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Analysis of Spatial Harvest Constraints on Ecological (wildlife habitat) versus Economic (timber harvest) Objectives

by

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ABSTRACT

Kaufmann, C.K. 2000. Analysis of Spatial Harvest Constraints on Ecological (wildlife habitat) versus Economic (timber harvest) Objectives. 238 pp. Advisor: Dr. R. Rempel Faculty of Forestry and Forest Environment, Lakehead University, Thunder Bay, Ontario.

Key Words: timber supply modeling, wildlife habitat supply modeling, Sustainable Forest Management Model, Stanley ™, *Martes americana*, *Rangifer tarandus*, *Alces alces*, *Seiurus aurscapillus*.

On a northwestern Ontario forest management unit, the effects of alternative forest management scenarios and spatial constraints on both the supply of suitable wildlife habitat and the ability to achieve non-spatially defined timber harvest volume objectives were modeled. The results include a decision surface model that identifies thresholds in the ecological (wildlife habitat) and economic (timber harvest) response variables, and allows managers to determine the "spatial domain" where both ecological and economic objectives converge. Such a model may be a useful approach for initial policy screening in an adaptive management cycle. The Ontario Ministry of Natural Resources' (OMNR) Strategic Forest Management Model (SFMM), a linear programming optimization model, and Remsoft's Stanley, a spatial harvest allocation program, were used to explore alternate forest management scenarios. Timber supply and habitat supply for both interior and ecotone wildlife species were examined after five 10-year terms of harvest using various spatial constraints (cut block size, proximity, and green up delay). Habitat Analyst and Patch Analyst, models developed by Dr. R. Rempel at the Center for Northern Forest Ecosystem Research, were used to evaluate habitat supply in both non-spatial and spatial analyses. Consistent with other studies, a green-up constraint had an adverse effect on the amount of available harvest area that could be allocated and blocked spatially. Forest management scenarios using a caribou stratification process of restricting harvest in large (>10,000 ha) blocks had an adverse effect on the amount of available harvest area that could be allocated and blocked spatially. A case study using the application of the caribou stratification constraint and a green up delay of one 10 – year term found the convergence of both economic and ecological objectives when maximum block size was between 200 and 1000 hectares and proximity was between 400 and 1000 meters. This combination of variables also produces a block size distribution approaching the natural disturbance pattern for the area. The study also found that while the use of the caribou stratification constraint improved habitat availability for caribou, it also improved habitat availability for moose and may undermine efforts to conserve caribou.

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INTRODUCTION

Forest management planning has evolved significantly over the past few decades. Historically forest management planning was limited to ensuring a steady supply of timber to the mills. The next phase of forest management planning included exploring various harvest options, selecting the option that best met timber supply objectives and evaluating the impact that option was expected to have on the habitat of a wildlife species of interest (usually a game species). The importance of biodiversity and the maintenance of ecosystems were then realised and it became understood that optimisation of the timber resource was affecting the function of the rest of the ecosystem (Kessler *et al.* 1992). Forest management planning then entered the phase of non-spatial analysis where both timber and wildlife habitat supply were used to help select a forest management option.

Foresters all over the world are now in the age of ecosystem management, striving for a balance of "getting the wood out" while minimising the effects on the function of the ecosystem. Most developed countries now have policies and legislation in place with sustainable management of ecosystems as the objective (Norton 1996). Forest management planning has also changed to help attain this goal. More detailed analyses of resources and expected effects of management options on those resources are now required. The non-spatial analysis approach is now considered insufficient to help forest planners in the selection of a forest management option for an area (Naesset 1997). Spatial analysis of timber and wildlife habitat supply is becoming more prevalent as a result of research and advances in geographical information system programs (Taylor *et al.* 1993, Turner *et al.* 1995, Dunsworth and Northway 1997, Naesset 1997).

In Ontario, the Ontario *Crown Forest Sustainability Act, 1994* (Government of Ontario 1994) requires the pursuit of forest sustainability at the forest-management-unit level. The Forest Management Planning Manual for Ontario's Crown Forests (Ontario Ministry of Natural Resources 1996) requires non-spatial timber and wildlife habitat supply analyses for management alternatives developed for all forest management units. The Ontario Ministry of Natural Resources (OMNR) has developed the Strategic Forest Management Model (SFMM) (Davis 1997) and SFMMTool (Watkins and Davis 1997) to meet these requirements. Recently the OMNR has been developing policy and exploring means by which to complete meaningful spatial analyses to assist in policy development and forest management decision-making. This study was designed to contribute to this exploration.

In 1997, using a north-western Ontario forest management unit, this study modelled the effects of alternative forest management scenarios and spatial constraints on both the supply of potentially suitable wildlife habitat and the ability to achieve non-spatially defined timber harvest objectives. The objective of the study was to test the hypotheses that block size, proximity, green-up delay and the addition of a caribou stratification constraint has no effect on the supply of potentially suitable wildlife habitat nor on the ability to block and schedule non-spatially-allocated timber harvests. Results include a set of decision surface models identifying thresholds in the ecological (wildlife habitat) and economic (timber harvest) variables. This study also produced a series of histograms depicting wildlife habitat and scheduled harvest block size distribution for the different landscapes resulting from the alternative forest management scenarios. Both the decision surface models and the histograms could be useful in the initial policy-screening phase of an adaptive management cycle that examines the outcomes of various policy options.

LITERATURE REVIEW

FOREST MANAGEMENT PLANNING

Forest management planning is the epitome of the definition of forestry requiring a precarious mix of art, science and business. Modern forest management planning analysis techniques can produce an overwhelming amount of results and information (Davis and Johnson 1987). The challenge is getting pertinent results easily and then using them to improve how forest resources are managed. The time-consuming "try it and see" method of forest management has become less useful (Kimmins 1987), especially at the strategic level, and today it is necessary to make more-accurate predictions of forest management practices.

Throughout the last few decades, forest management planning has changed dramatically to reflect changing social and economic values. From the mid-1900's to the early 1980's, forests were usually only considered in terms of the wood they produced. Early on, forest management was merely an exercise in ensuring a steady supply of timber to a mill. This was generally done through manual mapping exercises and using forest inventory and timber cruise information. The next phase of forest management planning brought with it non-spatial timber supply models that used forest inventory information to project a flow of timber over time. Eventually the value of other resources (mostly wildlife) was deemed to be important and forest management planning became a more complicated exercise. A variety of harvest options that met timber supply objectives would be explored and one selected. The one selected would then be assessed to evaluate how it would affect selected wildlife species (usually game species). Such wildlife assessments initially were qualitative in nature (opinion of some expert) but later more quantitative assessments (non-spatial tabulation of available habitat) became the norm.

As ecosystem management theories were introduced, forest management planning then became more inclusive and non-spatial timber supply and wildlife habitat supply analyses were undertaken in the planning process to help select the management option that best met objectives for both timber and wildlife. The non-spatial approach to analysis in forest management planning is no longer sufficient when attempting to maintain ecosystems as ecological processes are dependent on the spatial as well as the temporal dimension (Naesset 1997). In recent years the trend in forest management planning is to include a spatial component to both timber and wildlife habitat supply analyses. This allows managers to project responses of the timber and wildlife resources both spatially and temporally when evaluating alternative management strategies.

Throughout the world the current philosophy is to plan for ecosystems so many of the forest management planning projects in recent years included a spatial analysis component and attempted to predict the response of forest management actions on both timber supply and wildlife. Duinker *et al.* (1993) used spatial timber and wildlife analysis to evaluate the effects of Ontario's timber management guidelines for the provision of moose habitat. Demarchi and Walters (1996) developed a spatial simulation model to assess the effect of proposed conservation strategies and forest harvesting on the spotted owl. Arthaud and Rose (1996) demonstrated a forest planning assessment technique that used timber and wildlife habitat production as objectives. The analysis of wildlife habitat production included a spatial component. Nelson and Wells (1996) evaluated wildlife habitat and timber supply resulting from simulation of different management alternatives. Wells *et al.* (1997) used SIMFOR (Nelson and Hafer 1996) to evaluate wildlife habitat conditions after a simulated harvest proposed by the harvest schedule model. Dunsworth and Northway (1997) conducted a case study using spatial analysis to examine the effects of different forest harvest constraints on timber supply, habitat quality and fragmentation. Gustafson (1998) used a dynamic zoning and clustering harvests in time and space, a modification of the "get in and get out" approach to harvest scheduling. He found that spatial dynamics of timber harvest had more effect on the amounts of interior and edge than the dynamics of harvest intensity. The list is continually expanding with various methodologies, timber harvest simulation models and wildlife habitat assessment models being utilised.

In Canada forest management planning varies greatly in both the levels of planning and the amount of analysis required supporting planning efforts. British Columbia, for example, has developed into a state of "paralysis by analysis" with the enactment of the Forest Practices Code and associated regulations and guidelines. It is not unusual for harvesting areas to be in the planning stage for years, requiring numerous studies to be completed, from analysis of fish and wildlife habitat and hydrogeological resources to assessments of archaeological and First Nations sites and visual impact analyses.

In Ontario, forest management plans are required to be prepared in accordance with the Forest Management Planning Manual for Ontario's Crown Forests (FMPM) (OMNR 1996) for all forest management units (*Crown Forest Sustainability Act, 1994* Section 8). The *Crown Forest Sustainability Act, 1994* (Section 2.3.2) directs forest managers to maintain Crown forest health by using forest practices that emulate natural disturbances and landscape patterns. The FMPM identifies various criteria and indicators to assess forest sustainability when analysing alternative forest management scenarios. Under the heading of "Multiple Benefits to Society" it directs planning teams to look at the amount of habitat for selected wildlife species, the available harvest area (AHA), i.e., the amount of managed Crown forest available for timber production, and the proportion of the AHA that is actually utilised. Under the heading of "Biodiversity", it directs planning teams to look at the frequency distribution of clearcut and wildfire sizes. These criteria and indicators are the justification for the type of timber harvest and wildlife habitat supply analyses used in this study.

TIMBER SUPPLY MODEL AND SPATIAL BLOCKING PROGRAM

There are numerous timber supply models being used today – FORPLAN (Johnson *et al.* 1986), WOODSTOCK™ (Remsoft, Inc. 2000), and SIMFOR (Nelson and Hafer 1996) - to name a few. Each has advantages and disadvantages such as the incorporation of road systems, spatial components, or the ability to create both a strategic and an operational plan. In Ontario, the OMNR developed its own model to assist planning teams in meeting the analysis requirements of the FMPM. The Strategic Forest Management Model (SFMM) was developed by OMNR (Davis 1997) to help explore forest management options and prepare long-term forest management plans (FMP's). It is a linear optimisation model that determines a non-spatial AHA for an area based on the inventory and management objectives entered into the model. The FMPM requires planning teams to provide and analyse a set of alternate forest management scenarios. As the FMPM recommends the use of SFMM, it was the model selected for use in this study.

SFMM can be a powerful tool and is quite easy to use. The greatest difficulty in using SFMM is getting a good digital database of the forest inventory for the area being analysed. Often forest inventory databases are in need of "cleaning" to ensure no omissions or errors prior to use, and this "cleaning" process can take time to complete. SFMM has developed over the years to include a projection of forest condition, forest dynamics (such as rates growth and yield and natural forest succession), areas treated, finances (such as silviculture budgets, stumpage values and harvesting costs), volumes harvested, potential wildlife habitat areas, and forest diversity indices. Like any model, once the user is familiar with the set up, it is possible to manipulate its use to better describe the condition of the area being analysed or to make the model respond to a set of constraints. For instance, in this study it was possible to "tag" forest polygons to identify when they would be eligible for harvest, as opposed to having them available for harvest at any time based only on age and composition. Such flexibility was necessary to incorporate the Nakina North Forest caribou stratification constraint in this project.

One of the limitations of SFMM is that it is non-spatial and therefore may not project exactly what will happen in the forest. It provides the user with a non-spatial harvest allocation however this allocation may be difficult to achieve in a spatial context, especially when having to consider spatial constraints such as green-up delays. Being non-spatial makes SFMM useful more for strategic applications rather than operational – which was the objective of the developers. SFMM also does not do well with "the end of the world"; that is, if the planning term is 150 years, in year 150 it will propose to harvest the rest of the entire forest and plant nothing.

In Ontario, the forest resource inventory (FRI) attribute information is contained in STANF files that store non-spatial data on forested and non-forested stands. SFMM Tool (Watkins and Davis 1997) prepares the forest resource inventory files for use in SFMM by doing such things as classifying the area into forest units, defining a silviculture intensity matrix, classifying the forest into wildlife habitat units, and creating forest yield tables. SFMM Tool then generates a SFMM Input File for the forest management unit that can be entered into SFMM.

SFMM can then generate a non-spatial AHA for a 100-year period, which is the requirement of the FMPM for Ontario (OMNR 1996a). SFMM is capable of providing much more information, but for the purposes of this study, only the AHA and a resultant Choices file was required. The Choices file generated by SFMM is a database file identifying the stands that are available for harvest given the management objectives used in SFMM. The Choices file can be used in a blocking program such as Stanley, which can then spatially and temporally allocate the AHA.

Stanley is a spatial blocking program developed by Remsoft Inc. (1998). It uses the Choices file generated by SFMM along with the GPAT file (global polygon attribute table) of the forest to schedule cutblocks and spatially allocate them to meet the non-spatial harvest goal (AHA) determined by SFMM. Stanley creates and schedules harvest blocks taking into consideration adjacency, green-up period, opening size and harvest flow constraints defined by the user. For a detailed discussion of the Stanley algorithm, refer to “Design and development of a tactical harvest blocking/scheduling tool - Stanley” (Remsoft Inc. 1996).

WILDLIFE HABITAT

The ultimate goal of managing wildlife habitat is to conserve wildlife species and ultimately, biodiversity. Conservation of a species is dependent on the availability of habitat, behaviour of individual animals and the dynamics of the populations (Morrison *et al.* 1992). Sufficient resources must be available to support reproduction, foraging, resting and dispersal over various scales across the landscape (Morrison *et al.* 1992). Wildlife management focuses on the maintenance of wildlife habitat because it is related to the survival and reproduction of a species and because it is easier to measure and evaluate than populations (Wildlife Working Group 1991, Morrison *et al.* 1992, Anderson and Gutzwiller 1994, Turner *et al.* 1995).

A primary goal in managing wildlife at large scales is to ensure source habitats. Source habitats are those large enough and of sufficient quality to allow a stable population where births exceed deaths and the excess individuals disperse to other habitats (Pulliam 1988). Another goal is to decrease the number of meta-populations of species that have resulted from development and natural disturbances (Forman 1997). Meta-populations are composed of sub-populations that develop when habitat becomes fragmented and individuals move between the fragments. A meta-population is more volatile than a continuously distributed population and local extinction and colonisation dynamics are critical to its survival (Donovan *et al.* 1995 and Forman 1997). Forman (1997) suggested that the first step toward decreasing the number of meta-populations and local extinctions is to decrease habitat fragmentation, or heterogeneity due to forest harvesting. Larger patches of forest tend to have more species than smaller patches and patch size is more important than isolation, age and other variables used in predicting species numbers (Forman and Godron 1981, Robbins *et al.*. 1989, Forman 1997). Also, Burkey (1989), found that species are more likely to survive in a contiguous tract of habitat than one divided into isolated patches.

Forman (1997) also noted that just because a patch is good habitat does not mean the species in question will occupy it. This is sage advice and is why this study refers to it as potential preferred habitat - fully acknowledging that the species in question may in fact not be evident there but also acknowledging the usefulness of identifying where the potential habitat is and how it will change over time.

Relationships between wildlife and habitats are so complex they can never be replicated, however models can provide managers with information of sufficient accuracy to meet their needs (Kansas and Raine 1990). Wildlife habitat models simplify the network of relationships found in every ecosystem (Patton 1992). The role of habitat models is to assess wildlife and habitat relationships and to predict their sensitivity to alteration as a result of forest management decisions (Van Horne and Wiens 1991).

Wildlife habitat modelling has evolved in recent years. In the eighties and early nineties, the number and variety of models developed increased and forest managers were starting to use them more often (Bunnell 1989). In the early to mid-nineties the trend was to combine habitat supply models and forest succession models in what is referred to as habitat supply analysis (Higgelke 1994). This type of analysis measures the supply of habitat today and forecasts the future supply based on proposed management actions (Thomas 1991, Naylor *et al.* 1994). It essentially takes static habitat models (such as Habitat Suitability Indices) and makes them temporally dynamic. Most recent habitat modelling uses GIS to add a spatial component, looking at the configuration of the habitat in the landscape. It has become a popular theory that configuration of habitat is just as, if not more important to a species than the total amount (Lancia *et al.* 1986, Temple and Wilcox 1986, Taylor *et al.* 1993, Turner *et al.* 1995,). However, this theory has been disputed by some (Fahrig 1997 and McIntyre and Wiens 1999).

It is not necessary to know every species in an area to manage or plan for wildlife (Forman 1997). Using indicator species, species whose habitat overlaps with that of numerous other species is a common and useful method of analysing the effects of forest management activities on wildlife. Recently in Manitoba, Kuhnke and Watkins (1999) selected a set of wildlife species and proposed that the maintenance of habitat for this set of species would mean the habitat requirements for most species in the boreal forest would be met. The species in this study were selected based on their regional importance and/or to provide an evaluation of species requiring ecotone versus interior habitat. The study also wanted to examine species with a variety of home range sizes so as to see the effects forest management might have on species requiring large contiguously forested areas versus those that require smaller areas for food, shelter and reproduction. For example, a forest management regime in an area may result in many small patches of fragmented forest. The effect of this on a species requiring large forested patches, 1000 hectares (ha) for example, is quite different than the effect such a regime would have on a species whose home range is 100 ha. The species selected for this study were moose (*Alces alces*), woodland caribou (*Rangifer tarandus*), american marten (*Martes americana*) and ovenbird (*Seiurus aurocapillus*).

Ovenbird

The ovenbird (*S. aurocapillus*) is a warbler named after the dutch-oven-shaped nest it creates on the ground of primarily deciduous forests (Wetmore 1964, and Mackenzie 1976). The ovenbird feeds on snails, slugs, earthworms, ants, crickets and spiders found on the ground, under leaves and along downed woody debris (Wetmore 1964, Zovnic 1995). Its range in Canada extends from north-eastern British Columbia to Newfoundland (Wetmore 1964, and Mackenzie 1976). The bird is olive in colour with an orange crown and black stripes. It prefers immature and mature hardwood forests and avoids lowland coniferous forests (Hove *et al.* 1995). Zovnic (1995) found more ovenbirds in hardwood forest with low tree density and high shrub and conifer density at the ground level.

Ovenbird has been considered an interior species requiring large patches of contiguous forest for reproduction. It is believed that the large patches are required to reduce parasitism and predation due to nesting and feeding on the ground (Robinson *et al.* 1995). However, there has been some debate recently as to whether the ovenbird actually is an interior species as some studies have found no significant evidence supporting this theory (Peck and James 1987, Robbins *et al.* 1989). The majority of the literature does indicate that the ovenbird is most likely to be found in interior forest and so in this study it is treated as such.

In a study with sites in various mid-Atlantic states, Robbins *et al.* (1989) found that the probability of occurrence of ovenbird was at a maximum in patches of hardwood forest greater than 450 ha. They also determined that in patches greater than 6 ha, the probability of ovenbird occurrence was 50%, suggesting that 6 ha is the minimum size of patch required for breeding. Stauffer and Best (1980) also found that the ovenbird required large patches to support a breeding population. Hannon (1992) found ovenbirds only in fragments of forest greater than 10 ha in size. Donovan *et al.* (1995), Hagan *et al.* (1996) and Stauffer and Best (1980) all found that ovenbirds did not do well in largely heterogeneous (fragmented) landscapes. Porneluzi *et al.* (1993) found the number of male ovenbirds produced in large contiguous forests (>10,000 ha) was 20 times that found in forest fragments (<200 ha).

Donovan *et al.* (1995) found fewer young were produced in forested fragments due to nest predation, brood parasitism by the brown-headed cowbird (*Molothrus ater*) and decreased pairing success. Hagan *et al.* (1996) also found that territorial males in fragments were less likely to find mates and attributed this to an inability to maintain territory or an avoidance of the fragments by females who thought them inferior habitat.

Various habitat capability and suitability models have been generated for ovenbirds. Askins *et al.* (1987) used a multiple regression model that included patch area, amount of forest within 2 km of the patch and vegetative factors (% herbaceous cover, % tree cover and herbaceous species richness) to explain ovenbird abundance. Romito *et al.* (1995) developed a model to determine the best breeding habitat for ovenbirds for the Foothills Model Forest in Alberta. They found the best breeding habitat had >70% deciduous in the canopy, >50% canopy closure, an overstory height of >8 m and a density of shrubs of <7300 stems per ha. Mills *et al.* (1996) found the greatest abundance of ovenbirds in aspen stands 40 to 70 years of age with >70% canopy closure. They also determined that canopy closure was the most important factor in determining abundance.

The effects of forest management on neotropical migratory birds is important to investigate as there are over 170 bird species in Northern Ontario and over half of them breed in the boreal forest (Welsh 1992). The ovenbird has been found to be sensitive to forest fragmentation (Hagan *et al.* 1996), so it is an appropriate model species for spatial exploration of the effects of harvesting on its habitat.

American marten

American marten (*M. americana*) are a member of the weasel family (OMNR 1996b). They are brown in colour with a lighter-coloured throat patch. They are approximately half a meter (m) in length including tail, and weigh between 1.0 and 1.5

kilograms (kg) with males generally being larger than females. The home range for marten is large given their small body size (Buskirk 1994) and home range size depends on prey availability and intra-specific competition. Marten exist across North America from the tree line in the north to the southern boundary of coniferous forests. Its original range along the southern borders has been reduced due to human settlement and over trapping (Thompson 1991). Marten feed primarily on red-backed voles (*Clethrionomys gapperi*), meadow voles (*Microtus pennsylvanicus*) and snowshoe hares (*Lepus americanus*) (Koehler and Hornocker 1977, Thompson and Colgan 1987, and Martin 1994), which tend to occur in mature mixedwood and coniferous stands.

Marten prefer mixed or coniferous forests with low closed canopies (Bissonette *et al.* 1991, and Buskirk and Powell 1994). They require structure near the ground, in the form of vertical stems and large downed woody debris, usually associated with over-mature forests. Boles of large trees (living and dead) provide cavities sufficient for maternal den sites. Canopies of large conifers are used for resting sites in summer (Steventon and Major 1982). In winter the structure near the ground creates subnivean spaces beneath the snow. These subnivean spaces are believed to be important in providing access to prey, resting sites, escape from predation, and thermal protection (Buskirk and Powell 1994, Thompson and Harestad 1994, and Sturtevant *et al.* 1997).

Marten are considered an interior species, as they apparently will avoid even good habitat if large open areas surround it (Buskirk and Powell 1994 and Martin 1994). Bissonette and Fredrickson (1991) found that populations are denser in large, undisturbed forests. This is the result of prey availability as well as the threat of predation in open areas (Thompson 1994).

The marten is a provincially featured species in Ontario as defined in the April 1994 Environmental Assessment Board's ruling on timber management on Crown lands (Ontario Environmental Assessment Board 1994). They have late sexual maturity and small litters making them vulnerable to population declines (Mead 1994). Forest management guidelines have been created to help provide habitat for marten in Ontario (OMNR 1996b). Buskirk and Powell (1994) believe that habitat availability more than anything else will affect the geographic distribution of marten in the next decades. Thompson (1991) suggested that even if forest management operates on a longer rotation, plantations would still lack the structure to support as many marten as a natural forest.

Published models of marten habitat include the Marten Habitat Suitability Index (Allen 1982) which is based on crown closure, overstory composition, successional stage and amount of coarse woody debris. In 1994, Naylor *et al.* adapted Allen's Habitat Suitability Index to use with the FRI in Ontario. Thompson and Harestad (1994) developed a general management model depicting how forest age and amount of timber harvest affects the carrying capacity of marten. Schultz and Joyce (1992) used the marten habitat model from Hoover and Willis (1984) which considered structural stage of forested stands when defining stands as optimal, sub-optimal or not useful for marten habitat. Suitable habitat equalled the area of optimal habitat plus half of the area of sub-optimal habitat. The number of suitable home ranges was determined using a home range size of 212 ha where greater than 55% of the home range was suitable habitat. OMNR Northwest Region Science and Technology Unit has developed a local marten habitat suitability model using a home range size of 100 ha where stands that are preferred habitat provide both denning and prey (P. Elkie, pers. comm., 1998).

Moose

Moose (*A. alces*) is a species with a firm place in the political arena in Ontario. It is an important game species, an importance exemplified by the goal of OMNR to have a target population of 160,000 by the year 2000 (OMNR 1988). Moose is considered an ecotone species, preferring to dwell near the edges of open areas, usually within 200 meter of cover (Thompson and Vukelich 1981). The open areas and edges provide the deciduous and brush species used for browse while the closed canopy coniferous forest provides security cover from predators and thermal cover - warmer in the winter, cooler in the summer (Puttock *et al.* 1996, Balsom *et al.* 1996, Thompson and Vukelich 1981). Mineral licks are also important to the nutrition of moose in spring and early summer (OMNR 1988). The availability of good winter habitat is a great limitation to moose populations (Thompson and Vukelich 1981). In early winter moose require mixedwood forests to provide both food and cover. Later in winter, cover provided by closed canopy coniferous forests becomes more necessary.

Moose are found mostly in the boreal region of Ontario. One explanation for their absence in southern Ontario is human development. Development can adversely influence moose population dynamics through noise (affecting forage and reproduction activities), increased risk of falling prey to hunters, poachers or vehicles, and a decline in habitat. Another theory used to explain the absence of moose in southern Ontario is the interaction of moose with white-tailed deer in the area. The deer carry a brainworm that is fatal to moose (Anderson 1972).

Timber Management Guidelines For The Provision Of Moose Habitat were established in 1988 to help maintain and enhance moose habitat in timber management regimes (OMNR 1988). These guidelines generally restrict cutblock size to less than 130 ha so that forage from early successional plant communities is close to the protective cover of mature conifer forest (OMNR 1988). Rempel *et al.* (1997) argued that while in their study the application of the guidelines resulted in an increase in moose densities, unmanaged hunting in timber harvested areas may have an adverse affect on those predicted increases.

Various studies modelling the availability of moose habitat after timber harvest have been completed. Identification of moose habitat requirements has come in many forms and at many scales. Allen *et al.* (1987) developed an index to predict the suitability of habitat for moose in the Lake Superior region. This index is based on four components of habitat, proportion of forested area greater than 20 years old, proportion of area that is spruce/fir forest at least 20 years of age, proportion of area in upland deciduous or mixed forest at least 20 years of age, and proportion of area in riverine, lacustrine or plaustrine wetlands not covered by woody vegetation. Naylor *et al.* (1992)

adapted Allen's habitat suitability index to data available by OMNR (using the Forest Resource Inventory) and validated it for the northern portion of the Great Lakes-St. Lawrence Forest Region of Ontario. Allen *et al.* (1991) validated the original moose habitat suitability index and determined that the effects of forest management actions on moose habitat quality could be simulated without additional data requirements. Duinker *et al.* (1993) simulated the impacts of the application of Ontario's Moose Habitat Guidelines on moose habitat. Rempel *et al.* (1997a) used the Lake Superior region habitat suitability index for moose (Allen *et al.* 1987) in combination with vegetation maps made from satellite imagery to evaluate the effects of the application of Ontario's Moose Habitat Guidelines. Rempel *et al.* (1997b) used the Ontario Forest Ecosystem Classification system to develop a process to predict the availability of moose browse.

Caribou

Woodland caribou (*R. tarandus*) are members of the deer family (Racey *et al.* 1997). Caribou mature late (approximately 2.5 years) and do not have multiple births so they are vulnerable to population declines (Darby *et al.* 1989). In general they use mature and over-mature pine and spruce stands (40 to 100 years old) which tend to be open enough to provide the terrestrial lichen (e.g. *Cladina* spp.) upon which caribou feed. Pine and spruce forests 40 to 100 years of age provide the best conditions for *Cladina* spp. (Schaefer and Pruitt 1991 and Harris 1996) after which feathermosses succeed the lichen. However, pine and spruce forests greater than 100 years of age can continue to provide caribou with good thermal and security cover. Cumming and

Beange (1993) reported that caribou tend not to use young stands due to the increased risk of predation or high levels of snow accumulation. Caribou tend to use large areas of habitat for most of the year. One explanation for this is that it allows for them to spread out and therefore reduce the probability of encountering a predator (Bergerud 1996). Other habitat requirements include localised calving sites. These sites are usually open areas where predator risk is low, and they are often returned to year after year (Darby *et al.* 1989).

