range size, there is large variation in reported home ranges of North American lynx (8 to 738 km²) (Mowat et al. 2000). Lynx typically exhibit intrasexual territoriality, meaning that male home ranges exclude other male home ranges, but may overlap with the home ranges of neighbouring females (Poole 1994; Slough and Mowat 1996). Home ranges of related females may also overlap; however, the majority of activity within a home range is concentrated in core areas that seldom overlap between individuals (Poole 1995). Male home ranges are typically larger than female ranges (Koehler and Aubry 1994; Slough and Mowat 1996). Home range size may increase when individuals are breeding (Kesterson 1988), however, female home range size typically decreases during denning (Mowat et al. 2000). Home ranges may also be larger in the summer than in the winter. While lynx do not actively defend territories, they do scent-mark using urine, faeces, and anal gland secretions that provide spatial and temporal information which decreases confrontation between individuals (Mowat et al. 2000).

Home range size also appears to increase with decreasing snowshoe hare density (Brand et al. 1976; Ward and Krebs 1985); however, not all studies have demonstrated this trend (see Koehler and Aubry 1994 for review). It seems likely that there is a threshold hare density below which lynx home ranges begin to expand in response to declining prey abundance (Mowat et al. 2000). Declining hare density also influences the spatial and temporal distribution of individuals; during times of hare scarcity, lynx may abandon their home ranges and become nomadic or emigrate in search of prey (Ward and Krebs 1985). This often results in the breakdown of spatial and temporal segregation of individuals and the congregation of several lynx in areas where prey resources are more plentiful (Koehler and Aubry 1994). Home range expansion may also occur as a result of increased trapping pressure (Carbyn and Patriquin 1983; Bailey et al. 1986).

Movements and Dispersal

Lynx are generally considered solitary but will frequently travel in groups, such as females with kittens, two adult females with their kittens, and females traveling with males during the breeding season (Carbyn and Patriquin 1983; Parker et al. 1983). Daily movements by lynx vary greatly and appear to be influenced by environmental conditions, such as snow conditions and snowshoe hare densities (Koehler and Aubry 1994).

Long-range movements are common and include juvenile dispersal from the natal area and adult dispersal in response to environmental “catastrophe” (i.e. snowshoe hare decline) (Koehler and Aubry 1994). Juvenile dispersal occurs in the spring soon after independence; males may disperse further from their natal range than females, as females may establish home ranges within their natal area (Kesterson 1988; Slough and Mowat 1996). Adult dispersal generally occurs during periods of nutritional stress, which usually coincides with snowshoe hare declines. For example, in the Northwest Territories, adult dispersal was greatest during March and June following a winter hare decline and in mid-winter over the next two years (Poole 1997). Straight-line dispersal distances by adult lynx range up to 900 km (Ward and Krebs 1985; Slough and Mowat 1996; Poole 1997), and movements >100 km are considered common (Koehler and Aubry 1996). This adult dispersal may function in rebuilding lynx populations during recovery from low snowshoe hare abundance (Poole 1995).

8.3 HABITAT

Canada lynx are found throughout northern and boreal forests of North America. In general, habitats that provide foraging and cover opportunities for snowshoe hare are preferred foraging habitats for lynx.



Structural stage/seral stage

Lynx require foraging, denning, and travel habitat to meet their life history requirements; optimal lynx habitat is associated with forested conditions and an abundance of prey. As a result, lynx habitat is closely tied to snowshoe hare habitat; in fact, most descriptions of lynx foraging habitat is an account of snowshoe hare habitat preference (see Koehler and Brittell 1990; Koehler and Aubry 1994; Mowat and Slough 2003). Therefore, managing for adequate densities of snowshoe hare on the landbase will likely ensure an abundance of lynx foraging habitat.

Snowshoe hare typically rely on early successional forests that provide a combination of abundant foraging resources (understory forbs, shrubs and seedlings), and adequate thermal and security cover (Koehler and Brittell 1990; Fisher and Wilkinson 2005). These conditions are lacking in young cutblocks (<5 years old), but regenerating stands between 10 and 35 years of age appear to provide optimal snowshoe hare habitat (Koehler and Brittell 1990; Koehler and Aubry 1994). Late successional stands support a lower abundance of snowshoe hares primarily because of less dense understories that result in reduced cover and foraging opportunities. However, some mature habitats may be capable of supporting sufficient quantities of browse and horizontal cover to maintain small populations of hares, and therefore lynx (Mowat and Slough 2003).

While optimal lynx foraging habitat includes early successional forests that support large numbers of snowshoe hare, lynx also require physical structure (coarse woody debris) for denning. Some authors suggest that while early successional forests provide adequate foraging habitat for lynx, these young stands may not provide the physical structure required for denning (Koehler and Brittell 1990; Koehler and Aubry 1994). Given that coarse woody debris may be limited to late-successional forests, it has been suggested that lynx require a mosaic of habitats to meet both foraging and denning habitat requirements. However, lynx may be more plastic in their habitat use, surviving in single habitat types, such as early seral or mature forests, as long as these stands provide both suitable habitat for hare and forest structure required by lynx for denning (Mowat et al. 2000). In other words, stand type and age may be less important to lynx than the presence of prey and physical structure.

Landscape-scale effects

In general, lynx distribution and abundance mirrors that of snowshoe hares rather than with forest structure (Fisher and Wilkinson 2005). Consequently, any landscape scale actions that influence hare distribution and abundance will likely also influence lynx. Because snowshoe hare populations tend to be positively correlated with shrubby and herbaceous habitat associated with 10 to 30 year old cutblocks, lynx populations are not expected to be adversely affected by timber harvesting in Alberta.

Important Habitats

Conifer stands

Lynx have been shown to have a habitat preference for conifer stands in the Yukon throughout all phases of the hare cycle (Mowat and Slough 2003). This habitat preference may be tied to snowshoe hare habitat preference, since conifer stands are preferred winter habitat of the snowshoe hare. Winter is a critical time for snowshoe hare, as foraging resources are limiting due to snow pack depth and thermal cover is critical due to cold temperatures (Koehler and Aubry 1994). Conifer stands provide better thermal and security cover, lighter snow packs, and are generally warmer than deciduous stands. As a result, hares use stands with conifer overstory and a low-growing understory more often during the winter (Wolff et al. 1982; Parker et al. 1983; Fuller and Heisey 1986; Monthey 1986).

Important habitat features

Den sites

Female lynx require coarse woody debris (≥ 15 cm), such as fallen trees and root piles, for denning, security cover, and thermal cover (Koehler and Aubry 1994). While large woody debris is typically most abundant in late successional, mature stands, lynx do not select for mature habitats per se; rather, maternal



dens have been found in a variety of stand types provided that appropriate physical structure is present (Slough 1990). For example, Slough (1999) located 39 lynx dens in south-central Yukon, of which 37 were located in 30 year old regenerating stands, while only two were located in mature conifer stands; overwhelmingly, dens were located under dense tangles of blown-down trees, regardless of stand age. Similarly, Poole (1992) located maternal dens in areas of moderate to heavy deadfall in both mature conifer and regenerating mixed conifer and deciduous stands.

