Snowshoe Hare Population trend within Harvested Landscapes in Central-Northwest British Columbia

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Prepared For:

Forest Lands and Natural Resource Operations

Under direction of the Dothistroma Steering Committee

Contract #: GS12SME007

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December 2011

Executive Summary

Snowshoe hare populations in central-northwest British Columbia have been monitored since 2000 as part of several projects that are looking at snowshoe hare demography, and reducing the impact of snowshoe hare browsing damage on seedling trees.

Throughout this region hare populations have been monitored across two Biogeoclimatic Zones, the Interior Cedar Hemlock and the Sub-Boreal Spruce across the Nadina, Kalum and Skeena Stikine Forest Districts. Monitoring has taken place at 27 distinct sites, using fecal pellet sample quadrats (10X300cm).

Across the area as a whole the cyclic hare populations has been at a low in numbers since 2006, and is now possibly increasing across the region with a predicted peak in numbers in 2013-2014.

Overall, the Dothistroma and Mountain Pine Beetle outbreaks have increased the suitability of the landscape for hares, with an increase in the suitability of forest understorey for hares as a result of needle loss. Both this change and the change at a landscape scale to a forest dominated by young seral stands, will potentially result in the landscapes of central-northwest British Columbia predictably starting to support higher snowshoe hare densities.

From a re-stocking perspective “if the numbers of hares predictably increases” seedling trees underplanted over the next 2-5 years in MPB and Dothistroma killed and attached pine stands, may be expected to be vulnerable to browsing by hares. For those seedlings planted at the low of the hare cycle a re-assessment of seedling survival and damage may also be required after the peak in hare numbers, to determine if these trees were damaged by the hares, and if restocking requirements are still being met.

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Acknowledgements

This project is indebted to initial project funding support from the Ministry of Forests and Range, Forests for Tomorrow (FFT) in the Northern Interior Region, Nadina Forest District, and to the continued support from Forest Lands and Natural Resource Operations, Smithers.

Introduction

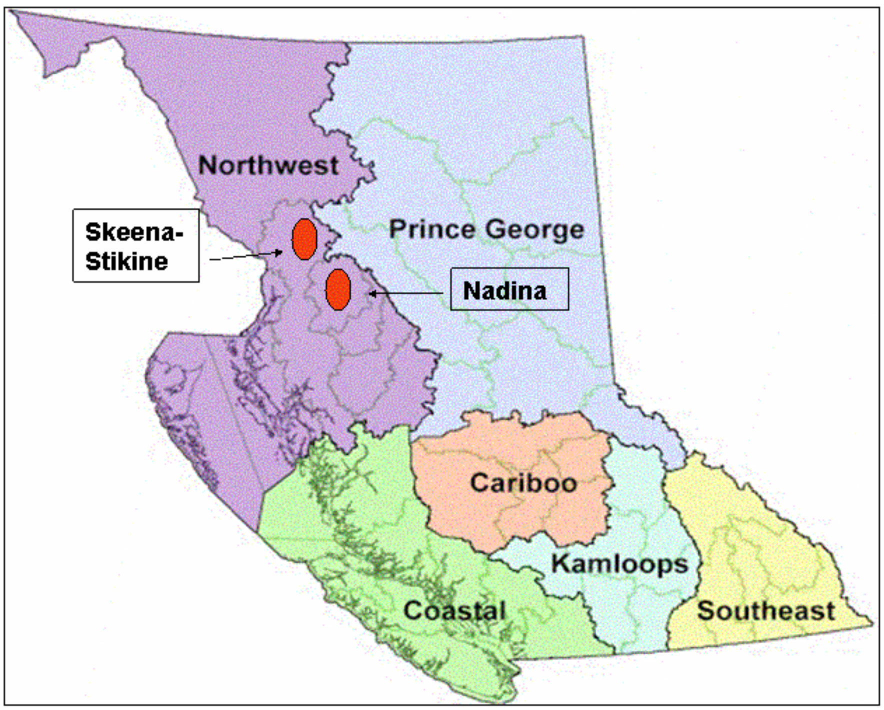
Snowshoe hares (*Lepus americanus*) have been identified as a focal species within the Boreal Forest Ecosystem (Krebs et al. 2001a), and have also been identified as a major pest species in young forest plantations, as they can cause severe damage to seedling trees (Sullivan & Sullivan 1982, Sullivan 1984, Doyle 2006a).