Caribou occur throughout the boreal forest but the southern boundary of the range of the woodland caribou has greatly receded north over the years. The OMNR is concerned about the distribution of the caribou in Ontario (Racey *et al.* 1997). Caribou once inhabited all of Ontario but after European settlement the range of the species moved north and continues to move north (Darby *et al.* 1989). One school of thought (predator switching theory) is that logging and predation arising from increased moose populations are affecting the distribution (Bergerud *et al.* 1984 and Cumming *et al.* 1996). Once an area is open to development, brush species thrive providing food and allowing the moose population to grow. The increase in moose would provide more food to the wolf populations and allow them to increase in number. Such an increase could result in more caribou predation as an alternate prey. Thus wolf numbers are sustained by increased moose density, but the effects of the incidental predation of caribou may be sufficient to cause the caribou distribution to move north. Other explanations for the current distribution of caribou in Ontario include loss of habitat due to development and interaction with white-tailed deer carrying the same fatal brainworm that affects moose in the area (Anderson 1971).

The Committee on the Status of Endangered Wildlife in Canada has designated caribou as vulnerable or at risk of becoming threatened (Greig and Duinker 1997). Caribou may also be sensitive to changes in their habitat due to timber harvest activities and may be considered an indicator of forest health (Racey *et al.* 1997). Forest management guidelines have been developed to help conserve caribou in Ontario (Racey *et al.* 1997). These guidelines propose leaving large tracts (greater than 10,000 ha) of forest for current and future caribou habitat. This is referred to as a caribou stratification plan. The map-based plan depicts, at a strategic level, where and when broad-based timber harvesting will occur over the long term (Greig and Duinker 1997) thus ensuring large intact areas of forest over time. Caribou stratification plans are completed for entire Forest Management Units and take plans from adjacent units into consideration.

Current distribution of caribou habitat has been shaped by fire. Caribou stratification plans assume that logging can regenerate caribou habitat as well as fire. Harris (1992) argued that this assumption is justified. Harris' work suggested that recovery of *Cladina* spp. may be faster after logging versus fire due to the presence of residual lichens. However, he also noted that silvicultural operations could negatively affect recovery after timber harvest.

ADAPTIVE MANAGEMENT

Great uncertainty plagues the long-term results of management decisions. While the best learning comes from carefully controlled replicated experiments, in forest and wildlife management this is precluded at large scales due to limited resources (financial and otherwise) and the long time frames required to see results. In addition, social values and goals are constantly changing and better information to be used in forest management planning is obtained. The latest strategy recommended to deal with this conundrum is adaptive management. Adaptive management is "a systematic approach to improving management and accommodating change by learning from the outcomes of management interventions" (Taylor *et al.* 1997: iii).

There are different views on the steps that comprise an adaptive management process. Taylor *et al.* (1997) summarise it as usually involving 1) definition of the management problem; 2) exploration of the potential effects of alternative policies on response indicators; 3) identifying critical uncertainties about the system that need to be resolved before the best policy can be identified; 4) development of policies and monitoring programs that test alternative hypotheses about ecosystem function and provide useful feedback; 5) monitor response of key indicators over time and on appropriate spatial scales; and 6) analysis of resultant data and using it to improve management and objectives. Walters (1995) offered an adaptive management design for forest management. He recommended first identifying what the management options are and the uncertainty of their consequences. For these options performance measures must be developed as well as the selection process for the "best" option. Walters then suggested predicting the results of the policy alternatives. In doing so, critical uncertainties resulting from policy options can be identified. The next stage in Walters' design is to weed out policies that are not worth further testing. In forest management policy testing commits large areas to certain strategies for long periods of time so screening of policies is a justifiable endeavour. Dividing the landscape into experimental units to test the policy treatments, and monitoring key responses over time and space complete Walters' recommended adaptive policy design for forest management.

Adaptive management is a process that allows forest managers to proceed with managing despite uncertainty, incomplete information, and disagreements over particular management regimes. It does not resolve issues, rather it provides managers the ability to respond to changes in values, conditions and information. Committing to an adaptive management approach is a paradigm shift for forest managers as following the process may require not always taking the most seemingly efficient route. Management actions must be designed so that something can be learned from the outcome. Actions must be more than a response to new information; any action taken is an opportunity to generate more information from the system being managed.

Another important characteristic of adaptive management is the commitment to monitoring. Many strategic forest management plans have some sort of clause regarding the need for monitoring. This is seldom fulfilled as there are no repercussions for not doing so and rarely is it established what the indicators will be, who will complete the monitoring, and what the strategy will be for each possible result of the monitoring. Adaptive management makes monitoring useful and effective. Key response indicators are established and monitored as part of the process. The monitoring includes an examination of whether the objectives of the actions have been met, the effects of the action on the forest and identifies thresholds in the ecosystem to focus on in further investigations and actions. Results are then incorporated in further decisions and strategies.

METHODS

STUDY AREA

The forest management unit studied was the Nakina North Forest, situated in northwestern Ontario. The unit is Forest Management Unit (FMU) 240, which is allocated to Buchanan Forest Products Ltd. (Figure 1). When this project was initiated in 1997, the Nakina North Forest had no timber harvesting history and only a road corridor had been installed. The area is predominantly boreal with a portion in the east similar to the Hudson's Bay Lowlands (Buchanan Forest Products 1997). The Nakina North Forest is in the Arctic Watershed flowing north to James Bay. The soils are mostly bouldery silt and sand till over bedrock with silty sand lacustrine and organic soils in low lying areas (Buchanan Forest Products 1997). Tree species include white spruce (*Picea glauca*), black spruce (*Picea mariana*), jack pine (*Pinus banksiana*), eastern white pine (*Pinus strobus*), aspen (*Populus spp.*), birch (*Betula spp.*), balsam (*Abies balsamea*), white cedar (*Thuja occidentalis*) and larch (*Larix laricina*). The forest is in a late successional stage (greater than 100 years old) and relatively even-aged due to large fires in the late 1800's. Fire suppression has affected the composition in that coniferous forest types that normally would have burned and succeeded to mixedwood types remain coniferous (Buchanan Forest Products 1997). Approximately 87% of the forest is made up of coniferous working groups (stands with mostly coniferous composition).

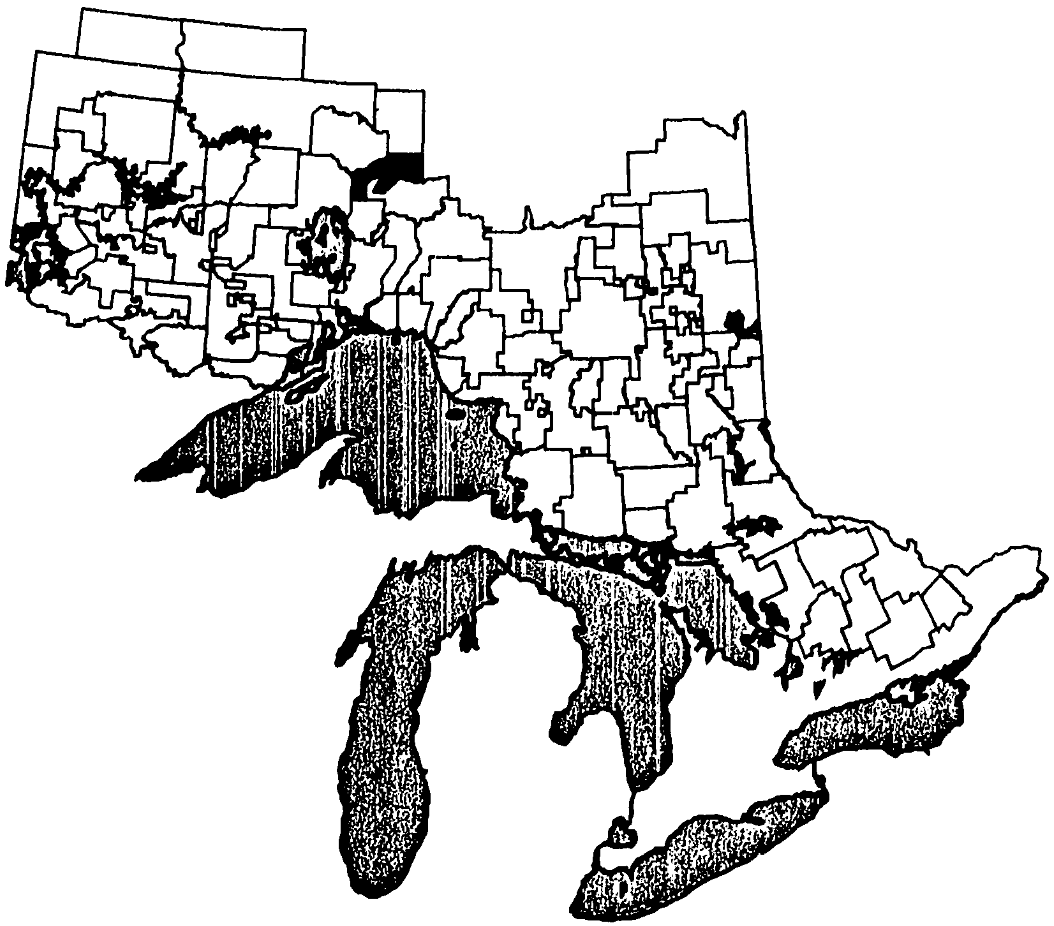

Figure 1. Forest Management Unit 240, the Nakina North Forest. The Nakina unit is in red.

The information used in this study originated from the Nakina North Forest Management Plan submitted to the OMNR for review and approval in May 1997. This inventory was completed in 1991 and was updated to 1994 when Buchanan Forest Products, Ltd. initiated its planning efforts.

The Nakina North Forest is within the range of the woodland caribou in Ontario. There is concern that since the early 1900's the range of the woodland caribou in the boreal forests in northern Ontario has been receding (Cumming and Beange 1993). As part of a management strategy to conserve caribou while allowing for timber harvesting, three large tracts (greater than 10,000 ha) of mature coniferous forest habitat were identified in the Nakina North Forest, and timber harvesting activities in these large areas are restricted for certain time periods. This is referred to as the "caribou stratification constraint" (Figure 2). The implications of this temporal and spatial constraint were explored in this study.

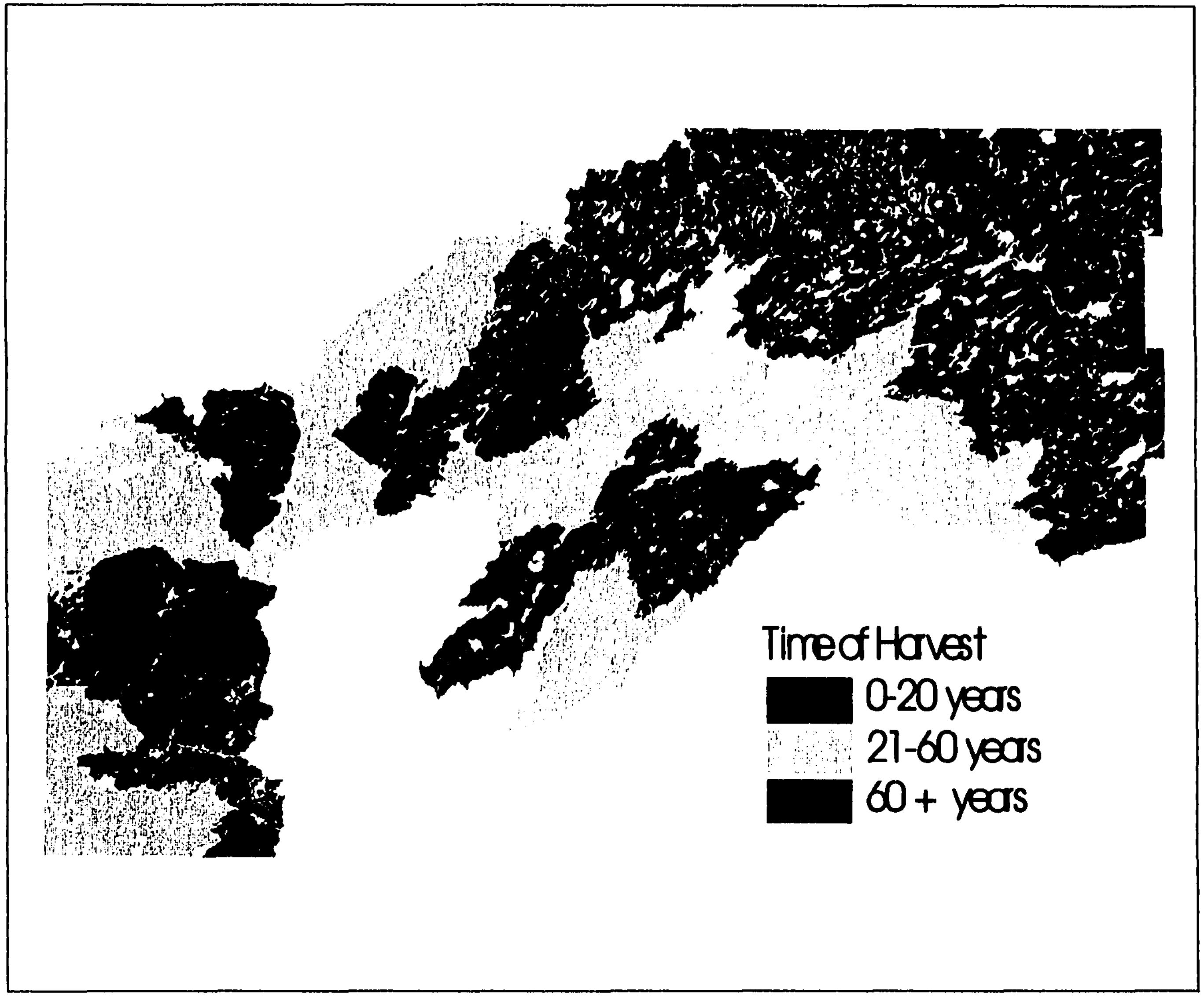

Figure 2. Caribou stratification harvesting constraint designated for the Nakina North Forest.

TIMBER HARVEST ANALYSIS

The first portion of the timber supply analysis required use of SFMM Tool to prepare the Nakina North Forest Inventory for use in SFMM. The inventory file for the forest was obtained from OMNR as a STANF file that was cleaned prior to use. SFMM Tool requires the forest to be defined into Forest Units (FU's) and this was done according to the draft forest management plan submitted by Buchanan Forest Products, Ltd. (Appendix I). SFMM Tool also allows for the forest to be defined into Habitat Units (HU's). The Habitat Units applied to the Nakina North Forest in this study were the Northwest Region Habitat Units, a template for which is selected within SFMM Tool. Finally, SFMM Tool generated a SFMM Input File that was then entered into SFMM.

With the Nakina North Forest inventory now classified and entered, SFMM was used to determine a non-spatial AHA for each of two forest management scenarios, one for the Nakina North Forest with the caribou stratification constraint applied and one for the Nakina North Forest without the caribou stratification constraint applied (See Figure 3). In addition to the forest inventory, SFMM requires silvicultural options and management objectives to be defined for each scenario. The silvicultural options and management objectives used for each of these two SFMM scenarios were those submitted by Buchanan Forest Products, Ltd. in its draft forest management plan for the area. For each scenario SFMM determined the AHA for a 200-year period, exceeding the 100 year requirement of the Forest Management Planning Manual for Ontario's

Crown Forests (OMNR, 1996). SFMM has the capability to generate an analysis of wildlife habitat for the same period; however, for this study a spatial component was added to the habitat analysis and was completed outside of SFMM.

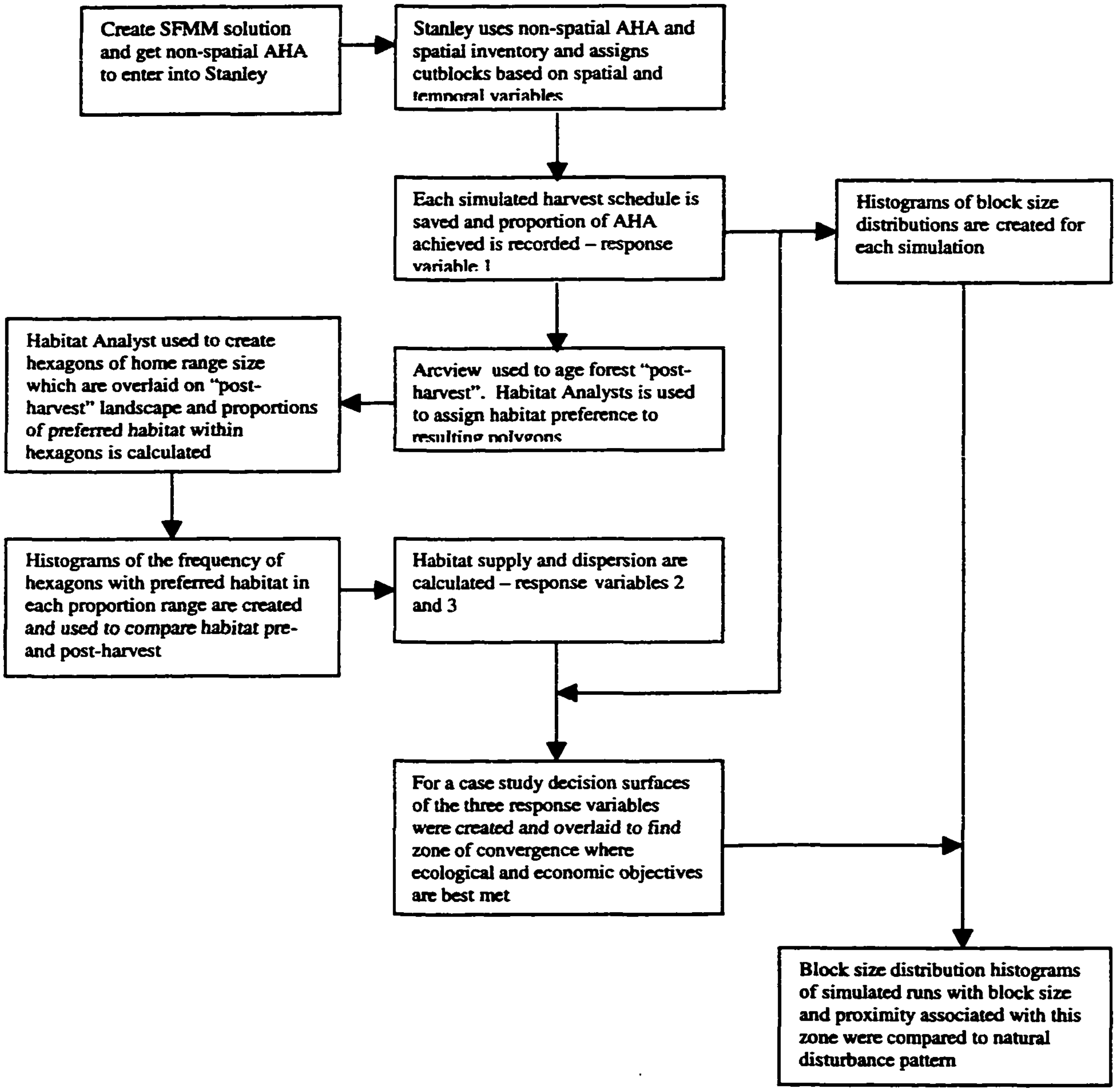

Figure 3. Flowchart providing a general summary of analysis steps.

The results of the SFMM runs were two Choices files - one for the Nakina North forest with the caribou stratification constraint and one for the Nakina North Forest without the caribou stratification constraint. The Choices files described the AHA and listed the harvest activities to be blocked and outlined the harvest operability limits. The Choices files were then used in Stanley, the spatial blocking and scheduling program used in this study (Figure 3).

Prior to completing a harvest blocking simulation run, certain inputs must be provided to Stanley. These include a Choices file, providing the non-spatial AHA from SFMM, and the spatial forest resource inventory for the area. The spatial inventory used for the Nakina North Forest was in the form of an Arcview shapefile (Environmental Systems Research Institute Inc. 1997). An Arcview shapefile is a "digital file that stores non-topological geometry and attribute information for spatial features in a data set" (Remsoft Inc. 1998).

Before the spatial blocking could begin, a GPAT (global polygon attribute table) database file was created describing each stand or polygon in the forest. An Adjacencies database file that lists adjacent stands and proximate stands was also created. In this study an adjacency of 10 m was used for all runs so that stands that are separated by a small creek for instance will still be considered adjacent. This is important as Stanley creates harvest blocks from adjacent eligible stands. Proximity is the maximum distance between the boundaries of two polygons that Stanley will consider the polygons proximal. Stanley uses adjacency when creating harvest blocks but uses both adjacency and proximity when scheduling them. That is, if there is a green-up delay of one harvest term, Stanley will not schedule adjacent nor proximal blocks in the same harvest term. Finally, an Extents file was generated identifying the co-ordinates that delimit the boundary for each stand. This is used to control block shape.

With all of the required files in place, Stanley was able to attempt a solution, i.e., to assign and schedule cutblocks. A Stanley run is a simulation run defined by one combination of spatial/temporal constraint variables and a solution (harvest schedule). The variables included proximity, target block size, maximum block size, minimum block size and green-up delay[1] (Table 1). For this project Stanley was asked to attempt to allocate spatially the harvest for five 10-year terms. Although SFMM provides an AHA for a 200-year period there is no succession model in Stanley and it was decided that five 10-year terms of harvest was the maximum acceptable time period for which to conduct harvest allocation without resulting in severe changes to stand composition and condition due to succession. When Stanley attempts to find a solution for each run, it will continue to run until it is told to stop finding a better solution. For this project the iteration with the highest proportion of the AHA spatially blocked and scheduled after a 10 minute period was selected, approximately 1000 iterations. For each run, Stanley achieved a spatially feasible solution and updated the GPAT file for the forest identifying which stands are to be harvested and in which 10-year period (from one to five).

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[1] Green-up delay is the amount of time that must lapse before the harvest of adjacent or proximal blocks which, if scheduled in the same period, would exceed maximum block size.

Table 1. Spatial constraint variables used in combination in the blocking program Stanley.

Forest Management Scenario	Proximity (m)	Target Block Size (ha)	Minimum Block Size (ha)	Maximum Block Size (ha)	Green-up (# of 10 - year periods)
NakNoCar[2]	100	100	10	125	0
	100	250	10	312.5	0
	100	1000	10	1250	0
	100	2000	10	2500	0
NakNoCar	250	100	10	125	0
	250	250	10	312.5	0
	250	1000	10	1250	0
	250	2000	10	2500	0
NakNoCar	1000	100	10	125	0
	1000	250	10	312.5	0
	1000	1000	10	1250	0
	1000	2000	10	2500	0
NakNoCar	2000	100	10	125	0
	2000	250	10	312.5	0
	2000	1000	10	1250	0
	2000	2000	10	2500	0
NakNoCar	100	100	10	125	1
	100	250	10	312.5	1
	100	1000	10	1250	1
	100	2000	10	2500	1
NakNoCar	250	100	10	125	1
	250	250	10	312.5	1
	250	1000	10	1250	1
	250	2000	10	2500	1
NakNoCar	1000	100	10	125	1
	1000	250	10	312.5	1
	1000	1000	10	1250	1
	1000	2000	10	2500	1
NakNoCar	2000	100	10	125	1
	2000	250	10	312.5	1
	2000	1000	10	1250	1
	2000	2000	10	2500	1
NakCar[3]	100	100	10	125	0
	100	250	10	312.5	0
	100	1000	10	1250	0
	100	2000	10	2500	0
NakCar	250	100	10	125	0
	250	250	10	312.5	0
	250	1000	10	1250	0
	250	2000	10	2500	0

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[2] NakNoCar refers to the management scenario without the caribou stratification constraint applied.

[3] NakCar refers to the management scenario with the caribou stratification constraint applied.

Table 1 (continued). Spatial constraint variables used in combination in the blocking program Stanley.

Forest Management Scenario	Proximity (m)	Target Block Size (ha)	Minimum Block Size (ha)	Maximum Block Size (ha)	Green-up (# of 10 - year periods)
NakCar	1000	100	10	125	0
	1000	250	10	312.5	0
	1000	1000	10	1250	0
	1000	2000	10	2500	0
NakCar	2000	100	10	125	0
	2000	250	10	312.5	0
	2000	1000	10	1250	0
	2000	2000	10	2500	0
NakCar	100	100	10	125	1
	100	250	10	312.5	1
	100	1000	10	1250	1
	100	2000	10	2500	1
NakCar	250	100	10	125	1
	250	250	10	312.5	1
	250	1000	10	1250	1
	250	2000	10	2500	1
NakCar	1000	100	10	125	1
	1000	250	10	312.5	1
	1000	1000	10	1250	1
	1000	2000	10	2500	1
NakCar	2000	100	10	125	1
	2000	250	10	312.5	1
	2000	1000	10	1250	1
	2000	2000	10	2500	1

Stanley was run a total of 64 times, once for every spatial/temporal constraint variable combination with the AHA for the Nakina North Forest without the caribou stratification constraint, and once for every spatial/temporal constraint variable combination with the AHA for the Nakina North Forest with the caribou stratification constraint applied (Figure 3). The solutions were then viewed in Arcview by classifying the forest by cut period and displaying the stands to be cut in each of the five 10-year periods (Figure 4).

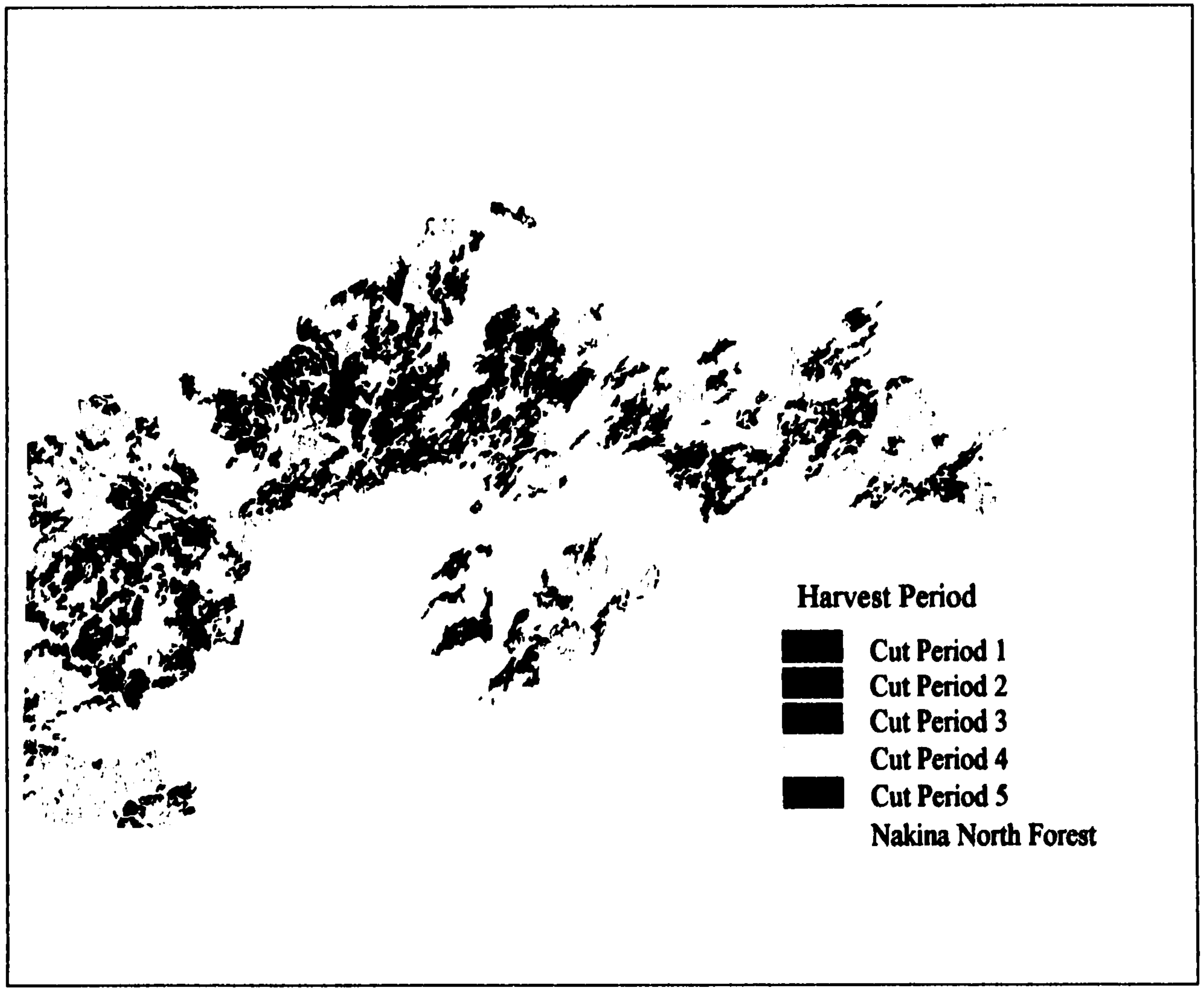

Figure 4. An example of the Stanley solution Run #20 for the Nakina North Forest with the caribou stratification. Depicted are stands to be cut in each of the five 10-year cut periods.