The density and positioning of downed woody debris appears to influence den site selection more than seral stage or stand type. For example, when modelling lynx denning habitat suitability, Gilbert and Pierce (2005) found that log density was the single most important variable in predicting lynx den microsite density. Recommendations for managing lynx denning habitat in the United States include: maintaining 2.0 ha habitat patches where the majority (75%) of the area is covered by an average of 40 downed logs/50 m, layered 0.3 to 1.2 m off the ground (Koehler and Brittell 1990). Den site habitat quality may also be influenced by degree of human disturbance, proximity to high quality foraging habitat, and habitat patch size (Koehler and Aubry 1994). As a result, denning sites that are connected to alternate denning habitat or foraging habitat are of higher quality compared to isolated den sites (Koehler and Aubry 1994).

Travel corridors

Lynx require cover for travel, security, and stalking prey, as evidenced in their avoidance of large open areas >100 m (Koehler and Brittell 1990). As a result, travel corridors connecting foraging and denning habitat may be important for maintaining lynx on landscapes influenced by forestry. Travel habitat is typically considered forested habitat that is not otherwise used for foraging or denning: including conifer or deciduous stands >2 m tall, with ≥ 450 trees/ha, and >40% horizontal cover (Koehler 1990; Koehler and Brittell 1990; Koehler and Aubry 1994). These stands are situated along natural travel routes, such as ridges, saddles, rivers, and streams where average snow accumulation is 1 m (Koehler and Brittell 1990).

8.4 RISK ASSESSMENT

Lynx benefit from early seral stages that have originated from either fire or logging. However, very recently disturbed stands (i.e., <5 years) do not provide suitable habitat because vegetation has not recovered sufficiently to provide adequate foraging habitat for snowshoe hares, and hence lynx; in addition, large openings are avoided by lynx. Therefore, DMI forestry operations could consider the following management strategies for lynx. At the stand and landscape level, maintain young (10 to 30 years old) conifer stands with $\geq 40\%$ vegetative ground cover for use by snowshoe hares in the winter which will meet the foraging habitat requirements of lynx. Maintain habitat patches for denning that are a minimum of one ha in size with large woody debris (≥ 15 cm) lying 0.3 to 1.2 m above the ground, at densities of 40 downed logs/50 m. Woody debris should cover the majority (75%) of the habitat patch (Koehler and Brittell 1990). Finally, provide travel corridors between denning and foraging habitats with minimum densities of 445 trees/ha and $\geq 40\%$ vegetative ground cover (Koehler and Brittell 1990).

There are several forest harvesting strategies that mitigate the negative effects of clearcutting on snowshoe hare (and therefore lynx), in particular variable retention and understory (conifer) protection. In addition, CWD retention and landscape-level connectivity of forested stands will also mitigate risk to lynx. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to lynx populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.



- Downed woody debris (DWD) management through retention of ‘in-situ’ dead debris after harvest and black tree retention during wildfire salvage.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

In general, stand and landscape level management strategies that maintain large patches (>2 ha) of residual forest patches, retain understory cover and CWD, and consideration of landscape level connectivity of forested stands will mitigate risk to lynx populations over the long-term.

Assessed risk to Canada lynx on DMI's FMA as a result of forestry practices – Low

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9. RED SQUIRREL

9.1 SUMMARY OF RISK

North American red squirrels (*Tamiasciurus hudsonicus*) are territorial rodents with a strong preference for mature closed canopy spruce or conifer dominated forest types to meet life requisites. They vigorously defend sex-specific territories necessary for exclusive access to food resources. Throughout the year they forage on locally abundant foods such as fungi, conifer buds, and rose hips; however, the staple of their diet is conifer seed. During the late summer and autumn, red squirrels collect and store conifer cones in central locations on their territories. This cache of cones (a midden) contains food necessary for overwinter survival. Year-round defense of individual territories and their dependence on conifer seed makes red squirrels sensitive to the structural changes in habitat caused by logging.

In general, red squirrels are virtually absent in recently cut stands (<10 years), low in young/immature forests (20 to 75 years) and abundant in mature (>75 years) stands. This relationship is not surprising given that conifer seed is the most important food resource for red squirrels and that conifer seed production increases with tree size and age. There are several forest harvesting strategies that mitigate the negative effects of clearcutting on squirrels, such as: understory (conifer) protection, pre-commercial thinning, and large patch retention. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to red squirrel populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory during the removal of ‘some’ deciduous overstory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including large areas of core old-growth stands in the long-term.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

In general, stand and landscape level management strategies that retain habitat structure, and in particular, large conifer (spruce) trees and large patches of mature coniferous forest will mitigate risk to red squirrel populations over the long-term. The protection of middens in retention patches may also be beneficial.

Assessed risk to red squirrels on DMI’s FMA as a result of forestry practices – Low

9.2 SPECIES INFORMATION

Status

Provincial: S5 Secure

Federal: N5

Global: G5

Description

The North American red squirrel (*Tamiasciurus hudsonicus*) is a diurnal mammal ranging from 270 to 385 mm in length (including its tail), and weighing between 197 to 282 g (Steele 1998). The red squirrel is distinguished from other squirrel species by its reddish coat, which can vary in colour from reddish, ferruginous brown, to olivaceous gray and includes a median band of red or brown; its underbelly is white with faint yellow, and it also has a white eye ring (Steele 1998). Its flat bushy tail has a black median band and can also vary in colour from yellowish grey to reddish. During the winter the red squirrel grows ear tufts (KRSP 2009).



Provincial Distribution

The red squirrel, a permanent resident of Alberta, is distributed across the province excluding the grassland region (Natureserve 2009).

Life History

Diet and Foraging Behaviour

Red squirrels primarily eat conifer seeds which can make up to 78% of their diet (Rusch and Reeder 1978; KRSP 2009). However, red squirrels cannot live solely on conifer seeds and can be considered seasonal and opportunistic foragers (KRSP 2009). Secondary food items such as meristem buds, tips, fungi, berries, leaves, invertebrate, bird and animal sources contribute to the red squirrel diet. During times of food shortages in the winter, spring, and early summer, squirrels may obtain their energy by stripping bark and girdling trees (Hosley 1928; Pike 1934).