Knowing how snowshoe hares respond to changes in landscape habitat conditions, and when they cause damage to young trees are therefore of interest for both ecosystem forest stewardship and for forest health and silviculture purposes. In addition to the presentation of the landscape scale snowshoe hare population monitoring, this report collates the information on hare populations that has been collected through the course of several hare studies initiated in central and north-western BC since 2000.

Methods

Location

Within central-northwest BC three studies have been initiated that require information on the relative abundance of snowshoe hares (Reid and Doyle 2005), Doyle 2006b, Doyle 2007), in the Nadina, Kalum and Skeena-Stikine Forest Districts (Map 1).



Map 1. Snowshoe Hare study areas (in red) in central-northwest BC

The Nadina Forest District is primarily within the Sub-Boreal Spruce biogeoclimatic (BGC) zone (Banner *et al*. 1993), of the Lakes and Morice Forest Districts (Figure 1). Mature stands on zonal sites are frequently dominated by lodgepole pine (*Pinus contorta*), with subalpine fir (*Abies lasiocarpa*), hybrid white spruce (*Picea glauca x engelmannii*), and trembling aspen (*Populus tremuloides*). Stands are mostly even aged with closed, single storied canopies resulting from frequent forest fires (i.e. every 100-150 years on average).

The Skeena Stikine Forest District is in contrast primarily within the Interior Cedar Hemlock (ICH) and Coastal Western Hemlock (CWH) biogeoclimatic zones

(Banner *et al*. 1993). This area falls primarily within the Northern Skeena Mountains Ecosection of the Sub-Boreal Interior Skeena Mountains Ecoregion and also partly in the Nass Ranges Ecoregion. Forests within the ICH and CWH are predominantly old growth (>200 years) coniferous stands dominated by western hemlock (*Tsuga heterophylla*), but including subalpine fir (*Abies lasiocarpa*; and balsam fir (*Abies amabilis*) *in the CWH*), western redcedar (*Thuja plicata*), and Roche spruce (*Picea sitchensis x glauca*). In the valley bottoms deciduous and mixed wood stands of trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are interspersed with cultivated fields and acreages.

Study Design

In all three studies the relative abundance of hares is assessed by sampling for fecal hare pellets in 10 x 300 cm quadrats (after Krebs et al. 2001b), at the end of winter (early April-May), and again at the end of summer (September-October) (Table 1).

Table 1. Snowshoe Hare monitoring studies in central-northwest BC.

Forest District	Study Reference	Study Focus	Trial Initiation Date	# of trial Sites	# of Hare pellet quadrats per site	Total Number of hare pellet quadrats
Nadina	Reid and Doyle 2005, Doyle 2006a	Landscape	2000	3	120	360
Nadina	Reid and Doyle 2005, Doyle 2006a Doyle 2006a	Landscape	2003	3	120	240
Nadina	Reid and Doyle 2005, Doyle 2006a Doyle 2006a	Patch	2006	5	19-53	176
Skeena-Stikine	Doyle 2006b	Dothistroma Removing Cover	2006	4	55-66	231
Skeena-Stikine	Doyle 2007	Dothistroma Protecting seedlings	2007	12	15	180

Results

The results from the long-term snowshoe hare monitoring in the Nadina Forest District show that in both extensively harvested and fist pass harvested landscapes, hare populations peaked in 2002-2003, and reached a low in numbers in 2006 (Figure 1). Snowshoe hare numbers then remained low until this past year or so, when the numbers of hares appears to be once again on the increase. This potential cyclic pattern was less pronounced in landscapes with contiguous mature forest (Fulton), where the relative peak and low in hare density was less pronounced.

The pattern in relative abundance between landscapes remained constant throughout the 12 years, with the highest density of hares associated with the larger areas of contiguous young suitable habitat (Chapman Y2 Axis).