A test run of Stanley was also conducted to see how much the blocking program would vary in its results. Using the Nakina North Forest without the caribou stratification constraint applied, a proximity of 2000 m, a target block size of 2000 ha, a maximum block size of 2500 ha, a minimum block size of 10 ha, and a green-up period of one 10-year period, Stanley was run 10 times. The results indicated a ±1.5% difference in the proportion of AHA that Stanley could successfully block and schedule. This result provided confidence that running Stanley just once for each spatial/temporal variable combination would be sufficiently representative for the purposes of this project. However, a single Stanley run is a solution obtained after hundreds of iterations so the variability among "runs" is expected to be low. The selected solution is not random, so statistical comparisons are neither valid nor necessary (Walpole 1982). It is more prudent to examine changes in effect size rather than statistical significance.

Once the GPAT file was revised by Stanley to identify cut periods for stands selected for harvest, the forest was "aged" using Arcview to reflect what the forest would look like after the five 10-year terms of harvest (Figure 3). This involved changing the age of the forested polygons such that if a polygon was not selected for harvest, 55 years was added to its age. If the polygon was selected for harvest in cut period one, 45 years was added to its age, and so on. A true "aging" would reflect changes occurring in the canopy structure, and would thus affect species composition. This was not feasible during this study so the projected harvest was restricted to five 10-year terms with the assumption that this time frame would result in little change to the relative species composition of the stands. This "aging" was necessary in order to look at the availability and spatial configuration of wildlife habitat if the proposed harvest occurred.

Block size distribution is an issue in forest management today, especially in light of the implementation of the proposed Fire Emulation Guidelines (in preparation) (J. McNicol, personal communication, 1998). As part of the timber supply analysis, histograms of the block-size distributions resulting from each of the 64 Stanley solutions were created to compare with the desired disturbance pattern for the area (Figure 3).

WILDLIFE HABITAT ANALYSIS

The FMPM (OMNR 1996a) requires that for every forest management alternative developed for a forest management unit, the available preferred habitat for selected species is analysed over time. SFMM has the ability to non-spatially track preferred wildlife habitat over time, however in this study a spatial component was incorporated into the habitat analysis.

Once Stanley allocated the timber harvest, the ages of the forest polygons were updated to account for the harvest taking place over the five 10-year terms. The resulting sixty-four "landscapes" were then analysed for potential preferred habitat for the four selected wildlife species; moose, caribou, american marten and ovenbird (Figure 3). The analyses included a non-spatial and spatial component and were completed using a combination of Arcview extension tools called Habitat Analyst and Patch

Analyst. Habitat Analyst and Patch Analyst were developed as part of the Natural Disturbance Analysis and Planning Tools Project (Rempel *et al.* 1999).

For the non-spatial habitat analysis component, Habitat Analyst was used to model the resulting landscapes of the alternate scenarios identifying potential preferred habitat for each selected species. SFMM Tool, used in the timber supply analysis, defined habitat units (HU's) for the Nakina North Forest (Table 2). These habitat units were then used to define potential preferred habitats for the four selected species. The definition of preferred habitats originated from OMNR Northwest Region's Habitat Matrix in SFMM Tool (Watkins and Davis 1997) which were imported and used in Habitat Analyst (Appendix II). The habitat matrix in SFMM Tool specifies what forest types and age classes comprise preferred and marginal habitats for various wildlife species. The habitat analysis in this study was restricted to potential preferred habitat based on the assumption that the availability of preferred habitat would be most limiting in this area for the four selected species. The definitions for marginal habitat were very inclusive resulting in almost the entire forest being suitable as marginal habitat for the selected species, thus not indicating a limitation to the production of the four species.

Table 2. Definition of the Northwest Region Habitat Units (HU's) (from Watkins and Davis 1997)[4]

Habitat Unit Number	Habitat Unit Name	Description
HU1	CuPjw	Pr +Pw >=20%, PFR or PF
HU2	CuPjS	Pj or Sb Working Group, PFR or PF
HU3	Cu Pwr	Pr + Pw >= 20%, Site Class 1,2,3
HU4	Cu_Pj	Pj>=50%, hardwood <10%, Site Class 3
HU5	Mi_PS	Pj or Sb Working Group, hardwood<50%, Site Class 2,3
HU6	HuBfS	Hardwoods (excl. Ab) >50%, Site Class 2,3
HU7	Cu_Ce	Ce Working Group, upland site
HU8	MiCBS	Bf or Sw Working Group, conifer >50%, Site Class 2,3
HU9	Cu_PS	Pj or Sb Working Group, hardwood <50% Site Class 1
HU10	MiBfS	Bf or Sw Working Group, conifer>50%, Site Class 1
HU11	MiHBS	Hardwoods (excl. Ab) >50%, Site Class 1
HU12	Hl_Ab	Ab Working Group
HU13	ClSb1	Sb or Pj lowland site, Site Class 1,2
HU14	ClSb3	Sb lowland site Site Class 3,4
HU15	Cl_Ce	Ce + T >30%, lowland site
HU16	H_Nfr	habitat non-forest

OMNR's Northwest Region Science and Technology Unit has developed a marten habitat suitability model (P. Elkie, pers. comm., 1998). A home range size of 100 ha is used based on the Thompson and Colgan (1987) study that found female home ranges in Ontario to be approximately 110 ha. The female home range size was used because males can impregnate more than one female thus making the home range size for the female more limiting. The marten habitat suitability model has a portion that looks at the potential habitat for voles and hares, the marten's prime food sources. In this study a home range size of 100 ha was used and stands were deemed preferred marten habitat if they provided both denning habitat and habitat used by the marten's food source (either voles or hares).

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[4] Cu=conifer upland, Pj=jack pine, Pw=white pine, Pr=red pine, S=spruce, Sb=black spruce, Sw=white spruce, Mi=mixedwood, Hu=hardwood upland, Bf=balsam fir, Ab=black ash, Ce=eastern white cedar, Cl=conifer lowland, T=tamarack, PF=protection forest, PFR=protection forest reserve

When analysing moose habitat, the preferred summer and winter habitat requirements obtained from the Northwest Region Habitat Matrix was found to be too limiting and it was modified in consultation with R. Rempel and J. McNicol of OMNR to reflect better the preferred habitat conditions in northwestern Ontario. The alterations made were based on ecosite/habitat correlations. The definitions of potential preferred moose habitat in the Northwest Region Habitat Matrix as well as the modified definitions used in this project are quite inclusive with regards to the age at which stands become suitable. With these definitions, some stands become suitable at 10 years of age. There is an assumption with this project that the definitions of preferred habitat are correct. This in fact may not be the case and must be considered when interpreting the results.

A combination of Patch Analyst and Habitat Analyst was then used to evaluate the potential preferred habitat for each landscape spatially. The goal of this exercise was to determine how the distribution of resulting potential preferred habitat for each species had changed as a result of the alternative forest management scenarios. This involved first overlaying and intersecting the resulting potential preferred habitat for each species for each scenario with a hexagonal pattern. The hexagons were the approximate size of the species home range; 3600 ha for moose (OMNR 1980), 100 ha for marten (from Thompson and Colgan 1987), 5300 ha for caribou (core winter range from Racey *et al.* 1997), and 100 ha for ovenbird (from Robbins *et al.* 1989). There is variability in home range sizes for ovenbird reported in the literature (from less than 10 ha to greater than

400 ha). Due to this variability and the fact that the forest inventory becomes more relevant at larger scales, a 100 hectare home range size was selected for ovenbird.

Once the hexagons were overlaid and intersected with the potential preferred habitat, the proportion of each hexagon that was potential preferred habitat was then calculated. This improves on the technique such as that used in Schultz and Joyce (1992), where simply the number of suitable home ranges in the landscape were compared, as it is now understood that not all of a home range must be preferred habitat to be functional. To illustrate, I use an example of the hexagon overlay for two runs, Run #19 (Figure 5) and Run #29 (Figure 6) for the Nakina North Forest with the caribou stratification. The landscapes created from Run #19 (Figure 5) and Run #26 (Figure 6) show the hexagon overlay for a portion of the forest where preferred potential marten habitat is highlighted in the dark tone.

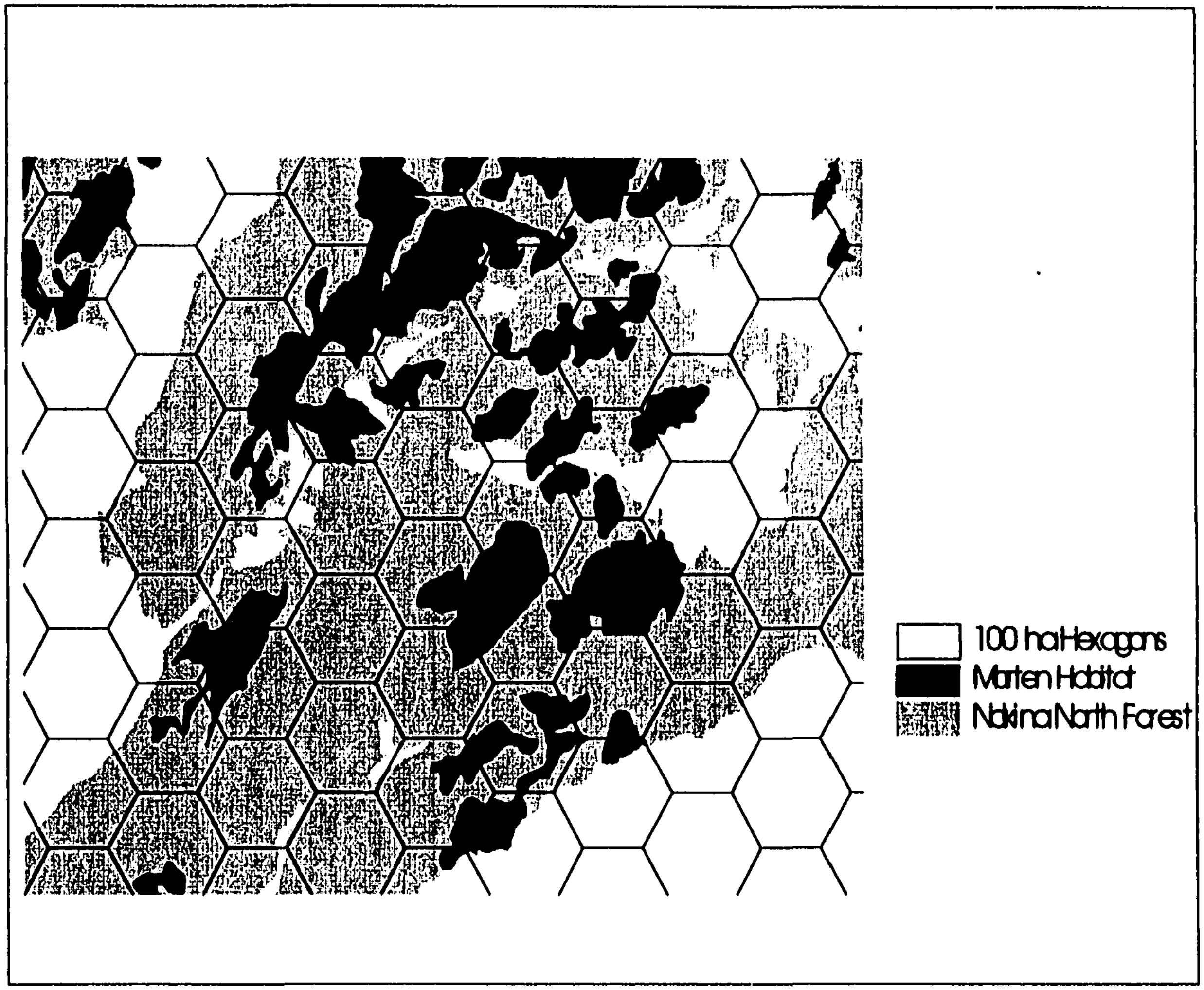

Figure 5. An example of the hexagon pattern overlay for potential preferred marten habitat (in dark tone) after simulated harvest for a portion of the Nakina North Forest with caribou stratification, Run #19. The hexagon is the approximate size of the home range (100 ha).

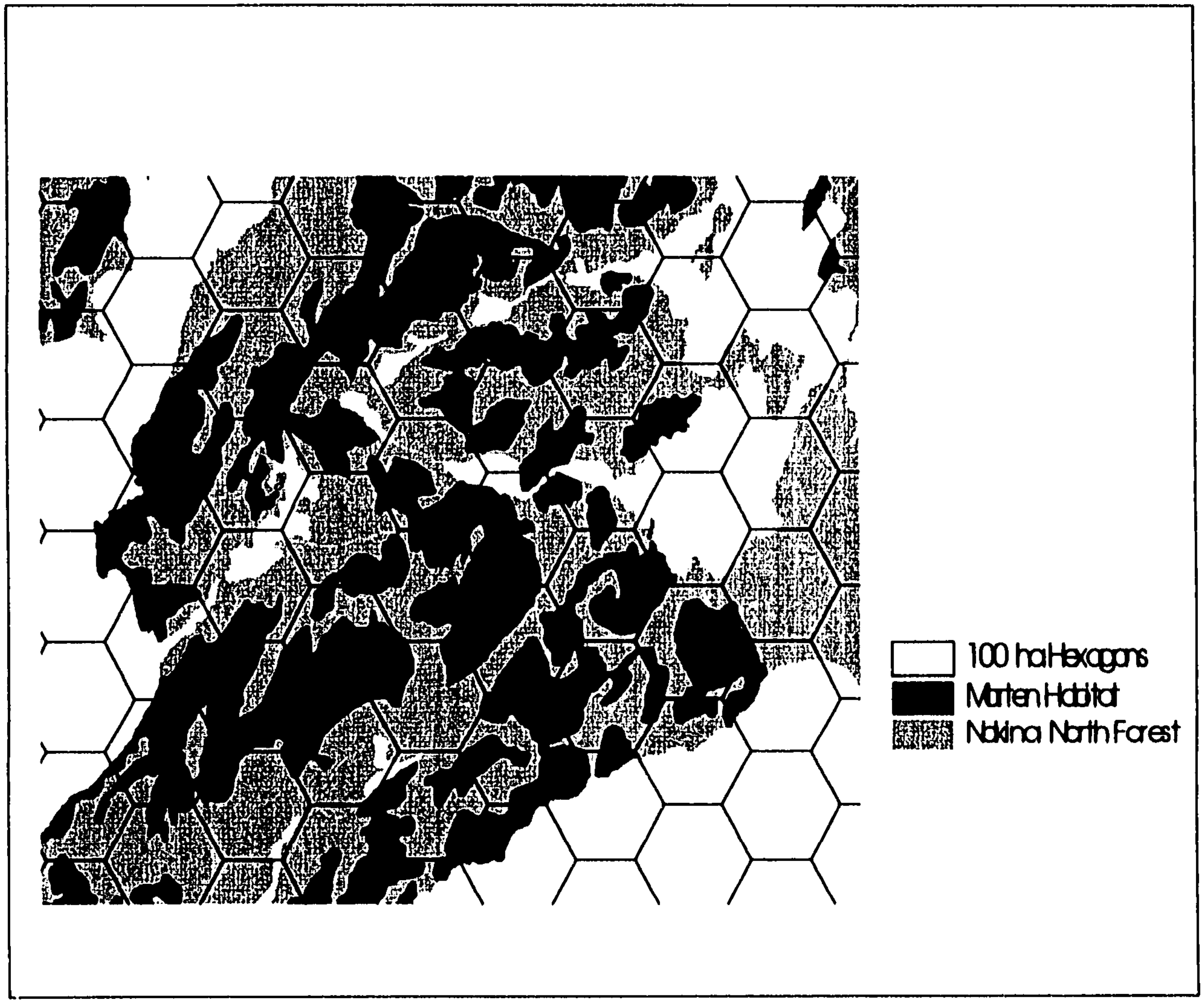

Figure 6. An example of the hexagon pattern overlay for potential preferred marten habitat (in dark tone) after simulated harvest for a portion of the Nakina North Forest with caribou stratification, Run #29. The hexagon is the approximate size of the home range (100 ha).

For each species, histograms depicting the number of hexagons in each potential preferred habitat proportion range (e.g. 0 – 0.1) were then created (Figure 3). Following the two example runs used above, see Figures 7 and 8 for illustration. The data in these histograms were used to calculate Habitat Dispersion and Habitat Supply.

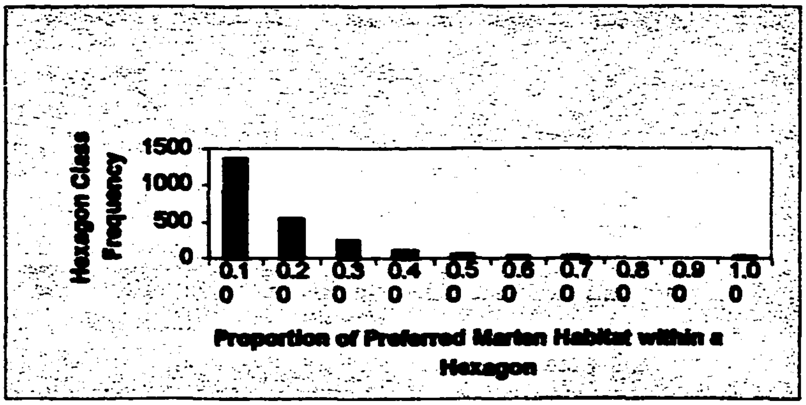

Figure 7. A histogram depicting the proportion of potential preferred marten habitat in areas of home range size (100 ha) after simulated harvest on the Nakina North Forest with caribou stratification, Run #19.

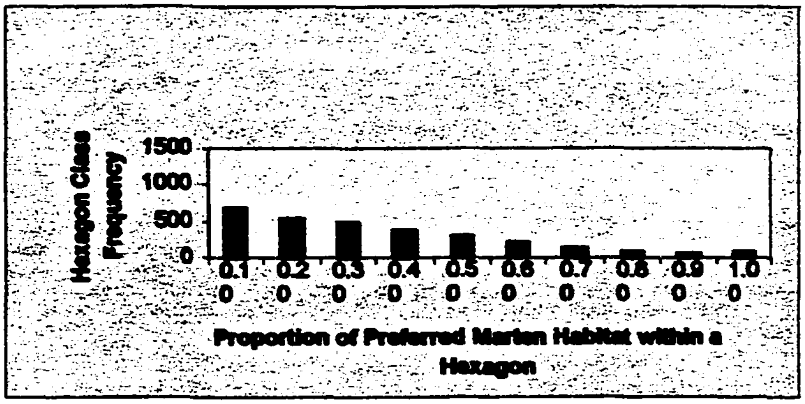

Figure 8. A histogram depicting the proportion of potential preferred marten habitat in areas of home range size (100 ha) after simulated harvest on the Nakina North Forest with caribou stratification, Run #29.

Habitat Supply was calculated using the weighted sum of the number of hexagons in each proportion range (0-0.10, 0.11-0.20, etc. up to 1.0) of potential preferred habitat for each species (Figure 3). Following the previous examples, the resulting landscape for Run #19 had 1351 hexagons that had 0-10% potential preferred marten habitat, 539 hexagons that had 11-20% potential preferred habitat, 256 hexagons that had 21-30% potential preferred habitat, 118 hexagons that had 31-40% potential preferred habitat, 44 hexagons in the 41-50% potential preferred habitat range, 25 hexagons in the 51-60% potential preferred habitat range, 17 hexagons in the 61-70% potential preferred habitat range, 12 hexagons in the 71-80% potential preferred habitat range, 5 hexagons in the 81-90% and 23 hexagons that had 91-100% potential preferred habitat. The weighted sum for this example would yield a habitat value of (1351 x 0.05) + (539 x 0.15) + (256 x 0.25) + (118 x 0.35) + (44 x 0.45) + (25 x 0.55) + (17 x 0.65) + (12 x 0.75) + (5 x 0.85) + (23 x 0.95) = 333.40. The same calculation for Run #29 yielded a weighted sum of 894.4.

This weighting scheme gives more weight to hexagons with large proportions of potential preferred habitat. If there was no scheme and all the hexagons that contained any amount of potential preferred habitat were simply tallied, there is an assumption that home ranges with 10% potential preferred habitat are as valuable as those with 90% potential preferred habitat. Usually this is not the case and such tallies would provide an inaccurate view of the number of useful potential home ranges exist in the landscape. Also, when comparing different landscapes, landscapes with lots of home ranges with little potential preferred habitat would be considered as valuable as those landscapes with perhaps fewer home ranges, but each with substantially more potential preferred habitat (thus giving them more potential to be used as functional home ranges). Using the weighted sum gave a more accurate reflection of the number of hexagons within each preferred habitat proportion range and allowed for a more useful comparison between scenarios, between various spatial constraint combinations and also between time frames (the habitat prior to harvesting occurring and habitat after five 10-year terms of harvest).

Habitat dispersion was looked at next for each run and species (Figure 3). First, an expected value for the number of hexagons in each "bin" (proportion range of preferred habitat within a hexagon) was determined based on the values from the pre-harvest condition of the forest. The expected values are the initial habitat conditions, how potential preferred wildlife habitat is dispersed across the landscape, with the null hypothesis that forest management will maintain current habitat conditions. The expected values were determined by first dividing the number of hexagons in each bin for the pre-harvest condition by the total number of hexagons that contained preferred habitat. This number was multiplied by the total number of hexagons that contained preferred habitat for the post-harvest condition to give an expected number of hexagons in each bin for the post-harvest condition. Histograms of the expected values and the observed values were then created and a Chi–square analysis used the observed and expected values to determine whether there were differences between pre-harvest and post-harvest habitat dispersion. Post-harvest Habitat Dispersion is quantitatively described by the histogram of observed and expected values (Figures 9 and 10). However, to examine whether the histograms, or the spatial dispersions of habitat, differ from the pre-harvest condition of the forest, a Chi–square analysis was used. A Chi–square value was calculated for each proportion range and summed to give a total Chi–square value for each run. The inverse of this value was then calculated. The higher the inverse of the value, the closer the pre– and post– harvest histogram patterns, and similarly the closer the pre– and post–harvest habitat dispersion.

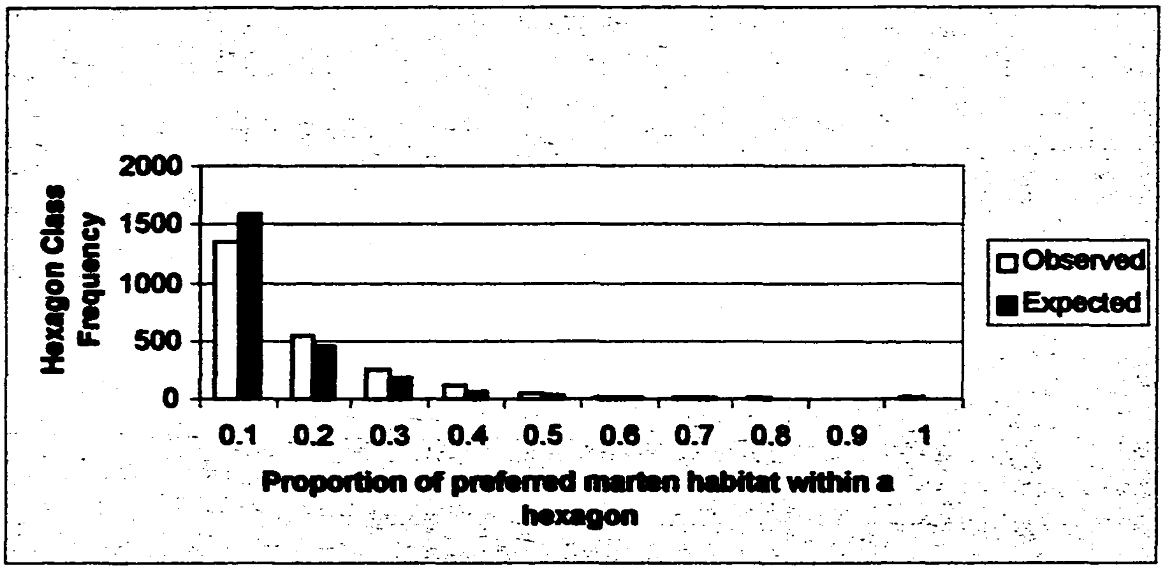

Figure 9. Pattern of marten habitat dispersion for the Nakina North Forest with caribou stratification Run #19 post-harvest. Inverse Chi-square = 2.59E^{-05}.

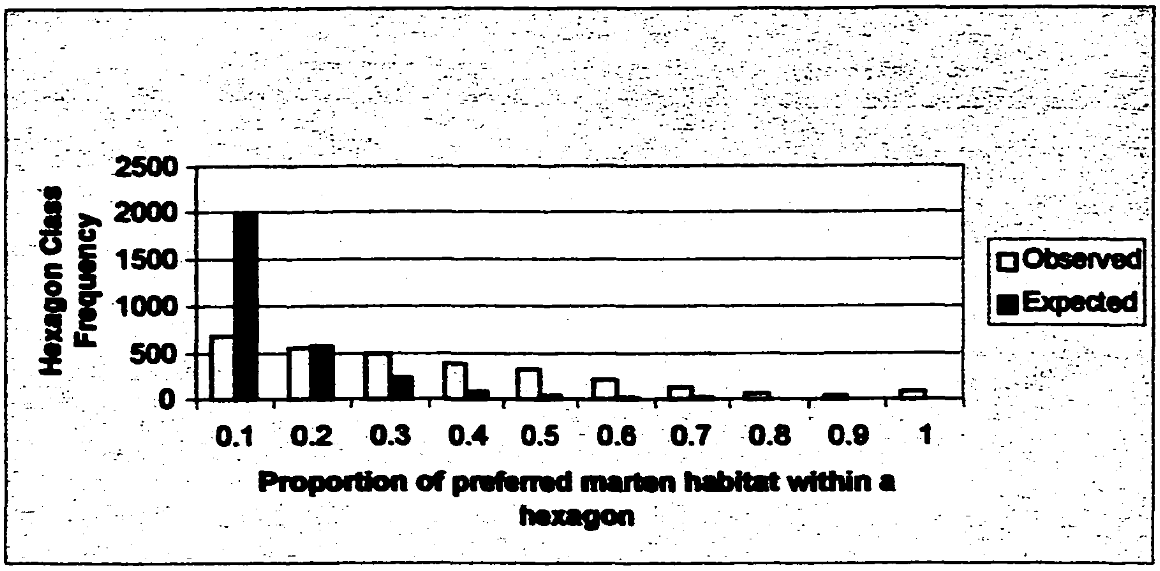

Figure 10. Pattern of marten habitat dispersion for the Nakina North Forest with caribou stratification Run #29 post-harvest. Inverse Chi-square = $2.22E^{-06}$.

Using the previous examples, Run #19 and Run #29, the proportions of potential preferred marten habitat pre- and post- simulated harvest were compared. The inverse Chi–square values for Run #19 and Run #29 were $2.59E^{-05}$ and $2.22E^{-06}$. These values indicate large differences between the pre- and post-harvest habitat dispersions for marten for both runs. They also indicate the difference between the marten habitat dispersions of Run #19 and Run #29 post-harvest.