Starting in mid-summer red squirrels collect and hoard conifer cones and other food items in central locations on their territories (C. Smith 1968). This cache of cones (a midden) contains food necessary for overwinter survival. Middens vary in size and number depending on habitat, food availability, individual squirrel, and age but usually contain enough food to last one to two seasons (Smith M.C 1968; Gurnell 1984, 1987; Wheatley et al. 2002). In addition to middens, squirrels save smaller amounts of cones through scatterhoarding, which can include up to 85% of all hoards and >50% of all cones stored within a territory (Hurly and Robertson 1986). Red squirrels are also known for stealing from other squirrels' hoards which can compose up to 26% of their diet (Gerhardt 2005)

Breeding Biology

Mating takes place at the end of February to the beginning of April depending on elevation, climate and latitude with young born 7 to 8 weeks later. Sexual maturity in female red squirrels is likely dependant on relative body mass gain with larger females reproducing earlier (Becker 1993). The majority (65%) of females reach sexual maturity in their second year with a small proportion (10%) reaching maturity in their first year, and the rest (25%) in their third year or later (Becker 1993; Boutin and Larsen 1993). Females are in estrus for one day and conception usually occurs within a few hours of mating (Smith C.C. 1968). Mean gestation time is 33 days (range 31 to 35 days)(Ferron and Prescott 1977; Lair 1985). Squirrel pups are usually born in April and May with one litter of 1 to 7 young (average 3 to 5) produced annually (Rusch and Reeder 1978; Humphries and Boutin 2000). Young emerge from the nest by 7 weeks, are weaned at 9 to 10 weeks of age, and are independent within a few weeks after weaning (Layne 1954; Nice et al. 1954; Boutin and Schweiger 1988; Humphries and Boutin 2000).

Site Fidelity

In general, individual red squirrels defend sex-specific non-overlapping home territories year round. Individuals are unlikely to shift territory boundaries in poor food years (Rusch and Reeder 1978), or when nearby areas become available (Price et al. 1986; Larsen and Boutin 1995). However, breeding females may occupy multiple territories until young disperse into the expanded territory (Boutin and Schweiger 1988). Some female red squirrels (up to 30%) display maternal dispersal, bequeathing home territories to their young in the fall and moving to a new territory themselves (Price and Boutin 1993). While red squirrels tend to show year-round site fidelity, seasonal site fidelity has also been observed with adults relocating to new territories, predominately in the spring (Rusch and Reeder 1978; Wheatley et al. 2002). Residents are more likely to occupy vacant territories than emigrants and adults are more successful in defending territories than juveniles (Boutin and Schweiger 1988).

Home Range

Across their range red squirrels' territory size ranges from 0.24 to 2.43 ha with area depending on a number of factors, including: habitat quality and composition, food abundance, competition, predation, level of disturbance, latitude and elevation (C.C. Smith 1968; Rusch and Reeder 1978; Gurnell 1984, 1987; Price et al. 1986). In northern Alberta, territories are generally less than 1 ha, averaging 0.24 ha in



white spruce forest, 0.35 ha in mixedwood, and 0.66 ha in jackpine dominated forest (Rusch and Reeder 1978; Larsen and Boutin 1995). Territory sizes are generally round in shape and centred on a midden to minimize the distance between the midden and surrounding food resources (Rothwell 1977). During the breeding season, male home range size increases by 10-fold relative to the non-mating season as males search for mates; female home range size increases by 2-fold during the breeding season (Lane et al. 2009).

Movements and Dispersal

Squirrels generally remain on their home territory year round; however, during spring breeding season, males can move up to 5.6 km away to find mating partners (Rusch and Reeder, 1978).

The majority of maternal and juvenile dispersal occurs in the late summer/early fall to allow individuals time to gather cones for the winter (Rusch and Reeder 1978; Boutin et al. 1993); juveniles without a midden do not survive their first winter (Larsen and Boutin 1994; KRSP 2009). However, both adults and juveniles may also disperse in the spring to occupy vacant territories (Rusch and Reeder 1978; Wheatley et al. 2002). When establishing a territory juveniles make exploratory forays (average distance 126 m) outside their mother's home territory but they do not abandon it until they acquire a vacant territory (Larsen and Boutin 1994), create a new territory, or become floaters without a home territory (Boutin and Schweiger 1988). Juveniles tend to settle within or adjacent to their natal territory (within 323m) although dispersal distances of tens of kilometers have been observed (Larsen and Boutin 1994; Haughland and Larsen 2004a). Offspring that do disperse larger distances tend to have larger home ranges and increased chances of overwintering success (Larsen and Boutin 1994).

9.3 HABITAT

North American red squirrels utilize a variety of habitats throughout their range. In Alberta, red squirrels will live successfully in all types of boreal forests regardless of seral stage and forest type, but they occur at their highest density in white spruce dominated forests (Rusch and Reeder 1978; Wheatley et al. 2002).

Forest type

In general, red squirrel densities are most related to food availability i.e. conifer cone production. Therefore red squirrels will occupy all forest types that produce enough conifer cones to support a territory including coniferous, mixedwood, and deciduous forest types. Squirrel densities vary by forest type and are highest in spruce dominated forest (1.61 to 6.84 squirrels/ha) followed by coniferous mixedwood or pine dominated stands (0.86 to 2.84/ha), with the lowest densities observed in deciduous or shrub dominated forests (0.00 to 0.99 squirrels/ha)(Rusch and Reeder 1978). In years of low white spruce mast production squirrel densities may drop to levels found in other conifer forest types (Wheatley et al. 2002).

In Alberta, red squirrels are most successful in white spruce dominated forests as indicated by higher squirrel densities, smaller territories, and greater individual body mass and reproductive success (Gurnell 1987; Wheatley et al. 2002). However, squirrels occur in a variety of forest types provided there are enough conifer cones to support individual territories. For example, mixedwood forest types with a significant white spruce understory may support high relative red squirrel densities (Fisher and Bradbury 2006). Further, squirrels will also establish territories in forests dominated by aspen as long as appropriate spruce and conifer understory is present (Fisher and Bradbury 2006).

Structural stage/seral stage

In general, red squirrels are virtually absent in recently cut stands (<10 years), low in young/immature forests (20 to 75 years) and abundant in mature stands (Kirkland 1990; DeBano et al. 1998; Fisher 1999; Herbers and Maxcy 2003; Koprowski 2005; review in Fisher and Wilkinson 2005). This relationship is not surprising given that conifer seed is the most important food resource for red squirrels (C. Smith 1968, M. Smith 1968, Rusch and Reeder 1978) and that conifer seed production increases with tree size and age (Carey 1995). Squirrel populations may take decades to recover following forest harvesting



(Crete et al. 1995; Fisher and Wilkinson 2005) because young forests (<30 years) tend to produce fewer seeds/cones than mature trees (Rusch and Reeder 1978).

Pre-commercial thinning of young stands may increase the habitat quality of regenerating stands and mitigate the risk to red squirrels which results from clearcut harvesting. For example, in lodgepole pine forests in British Columbia, young, thinned (500 stems/ha) pine stands supported red squirrel densities similar to pre-harvest levels within 12 to 14 years of thinning. If stands of 1000 stems/ha and greater were retained red squirrel densities were comparable to mature lodgepole pine stands within 3 years (Ransome and Sullivan 2002; Ransome et al. 2004).