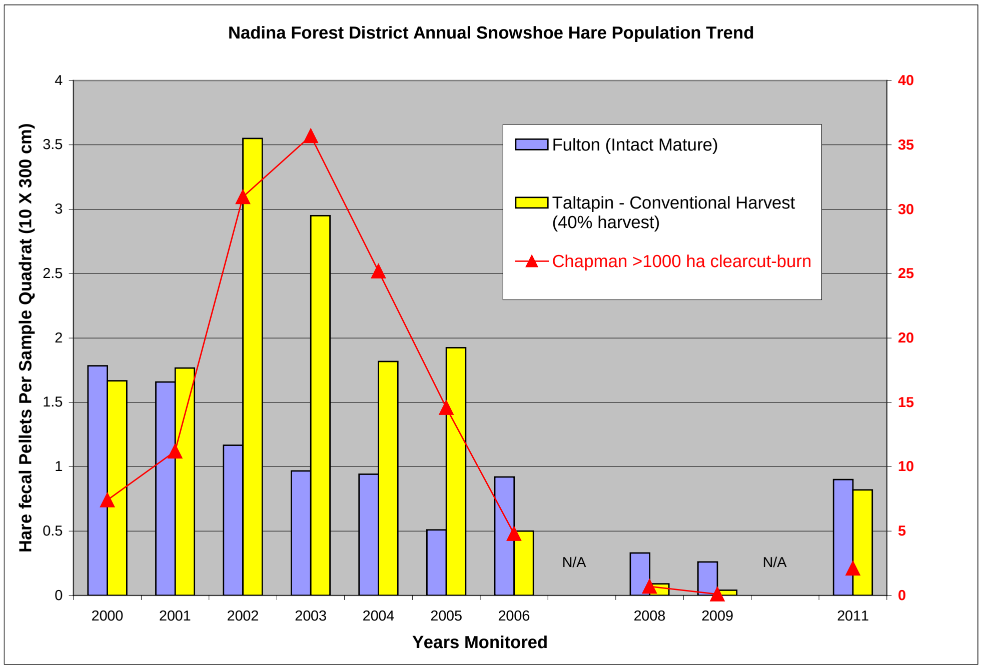


Figure 1. Fecal Snowshoe Hare pellet counts in the 3 long-term study areas.

A similar pattern in the annual changes in hare density were also observed in two additional areas monitored since 2003 (Lamprey: Conventional 3 Pass Harvest and the Swiss Fire), (Figure 2), and both areas are showing an increase in hare numbers in 2011.

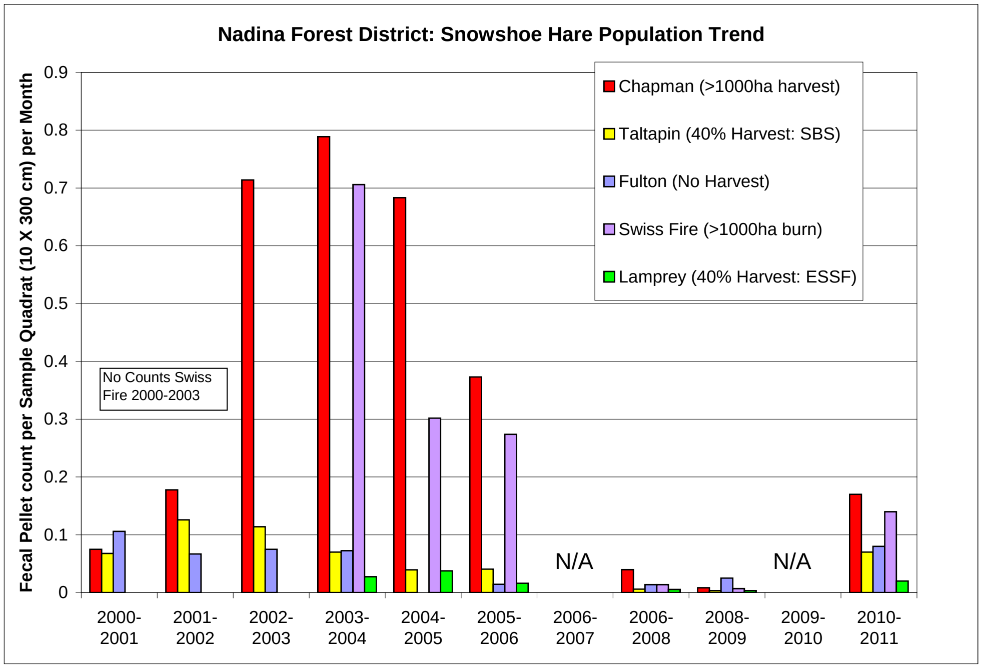


Figure 2. Fecal Snowshoe Hare pellet counts per month* in all the long-term study areas. (*Standardized per month to allow comparison between monitoring areas with differing annual sampling dates.)