CASE STUDY

Once the timber supply and wildlife habitat analyses were completed, further examination was required to determine which constraint combinations best met ecological and economic objectives. The timber supply and wildlife habitat supply analyses resulted in the calculation of three response variables for each of the 64 runs: 1) wood supply (proportion of AHA achieved); 2) habitat supply (weighted sum of number of areas of potential preferred habitat of home range size); and 3) habitat dispersion (inverse Chi-square value comparing pre- and post-harvest conditions) for each species.

For a case study, surface response graphs depicting the relationship between each response variable and spatial constraint combination were then created. That is, for each combination of four cutblock sizes and four proximity distances, a separate contour graph was created for each of the four response variables. Finally, the surface response graphs were overlaid and used to identify thresholds where the response variables (economic and ecological objectives) overlap and to note the spatial constraint combinations associated with those thresholds. Clear acetates of the four surface response graphs resulting from each combination of cutblock size and proximity were made. For each response variable the acetates were then overlaid and areas of overlap manually estimated. This identified the thresholds of maximum block sizes and proximities where the values of each response variable were greatest.

RESULTS

TIMBER HARVEST AND WILDLIFE HABITAT ANALYSES

The various combinations of spatial/temporal constraints, proportion of the AHA determined by SFMM that Stanley could feasibly block over the five 10 - year terms, and weighted sum of potential preferred habitat areas of home range size are given in Table 3. For example, for Run #5 of the management scenario for the Nakina North Forest with the caribou constraint applied (NakCar), 78% of the AHA was able to be blocked out spatially by Stanley given the parameters for target block size, minimum block size, maximum block size, proximity, and green-up period. Note that some of the proportions exceed 100%. This is due to a harvest-flow fluctuation setting entered into Stanley that allows an acceptable fluctuation in the objective target harvest level over time. This fluctuation increases flexibility for Stanley when trying to determine harvest blocks. In this study, a leniency of plus or minus 10% of the AHA was allowed. Such fluctuations are standard in timber supply modelling and are reflected in harvest cut control regulations.

Table 3. Proportion of AHA blocked and weighted sum of potential preferred habitat areas of home range (hr) size for the two management scenarios (Nakina North Forest with the caribou stratification constraint applied and the Nakina North Forest without the caribou stratification constraint applied) and thirty-two spatial and temporal variable constraint combinations.

Forest Management Scenario	Run	Proximity (m)	Target Block Size (ha)	Green Up (# of 10 - year periods)	Maximum Block Size (ha)	Minimum Block Size (ha)	Proportion of AHA Blocked	Caribou Habitat (wt. sum)	Moose Winter Range (wt. sum)	Moose Summer Range (wt. sum)	Marten Habitat (wt. sum)	Ovenbird Habitat (wt. sum)
Term 0	0							33.20	59.60	10.95	191.65	140.15
NakNoCar	1	100	100	0	125	10	1.03	29.25	54.35	12.60	466.45	8.15
NakNoCar	2	100	250	0	312.5	10	1.06	29.05	56.95	13.50	234.60	6.55
NakNoCar	3	100	1000	0	1250	10	1.07	28.95	56.65	6.75	233.30	8.05
NakNoCar	4	100	2000	0	2500	10	1.06	28.95	54.65	12.85	234.30	7.80
NakNoCar	5	250	100	0	125	10	1.01	29.45	57.15	13.65	248.40	6.95
NakNoCar	6	250	250	0	312.5	10	1.06	28.85	54.50	12.35	233.35	8.00
NakNcCar	7	250	1000	0	1250	10	1.06	27.85	54.25	12.75	223.05	6.65
NakNoCar	8	250	2000	0	2500	10	1.07	31.05	54.25	12.60	250.35	4.25
NakNoCar	9	1000	100	0	125	10	0.76	31.2	56.95	12.30	304.05	4.40
NakNoCar	10	1000	250	0	312.5	10	1.04	29	54.65	12.35	258.30	8.05
NakNoCar	11	1000	1000	0	1250	10	1.05	29.05	54.70	12.95	239.90	8.45
NakNoCar	12	1000	2000	0	2500	10	1.07	28.8	54.25	12.70	236.30	6.65
NakNoCar	13	2000	100	0	125	10	0.60	32.8	58.20	11.40	377.00	5.55
NakNoCar	14	2000	250	0	312.5	10	0.88	30.6	55.45	12.45	278.60	5.05
NakNoCar	15	2000	1000	0	1250	10	1.03	28.75	55.10	12.75	243.00	7.40
NakNoCar	16	2000	2000	0	2500	10	1.07	28.45	54.30	13.05	256.60	10.05
NakNoCar	17	100	100	1	125	10	0.92	29.95	55.30	12.35	293.30	7.70
NakNoCar	18	100	250	1	312.5	10	1.04	29.25	54.70	12.45	241.55	7.40
NakNoCar	19	100	1000	1	1250	10	1.04	29.7	55.10	12.40	259.55	8.75
NakNoCar	20	100	2000	1	2500	10	1.05	29.25	54.40	13.15	233.90	6.10
NakNoCar	21	250	100	1	125	10	0.85	30.9	56.10	11.95	286.10	5.60
NakNoCar	22	250	250	1	312.5	10	0.99	29.75	54.90	12.45	254.45	6.10
NakNoCar	23	250	1000	1	1250	10	1.04	29.55	54.60	12.85	240.60	9.45
NakNoCar	24	250	2000	1	2500	10	1.04	29.55	54.60	12.65	238.80	7.65
NakNoCar	25	1000	100	1	125	10	0.59	32.85	58.00	11.30	392.60	4.80
NakNoCar	26	1000	250	1	312.5	10	0.79	31.1	56.15	11.75	334.25	5.45
NakNoCar	27	1000	1000	1	1250	10	0.98	29.45	55.40	12.25	268.85	11.00
NakNoCar	28	1000	2000	1	2500	10	1.02	29.25	54.65	12.65	266.60	6.30
NakNoCar	29	2000	100	1	125	10	0.37	34.1	60.05	10.25	447.75	4.35
NakNoCar	30	2000	250	1	312.5	10	0.55	33.05	58.20	11.00	391.75	3.65
NakNoCar	31	2000	1000	1	1250	10	0.83	30.95	56.00	11.90	317.95	4.10
NakNoCar	32	2000	2000	1	2500	10	0.94	30.25	55.30	12.35	288.80	6.35
NakCar	1	100	100	0	125	10	0.86	30.15	57.20	11.95	322.75	6.35
NakCar	2	100	250	0	312.5	10	1.03	28.95	56.00	11.95	318.60	6.45
NakCar	3	100	1000	0	1250	10	1.02	29.15	56.50	11.85	316.70	10.10
NakCar	4	100	2000	0	2500	10	0.93	29.95	57.20	11.55	334.85	5.85
NakCar	5	250	100	0	125	10	0.78	29.95	58.55	12.65	666.25	7.75
NakCar	6	250	250	0	312.5	10	0.98	29.35	56.20	11.65	326.65	8.10
NakCar	7	250	1000	0	1250	10	0.98	29.35	56.20	12.05	331.50	5.45
NakCar	8	250	2000	0	2500	10	0.94	29.75	56.40	11.55	335.80	7.85
NakCar	9	1000	100	0	125	10	0.54	33.1	59.20	10.45	423.70	5.40
NakCar	10	1000	250	0	312.5	10	0.76	30.75	57.80	11.35	382.35	5.60
NakCar	11	1000	1000	0	1250	10	0.99	28.9	56.30	11.75	326.90	7.05
NakCar	12	1000	2000	0	2500	10	1.04	28.65	55.80	12.25	309.40	5.75
NakCar	13	2000	100	0	125	10	0.33	35.25	60.40	9.95	845.90	4.80
NakCar	14	2000	250	0	312.5	10	0.48	33.2	59.40	10.65	793.05	4.55
NakCar	15	2000	1000	0	1250	10	0.82	30.85	57.50	11.55	366.90	5.90
NakCar	16	2000	2000	0	2500	10	0.81	30.65	57.60	11.05	327.00	4.75
NakCar	17	100	100	1	125	10	0.63	32.7	58.50	10.85	741.70	7.55
NakCar	18	100	250	1	312.5	10	0.80	30.6	57.20	11.05	360.35	7.20
NakCar	19	100	1000	1	1250	10	0.92	30.1	56.90	11.45	333.40	8.90
NakCar	20	100	2000	1	2500	10	0.93	29.7	56.40	11.95	333.75	6.30
NakCar	21	250	100	1	125	10	0.53	33.2	59.20	10.65	776.95	4.35
NakCar	22	250	250	1	312.5	10	0.72	32	57.80	10.95	382.10	6.10
NakCar	23	250	1000	1	1250	10	0.86	30.35	56.70	11.45	355.40	7.85
NakCar	24	250	2000	1	2500	10	0.89	30.15	56.70	11.55	346.30	6.05
NakCar	25	1000	100	1	125	10	0.32	35	60.90	10.25	855.40	5.05
NakCar	26	1000	250	1	312.5	10	0.44	34.1	59.70	10.35	810.30	6.85
NakCar	27	1000	1000	1	1250	10	0.73	31.15	57.70	11.15	383.55	4.10
NakCar	28	1000	2000	1	2500	10	0.84	30.35	57.20	12.15	363.40	4.35
NakCar	29	2000	100	1	125	10	0.19	36	61.50	9.45	894.40	4.00
NakCar	30	2000	250	1	312.5	10	0.31	34.7	60.80	9.85	856.80	4.65
NakCar	31	2000	1000	1	1250	10	0.57	32.4	58.30	11.25	768.30	5.00
NakCar	32	2000	2000	1	2500	10	0.72	31.45	57.40	11.55	713.95	4.85

WOOD SUPPLY

Figures 11 to 14 depict the relationships between maximum block size, proximity and the proportion of AHA that Stanley could achieve for the Nakina North Forest 1) without caribou stratification and no green-up delay applied; 2) without caribou stratification and a green-up delay of one 10-year term applied; 3) with caribou stratification and no green-up delay applied and 4) with caribou stratification and a green-up delay of one 10-year term applied. The highest proportion of AHA was achieved when there was no caribou stratification and no green-up delay applied (Table 3). The lowest AHA was achieved when there were both the caribou stratification and a green-up delay applied to the simulation (Table 3). Overlaying the figures for these four scenarios indicates that the zone of convergence (i.e. maximum proportion of AHA achieved) occurs when proximity is less than 1000 m and when maximum block size is greater than 500 ha.

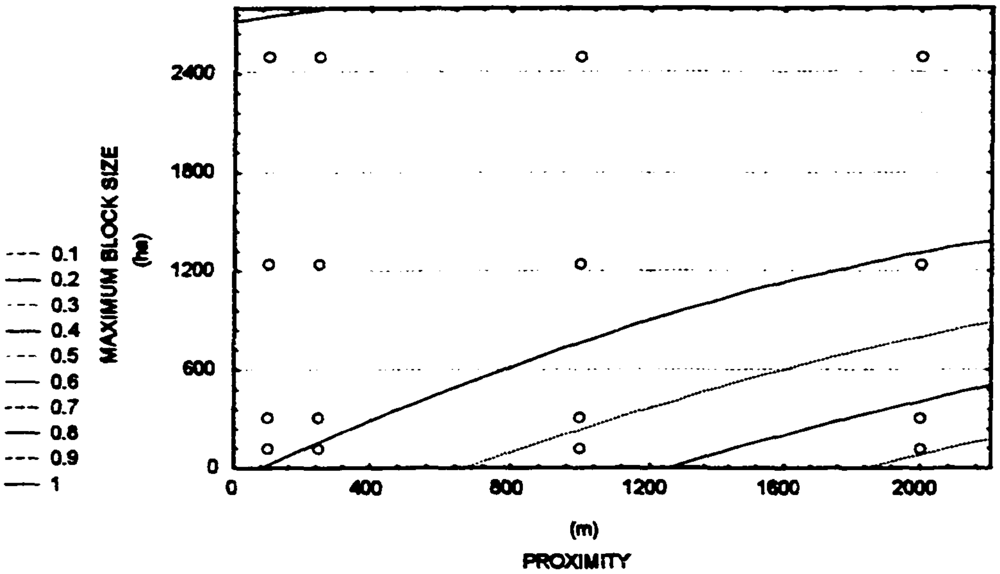

Figure 11. Surface response graph of the relationship between the spatial constraint variables and wood supply after five 10–year terms of harvest for the Nakina North Forest without caribou stratification and with no green-up delay (expressed as proportion of AHA achieved).

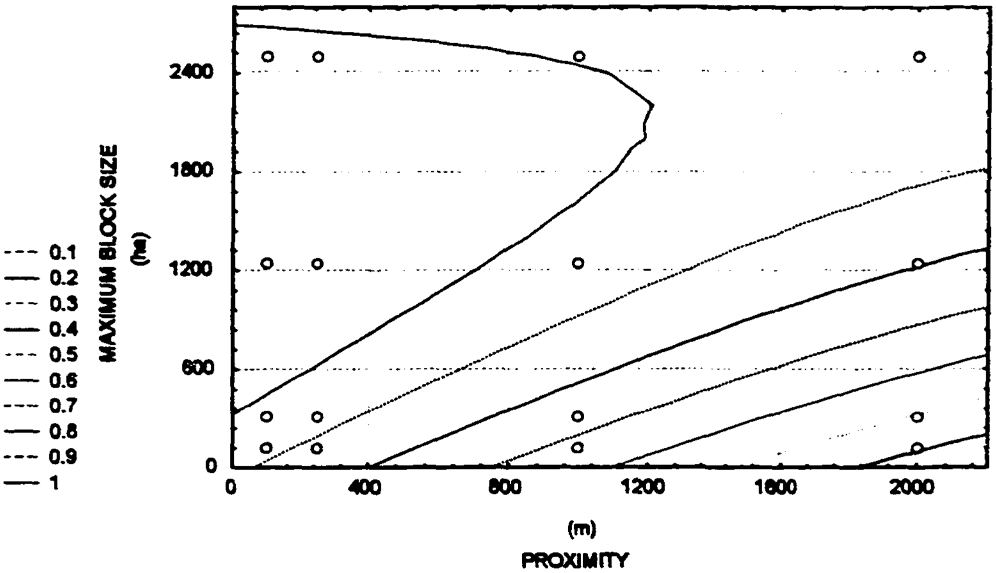

Figure 12. Surface response graph of the relationship between the spatial constraint variables and wood supply after five 10–year terms of harvest for the Nakina North Forest without caribou stratification and with a green-up delay of one 10–year term (expressed as proportion of AHA achieved). The highest contour touches the left axis.

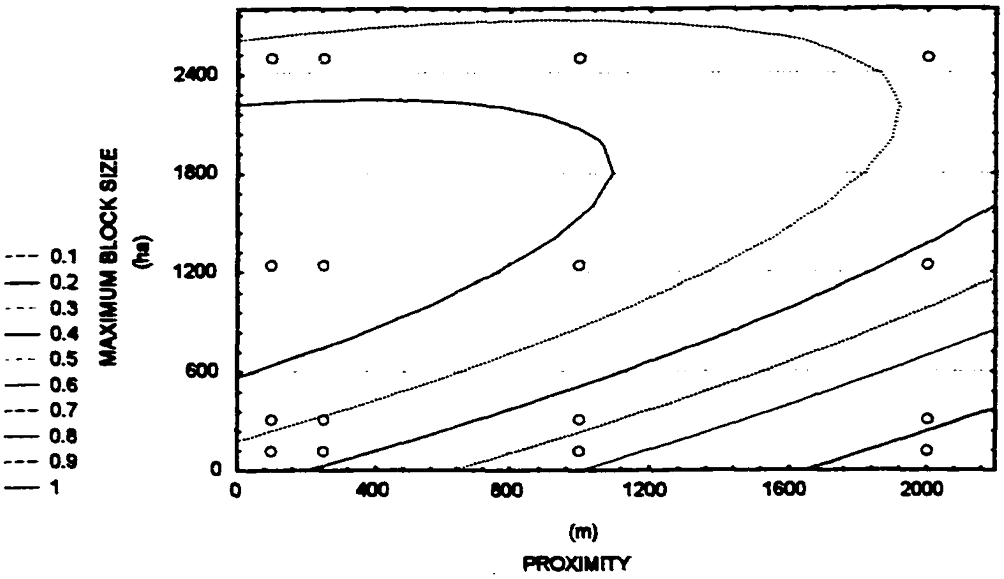

Figure 13. **Surface response graph of the relationship between the spatial constraint variables and wood supply after five 10–year terms of harvest for the Nakina North Forest with caribou stratification and with no green-up delay (expressed as proportion of AHA achieved).**

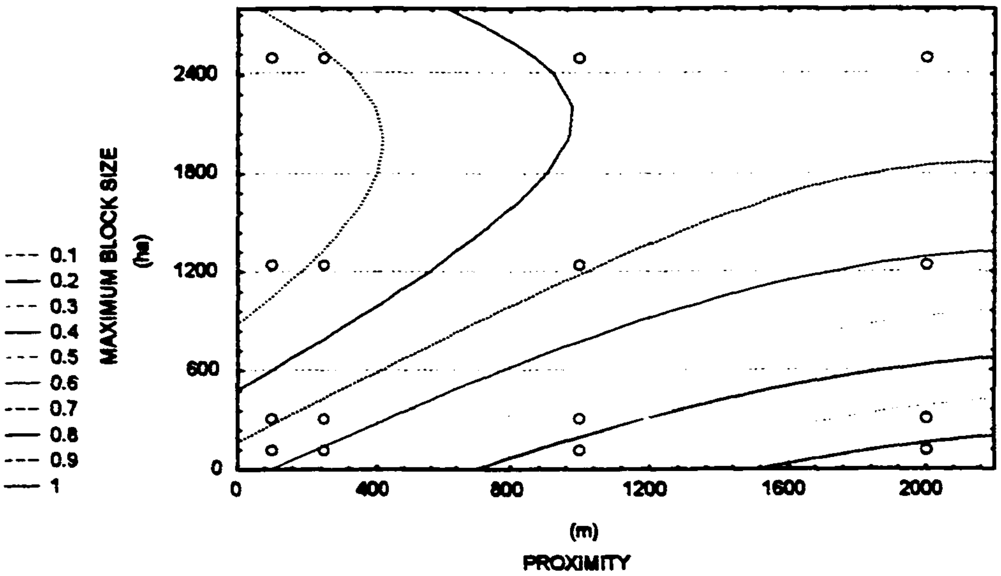

Figure 14. **Surface response graph of the relationship between the spatial constraint variables and wood supply after five 10–year terms of harvest for the Nakina North Forest with caribou stratification and with a green-up delay of one 10–year term (expressed as proportion of AHA achieved).**

In Figure 15, which demonstrates the pattern of the proportion of AHA achieved resulting from each of the four scenarios in response to each of the sixteen runs or spatial constraint combinations, it is evident that all four scenarios follow a similar pattern in terms of proportion of AHA achieved. AHA seems to increase with increasing block size for all scenarios regardless of proximity. The scenario without caribou stratification but with a green-up delay and the scenario with the caribou stratification but without a green-up delay is quite similar in magnitude. For the scenario with caribou stratification and a green-up delay the negative effect of small block size was exacerbated.

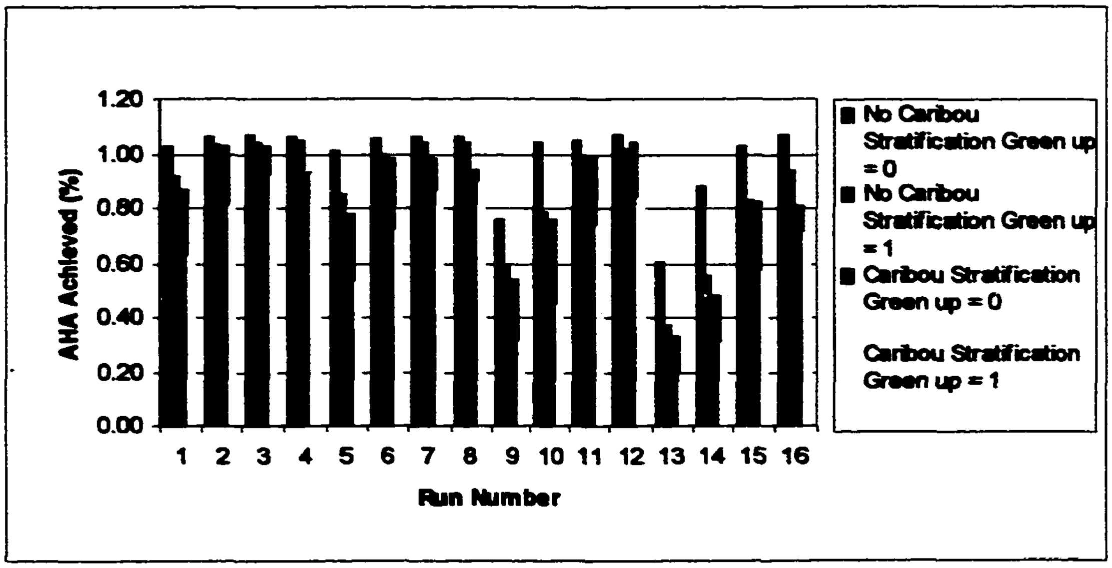

Figure 15. The pattern of the proportion of AHA achieved on the Nakina North Forest resulting from each of four management scenarios in response to each of sixteen runs. The spatial constraint combination for each run is in Table 4.

Table 4. Spatial constraint combination for runs shown in Figure 15.

Run	Proximity (m)	Target Block Size (ha)	Maximum Block Size (ha)	Minimum Block Size (ha)
1	100	100	125	10
2	100	250	312.5	10
3	100	1000	1250	10
4	100	2000	2500	10
5	250	100	125	10
6	250	250	312.5	10
7	250	1000	1250	10
8	250	2000	2500	10
9	1000	100	125	10
10	1000	250	312.5	10
11	1000	1000	1250	10
12	1000	2000	2500	10
13	2000	100	125	10
14	2000	250	312.5	10
15	2000	1000	1250	10
16	2000	2000	2500	10

Histograms depicting the block size distribution resulting from the sixty-four harvest scenarios after the five 10-year terms of harvest were created (Appendix III). Essentially three main patterns emerged from these histograms, 1) a distribution where the majority of the area was in small block sizes; 2) a distribution where the majority of the area was in fewer larger block sizes; and 3) a more even distribution where a similar amount of area was harvested in the medium block size ranges. Figure 16 shows that the result of the five ten-year term of harvest of Run #12 (for the Nakina North Forest, without the caribou stratification constraint and with no green-up delay period) is a harvest block distribution with a large amount of area and a large number of blocks in the smallest block size class. This can be compared with Run #28 (with the same proximity and maximum block size for the Nakina North Forest without the caribou stratification but with a green-up delay of one 10–year term) (Figure 17) where the histogram shows more area in the larger blocks size classes but distributed over fewer blocks. The block size distribution for Run #28 (Figure 17) is more similar to the natural disturbance pattern for the area which is characterised by a large amount of area in fewer bigger patches (J. McNicol, personal communication, 1998).

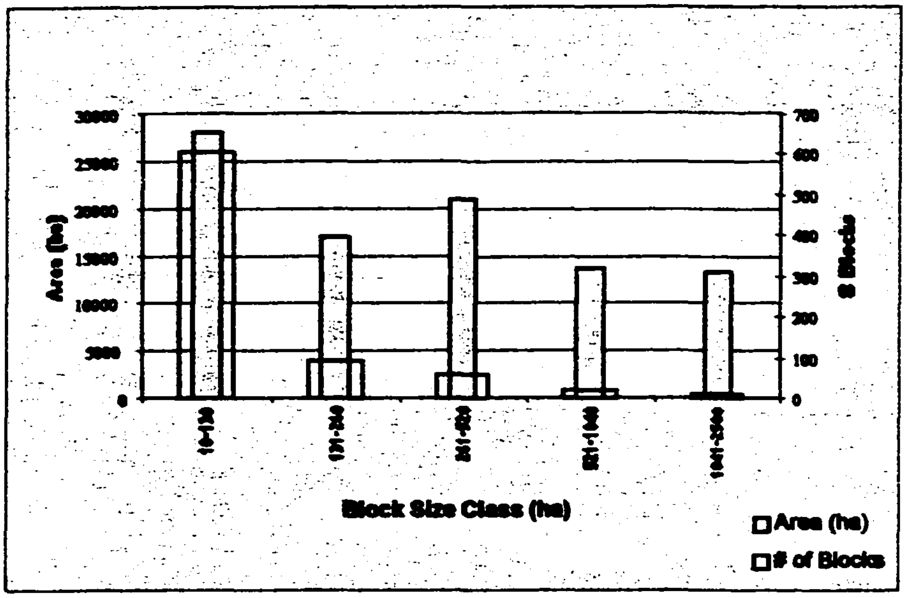

Figure 16. An example of a histogram depicting the block size distribution resulting from the five 10-year terms of harvest of Run #12 for the Nakina North Forest without the caribou stratification constraint applied and with no green-up delay applied.

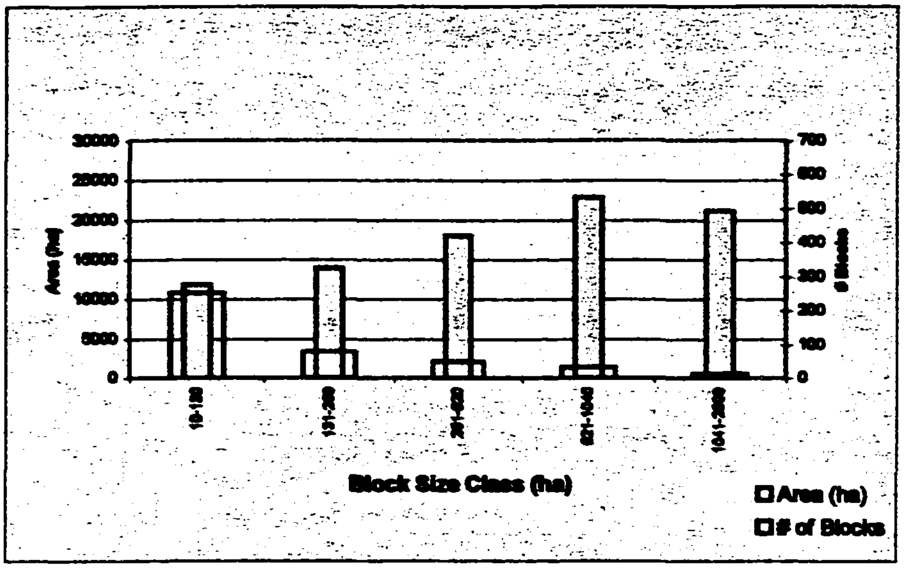

Figure 17. **An example of a histogram depicting the block size distribution resulting from the five 10-year terms of harvest of Run #28 for the Nakina North Forest without the caribou stratification constraint applied and with a green-up delay of one 10–year term applied.**

WILDLIFE HABITAT DISPERSION

Histograms of habitat dispersion, or the proportion of potential preferred habitat in areas of home range size prior to harvest, can be found in APPENDIX IV. Figure 18 shows that for the Nakina North Forest prior to harvest, the majority of hexagons, of home range size, contain greater than 40% potential preferred caribou habitat. Histograms showing habitat dispersion after five 10-year year terms of harvest can be found in APPENDIX V. Figure 19 depicts the post-harvest habitat dispersion for Run#7 of the Nakina North Forest without the caribou stratification constraint applied and without a green-up delay period. It shows both expected and observed proportions of

potential preferred habitat in areas of home range size. The expected proportions are those from the pre-harvest condition (Figure 18) as one hypothesis is that forest management will have no effect on potential preferred caribou habitat. Showing both the expected and observed values demonstrates how the post-harvest dispersion compares to the pre-harvest dispersion.

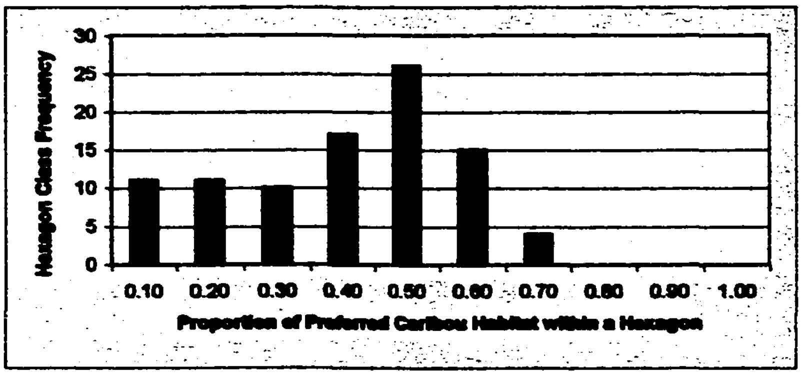

Figure 18. A histogram depicting caribou habitat dispersion for the Nakina North Forest prior to harvest.