Variable retention strategies

In general, partial harvesting strategies in conifer stands mitigate impacts of forest harvesting on red squirrel populations, although abundances are generally reduced compared to mature forest (Holloway and Malcolm 2005; Herbers and Klenner 2007). In mixedwood forest types, mixedwood understory protection (MUP) harvesting techniques maintain red squirrel populations in similar abundance to unharvested mixedwood stands (Fisher and Bradbury 2006). Using the MUP strategy, mature aspen are selectively removed while some mature aspen and spruce understory is retained. This overstory removal promotes conifer (spruce) release in the understory and therefore maintains red squirrels' main food source.

There is limited data on the minimum patch size required for red squirrels. Bayne and Hobson (2000) examined the relative abundance of red squirrels in forest fragments of different sizes (0.2 – 81 ha) in an agricultural landscape. Red squirrels were detected in 95% of the forest fragments and red squirrel relative abundance increased only slightly with fragment size suggesting red squirrels were not particularly sensitive to patch area. Côté and Ferron (2001) investigated the density of red squirrels in residual patches left after harvesting compared to mature, contiguous forests in the boreal forest in Quebec. The three types of residual patches include upland strips (2.0 – 6.9 ha), riparian strips (2.0 – 6.9 ha), and residual blocks (19 – 50 ha). Red squirrels were observed in all residual patches with no differences in density observed. Further, population parameters such as juvenile recruitment, survival, and body mass were also similar among treatments suggesting these patches provided suitable habitat for red squirrels. Together, these results suggest that red squirrels are capable of living in patches that are large enough to hold at least one territory. When large (19-50 ha) forest patches are retained, red squirrel abundance can be similar to mature forest (Cote and Ferron 2001).

In terms of pattern, red squirrels preferentially harvest cones in patches rather than in dispersed (single tree) retention stands (Peters et al. 2003). This is not surprising given that red squirrels avoid forest openings (Pelech 1999; Herbers 2001). Currently, no threshold number of stems has been identified to maintain red squirrels in partially harvested stands. However, squirrel densities increase with the number of residual trees left behind (Herbers and Maxcy 2003). Therefore, maintaining trees in patches and increasing the percent of trees behind will mitigate risk to red squirrels.

Fragmentation and Edge effects

Although the effect of fragmentation on red squirrels has been little studied, fragmentation does not appear to negatively impact red squirrel populations. For example, Bayne and Hobson (2000) found that red squirrel densities were higher in fragmented forest than contiguous forest in an agricultural landscape. While red squirrels tend to avoid forest openings, edges do not appear to affect red squirrel habitat use. Pelech (1999) reports that red squirrels selected for edge habitat from late spring to early summer, but showed neutral selection for edge in late summer. Of eighteen red squirrels that had territories bordering canopy openings larger than 0.2 ha, squirrels strongly avoided habitat ≥ 10 m into an opening and selected habitat in proportion to its availability from the edge up to 30 m into the forest (Herbers 2001). Juveniles were observed to have higher survival rates and relative densities in territories containing forest edges (Anderson and Boutin 2002). The edges created by forest patches appeared to provide red squirrels with



greater access to alternative food sources including songbird eggs without an observed increase in squirrel predation rates (King et al. 1998; Willson et al. 2003; Koprowski 2005).

Landscape-scale characteristics

Red squirrel abundance seems to be better explained by stand level characteristics (e.g. large spruce trees) than landscape-scale characteristics (Fisher et al. 2005; Holloway and Malcolm 2006). At large spatial scales, the ecological importance of different patch types can change depending on landscape context as well as the scale and year analyzed (Fisher et al. 2005). For example, in northeastern Alberta red squirrels were associated with deciduous stands in a landscape in which conifer stands were burned; however, squirrel presence in general was positively correlated with large homogenous tracts of conifer dominated forest where these stands were available (Fisher et al. 2005). In Quebec, red squirrel populations are maintained if 30% of the landbase was retained in large forest patches (Potvin and Bertrand 2004). The threshold level of mature forest patches to maintain at the landscape level to provide habitat and mitigate risk to squirrel populations is unknown.

Important Habitats

Spruce and conifer dominant stands

As mentioned previously, red squirrels live in a variety of habitat types but red squirrel densities are highest in conifer stands (e.g. *Pinus* spp., *Abies* spp., *Picea* spp., and *Pseudotsuga menziesii*) because of the abundance of conifer seeds (M. Smith 1968; Rusch and Reeder 1978). In conifer-dominated stands red squirrels have increased body mass (Rusch and Reeder 1978; Boutin and Larsen 1993), reproductive success (Haughland and Larsen 2004b), and overwinter survival rate (Rusch and Reeder 1978; Larsen and Boutin 1994) compared to mixwood or deciduous stands. Coniferous forests also provide better forage, cover from predators and thermoregulatory properties (Flyger and Gates 1982; Rusch and Reeder 1978; C. C. Smith 1968; Vahle and Patton 1983).

Spruce stands in particular provide high quality habitat for red squirrels. As the percentage of spruce in the canopy increases, there is a compensatory effect on the habitat quality. That is, squirrels can survive in forest types with no spruce; however, habitat quality, and therefore squirrel density increases with increasing percent of spruce in the canopy (Herbers and Maxcy 2003). In a meta-analysis of squirrel abundance and tree species composition, abundance was approximately two times higher in mature stands with greater than 75% spruce compared to stands composed of less than 25% spruce (Herbers and Maxcy 2003).

Important Habitat Features

Tree size

Red squirrel abundance is related to higher densities of large conifer trees at the stand level (Herbers 2001; Holloway and Malcolm 2006). For example, the density of large, live conifer trees (≥ 30 cm dbh) was the best explanation of red squirrel territory size in Douglas-fir forests in central British Columbia (Herbers 2001). When the density of trees ≥ 30 cm dbh trees fell below 50 to 60 stems per ha territory sizes increased, likely to encompass additional conifer resources. In contrast, there was little change in squirrel territory size in areas where tree densities ranged from 50-60 stems per ha up to 110 stems per ha. Similarly, red squirrel densities were positively correlated with the density of large (> 25 cm/dbh) spruce trees in Ontario. This relationship to large trees again is likely related to increased abundance of conifer cones, their primary food source

Foraging

Red squirrel select tree species with the highest seed energy per cone, and then concentrate on the tree species with the next highest energy value (Smith 1970); therefore, in Alberta red squirrels select white spruce cones because of their energy content followed by black spruce, and then pine cones.