Over a larger geographic area, a similar trend in hare numbers have also been observed in areas within the Kalum and Skeena-Stikine Forest District, in sites where hare pellet sample quadrats research trials were established to determine how to mitigate the loss of underplanted seedlings to hare browsing in Dothistroma attacked pine stands. Overall, snowshoe hare densities in two of these trial areas (Bulkley and Kispiox)showed a similar pattern to those observed in the Nadina with declining and subsequent low number of hares observed since monitoring was initiated in 2006 (Figure 3), and an increase in numbers over this past year. In a third area (Highway 37), no increase in the number of hares has been observed, however there is high annual variation in hare density both within and between sites (Figure 4).

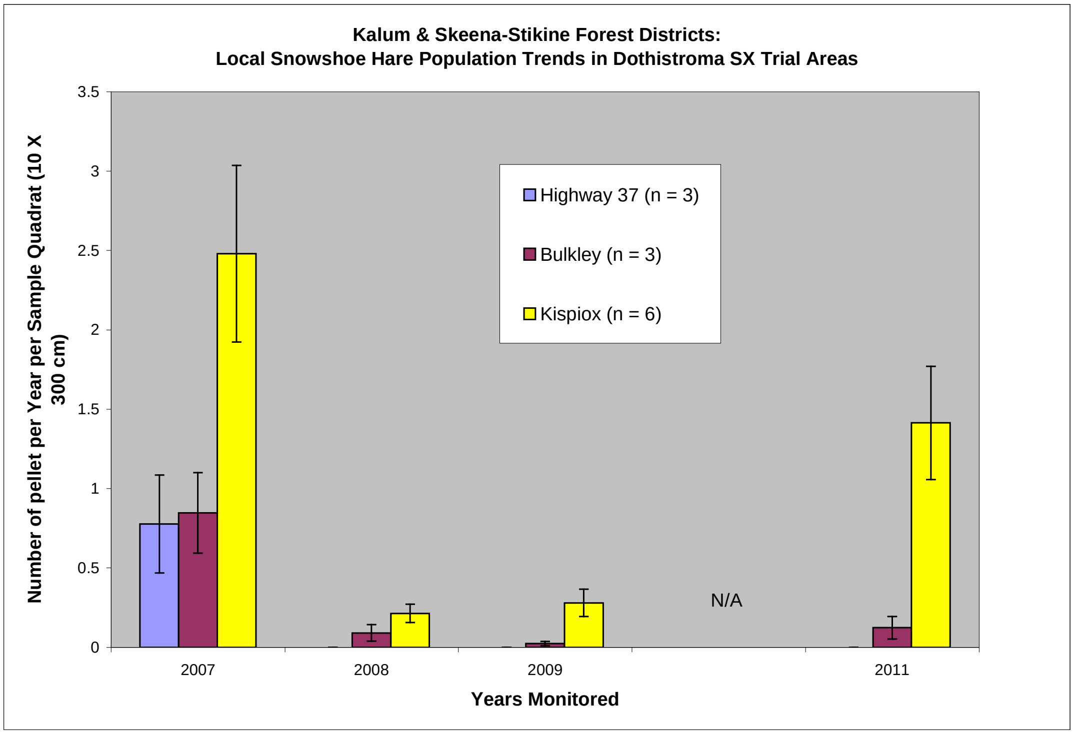


Figure 3. Regional variation in Snowshoe Hare density.