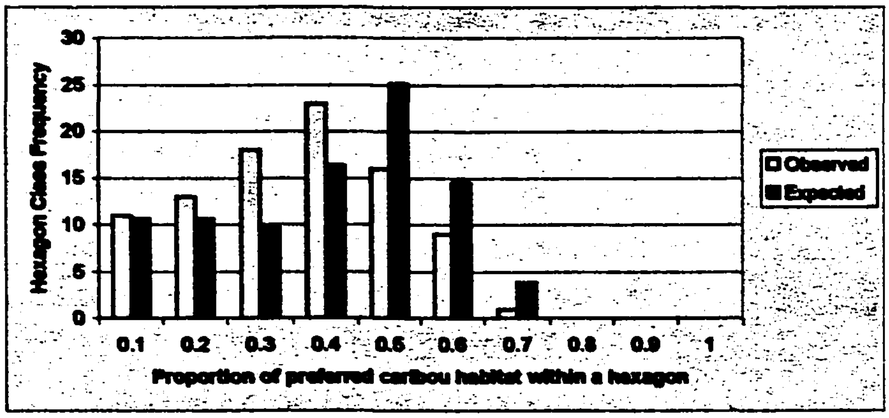

Figure 19. A histogram depicting habitat dispersion for caribou after five 10-year year terms of harvest of the Nakina North Forest without the caribou stratification constraint applied. Proximity = 250 m, maximum block size = 1250 ha, and green-up period = 0 (Run #7).

CASE STUDY

A detailed, case study analysis was undertaken focussing on sixteen harvest scenarios completed for the Nakina North Forest using the caribou stratification and a green-up delay of one 10-year term. These runs were selected for further examination because it seemed most likely that a planning group would use the caribou stratification and a green-up delay of one 10-year term when planning harvest activities for this area. These runs also resulted in the best supply of caribou habitat and caribou is a selected species in the area. Preliminary examination showed that post-harvest ovenbird habitat and moose summer range were similar for all runs and as such these habitats were not explored further. The detailed analysis concentrated instead on the resulting wood supply as well as habitat supply and dispersion for caribou, marten and moose winter range.

Using surface response graphs, this analysis explored the relationship between proximity, maximum block size, and 1) wood supply (Figure 20); 2) habitat supply for each of the three species (Figures 21-23); and 3) habitat dispersion for each of the three species (Figures 24-26). Habitat dispersion is presented as the inverse Chi-square value. The higher the inverse Chi-square value, the closer the pre- and post-harvest conditions for dispersion of potential preferred wildlife habitat. This is a positive result given the hypothesis that forest management will neither affect habitat supply or dispersion at the end of the harvest periods.

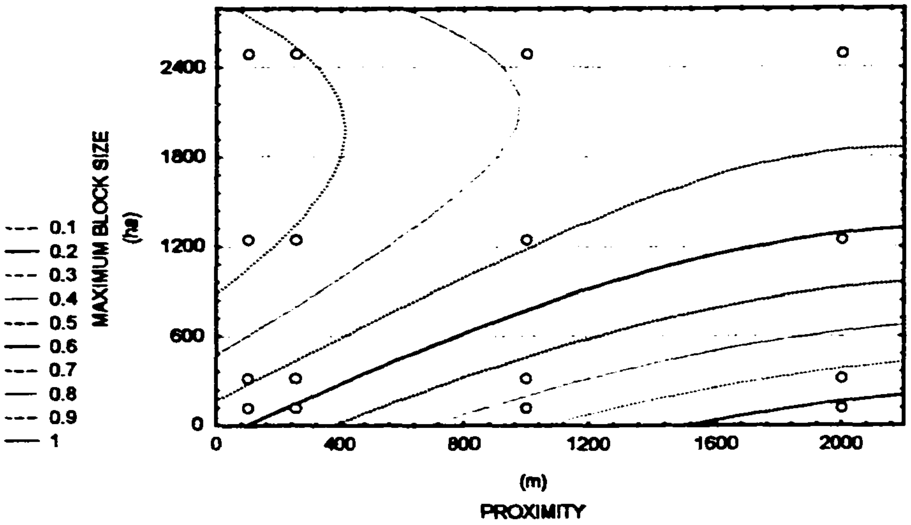

Figure 20. Surface response graph depicting the relationship between proximity, maximum block size and proportion of AHA achieved for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term.

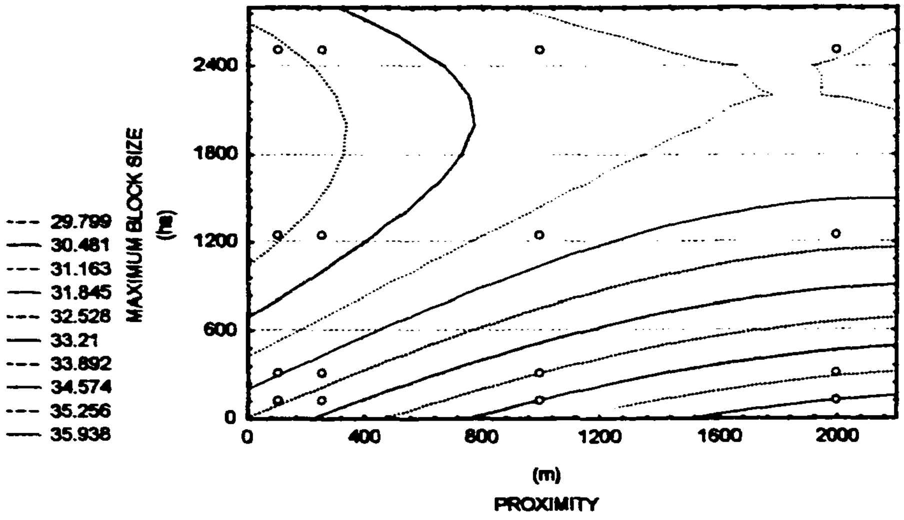

Figure 21. Surface response graph depicting the relationship between proximity, maximum block size and caribou habitat supply for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term.

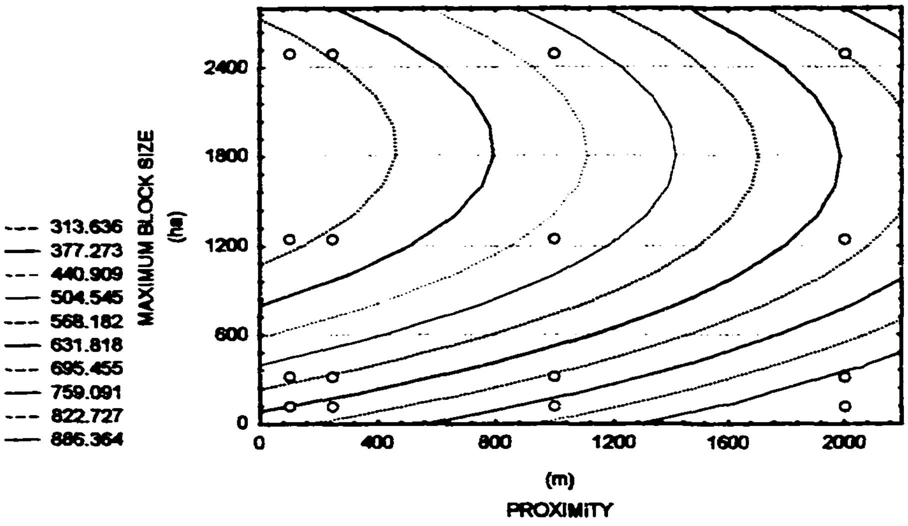

Figure 22. Surface response graph depicting the relationship between proximity, maximum block size and marten habitat supply for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term.

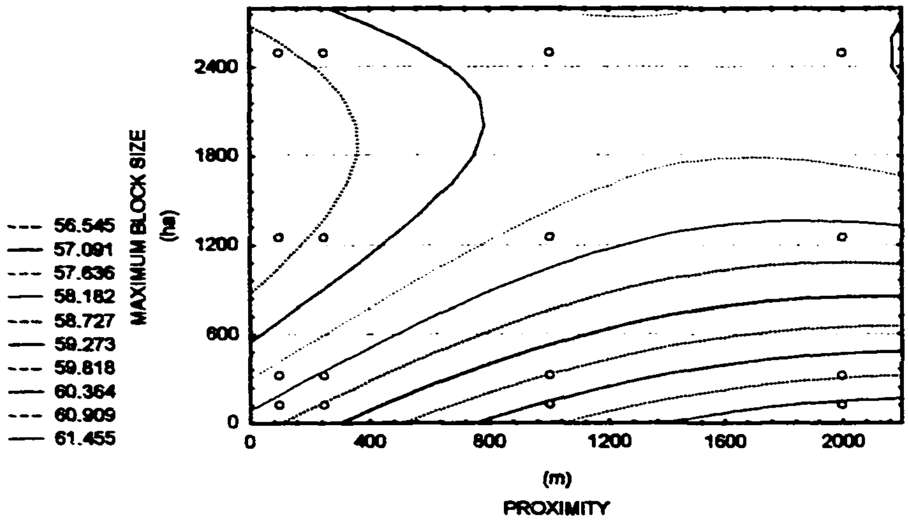

Figure 23. Surface response graph depicting the relationship between proximity, maximum block size and the supply of moose winter range for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term.

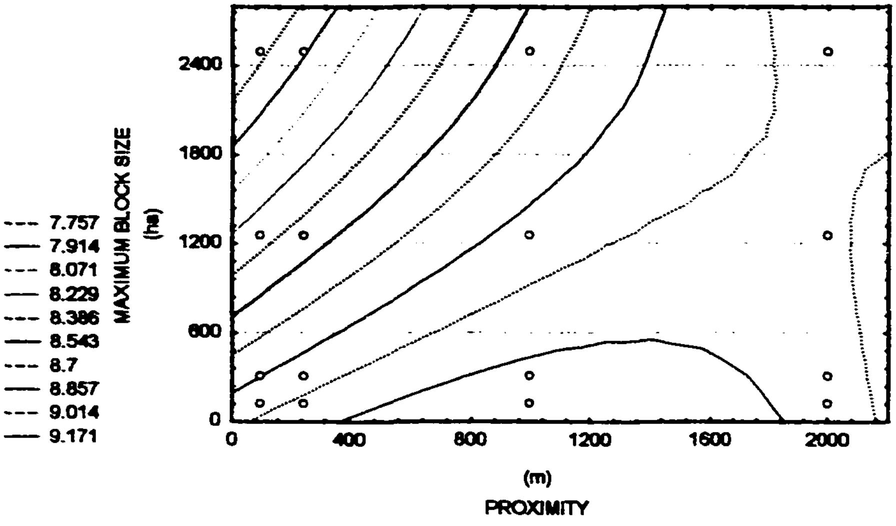

Figure 24. Surface response graph depicting the relationship between proximity, maximum block size and caribou habitat dispersion for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term. Habitat dispersion = inverse Chi-square value x 1000.

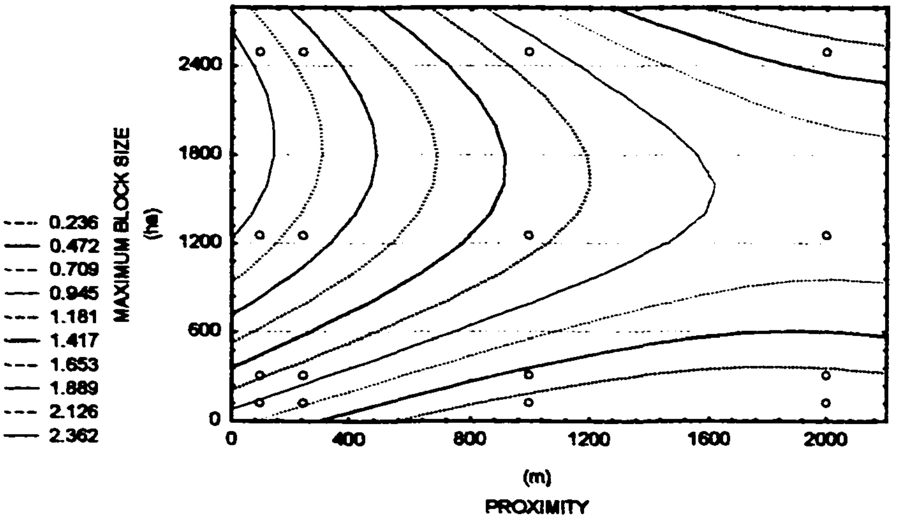

Figure 25. Surface response graph depicting the relationship between proximity, maximum block size and marten habitat dispersion for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term. Habitat dispersion = inverse Chi-square value x 100,000.

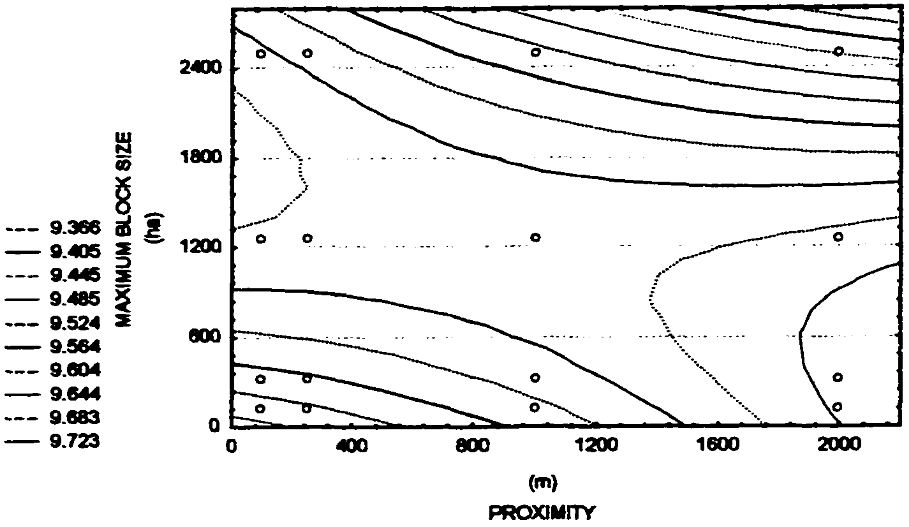

Figure 26. **Surface response graph depicting the relationship between proximity, maximum block size and the dispersion of moose winter range for the case study – the Nakina North Forest with caribou stratification and a green-up delay of one 10-year term. Habitat dispersion = inverse Chi-square value x 1000.**

The final portion of the case study was determination of thresholds where the ecological and economic objectives were best met. Overlaying the surface response graphs and examining them for areas of convergence completed this. A zone of convergence was determined to be where maximum block size is between 200 ha and 1000 ha and where proximity is between 400 m and 1000 m. In this zone, objectives of greatest proportion AHA achieved, and of having a post-harvest habitat supply and habitat dispersion most similar to the pre-harvest condition of the forest for the three species were best met.

DISCUSSION

SURFACE RESPONSE GRAPHS

The contour surface response graphs can be used as “decision surfaces”. They allow exploration of how spatial constraints affect timber harvest and wildlife habitat objectives and can further be useful in determining the spatial domain where both objectives converge. This is valuable information when analysing spatial harvest constraints written into forest management guidelines or when assessing alternative forest management scenarios. The decision surfaces can also be helpful in determining where to spend research resources, and to exclude unreasonable options in the design of large-scale management experiments.

Timber Harvest Analysis

The surface response graphs created for the timber supply analysis demonstrated the effects of applying both the caribou stratification and a green-up delay of one 10-year term on wood supply (% AHA achieved). The lowest wood supply (for all 16 runs) was achieved when both the caribou stratification and the green-up delay were applied to the Nakina North Forest (Figure 15). This was expected as the caribou stratification and the green-up delay limit cut block allocation both temporally and spatially. Without these constraints, Stanley has more flexibility in forming blocks and is more likely to achieve the AHA target.

Application of the caribou stratification constraint alone also resulted in a decline in wood supply, as did the application of the green-up delay alone (Figure 15). It was interesting to note, however, that the effect of each of these constraints applied in isolation of one another produced a similar decline in wood supply. Further, the application of both constraints together seemed to exacerbate the negative effect on wood supply (Figure 15).

Without either the caribou stratification constraint or the green-up delay applied, wood supply increased with block size and proximity to a maximum block size of approximately 2000 ha and proximity of approximately 1500 m (Figure 11). This demonstrated that without the constraints Stanley has more flexibility to look farther away for stands to achieve the AHA target. With the green-up delay constraint but not the caribou stratification applied, wood supply increased with a decline in proximity and maximum block size in the 1500 ha range (Figure 12). This effect was similar to that resulting from application of the caribou stratification constraint but no green-up delay and that resulting from the application of both constraints (Figure 13). This means that the closer Stanley can create large blocks, the better able Stanley is to achieve the target AHA. Again, this is affected by the situation in the Nakina North Forest, namely lack of industrial forest development and over-mature conifer stand composition. As harvesting occurs in the area, it is expected that Stanley will have more difficulty in finding and scheduling large eligible blocks and still meet spatial and temporal constraints such as green-up delay periods.

Case Study

The spatial domain for the Nakina North Forest case study (with the caribou stratification and a green-up delay of one 10–year term) was determined by overlaying the decision surfaces and finding the area where the best values for AHA, caribou, moose winter range and marten habitat occur. This is the range of the variables that reasonably meets both timber harvest and wildlife objectives – the convergence of economic and ecological values.

Timber supply (% AHA achieved) was greatest with large block sizes and smaller proximities. This was expected on the Nakina North Forest as it has no harvesting history and consists of large stands of late successional conifer. This combination makes harvest scheduling relatively easy, even with the caribou stratification constraint. As this area is opened to industrial development and the forest becomes more fragmented it is expected that blocks will be harder to find and schedule and the proportion AHA achieved is expected to decline further.

As expected, habitat supply for moose winter range, marten and caribou increases with larger proximities. When proximity is large, Stanley must go a greater distance to schedule blocks in the same harvest period, as Stanley will not schedule adjacent or proximal blocks in the same harvest period. When the proximity is set at 1000m, for example, blocks that Stanley has created must be at least 1000 m apart in order to be scheduled for harvest in the same harvest period (in this case the harvest period is 10 years). In doing this, Stanley essentially ties up the area between the blocks, making those stands ineligible for harvest in the same 10-year harvest period. Figure 27 visually demonstrates how a proximity of 1000 m ties up more area than a proximity of 100 m. As proximity increases, it makes more area unavailable for harvest and thus makes it more difficult to find and schedule blocks. This is turn reduces the proportion of AHA achieved and leaves more large patches of habitat required for caribou, marten and moose winter range.

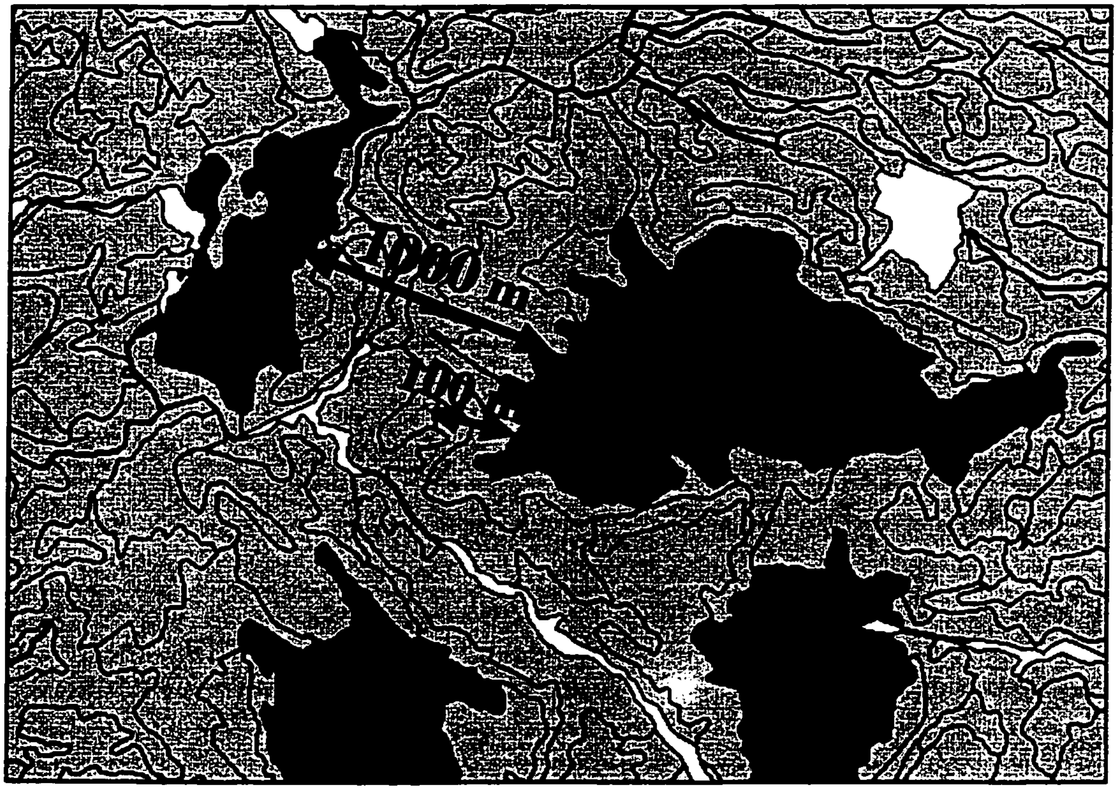

Figure 27. Illustration of how a larger proximity makes more area ineligible for harvest in the same harvest period thus making it more difficult to find and schedule harvest blocks over time. Not to scale.

The surface response graphs for caribou show that both supply and dispersion of habitat is greater with large proximities and relatively small block sizes (less than 1200 ha. Small harvest blocks with large areas between them left for harvest in the next 10-year cut period would leave a large amount of potential preferred habitat intact for caribou, both in supply and configuration. Using larger block sizes depletes the supply of potential preferred caribou habitat and also affects the dispersion on the Nakina North Forest. This conflicts with proposed caribou guidelines (Racey *et al.* 1997) calling for large block sizes, or large disturbance events, to help conserve caribou (in addition to the caribou stratification).

Over various cut periods, the Nakina North Forest caribou stratification conserves large tracts of mature coniferous forest containing winter habitat attributes such as thermal protection and access to terrestrial lichens for forage. Outside the protected tract for designated cut periods, harvesting is allowed to occur in a manner recommended by the Fire Emulation Guidelines. In areas with high potential for current or future caribou habitat, disturbance events of 5,000 ha or more are prescribed (Racey *et al.* 1997). This project indicates that for the Nakina North Forest, the use of large block sizes may result in a decline in potential preferred caribou habitat supply and dispersion. This could be the result of virtually all of the stands used to create the large blocks having the characteristics of potential preferred caribou habitat. Once timber harvesting had taken place, the caribou habitat supply would decline and, because those harvest blocks were large, many hexagons (home ranges) would be affected. That is, the number of home ranges with a high proportion of potential preferred caribou habitat would decline, thus affecting dispersion.

As suggested in the previous paragraph, there are possible explanations for this result. However, the results may have been different if the application of the caribou guidelines had been more accurately modelled in the project. The caribou guidelines recommend extremely large harvest blocks in the areas available for harvest under the caribou stratification constraint. Stanley does concentrate the harvest somewhat to conform to the caribou guidelines but not entirely to meet the full intent of them. That is, the harvests scheduled by Stanley are more dispersed and blocks do not reach the 5000 ha or greater range. Also, if not so much of the Nakina North Forest was potential preferred caribou habitat, or if the characteristics of potential preferred caribou habitat were not also optimal for timber harvest, this result may not have occurred. On another landscape (perhaps one with more timber harvesting history and less caribou habitat) caribou habitat may be conserved with the use of both the caribou stratification and prescription of large disturbance events. These questions indicate that further investigation of this issue is warranted.

An unexpected result from analysis of the surface response graphs was that habitat dispersion for marten increased with greater maximum block sizes and decreased with small proximities. In contrast, habitat supply for marten increased with maximum block size and proximity. When Stanley was allowed to go greater distances to include blocks in the same harvest period, or harvest smaller blocks, it negatively affected the configuration of the remaining marten habitat. The scheduled harvest resulted in more hexagons (home ranges) with lower proportions of potential preferred marten habitat in them. In the pre-harvest condition some hexagons might have contained 60% potential preferred marten habitat, while after harvest those same hexagons might have contained 10%, resulting in a decline in habitat dispersion after harvest. Large harvest blocks and small proximities allowed Stanley to congregate harvests over a smaller area, leaving more home ranges with larger proportions of potential preferred marten habitat, and increasing habitat dispersion. The Forest Management Guidelines for the Provision of Marten Habitat (OMNR 1996b) recommend maintaining large cores of marten habitat and small harvest blocks (to prevent expanses of open habitat). As this project suggests that following these recommendations may increase marten habitat supply but have a negative effect on its configuration in the landscape (and as such be less useful to marten), this issue should be investigated further.

Post-harvest supply of moose winter range was greater than the pre-harvest condition with small block sizes and large proximities. This was expected as prior to harvest, some stands that met only the composition requirements for habitat would have come of age and become potential preferred moose winter range. Also large proximities create a situation where the existing potential preferred moose winter range has a greater chance of being maintained rather than harvested. The post-harvest dispersion of moose winter range also benefited from these variable combinations. Post-harvest dispersion of moose winter range was closer to the pre-harvest condition with small block sizes and large proximities. As there was not a large amount of potential preferred moose winter range in the forest pre-harvest, it is feasible that the scheduled harvests did not affect the dispersion of habitat. That is, the harvests may have missed or caused minimal change in hexagons with large proportions of potential preferred moose winter range. As the Nakina North Forest is an area where conservation of caribou is an issue, further examination of the ramifications of possibly improving conditions for moose production is warranted.

HISTOGRAMS

Histograms can be used to explore visually how landscapes using alternate management scenarios will differ, from each other as well as from a baseline or desired outcome. For example, histograms depicting block size distribution before and after proposed harvest based on various spatial constraints can help managers assess whether the landscape will be different from the area's natural disturbance pattern. Histograms of wildlife habitat values both before and after harvest can help determine how much change in preferred habitat will accompany the proposed harvest. The histograms can be useful in speculating how species with similar requirements will respond to such harvest constraints and can help further direct research resources.

In this project histograms were used to help determine whether specific combinations of management scenarios and variable constraints would produce both a desired cut-block size distribution and acceptable habitat and wood supply values. The habitat histograms suggest graphically how the dispersion of habitat in the landscape will change as a result of the harvest. The results of a Chi-square analysis were the basis for the habitat dispersion decision surfaces for each species. The overlaying of the decision surfaces for the case study determined the zone of constraint variable values where wood supply and wildlife objectives were best met. Cut-block size distributions were examined for the simulated harvest runs whose variable constraint combinations were within this zone. They all produced cut-block size distributions similar to natural disturbance event distributions that exist in the landscape for the Nakina North Forest area.

As required by the *Crown Forest Sustainability Act* (Government of Ontario 1994) and the decision of the Environmental Assessment Board (Ontario Environmental Assessment Board 1994), Fire Emulation Guidelines are being designed to assist forest landscape management to emulate natural disturbance patterns in Ontario (Racey *et al.* 1997). For the Nakina North Forest area the Fire Emulation Guidelines recommend a percentage of the harvest area to be in cut-blocks of size classes greater than 5000 ha. Unfortunately, in this study it was not possible to complete any blocking exercises with Stanley that achieved cut blocks of such size. Cut blocks of up to 2500 ha were achieved. This is likely due to the forest age class and species composition of the Nakina North Forest, eligibility of forest stands, and AHA limitations. As a result, when analysing the outcome of the blocking exercises, a cut block distribution where the majority of the harvested area was in block sizes > 1040 ha was accepted as a distribution most similar to that which exists naturally.