9.4 RISK ASSESSMENT

Given that red squirrels are forest dwelling species and are negatively affected by clearcut harvesting, the key to minimizing risk squirrels is the protection, maintenance and recovery of forest habitats. Currently, DMI forestry operations include several strategies at the stand and landscape level that will mitigate risk to red squirrel populations on their operational landbase, including (but not limited to):

- Variable retention target of 0 to 30% at the block level including 7.5% as large patches greater than 2 ha.
- Management to retain conifer understory during the removal of ‘some’ deciduous overstory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types including old-growth stand representation in perpetuity.
- Natural-disturbance regime based strategy to maintain ‘large areas’ of old core forest in the long-term on the landscape.
- Variable retention landscape-average target of 15% to provide widespread structural complexity in the long-term across the landscape, and that by design is inherently well-distributed across the landscape. This distribution of structure is ‘in addition to’ structure associated with buffers and all other voluntary (passive) reserves.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

Overall, stand and landscape level management strategies that retain habitat structure, and in particular, large conifer (spruce) trees and large patches of mature coniferous forest will mitigate risk to red squirrel populations. The protection of middens in retention patches may also be beneficial.

Assessed risk to red squirrels on DMI’s FMA as a result of forestry practices – Low

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10. SNOWSHOE HARE

10.1 SUMMARY OF RISK

Snowshoe hare may live in a range of habitat types provided that adequate understory cover and browse species are present. In general, they are generally considered an early successional species as they are often more abundant in regenerating stands compared to mature/old control forest. While snowshoe hares are abundant in regenerating forests, recent clearcuts provide unsuitable habitat. Given the importance of snowshoe hare as a keystone prey species for many predators, and in particular lynx, management practices that retain forest patches and understory structure at threshold levels of >75% will mitigate risk to snowshoe hare populations in harvested landscapes.

There are several forest harvesting strategies that mitigate the negative effects of clearcutting on snowshoe hare, in particular variable retention and understory (conifer) protection. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to snowshoe hare populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types.
- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

In general, stand and landscape level management strategies that large patches (>2 ha) of residual forest patches, and retain understory cover will mitigate risk to snowshoe hare populations over the long-term.

Assessed risk to snowshoe hare on DMI's FMA as a result of forestry practices – Low

10.2 SPECIES INFORMATION

Status

Provincial: S5

Federal: N5

Global: G5

Description

The snowshoe hare (*Lepus americanus*) is approximately 25 to 40 cm long and weighs between 0.9 and 2.3 kg (average 1.3 kg), with adult females weighing 10 to 25% more than adult males (Banfield 1974; Murray 2003). Snowshoe hare have long, black-tipped ears, and a coat that changes from brown-grey during the summer to white during the winter. The snowshoe hare gets its name from its large back feet (10 to 15 cm long), which help to keep the animal on top of deep snowpack. Hares are most active during the night (Foresman and Pearson 1999), and spend the majority of the day resting in sheltered spots under logs, stumps or bushes (Soper 1964; Banfield 1974; Natureserve 2009).

Provincial Distribution

The snowshoe hare is a year round resident that is distributed across Alberta, with the exception of the southeast corner of the province (Natureserve 2009).

Life History

Diet and Foraging Behaviour



Snowshoe hares specialize on green herbaceous vegetation during the summer and switch to woody plant species during the winter. Forage preference appears to be driven by energy and protein requirements, with hares avoiding larger, older plants that may have high concentrations of secondary compounds, and selecting for young buds on smaller plants (<4 mm diameter) (Klein 1977; Sinclair et al. 1982; Sinclair and Smith 1984; Rogowitz 1988; Sinclair et al. 1988; Schmitz et al. 1992; Rangen et al. 1994; Rodgers and Sinclair 1997; Hodges and Sinclair 2003; Secombe-Hett and Turkington 2008). Regardless of season, snowshoe hares choose browse sites located within 1 m of cover (Hodges and Sinclair 2005) and prefer to forage in areas with >75% lateral vegetative closure (Ferron and Ouellet 1992).

Breeding Biology

Snowshoe hares begin breeding in late-March, and females give birth to litters of 1 to 9 young within 34 to 40 days of breeding. Females will re-mate within hours of giving birth, and as a result, each female can produce up to four litters per year (Ellsworth and Reynolds 2006; Banfield 1974). Newborn snowshoe hares are precocial, fully furred, and can open their eyes within an hour of birth (Severaid 1942). Young are nursed daily for up to 28 days, and reach an adult weight at approximately 5 months. Females produce their first litters the spring following birth and live up to three years (Soper 1964; Banfield 1974; NatureServe 2009).

In Alberta, snowshoe hare populations are cyclical, with population densities peaking in 8 to 11 year intervals (Ellsworth and Reynolds 2006). During years in which the snowshoe hare population peaks, females can produce litters of up to 18 young. Conversely, during years in which populations are declining, there is a reduction in both the number of litters and number of young produced by females, with females experiencing reproductive failure in some years. This population cycling is thought to be driven by forage availability and predation pressure, primarily by lynx (Keith 1990; Krebs et al. 1995; Hodges et al. 2001; Krebs et al. 2001).

Site Fidelity

Snowshoe hares remain in their home range throughout their life. They do not defend their territory, but rather, share home ranges with conspecifics regardless of age or sex (Boutin 1980; Boutin 1984b).

Home Range

Home range size varies from <1 ha to 100 ha, depending on habitat quality; however, the majority of home ranges are <10 ha (Keith 1990; Keith et al. 1993; Hodges 2000; Murray 2003). Home range size may change in response to population density (Murray 2003), per capita food resources (Boutin 1984a; Hodges 1999), habitat quality (Murray 2003), predation risk (Hodges 1999), or access to breeding opportunities (Hodges 1999).

Movements and Dispersal

Young stay at their natal site for an average of 2.7 days, then explore progressively farther from the natal site until they are weaned (O'Donoghue and Bergman 1992; Gillis and Krebs 1999). After weaning, juvenile hares will disperse up to 20 km, with the majority of dispersal movements being <10 km (Aldous 1937; O'Farrell 1965; Keith et al. 1993; Hodges 1998; Gillis and Krebs 1999; Griffin 2004; Bray et al. 2007). Juvenile males may disperse sooner and travel further than females (Bray et al. 2007). Dispersal of snowshoe hares may be influenced by both population density and habitat quality. For example, during years where the population has peaked, juvenile hares will disperse long distances (Windberg and Keith 1976; Boutin et al. 1985). Dispersal rates are higher in areas with small habitat patches and low cover (Keith et al. 1993; Wirsing et al. 2002).

10.3 HABITAT

Snowshoe hare habitat preference is driven primarily by seral stage, understory cover (St-Laurent et al. 2008a), and vegetative composition rather than by forest type (Ferron and Ouellet 1992). Snowshoe hares occupy a wide variety of forest types including: conifer, mixedwood and deciduous forests, orchards, tree plantations, and riparian woodlands (Adams 1959; Wolff 1980; Wolfe et al. 1982; Pietz and Tester 1983;



Carreker 1985; Litvaitis et al. 1985; MacCracken et al. 1988; Ferron and Ouellette 1992; Hodges 2000; Wirsing et al. 2002; Murray 2003; Zimmer 2004).