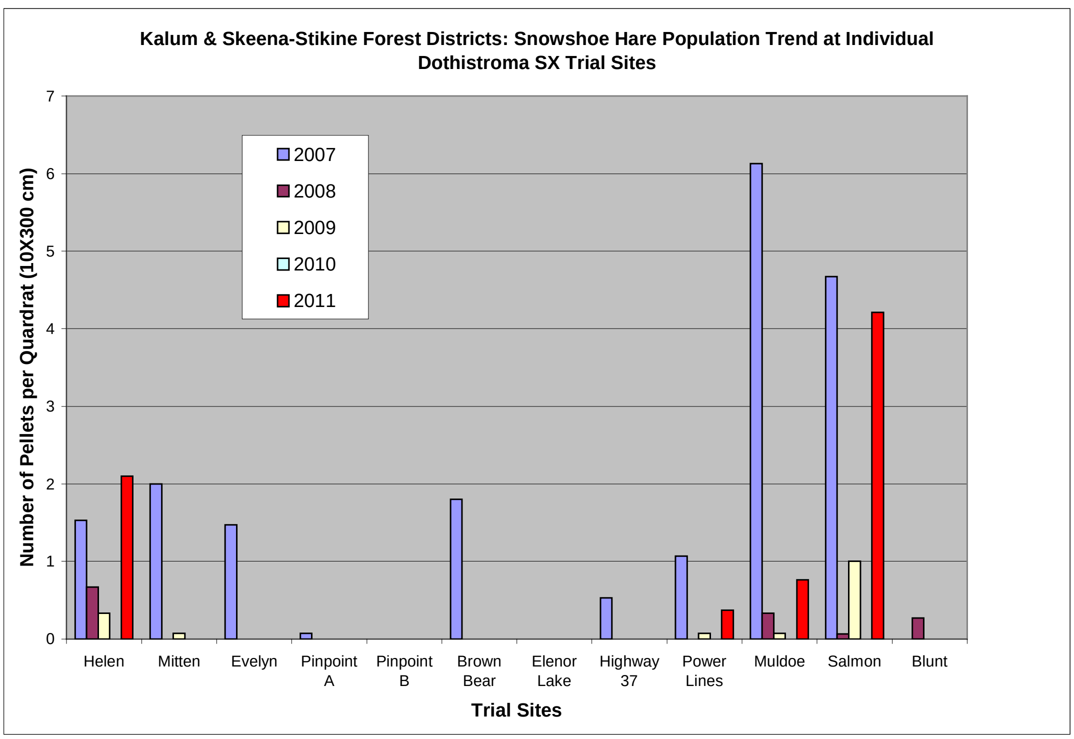


Figure 4. Fecal Snowshoe Hare pellet quadrat counts in the Sx Trial Sites.

Discussion

The hare population trend and the threat to seedlings planted in, or adjacent to suitable hare habitat remains the same as outlined in the earlier reports (Doyle 2009), with a potential peak in hare numbers expected in the next 2-3 years.

The snowshoe hare monitoring sites cover an area ~350km north-south x 250km east-west, in central-northwest British Columbia, and in all of these sites irrespective of habitat type, the same pattern in relative annual hare density has been observed. As reported in 2008 (Doyle 2008), the snowshoe hare population appears to be following a cyclic pattern that is well documented in northern snowshoe hare populations (Krebs et al. 2001a). Across this region the hare population appears to be in synchrony irrespective of ecosystem, or habitat type. Long-term hare population monitoring in the Yukon (Krebs et al. 2001a and Henry et al. 2007), provides our closest geographic comparison for the synchrony of hare populations at the larger geographic scales, and here the peak in population is offset by several years with the peak occurring 2006-2007 (Krebs et al. In press.).

By looking at the pattern of the hare cycle in other long-term snowshoe hare monitoring studies (Hodges 2000a & 2000b, Krebs 2001a & 2001c0, hare population follow a predictable pattern, and we may expect the hare populations to increase over the next few years, with a possible peak in numbers in 2013-2014.

Within the Nadina, Kalum and Skeena Stikine Forest Districts hare abundance appears to be tied to both the age of the forest, and to the distribution and size of habitat patches. With the highest hare densities seen in large post fire and clearcut stands ~ 25-40 years of age (Doyle 2008). At this stage these stands are a mix of shrubs-herbs and young tree with near to 100% ground cover, a combination that provides for both foraging opportunities and protection from predation, which hares have been observed to select (Hodges 2000a). Harvesting within a large portion of both study Forest Districts was initiated in the mid 1970's and therefore suitable snowshoe hare habitat (clearcut stands ~ 25-40 years) is now widespread. In addition, we now have suitable understorey hare habitat conditions in both Dothistroma and Mountain Pine Beetle Killed stands (Doyle 2006a), and also as a result of the uplift in harvesting of attacked stands, we can now expect suitable hare habitat to become the dominant habitat across our landscape, over the next few decades.