MANAGEMENT IMPLICATIONS

The results of this study did not indicate a great decline in habitat (i.e. loss of greater than 50% potential preferred habitat by area) for most species. For both scenarios, Nakina North Forest with and without the caribou stratification constraint applied, only ovenbird habitat exhibited a large change compared to the potential preferred habitat available prior to harvest. The supply of potential preferred ovenbird habitat had a weighted sum of 140.15 prior to harvest and ranged from a low of 3.65 to a high of 11.00 post-harvest (Table 3). Regardless of harvest regime, very little potential preferred ovenbird habitat remained post-harvest. This indicates that species requiring 100 ha patches of mixed-wood forest may be adversely impacted once harvesting commences in this management unit. That being said, however, it should be noted that there are not many mixed-wood or hardwood stands in the Nakina North Forest so any harvest of them will result in great impact. Further study or some protection measures may be in order if there is a designated species in the area that has similar habitat requirements.

After preliminary examination of results it was found that moose summer range supply values were similar for all runs post-harvest (Table 3). The requirements for potential preferred moose summer range are quite inclusive encompassing nearly all habitat units (except lowland spruce sites) when stands are at a relatively young age (eligible from 0-30 years). Under all harvest regimes the resulting potential preferred moose summer range was similar. Prior to harvest the weighted average for potential preferred moose summer range supply was 10.95. Post-harvest the values ranged from a low of 6.75 to a high of 13.65. The supply of moose summer range is not expected to be a concern in the management of the Nakina North Forest, nor is it expected to be a limiting factor to the moose population in the area.

The Timber Harvest Guidelines for the Provision of Moose Habitat (OMNR 1988) advocate small blocks to help provide moose forage in the vicinity of thermal and security cover. The results of this study suggest that small blocks may indeed result in greater moose winter range values. However, the results also suggest that there may be even greater increases in moose winter range (a limiting factor of moose production) with the inclusion of the caribou stratification constraint. Promoting moose production in an area of caribou conservation may be counter-productive in light of the predator switching theory (Bergerud *et al.* 1984). An increase in moose production with the combination of caribou stratification constraint and small block size supports the suggestion in Greig and Duinker (1997) that despite the application of a caribou stratification constraint, rate of harvest and the use of leave blocks to protect other resources may result in greater moose production and undermine efforts to conserve caribou. That being said, it must be noted again that the definition of potential preferred moose winter range for this project may be too inclusive which will affect the supply and dispersion of moose winter range post-harvest. Also, the manner in which the caribou guidelines (including the caribou stratification constraint) were modelled may not exactly fulfil the intent of the guidelines. This result is not definitive, rather it is a red flag indicating another issue that warrants further investigation.

The results of this project support to the findings of Rempel *et al.* (1997) who suggested that the application of the moose guidelines with block sizes of less than 130 ha is inappropriate if forest management is to target a natural disturbance pattern. The natural disturbance pattern for this area is one where a few large fires have shaped the landscape. Examination of alternate maximum block sizes in this study showed that large blocks rather than small blocks provide a block distribution pattern (disturbance event pattern) most similar to that found on the natural landscape of the Nakina North Forest.

Project results indicate that the inclusion of the caribou stratification constraint will benefit caribou habitat supply and dispersion. However, while the results of this strategic exercise may be promising, caution is required when interpreting the results. For example, the caribou stratification constraint may not be helpful given that caribou show some affinity to returning to the same wintering grounds annually (Cumming and Beange 1987). That is, even if large patches of caribou habitat are protected from harvest with the use of the caribou stratification constraint, it is the protection of enough wintering grounds that may be more the issue. If too few of them are in areas not scheduled for harvest, the caribou population may be adversely affected. Thus identification of these areas and their inclusion in the timber harvest planning for the area is crucial. Whether or not the caribou will select alternate wintering areas also needs to be verified.

Some analysts (Dunsworth and Northway 1997) believe that using targets for tree species and wildlife habitat based on natural disturbance patterns might only be accomplished with no resource development. This study suggests that theoretically at least, this is not the case. The scenarios selected where economic and ecological values are best met demonstrate that one can achieve targets based on natural disturbance patterns and still have some level of timber resource development. In this case however, it must be noted that the targets are not "hard" targets such as those used in British Columbia. The Biodiversity Guidebook (British Columbia Ministry of Forests/ British Columbia Ministry of Environment, Lands, and Parks 1995) recommends that proportions of a biogeoclimatic zone be of a certain age. For example, in areas identified as Natural Disturbance Type 1, Coastal Western Hemlock Zone, less than 30% of the forest area in a landscape unit is to be in an early seral stage. In contrast, using trends or patch size distribution patterns (as proposed in Ontario) provides greater flexibility to achieve both ecological and economic goals.

Initial conditions of a landscape always affect the results of a simulation study. The Nakina North Forest had no timber harvesting history and this definitely affected the results of the study. In absence of timber harvesting and with a forest structure dominated by over-mature coniferous stands, harvest scheduling is not difficult, even with the caribou stratification constraint applied. This also helps to explain why the effects of timber harvesting on habitat values were not great for most species. As this area is opened to development and the forest becomes more fragmented, it is expected that it will become more difficult to achieve the AHA objectives spatially and that the effects of timber harvesting on wildlife habitat values will be increasingly adverse.

LIMITATIONS OF STUDY

Wildlife habitat models based on vegetation, while useful, do not replace spatially explicit wildlife population models (Holt *et al.* 1995). Wildlife species view the world at different spatial scales and have various responses to changes in vegetation. Species use different habitats for different life requirements such as breeding, feeding or thermal cover. Species with small bodies, such as a vole, experience life at a much finer scale than a moose. Species with a large home range have a different response to loss of a habitat area than a species with a small home range. Also, identifying a vegetation type as being preferred habitat does not guarantee that the wildlife species is using it. While population models may be a more direct study of a species, habitat models are frequently used because it is often easier to measure and evaluate habitat than populations (Wildlife Working Group 1991, Morrison *et al.* 1992). Using a vegetation model that queries for potential preferred habitat with the addition of a spatial component was sufficient for the purposes of this study and is more directly related to forest management activities. In addition, working knowledge of the relationships between wildlife and vegetation is continually changing and modelling exercises can help identify key uncertainties about these relationships.

Stanley does not incorporate succession in its allocation and scheduling of harvest blocks. To minimise the effects of this on the study, the projected harvest was restricted to five 10-year periods. This was based on the assumption that within this timeframe, there would be little change in stand composition and condition. In terms of the processes used in the study, this is assuming that few stands will require a change to the Forest Unit (FU) assigned to it (based on stand composition prior to running SFMM) after the five 10-year harvest periods. However, most coniferous stands in the forest are over 100 years of age and in fact may change to a different FU over the term of harvest. This will affect both wood supply and habitat analysis results. The lack of a succession model in Stanley also meant that I was unable to project wood supply, habitat supply and habitat dispersion for two or three rotations. This affects the ability to fully investigate the effects of the application of the caribou stratification constraint and the proposed guidelines for the conservation of caribou. As such, interpretations of the results must take this limitation into consideration. The addition of a succession component to Stanley (in development) will make Stanley an even more powerful tool in forest management planning.

This study did not incorporate road systems or costs in the timber harvest and wildlife habitat analyses. In terms of timber management, this project explored "sufficient" management (how to get the wood out) rather than "efficient" management (how to get the wood out the most efficient manner) (Grumbine 1994). To that end, some of the timber harvest allocated and scheduled by Stanley may not be operationally feasible. This issue is common to strategic studies. However, incorporation of roads and costs into analyses is developing as the technology for harvest blocking programs improves. While Stanley groups and schedules blocks together by nature of its algorithm, Stanley does not explicitly limit its scheduling of blocks based on road systems, either developed or planned. This is a planned improvement to the program but it was not available at the initiation of this study. While other programs could have been used, Stanley was chosen because of its established link to SFMM and it ease of use.

This study investigated the effects of harvest variables at the strategic or landscape level. Many stand-level activities have the ability to affect habitat values, perhaps to a degree that would offset the effects of the forest-level harvest variables. For example, partial harvests or the retention of coarse woody debris (existing and future) in cut blocks may mitigate the effect of large block size on marten. In another example, Sturtevant *et al.* (1996) suggested silviculture methods for creating mature forest characteristics in younger stands, thereby mitigating impacts of past timber harvesting on marten habitat. It was not the intention of the study to provide definitive results based on a landscape-level exercise.

CONCLUSIONS

One of the first stages in an adaptive management cycle is to “identify major uncertainties by trying to predict the outcome of policy alternatives” (Walters 1995: 82). This study demonstrated a technique of analysis that examined the outcomes of various policy alternatives: use of the caribou stratification constraint, and use of variable spatial and temporal harvest constraints such as green-up period, block size and proximity. The outcomes of these alternatives were determined in terms of economic and ecological values, namely timber supply and wildlife habitat supply and dispersion. One critical uncertainty that resulted from this study was the possible extreme decline in habitat values for wildlife species requiring mixedwood and hardwood stands with the onset of timber harvests in the Nakina North Forest. While this is a function of the forest composition prior to harvest, it is a concern that requires further investigation. Another uncertainty is the effect of the caribou stratification constraint on habitat values for both moose winter range and caribou. The caribou stratification constraint does achieve its goal of conserving caribou habitat values but it also conserved moose winter range values. There are a number of possible explanations for this but it warrants further investigation if the goals of caribou conservation may be compromised. Again, the uncertainties identified in the results of the study are not definitive but rather serve as red flags that need to be addressed in further research.

Another suggestion in adaptive management is to use "policy screening models to define a good set of policy treatments" (Walters 1995: 82). This project demonstrated the use of a set of tools that could comprise a policy screening model. Also, the results using the methodology of this project included a set of treatments where economic and ecological values were best met. In an adaptive management process, the next stage would be to put those treatments into operation and monitor key responses at different spatial and temporal scales. The responses will provide more detailed information that can be incorporated into future policy and management.

The host of tools used in this modelling and analysis exercise met the requirements of being a practical decision support system integrating timber and wildlife habitat supply. These requirements, as defined by Beck and Beck (1996), include a spatial and non-spatial wildlife habitat assessment somewhat independent of the timber supply model, a timber supply model that is efficient and does not over simplify forest information, and that the wildlife and timber supply models be portable and produce results in a timely manner. The timber supply model (SFMM) and blocking program (Stanley) were easy to use and efficient. The wildlife assessment tools (Habitat Analyst and Patch Analyst) were equally easy to use and have the capability of being used to a degree far greater than what they were used for in this study. The support available for these tools was more than adequate and at no time during this study was technical support a problem nor was there any evidence of it in discussions with other planning teams going through similar exercises. Finally, and most importantly, these tools were all able to run on a desktop PC without unrealistically large computational or graphical requirements. This capability increases the access of such tools to a greater audience of forest managers and planners.

The results of this study can be summarised as follows. There was a determination of a zone of maximum block size and proximity that best met the objectives of a) maintaining the pre-harvest habitat supply and dispersion; and b) achieving the AHA determined by SFMM. The harvests in the zone also produced cut block distribution patterns similar to those that occur historically in the Nakina North

Forest. The flexibility in Ontario's guidelines for emulating natural disturbance patterns makes it easier to achieve economic and ecological objectives and meet natural disturbance targets. Some results of the study have been identified as critical uncertainties and require further investigation. Species in the Nakina North Forest that require mixedwood or hardwood stands may be extremely vulnerable to timber harvest in the area. Moose may benefit from the application of the caribou stratification and this has the potential to undermine efforts to conserve caribou in the area. Caribou may benefit from the application of the caribou stratification however the issue of whether the caribou will shift to other wintering grounds has yet to be resolved. Caribou may not fare well under a forest management regime that prescribes extremely large cutblocks as in the proposed caribou guidelines.

Baskent and Yolasigmaz (1999) noted that forest management has greatly improved. The approach now focuses on ecosystems, there is more information, that information is being used better, and there is an increasing understanding of spatial forest dynamics. This project has explored some useful non-spatial and spatial modelling tools available to assist forest managers and demonstrated how they can be used to help improve forest management planning. This study has also suggested how similar methodology could be used to aid policy development in an adaptive management process.

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APPENDICES

APPENDIX I

FOREST UNIT DEFINITIONS FOR THE NAKINA NORTH FOREST

Forest Unit Name	Label	Definition (SQL Syntax)
CnFr3	Jackpine/Spruce	(Sb<1.0)(Po+Bw+OH<0.2)(Ce+OC<=0.1) SC 2,3
Hw1	Hardwood	(Po+Bw+OH>0.8) SC 1
Hw3	Hardwood	(Po+Bw+OH>0.8) SC 2,3
MxWd1	Mixed Wood	(Po+Bw+OH<0.9)(Sb+Sw+Pj<0.9)(Ce+OC<0.2) or (WG=Bf) SC 1
MxWd3	Mixed Wood	(Po+Bw+OH<0.9)(Sb+Sw+Pj<0.9)(Ce+OC<0.2) or (WG=Bf) SC 2,3
Pj1	Jackpine	(Pj>=0.5) (Po+Bw+OH<=0.2) SC 1
Slow1	Lowland Spruce	(Sb=1.0) or (Ce+OC>=0.2) SC 1
Slow3	Lowland Spruce	(Sb=1.0) or (Ce+OC>=0.2) SC 2,3
SpUp	Upland Spruce	(Sb>=0.4 and Sb<=0.9)(Po+Bw+OH<=0.2)(Pj<0.5) SC 1,2,3

APPENDIX II

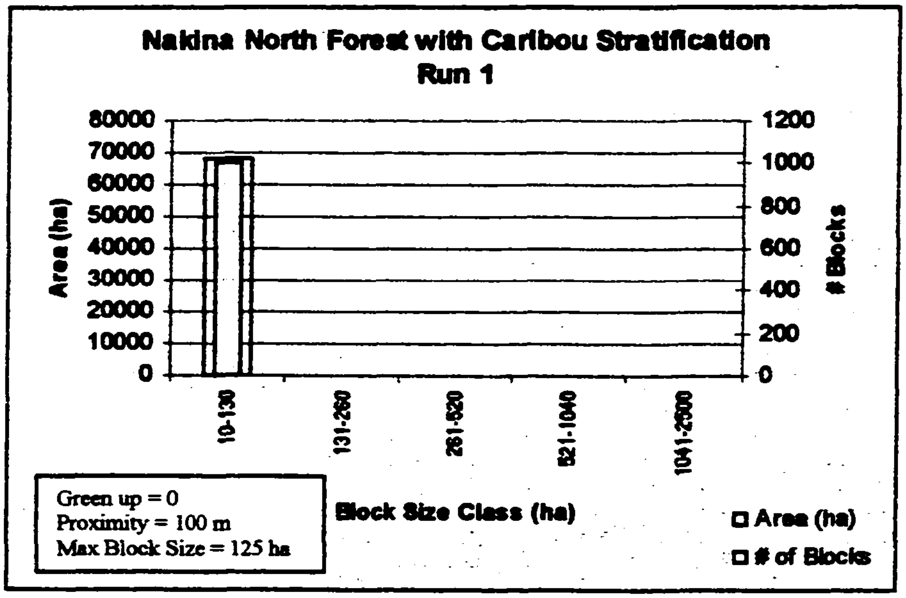
Definition of potential preferred habitat for the four selected wildlife species (adapted from Watkins and Davis 1997 and R.Rempel and J. McNichol personal communication 1998).

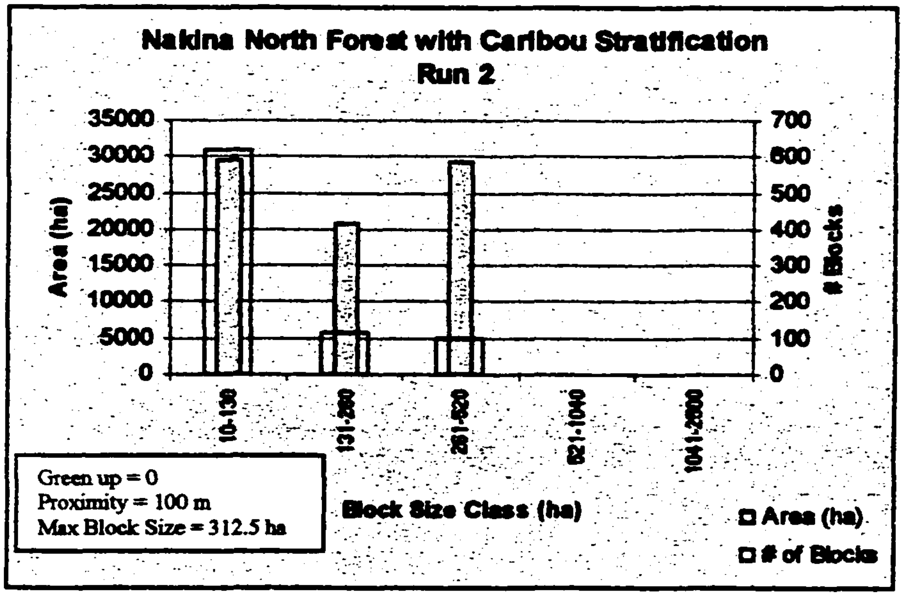
Habitat	Potential Preferred Habitat Description
Moose Summer Range	([HU]=1) and ([Age]<20) ([HU]=2) and ([Age]<20) ([HU]=3) and ([Age]<20) ([HU]=4) and ([Age]<30) ([HU]=7) and ([Age]<30) ([HU]=8) and ([Age]<10) ([HU]=9) and ([Age]<30) ([HU]=12) and ([Age]>=20) ([HU]=13) and ([Age]<30) ([HU]=15) and ([Age]<30)
Moose Winter Range	([HU]=6) and ([Age] >=10) ([HU]=7) and ([Age] >=30) ([HU]=11) and ([Age] >=10) ([HU]=12) and ([Age] >=20) ([HU]=14) and ([Age] >=30) ([HU]=13) and ([Age] >=30) ([HU]=15) and ([Age] >=30)
Marten Food - Hare	([HU]=1) and ([Age] >=5) ([HU]=2) and ([Age] >=5) ([HU]=3) and ([Age] >=5) ([HU]=4) and ([Age] >=10) ([HU]=5) and (([Age] >=10) and ([Age]<70)) ([HU]=6) and (([Age] >=10) and ([Age] <90)) ([HU]=7) and ([Age] >=10) ([HU]=8) and (([Age] >=10) and ([Age]<90)) ([HU]=9) and ([Age] >=10) ([HU]=10) and (([Age] >=10) and ([Age]<90)) ([HU]=11) and (([Age] >=10) and ([Age] <70)) ([HU]=12) and (([Age] >=20) and ([Age]<120)) ([HU]=13) and ([Age] >=10) ([HU]=14) and ([Age] >=10) ([HU]=15) and (([Age] >=30) and ([Age]<130))

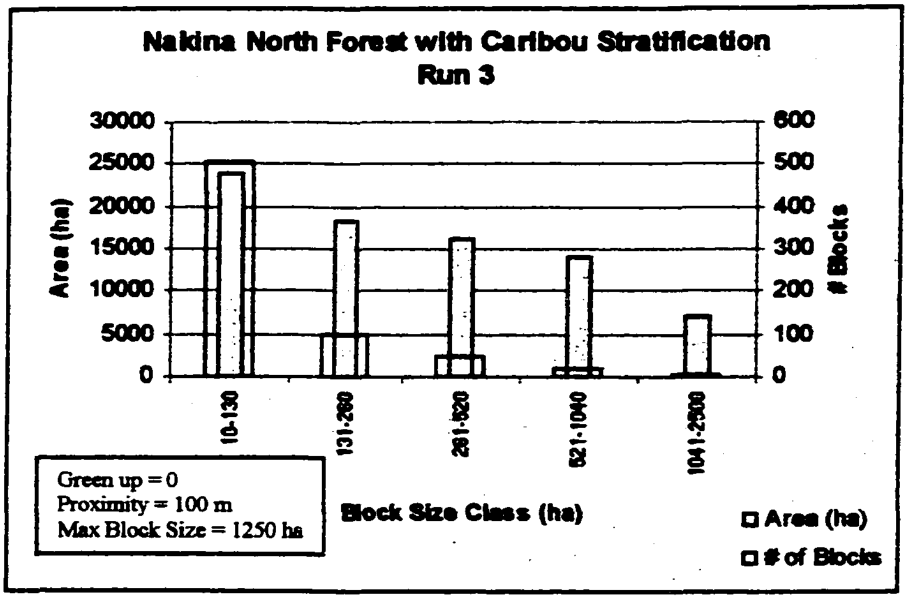
Habitat	Potential Preferred Habitat Description
Marten Food - Voles	([HU]=1) and ([Age] >=5)
	([HU]=2) and ([Age] >=5)
	([HU]=3) and (([Age] >=5) and ([Age] <80))
	([HU]=4) and ([Age] >=10)
	([HU]=5) and (([Age] >=10) and ([Age]<70))
	([HU]=6) and ([Age] >=5)
	([HU]=7) and (([Age] >=10) and ([Age]<70))
	([HU]=8) and (([Age] >=5) and ([Age]<60))
	([HU]=9) and (([Age] >=10) and ([Age]<70))
	([HU]=10) and (([Age] >=5) and ([Age]<60))
	([HU]=11) and ([Age] >=5)
	([HU]=12) and ([Age] >=5)
	([HU]=13) and (([Age] >=5) and ([Age]<70))
	([HU]=14) and ([Age] >=10)
	([HU]=15) and (([Age] >=10) and ([Age]<70))
Marten Denning	([HU]=1) and ([Age] >=60)
	([HU]=4) and ([Age] >=120)
	([HU]=5) and ([Age] >=70)
	([HU]=8) and (([Age] >=60) and ([Age]<90))
	([HU]=9) and (([Age] >=70) and ([Age]<120))
	([HU]=12) and ([Age] >=60)
	([HU]=13) and (([Age] >=70) and ([Age]<120))
	([HU]=14) and ([Age] >=120)
	([HU]=15) and (([Age] >=70) and ([Age]<130))
Ovenbird	([HU]=1) and ([Age]>=20)
	([HU]=2) and ([Age]>=20)
	([HU]=3) and ([Age]>=20)
	([HU]=4) and ([Age]>=30)
	([HU]=5) and ([Age]>=30)
	([HU]=6) and ((([Age]>=10) and ([Age]<60)) or ([Age]>=90))
	([HU]=7) and ([Age]>=30)
	([HU]=8) and ([Age]>=10)
	([HU]=9) and ([Age]>=30)
	([HU]=10) and ((([Age]>=10) and ([Age]<60)) or ([Age]>90))
	([HU]=11) and ((([Age]>=10) and ([Age]<50)) or ([Age]>70))
	([HU]=12) and ((([Age]>=20) and ([Age]<60)) or ([Age]>90))
	([HU]=13) and ([Age]>=30)
	([HU]=14) and ([Age]>=30)
	([HU]=15) and ([Age]>=30)
Caribou	([HU]=14) and ([Age] >=70)

APPENDIX III

BLOCK SIZE DISTRIBUTION RESULTS FROM STANLEY SCHEDULED HARVEST SIMULATIONS

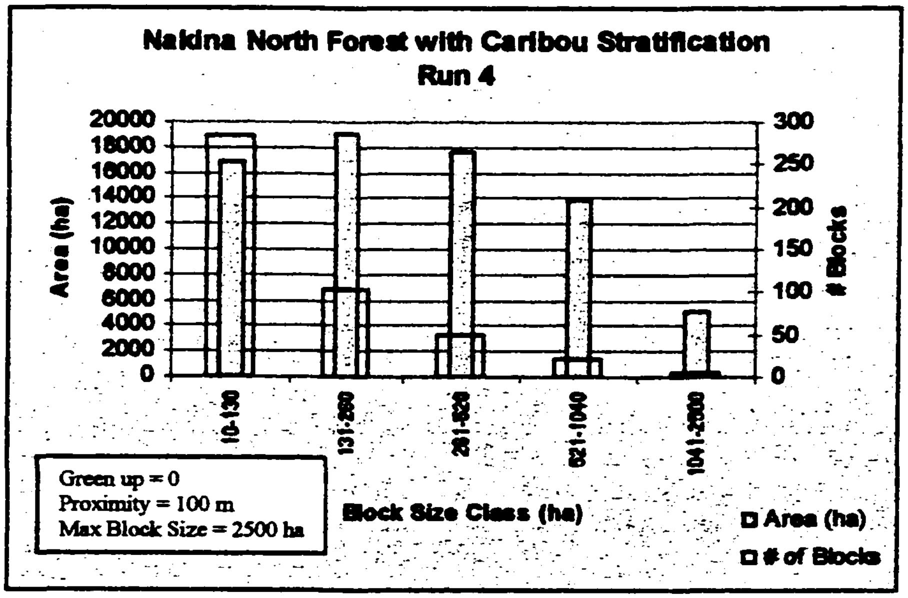






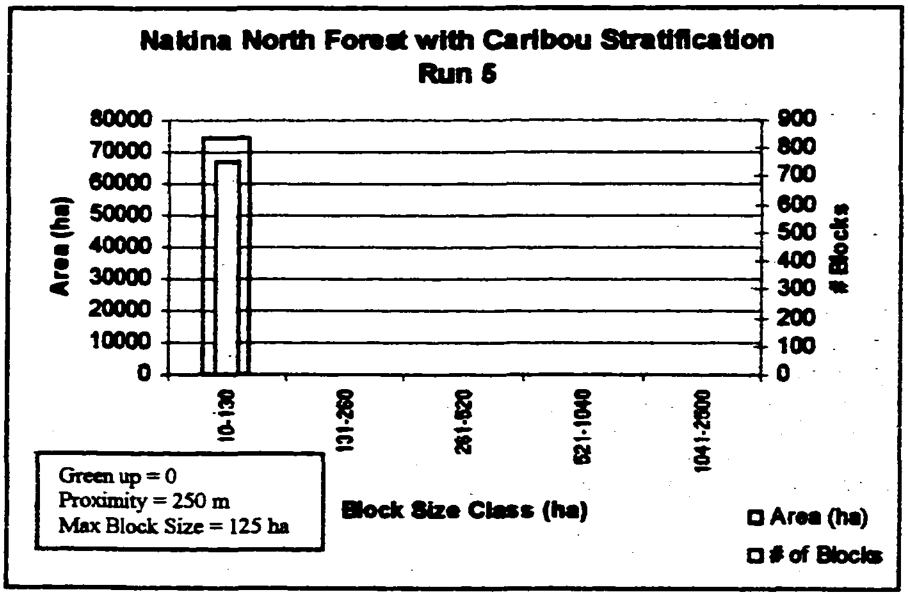
Nakina North Forest with Caribou Stratification
Run 3

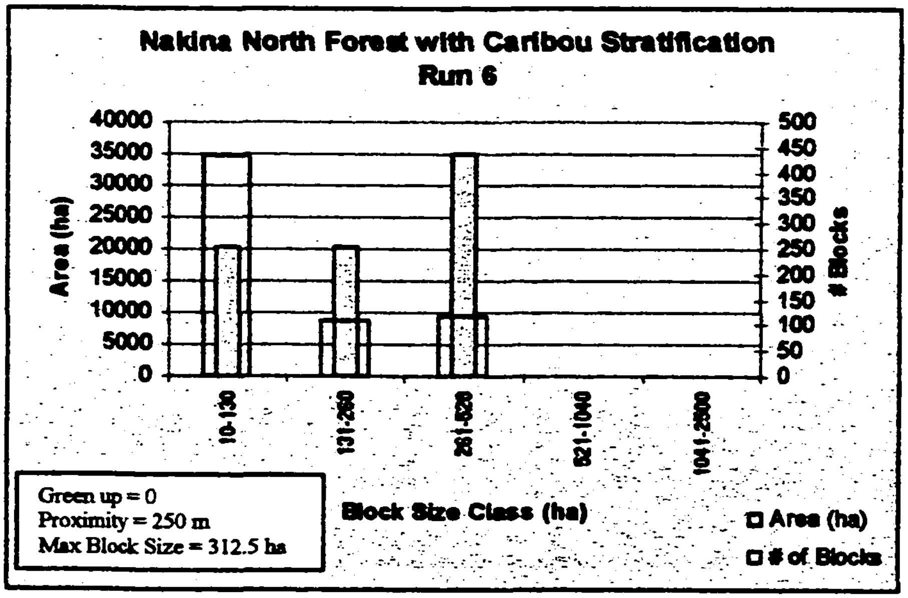
Green up = 0
Proximity = 100 m
Max Block Size = 1250 ha