Structural stage/seral stage

Habitat suitability for snowshoe hares is generally not determined by forest age but rather by availability of browse and understory cover, particularly in the winter. As a result, snowshoe hares can be found in a range of seral stages depending on forest type, with the exception of recent clearcuts which are generally avoided because of lack of cover (Gashwiler 1959; Pietz and Tester 1983; Murray et al. 1994; St.-Georges et al. 1995; St. Laurent 2008). However, once regenerating stands reach 2 to 3 m in height which can occur in as little as 10 years in some forest types, these stands can support high densities of snowshoe hares; these stands sometimes support hare densities greater than densities found in uncut forest (Parker 1984; Monthey 1986; Darveau et al. 1998; Darveau et al. 1998; Newbury and Simon 2005; St-Laurent et al. 2008b).

Habitat recovery varies by forest type. For example, harvested deciduous and mixedwood forests may have enough browse and lateral cover to provide good habitat for snowshoe hares within 10 years after harvest (Potvin et al. 2005b). Conifer dominated forests may take slightly long to recover depending on the forest type ranging from 13 to up to 30 years for black spruce dominated stands (de Bellefeuille et al. 2001; Potvin et al. 2005b). In pine-dominated stands, hares are most abundant in stands <50 years old but not in very young (<20 years) or mature (>50 years) pine stands (Koehler et al. 1979; Koehler 1990; Malloy 2000; Zimmer 2004; Miller 2005). Some mature forest types (e.g. mature spruce-fir forests) can provide high quality habitat for hares (Wolfe et al. 1982; Zahratka 2004; Miller 2005). Finally, while recently harvested stand are unsuitable for hares, early successional fire created stands can support high densities of hare populations because the quick regeneration of vegetation provides abundant food and cover. Overall, snowshoe hare use most habitats found within Alberta; dense shrub, early seral deciduous forest, and late seral coniferous forests seem to provide optimal levels of browse and understory cover throughout the seasons.

The impacts of one particular silvicultural practice, precommercial thinning, has been relatively well studied for snowshoe hares. As snowshoe hare require sufficient amounts of understory protection pre-commercial thinning usually leads to lowered snowshoe hare levels (Sullivan and Sullivan 1988; Abele 2004; Griffin 2004; Ausband and Baty 2005; Etcheverry et al. 2005; Griffin and Mills 2007). Over the longer term, however, precommercial thinning may pose no more risk to snowshoe hares than unthinned harvested stands (Griffin and Mills 2004; Zimmer 2004; Sullivan et al. 2006; Sullivan and Sullivan 2007), and may actually be beneficial in some forest types (e.g. pine)(Zimmer 2004).

Partial Retention

Snowshoe hares avoid open areas and rarely cross openings without adequate understory cover due to increased predation risk. Further, edge habitats such as forest/clearcut edges or riparian buffers are also avoided by snowshoe hares which is also likely a response to increased predation risk (Darveau et al. 1998; Etcheverry et al. 2005; Potvin et al. 2005a; St. Laurent et al. 2008a). Therefore, any form of retention adjacent to unharvested forest including the retention of large forested patches (at least 100 m in width) as well as understory retention mitigates risk to snowshoe hare populations as a result of forest harvesting (Etcheverry et al. 2005; Potvin et al. 2005a).

Important Habitats

Snowshoe hare are found in many habitat types and select these habitats based on microhabitat characteristics, such as understory cover (St-Laurent et al. 2008a) and vegetative composition rather than by forest type (Ferron and Ouellet 1992).

Important Habitat Features

Stand characteristics



Understory cover meets snowshoe life requisites for winter forage, winter thermal cover, and predation protection; it is therefore the primary determinant of habitat quality for snowshoe hare. The threshold level of cover required at the stand level is >75% cover, below which habitat becomes less suitable (Ferron and Ouellet 1992; St Laurent et al. 2008a). As understory cover varies by tree species, seral stage, and understory composition, habitat quality varies by forest type. In general, younger forests, whether deciduous or conifer dominated, provide more forage and cover requirements compared to very young regenerating or old/mature forests. Overall, stands with high amounts of lateral vegetation and understory cover and sufficient browse provide optimal snowshoe hare habitat.

Stem density can be an indirect measure of understory cover. Stem densities of 4,600 to 33, 210 stems/ha depending of forest type and seral stage have been found to be optimal (Wolff 1980; Parker 1984; Litvaitis et al. 1985; Monthey 1986; Parker 1986; Koehler 1990; Griffin 2004). Forests with stem densities lower or higher than the optimal range usually are too open or too dense to provide sufficient understory cover.

Denning/Resting

Snowshoe hare rest during the day in a sheltered spot (e.g. under a bush, log or stump) with a lot a high level of lateral vegetative closure (>75%)(Natureserve 2009). Snowshoe hare may utilize burrows dug by other animals for resting but do not den themselves. In the winter, snowshoe hare also chose sites under conifer with high levels of lateral vegetative closure or in stands with dense shrub and high understory cover.

Foraging

Foraging sites have similar characteristics to resting sites as both foraging and resting sites are characterized by high vegetative cover. In both the summer and winter at sites with 75 to 95 % vegetative cover (Ferron and Ouellet 1992; Etcheverry et al. 2005; Hodges and Sinclair 2005).

10.4 RISK ASSESSMENT

Snowshoe hares are generally considered an early successional species as they are often more abundant in regenerating stand compared to mature/old control forest (Parker 1984; Monthey 1986; Darveau et al. 1998; Newbury and Simon 2005; St-Laurent et al. 2008b). Given the importance of snowshoe hare as a keystone prey species for many predators, and in particular lynx, management practices that increase the amount of deciduous understory, and early successional conifer or deciduous forest with high understory cover will mitigate risk to snowshoe hare populations in harvested landscapes. However, as snowshoe hare populations are dramatically reduced after harvesting and some stands do not recover sufficient levels of understory cover, have high stem densities, and take time to recover adequate tree heights relative to snow pack (Potvin et al. 1999) harvesting should not be seen as a way to potentially increase snowshoe hare populations.

There are several forest harvesting strategies that mitigate the negative effects of clearcutting on snowshoe hare, such as: variable retention and understory (conifer) protection. Currently, DMI forestry operations include a number of these strategies at the stand and landscape level that mitigates risk to snowshoe hare populations on their operational landbase, including (but not limited to):

- Variable retention targets at the block (0 to 30% retention) and landscape (15% retention) including large patch retention to provide widespread structural complexity that is well distributed within blocks and across the landscape.
- Management to retain conifer understory.
- Natural-disturbance regime based strategy to maintain the full range of forest habitat types.



- Consideration of the ecological and hydrological connectivity between protected areas, passive areas of landscape (i.e. wetland complexes), provisioned permanent buffers, and areas voluntarily excluded from timber supply.