In addition to the increasing suitability of the landscape for hares based on the habitat type, work is ongoing (Reid and Doyle unpublished) to determine the role of predation on snowshoe hare density. This work indicates that as we move from a patchy landscape (1st and 2nd pass harvest mature-young seral forest) to a landscape dominated by young seral forest, we are also seeing a comparable reduction in the suitability of the landscape for generalist predators (squirrels and marten), that prey on snowshoe hares in summer and winter (Raine 1987, O'Donoghue 1994, Potvin 2000, Thompson and Colgan 1990, Bull 2000, Cumberland et al. 2001). As these predators also require mature-old growth forest for denning and foraging opportunities (Hargis and McCullough 1984, Buskirk, et al. 1989, Potvin 2000, Boonstra et al. 2001), then the further the hares are from this habitat the lower the density of these predators (Chapin et al. 1998), and therefore potentially the lower the predation risk.

This potential is supported by or own observations whereby a higher density of hares was observed the further the hare pellet sample quadrat was located from a mature-old growth edge (Figure 7, Doyle 2008). In this context the larger the area of suitable hare habitat the lower the density of generalist predators, and therefore the lower the potential risk of predation on hares living in that habitat. Eventually, specialist predators such as the Lynx will probably respond to these high hare densities (Boutin et al. 1995), but widespread damage to seeding trees may have occurred in suitable hare habitat by that time.

Within the context of a changing seral composition across the landscape, and the probable decline in generalist hare predators, we may also see higher cyclic snowshoe hare densities than have been observed in the past 20-30 years. Consequently we may also expect to see higher rates of damage and loss of unprotected newly planted seedlings trees, than have been observed in recent decades (Doyle 2006a). For seedlings planted at the low in hare numbers, continued monitoring of the damage to seedlings within the established Trial Sites will be required to determine if they are still vulnerable to browsing by the hares, when hare numbers once again predictably increase.

To potentially minimize the risk of seedling damage and loss from browsing if the landscape does start to support high numbers of hares, planting guidelines are being developed (Appendix 1), that outline conditions where browsing may be expected and potential measures that can be used to reduce the risk of browsing.

Future Work

- In the next few years snowshoe hare numbers will predictably increase not only as part of the observed hare cycle, but also as a result of the landscape scale understory vegetation responses to MPB and Dothistroma outbreaks, and to the large increase in the area of young seral stands also seen in response to the MPB outbreak. Within the role of both providing a supporting context for the ongoing silvicultural seedling-hare browsing trials (initiated in response to the observed and predicted economic and future timber supply impacts caused by hare browsing damage), and to the larger landscape scale understanding of where and when seedlings are at risk from hare browsing, it is recommended that this long-term base line population monitoring continues, within the range of harvested landscapes in the Nadina Forest District.
    - This will allow us to determine when (seral stage, site type and timing of planting in relation to the hare cycle) and where (patch size) silvicultural action is required to mitigate seedling damage and mortality from hare browsing.
    - This base line information also critically allows us to determine the effectiveness of the ongoing seedling – hare browsing trials, both in relation to the hare cycle, changes in habitat suitability (seral, MPB and Dothistroma) and harvest patch size).

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Appendix 1.

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Factors impacting the Risk of Damage-Mortality to unprotected Seedlings by Snowshoe Hares in north-central BC

	Influential Factors	**Low Risk**	**High Risk**
Tree Species	Palatability	Subalpine Fir, Hemlock	Spruce, Pine, Cedar
Stocking Density	# Seedlings planted	High stocking density (1.5 X 1.5 m spacing	Standard stocking density
Hare Density	Hare Cycle	2 years after Peak	All other Years
Site Conditions	**% Ground Cover**	**<30% Ground Cover (>0.5m High)**	**>30% Ground Cover (>0.5m High)**
Fire History	Time Since Fire	Recent <=1 year	>= 3 years
	Site Treatment	Suppression of Cover (brushing-herbicide, etc,)	None
Harvest History	Time Since Harvest	Recent <=1 year	>= 3 years
	Harvest Type	Clear cut	Patch Retention
	Site Treatment	Suppression of Cover (brushing-herbicide, etc,)	None
Snow Depth	Stand cover in winter	Snow will typically cover seedlings early in fall	Snow will NOT typically cover seedlings early in fall
Adjacent Stands	Hare carrying capacity	Low density of hares	High density of hares