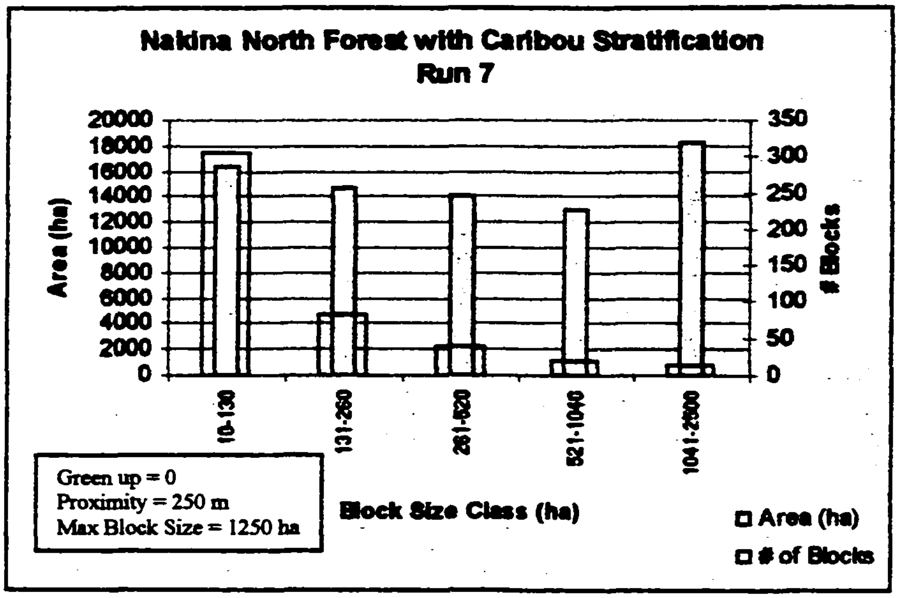


Nakina North Forest with Caribou Stratification
Run 4

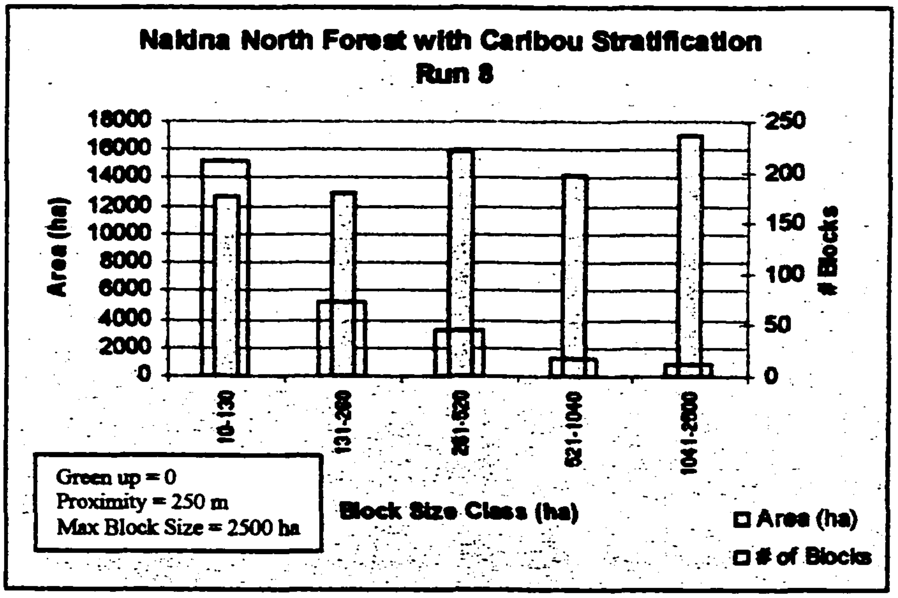
Green up = 0
Proximity = 100 m
Max Block Size = 2500 ha


Nakina North Forest with Caribou Stratification
Run 5
80000
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
900
800
700
600
500
400
300
200
100
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Green up = 0
Proximity = 250 m
Max Block Size = 125 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

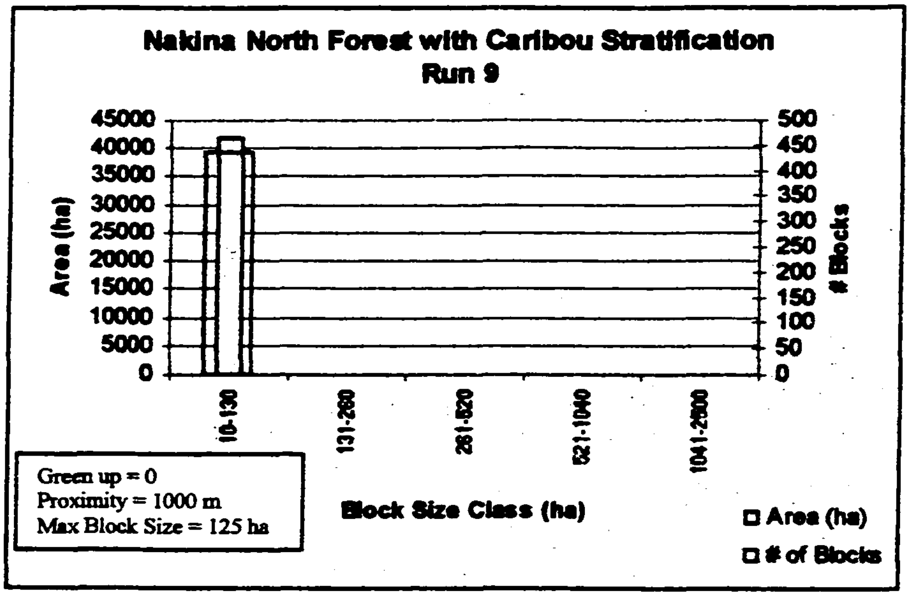

Nakina North Forest with Caribou Stratification
Run 6
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
500
450
400
350
300
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Green up = 0
Proximity = 250 m
Max Block Size = 312.5 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

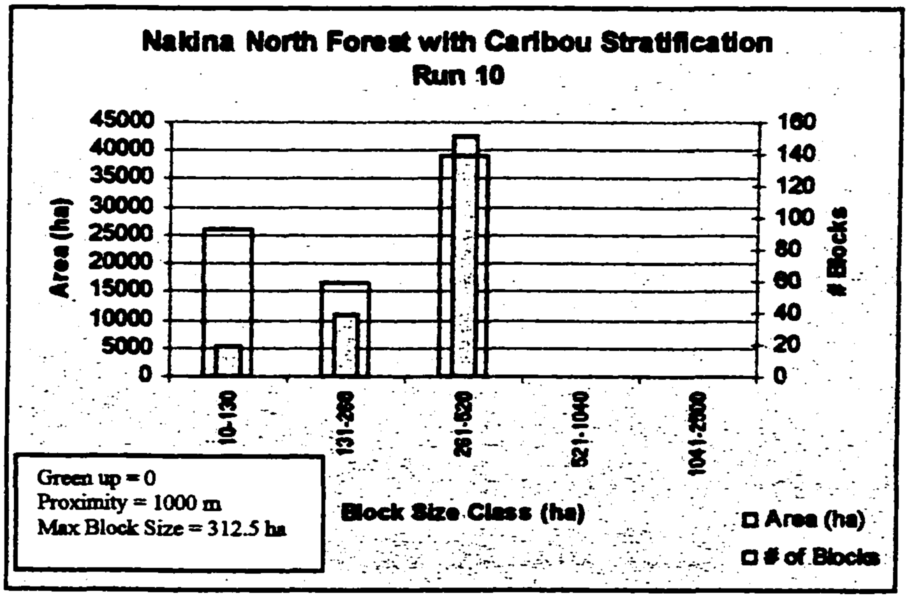


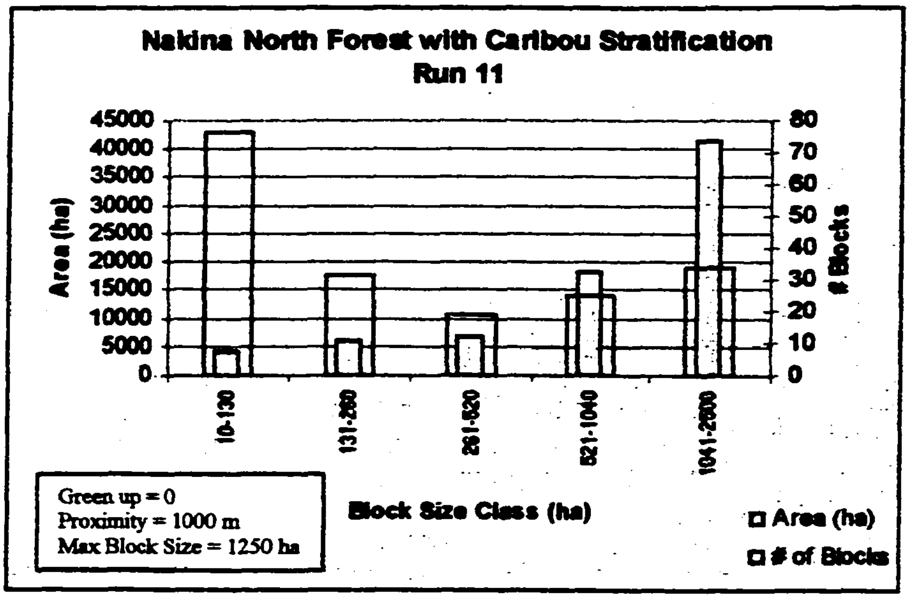
Nakina North Forest with Caribou Stratification
Run 7

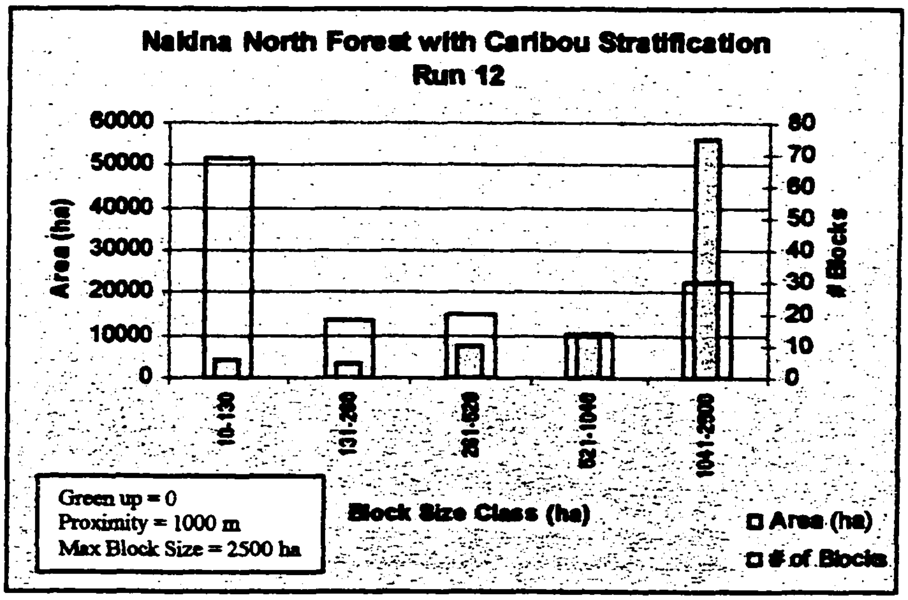


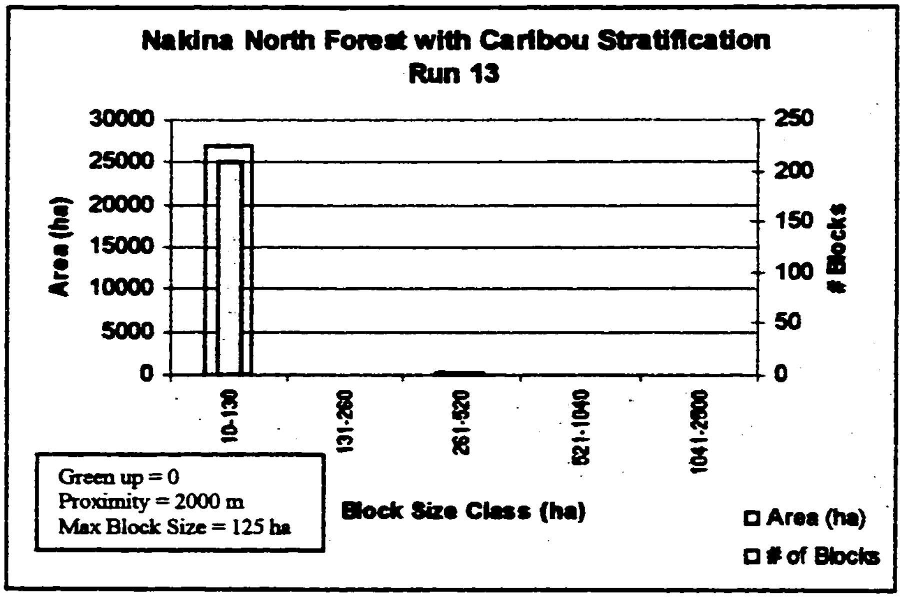
Nakina North Forest with Caribou Stratification
Run 8


Nakina North Forest with Caribou Stratification
Run 9
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
500
450
400
350
300
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Green up = 0
Proximity = 1000 m
Max Block Size = 125 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

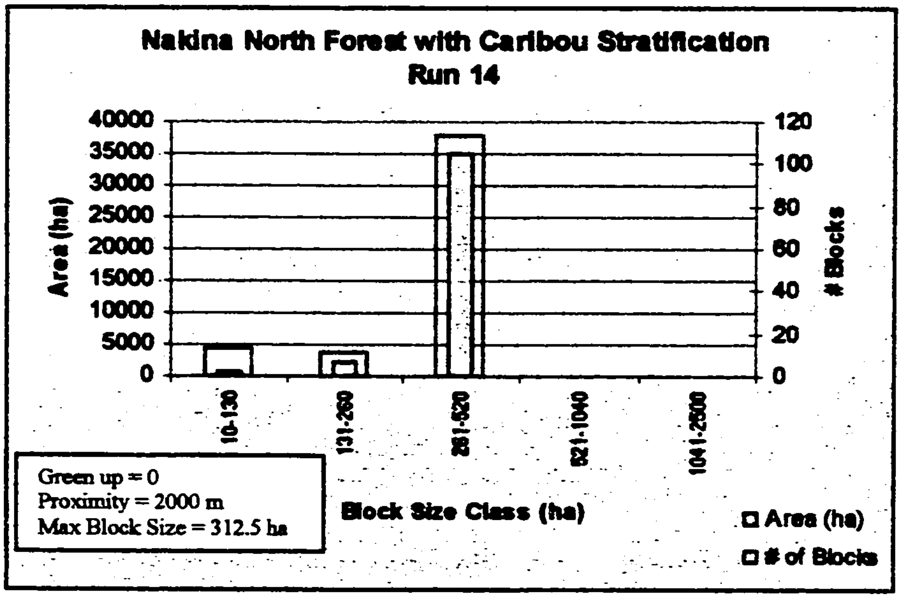

Nakina North Forest with Caribou Stratification
Run 10
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
160
140
120
100
80
60
40
20
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Green up = 0
Proximity = 1000 m
Max Block Size = 312.5 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks


Nakina North Forest with Caribou Stratification
Run 11
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
80
70
60
50
40
30
20
10
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 0
Proximity = 1000 m
Max Block Size = 1250 ha
□ Area (ha)
□ # of Blocks

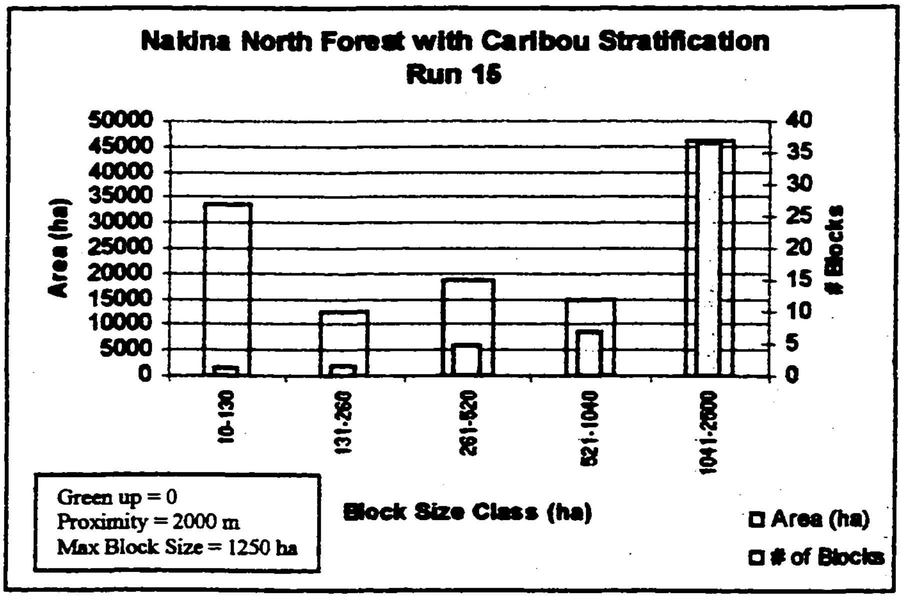

Nakina North Forest with Caribou Stratification
Run 12
60000
50000
40000
30000
20000
10000
0
Area (ha)
80
70
60
50
40
30
20
10
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 0
Proximity = 1000 m
Max Block Size = 2500 ha
□ Area (ha)
□ # of Blocks

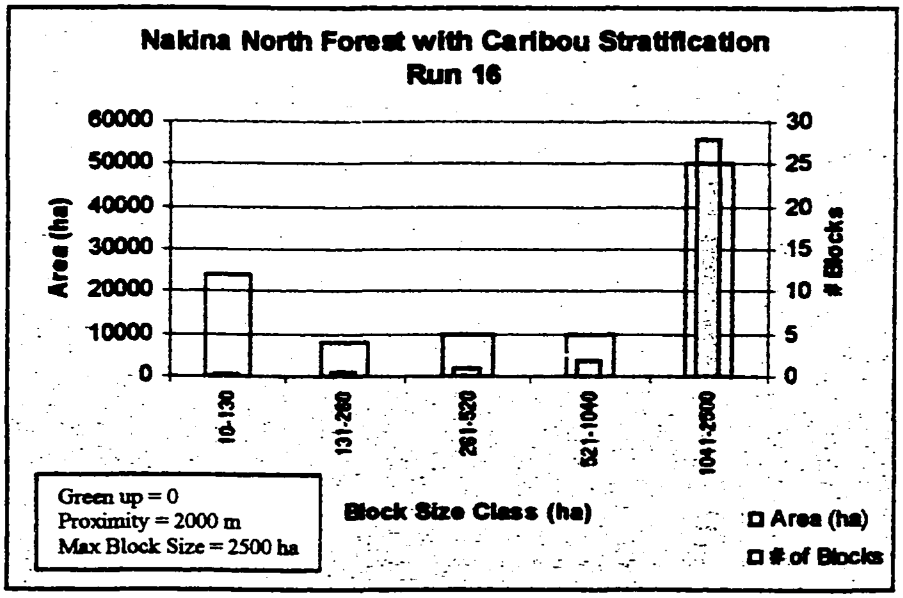


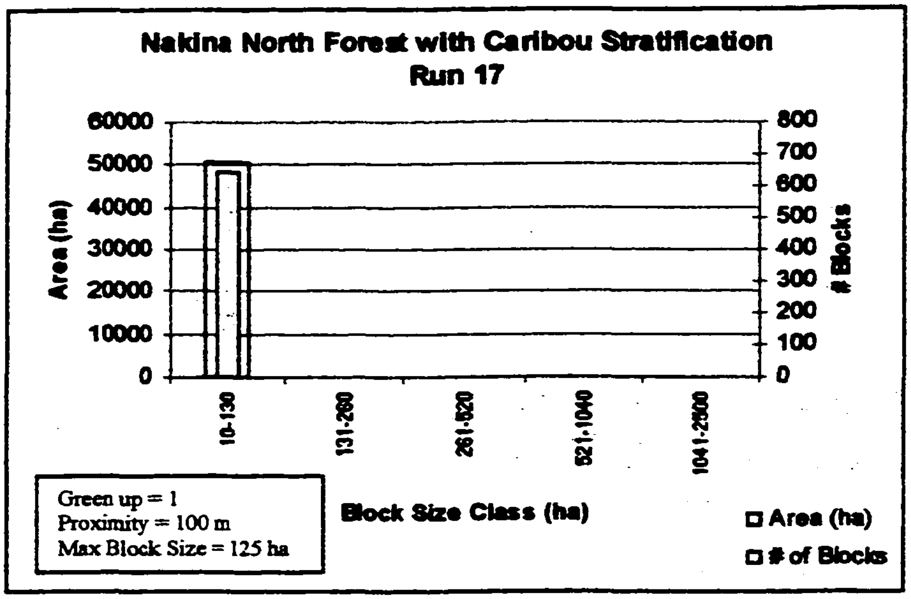
Green up = 0
Proximity = 2000 m
Max Block Size = 125 ha

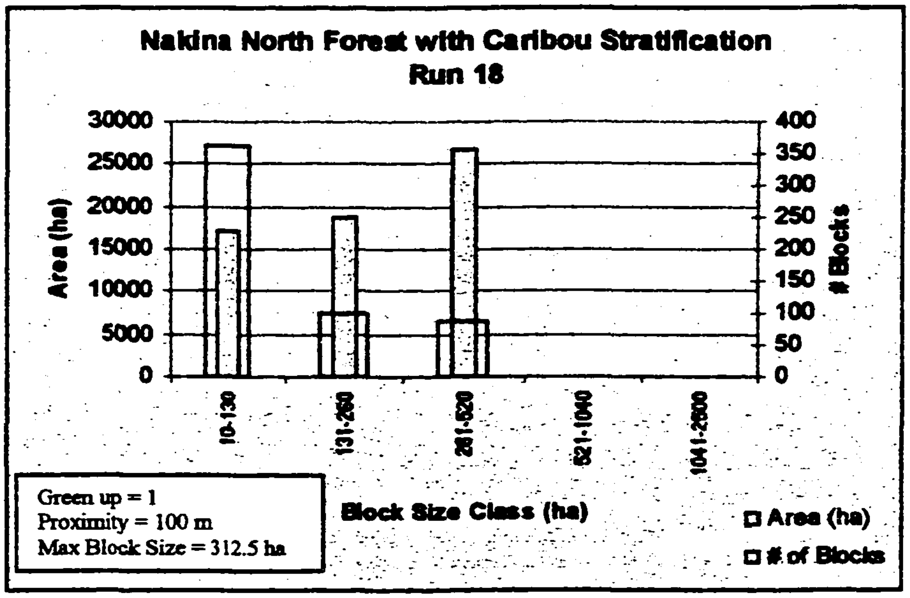


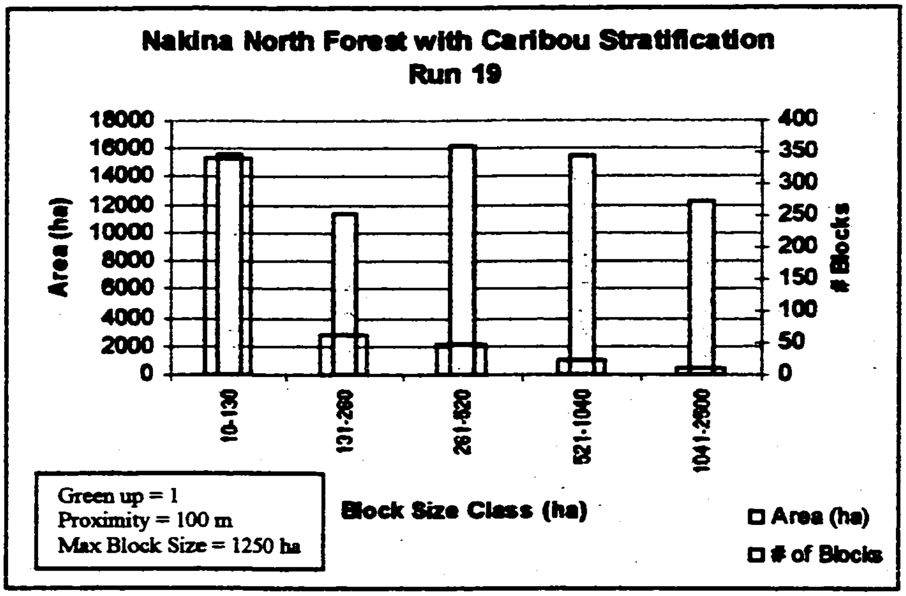
Green up = 0
Proximity = 2000 m
Max Block Size = 312.5 ha

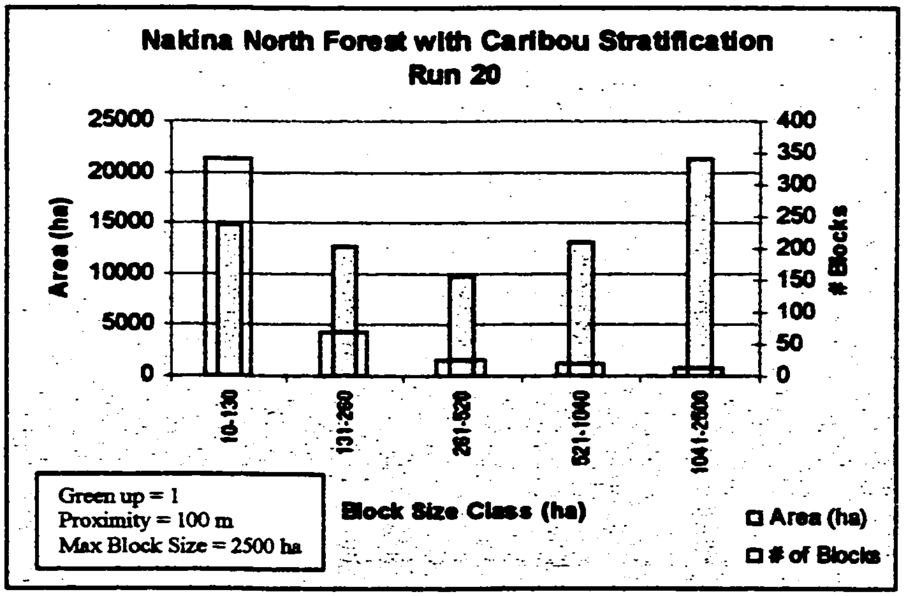

Nakina North Forest with Caribou Stratification
Run 15
Area (ha)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
40
35
30
25
20
15
10
5
0
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 0
Proximity = 2000 m
Max Block Size = 1250 ha
□ Area (ha)
□ # of Blocks

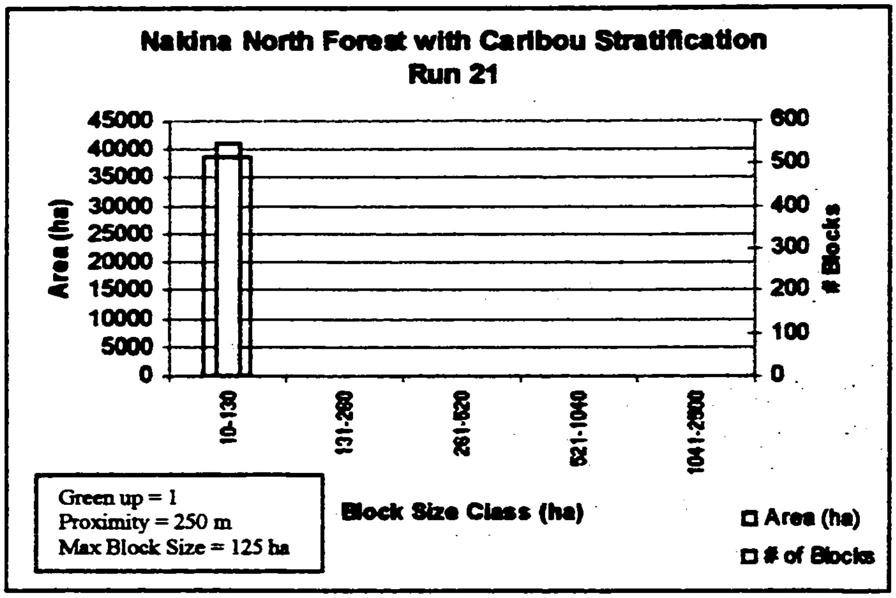

Nakina North Forest with Caribou Stratification
Run 16
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
30
25
20
15
10
5
0
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 0
Proximity = 2000 m
Max Block Size = 2500 ha
□ Area (ha)
□ # of Blocks