In general, stand and landscape level management strategies that large patches (>2 ha) of residual forest patches, and retain understory cover will mitigate risk to snowshoe hare populations over the long-term.

Assessed risk to snowshoe hare on DMI's FMA as a result of forestry practices – Low

10.5 LITERATURE CITED

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11. WOLF

11.1 SUMMARY OF RISK

Wolves are a large, wide-ranging wild dog species that occurs throughout most of North America and Eurasia. Within the province of Alberta, wolves are considered stable or increasing; a phenomenon that has been attributed to higher ungulate densities and decreased persecution by humans. Wolves are considered habitat generalists, and tend to use those areas of their territories where prey densities or prey vulnerability are highest. Rivers, streams, lake edges, and ridgelines have historically been considered important habitat features for wolves. Recent evidence suggests that anthropogenic linear features may similarly be important travel corridors for wolves, and may result in altered predator-prey dynamics. Except where subsequent human persecution of wolves occurs, wolf populations are not generally negatively affected by forestry activity. Rather, wolf populations may show increases in regions where the early seral habitat that results from logging has resulted in high densities of deer, elk, and moose.

Assessed risk to wolf on DMI's FMA as a result of forestry practices – Very low

11.2 SPECIES INFORMATION

Status

Provincial: SNR (not ranked)

Federal: NNR

Global: G4 TNR (Apparently Secure) - Uncommon but not rare; some cause for long-term concern due to declines or other factors.

Description

The wolf (*Canis lupus*) is the largest of the wild dog species. They vary geographically in size and coat colour (Nowak 1995); however, in North America they are approximately 139 to 170 cm in length (including tail), stand 66 to 71 cm at the shoulder, and generally weigh between 31 and 54 kg (Burt and Grossenheider 1980). Although wolves are usually grey, their coats can range from black to almost white in colour (Nowak 1995).

Provincial Distribution

Historically, wolves were found across most of North America and Eurasia (Young and Goldman 1944; Mech 1970, 1995); however, they have been extirpated from much of their former range and are currently confined to the more remote parts of their range (Boitani 1995; Musiani and Paquet 2004). The subspecies (*C. l. occidentalis*) that occurs in Alberta is similarly confined to more remote forested areas (Nowak 2003). Most notably permanent populations of wolves in Alberta occur in the Rocky Mountains and foothills and in northern Alberta; an area of about 400,000 km² or 60% of the province (Hayes and Gunson 1995).

Life History

Diet and Foraging Behaviour

Wolves are a large, wide-ranging carnivore capable of moving over extensive areas encompassing a variety of habitats containing variable prey densities, and consequently have often been described as habitat generalists (Mech 1970; Mladenoff et al. 1995; 1999). Although wolves have been shown to subsist on garbage, rodents, carrion, and domestic livestock (particularly in Europe and Asia Minor), wild prey, particularly ungulates, is the main food of wolves (Peterson and Ciucci 2003). In Alberta, wolves prey primarily on ungulates, most notably elk (*Cervus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*O. virginianus*) (Fuller and Keith 1980; Bjorge and Gunson 1989; Huggard 1993; James et al. 2004; Latham 2009; Webb 2009). Beaver (*Castor canadensis*) have also been shown to be an important



prey species for wolves in North America (Peterson 1977; Messier 1985; Peterson and Ciucci 2003), including Alberta (Fuller and Keith 1980; Latham 2009).

Wolves use keen hearing, an acute sense of smell, and excellent eyesight to locate prey over large areas, even when prey is scarce (Harrington and Asa 2003; Peterson and Ciucci 2003). Although wolves often hunt in packs or pairs, single individuals are known to kill even large prey such as moose (Thurber and Peterson 1993), bison (D. Dragon, cited in Carbyn et al. 1993), and muskoxen (Gray 1970). Many experts suggest that wolf pack hunting and killing of prey is initiated primarily by the breeding pair, with young members of the pack contributing little to the attack (Mech 1966; Haber 1977). The hunt sequence usually involves some combination of locating, stalking, encountering, and chasing the prey (Peterson and Ciucci 2003). Wolves often target those prey species that are most vulnerable to predation, e.g., wolves tend to target the less fit individuals in a population, those species that are less able to cope with deep or dense snow in winter, or those species that are less aggressive and dangerous to wolves (Kelsall 1969; Mech 1970; Mech and Peterson 2003).

Breeding Biology

Although all wolves are capable of breeding, their social environment usually permits that only the mature breeding pair within a pack mate and produce a litter of pups (Packard 2003). Wolves mate in winter, and females have a gestation period of 60 to 65 days (Mech 1970; Kreeger 2003; Packard 2003). An average litter of between 5 and 6 pups is born in April to May (Fuller et al. 2003). Wolf den sites are usually located near water, but can occur in a variety of habitats, such as forestry cutblocks, crevices on rocky or sandy ridges, under tree roots in forests, and above-ground under dense over-hanging branches (Mech 1970; Mech 1988; Latham 2009). Wolf pups' eyes open at about 12 to 14 days (Mech 1970). At this stage, pups make exploratory movements within the natal chamber of the den, gradually making larger movements around the immediate vicinity of the den at about 5 weeks of age (Packard 2003). Pups are normally weaned from their mother's milk at 5 to 9 weeks of age (Kreeger 2003), and sufficiently mobile to follow the pack on hunts at 4 to 10 months of age (Packard 2003).

Site Fidelity

Wolves are generally highly territorial (Mech and Boitani 2003), and wolf pack territories tend to be large enough to support sufficient vulnerable prey for pack members to make a living (Peterson et al. 1984). Further, extraterritorial movements often result in intraspecific strife amongst wolves, and with the exception of human-caused mortality this strife is the greatest source of mortality in wolf populations (Fuller et al. 2003). Consequently, wolf packs tend to show high fidelity to their territories. However, it is important to note that most juveniles will disperse from their natal pack to seek mating opportunities at some point between 11 to 24 months (Mech and Boitani 2003). Regardless, most individuals in a wolf population will be associated with their territory, and only 10 to 15% of individuals within a population at any one point in time are lone wolves (without a pack)(Fuller et al. 2003).

Except where wolves are persecuted by humans (Musiani and Paquet 2004), wolves are generally tolerant of human disturbances such as logging, and are unlikely to abandon their territories because of such activities (Fuller et al. 2003; Fisher and Wilkinson, 2005). Indeed it has been hypothesized that wolves may benefit from the higher moose and deer numbers associated with the footprint from industrial practices (Cumming 1992; James et al. 2004). However, during the denning season wolves may be affected by natural events (such as heavy rain) or human disturbances, particularly when the disturbance occurs close to active den sites (Fritts et al. 2003; Latham 2009). Such circumstances may result in the movement of pups to alternative den locations within the territory (Latham 2009; Webb 2009).

Home Range



A wolf pack's home range is termed a territory, i.e., a defended home range (Mech and Boitani 2003). Territory sizes can vary by an order of magnitude, and tend to be influenced by factors such as latitude, pack size, prey size and distribution, and the number of points used to define the territory (Mech and Boitani 2003). Past studies have typically shown that prey density affects wolf territory size, with smaller territories having high prey densities of species such as white-tailed deer (e.g., Fuller 1989) and larger territories having low densities of prey like moose (e.g., Fuller and Keith 1980). In Alberta territories typically range from about 300 to 1,000 km² (Fuller and Keith 1980; Latham 2009), a phenomenon that is likely related to differences in ungulate species composition and abundances throughout the province (Hayes and Gunson 1995). In general, wolf pack territories form a hexagonal mosaic across the landscape (as this spacing allows for the maximum number of territories), with all suitable habitat being occupied by packs (Mech and Boitani 2003).

Movements and Dispersal

Wolves make widespread and regular movements within their territories to secure prey and to mark territory boundaries (Mech and Boitani 2003). Even in territories as large as 1,600 km², wolves can cover their territory in a single day (Mech 1970). Wolves frequently use natural features such as rivers and streams, shore lines, and ridges as travel routes within their territories (Stenlund 1955; Mech 1966; Jordan et al. 1967; Mech and Frenzel 1971; Peterson 1977; Latham 2009). Recent research has shown that wolves also use anthropogenic linear features, particularly those that receive limited human activity (e.g., Thurber et al. 1994; Jalkotzy et al. 1997; James 1999; James and Stuart-Smith 2000; Ciucci et al. 2003; Whittington et al. 2005; Hebblewhite and Merrill 2008): a factor that may alter historical wolf-prey relationships (James et al. 2004; Latham 2009).

Most wolves will disperse from their natal pack (Mech and Boitani 2003). These movements are motivated primarily by food, mating opportunities, and the possibility of locating an available territory. Dispersal may occur at a wide variety of ages, but most commonly happens at 11 to 24 months (Fritts and Mech 1981; Peterson et al. 1984). Dispersals may occur as exploratory predispersals with the individual returning to the natal pack before eventually dispersing permanently, or dispersals may occur as a single permanent, distant emigration (Mech and Boitani 2003). The distances associated with dispersals vary from short movements into adjacent territories, to floating around the local population, to dispersals up to a distance of 886 km (Van Camp and Gluckie 1979; Fritts and Mech 1981; Wabakken et al. 2001; Latham 2009).

11.3 HABITAT

Wolves are widely considered to be habitat generalists (Mech 1970; Mladenoff et al. 1995; 1999), gravitating to areas within their territories where prey reside (Mech and Boitani 2003). Consequently, wolf habitat use and selection (particularly in the absence of human persecution) is largely determined by the distribution, abundance, and relative vulnerability of their prey (Mech and Boitani 2003).

Structural stage/seral stage

Limited data exists on wolf use of successional stages of forest stands; however, wolves are believed to use both logged and burned habitat of 1 to 10 years, establishing forest (11 to 25 years), and forest in the aggradation stage (26 to 75 years), although abundance is unknown (Fisher and Wilkinson 2005). It has been reported that wolves tend to avoid burned stands for 2 years post-fire, but used burns approximately 3 years post-fire; a phenomenon that may be related to prey use of burns (Ballard et al. 2000). Wolves have been observed using 10 to 15 year old burns (Theberge and Pimlott 1969; Schwartz and Franzmann 1989), although further details are unavailable (Fisher and Wilkinson 2005).



In general, wolf populations are not affected by forestry or the human activity associated with logging, except where those activities facilitate accidental or intentional killing of wolves or change prey density (Fuller et al. 2003). A number of authors in Alberta have hypothesized that logging may result in increases in deer, elk or moose densities, a factor that may result in a numeric response by wolves (e.g., Cumming 1992; Smith et al. 2000; James et al. 2004). Latham (2009) found that wolves in northeastern Alberta showed strong selection for forestry cutblocks in both snow (October-March) and snow-free (April-September) seasons; possibly because of high white-tailed deer numbers associated with cutblocks. Little is known about wolf use of more mature forest stands, although wolf use of this habitat is also likely related to prey density (Mech and Boitani 2003).

Important Habitats

Wolves are found in a wide variety of habitats across their range, including tundra, boreal forest, temperate forest, mountains, prairies, and desert (Mech and Boitani 2003). So long as they have sufficient food, and are not heavily persecuted by humans, wolves can exist in many different types of habitat (Boitani 1995). James et al. (2004) showed that well-drained upland habitat was more important habitat for wolves in northeastern Alberta than black spruce (*Picea mariana*)-tamarack (*Larix laricina*) bogs and fens. Despite high prey densities in many agricultural zones, wolves are absent, or occur sporadically within these areas because of high persecution by humans (Boitani 1995; Musiani and Paquet 2004).

Important Habitat Features

Wolves live, hunt, and den in a variety of habitats; however, some habitats have been shown to be important for wolves (Mech and Boitani 2003). Wolves usually den near water (Mech 1970), as well as travel and hunt on lake shores and rivers and streams (Stenlund 1955; Mech 1966; Jordan et al. 1967). In northeastern Alberta, wolves show strong selection for rivers, streams, and other water bodies; probably because of the high availability of beaver associated with these areas during summer months and as travel corridors during winter months (Fuller and Keith 1980; Latham 2009). In western Alberta, large wolf packs are frequently observed using river valleys (Dekker et al. 1995; Webb 2009).

Recent research has highlighted the potential importance of anthropogenic linear features as travel corridors for wolves (e.g., Jalkotzy et al. 1997; James and Stuart-Smith 2000; Ciucci et al. 2003). For example, wolves have been shown to travel faster on seismic lines and other linear features than in adjacent forested habitat (James 1999), a phenomenon that may alter wolf movements across their territories (Fritts et al. 2003; Whittington et al. 2004). Similarly, it has been hypothesized that linear features may increase wolf hunting efficiency by increasing rates of travel and line-of-sight, or altering the orientation of wolf movements within territories, factors that may result in increased encounter rates between wolves and their prey (James 1999; James and Stuart-Smith 2000; Latham 2009). However, anthropogenic linear features, particularly roads, can also result in high human-caused wolf mortality (Paquet and Callaghan 1996; Fritts et al. 2003; Musiani and Paquet 2004).

11.4 RISK ASSESSMENT

Wolf habitat use and selection (particularly in the absence of human persecution) is largely determined by the distribution, abundance, and relative vulnerability of their prey (Mech and Boitani 2003). Considered habitat generalists, wolves are not directly affected by forestry practices but rather are hypothesized to be indirectly affected due to increased prey densities associated with early seral forest.

Assessed risk to wolf on DMI's FMA as a result of forestry practices – Very low



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