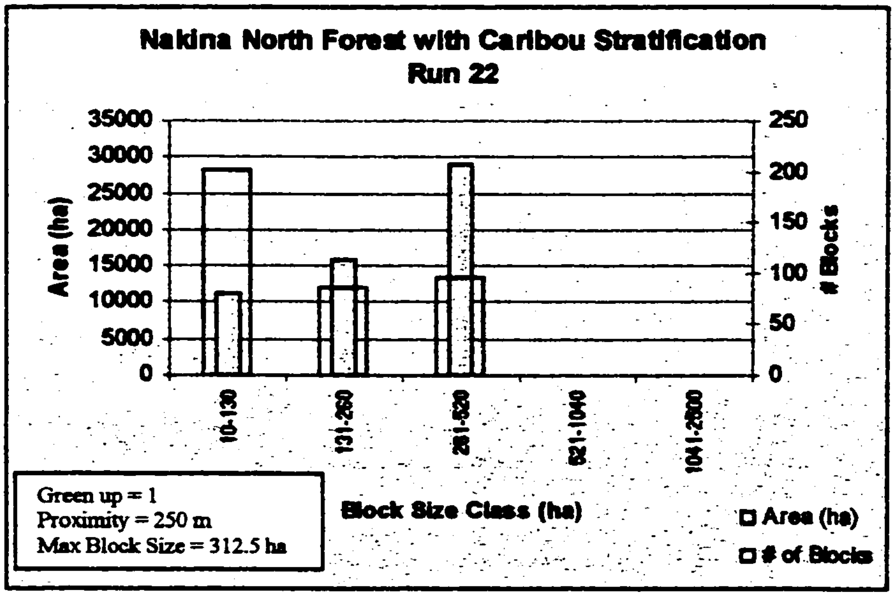

Nakina North Forest with Caribou Stratification
Run 17
60000
50000
40000
30000
20000
10000
0
Area (ha)
800
700
600
500
400
300
200
100
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Green up = 1
Proximity = 100 m
Max Block Size = 125 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

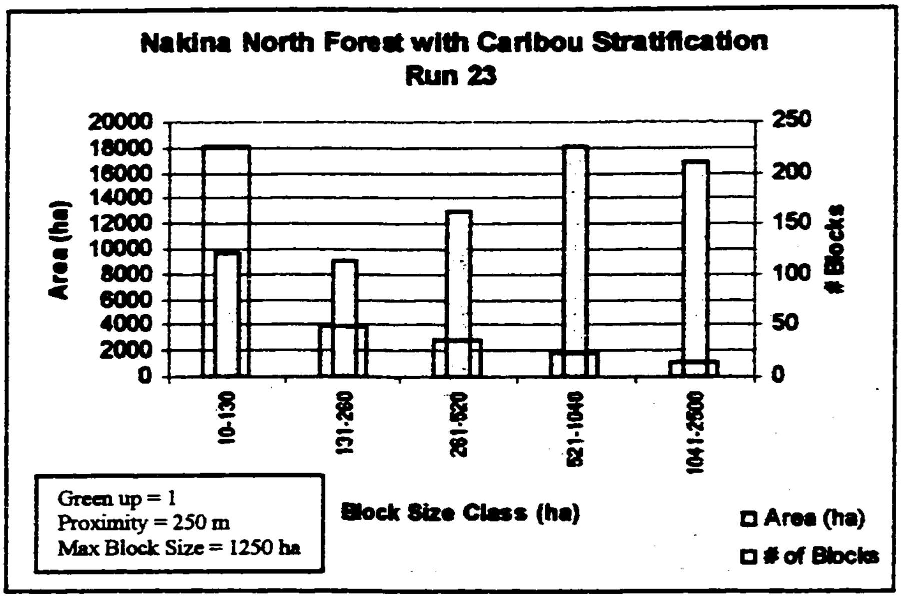

Nakina North Forest with Caribou Stratification
Run 18
30000
25000
20000
15000
10000
5000
0
Area (ha)
400
350
300
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2600
Green up = 1
Proximity = 100 m
Max Block Size = 312.5 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

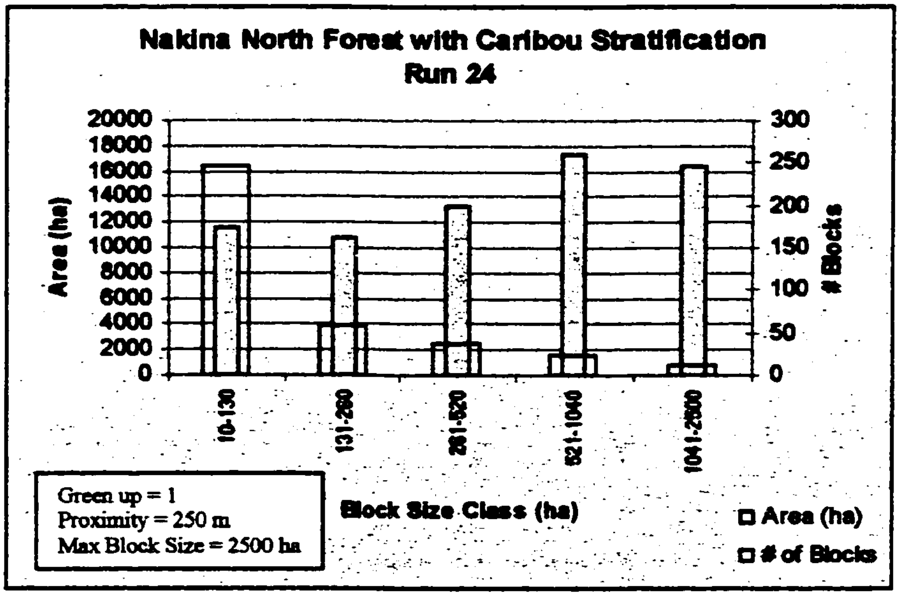

Nakina North Forest with Caribou Stratification
Run 19
Area (ha)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Blocks
400
350
300
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 1
Proximity = 100 m
Max Block Size = 1250 ha
□ Area (ha)
□ # of Blocks

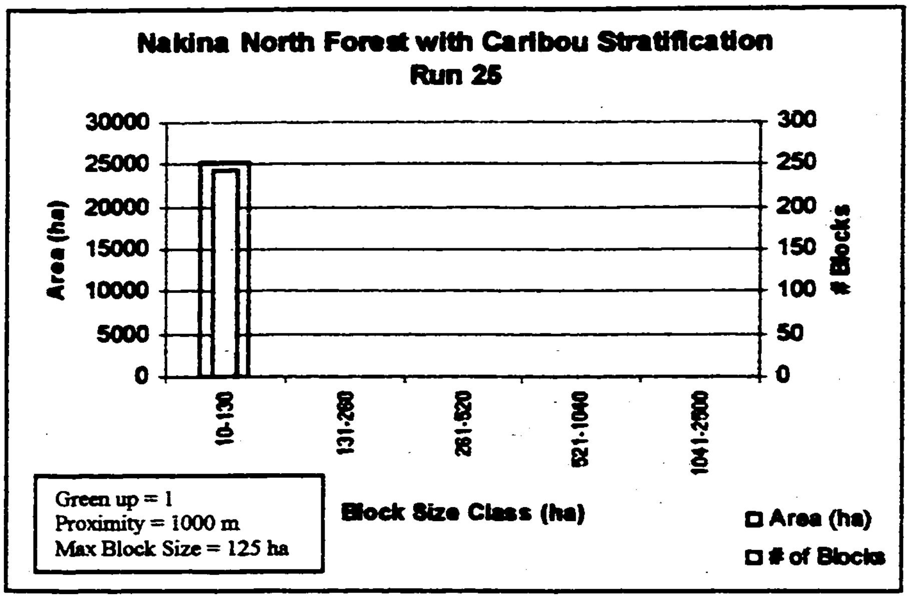

Nakina North Forest with Caribou Stratification
Run 20
Area (ha)
25000
20000
15000
10000
5000
0
Blocks
400
350
300
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2600
Block Size Class (ha)
Green up = 1
Proximity = 100 m
Max Block Size = 2500 ha
□ Area (ha)
□ # of Blocks

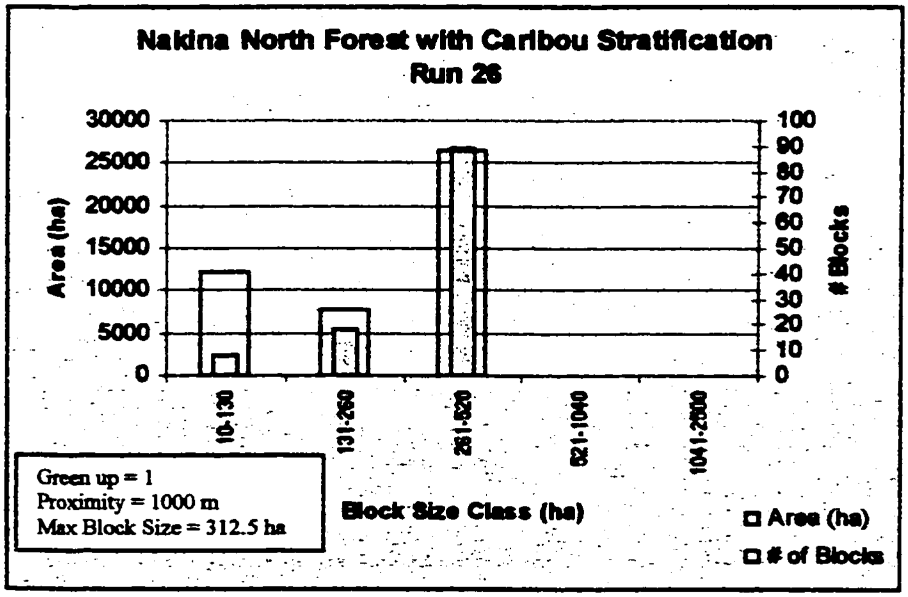

Nakina North Forest with Caribou Stratification
Run 21
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
600
500
400
300
200
100
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Block Size Class (ha)
Green up = 1
Proximity = 250 m
Max Block Size = 125 ha
□ Area (ha)
□ # of Blocks

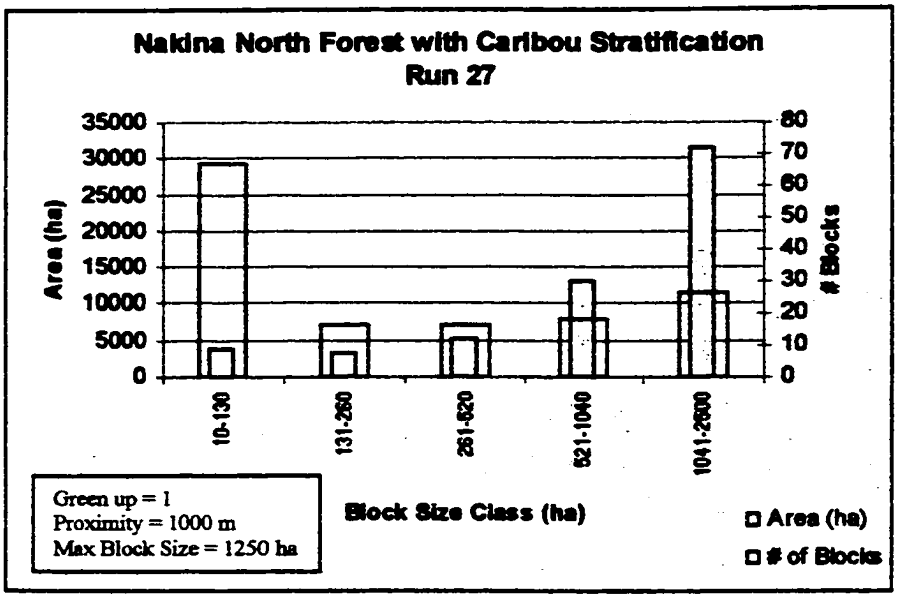

Nakina North Forest with Caribou Stratification
Run 22
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Block Size Class (ha)
Green up = 1
Proximity = 250 m
Max Block Size = 312.5 ha
□ Area (ha)
□ # of Blocks


Nakina North Forest with Caribou Stratification
Run 23
Area (ha)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Blocks
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
□ Area (ha)
□ # of Blocks
Green up = 1
Proximity = 250 m
Max Block Size = 1250 ha

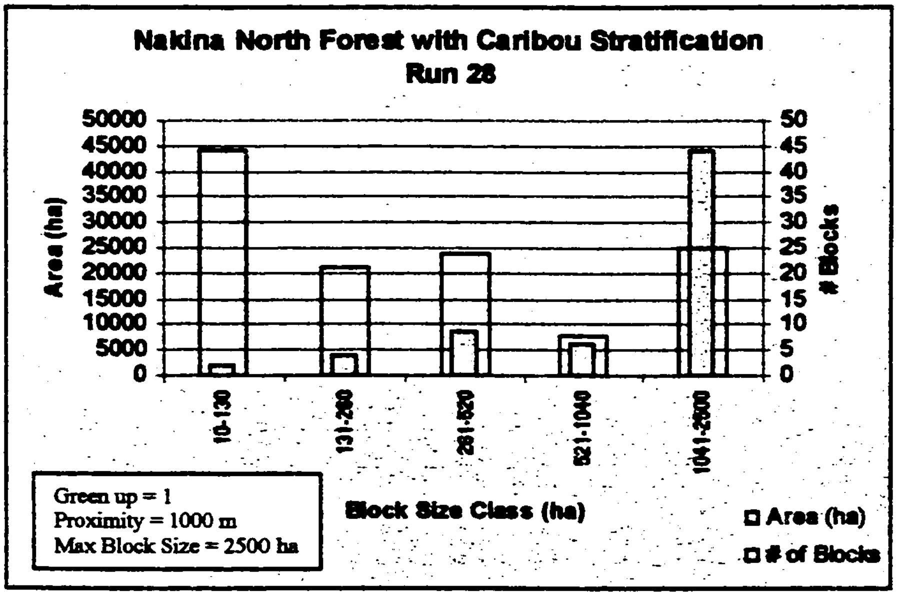

Nakina North Forest with Caribou Stratification
Run 24
Area (ha)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Blocks
300
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
□ Area (ha)
□ # of Blocks
Green up = 1
Proximity = 250 m
Max Block Size = 2500 ha


Nakina North Forest with Caribou Stratification
Run 25
30000
25000
20000
15000
10000
5000
0
Area (ha)
300
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Block Size Class (ha)
Green up = 1
Proximity = 1000 m
Max Block Size = 125 ha
□ Area (ha)
□ # of Blocks

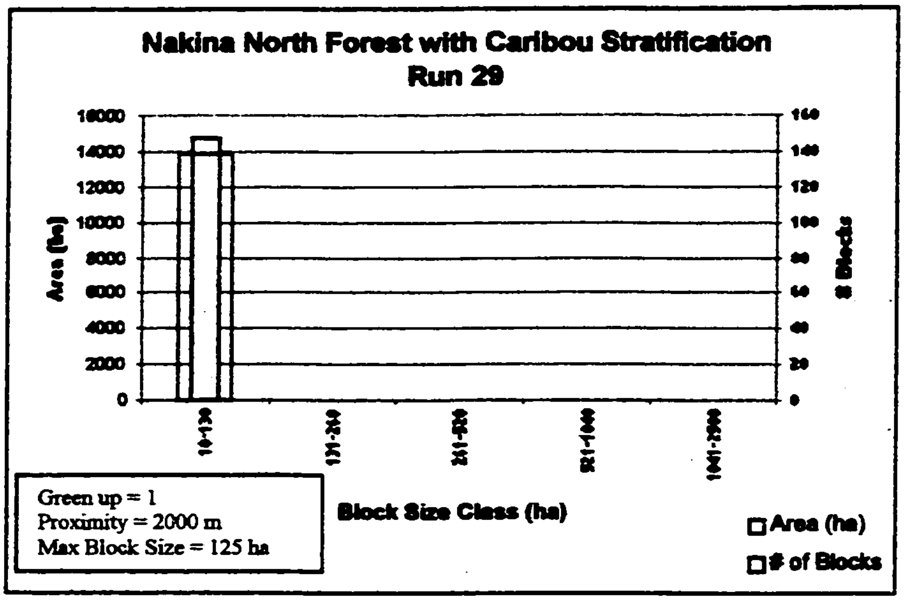

Nakina North Forest with Caribou Stratification
Run 26
30000
25000
20000
15000
10000
5000
0
Area (ha)
100
90
80
70
60
50
40
30
20
10
0
Blocks
10-130
131-260
261-520
521-1040
1041-2800
Block Size Class (ha)
Green up = 1
Proximity = 1000 m
Max Block Size = 312.5 ha
□ Area (ha)
□ # of Blocks

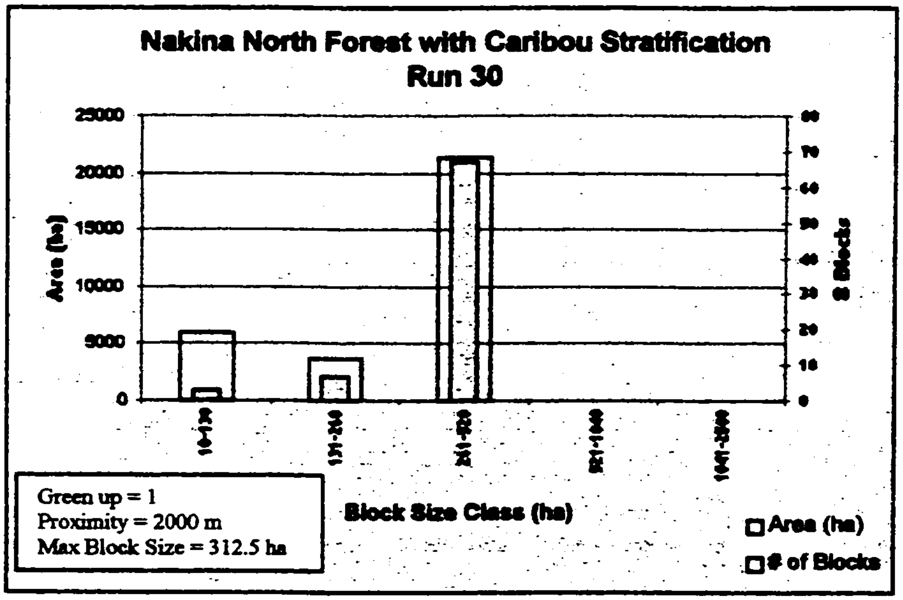


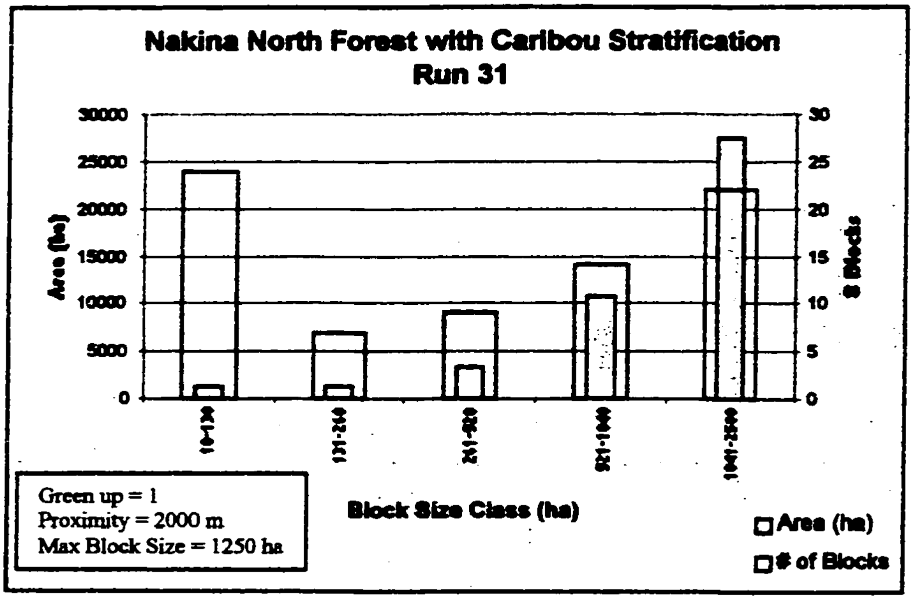
Green up = 1
Proximity = 1000 m
Max Block Size = 1250 ha

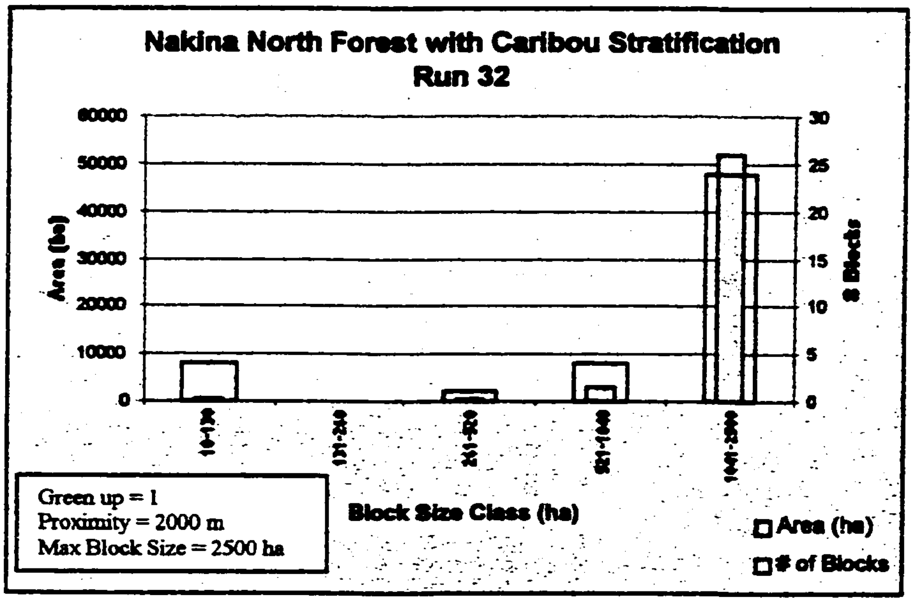


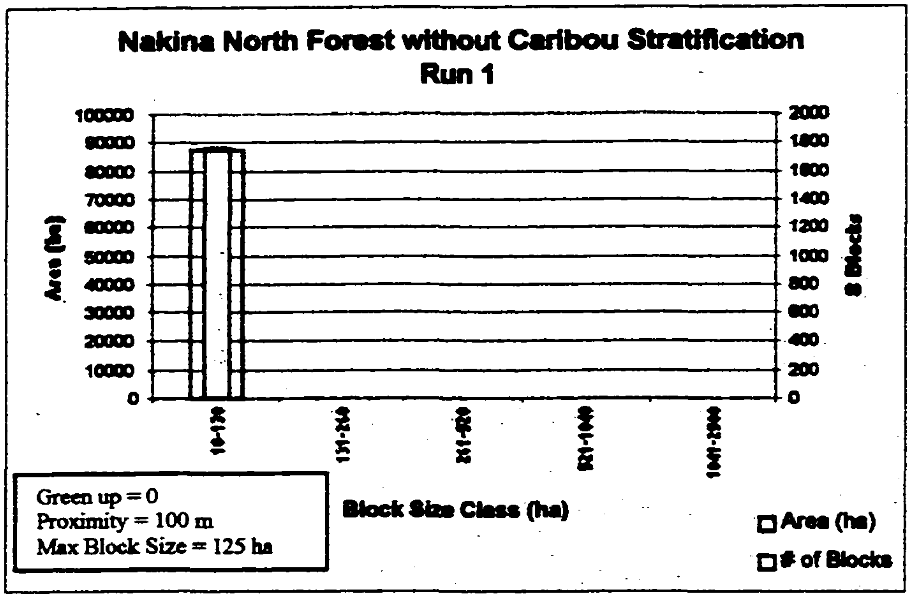
Green up = 1
Proximity = 1000 m
Max Block Size = 2500 ha

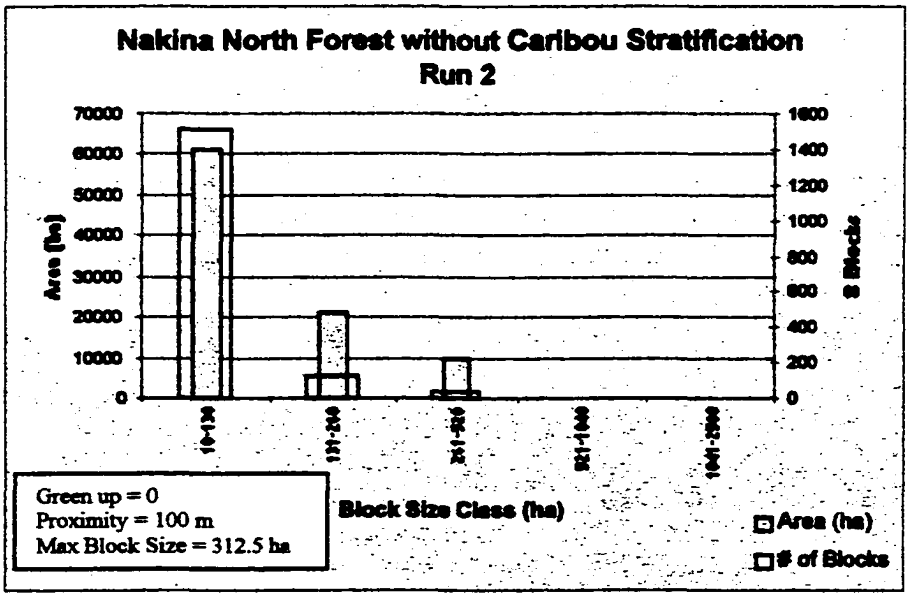

Nakina North Forest with Caribou Stratification
Run 29
16000
14000
12000
10000
8000
6000
4000
2000
0
Area (ha)
160
140
120
100
80
60
40
20
0
Blocks
10-130
131-260
261-520
521-1040
1041-2000
Green up = 1
Proximity = 2000 m
Max Block Size = 125 ha
Block Size Class (ha)
☐ Area (ha)
☐ # of Blocks

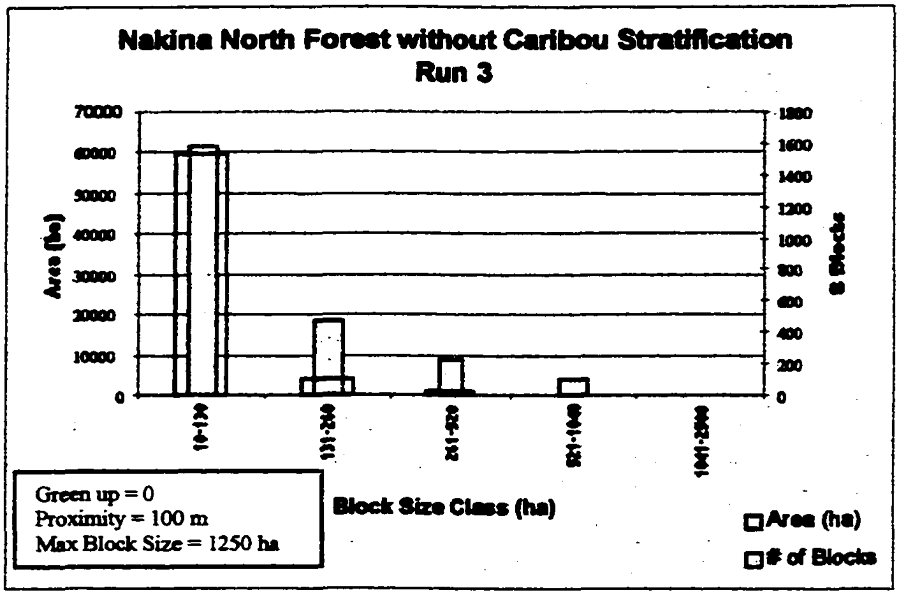

Nakina North Forest with Caribou Stratification
Run 30
25000
20000
15000
10000
5000
0
Area (ha)
80
70
60
50
40
30
20
10
0
Blocks
10-130
131-260
261-520
521-1040
1041-2000
Green up = 1
Proximity = 2000 m
Max Block Size = 312.5 ha
Block Size Class (ha)
☐ Area (ha)
☐ # of Blocks

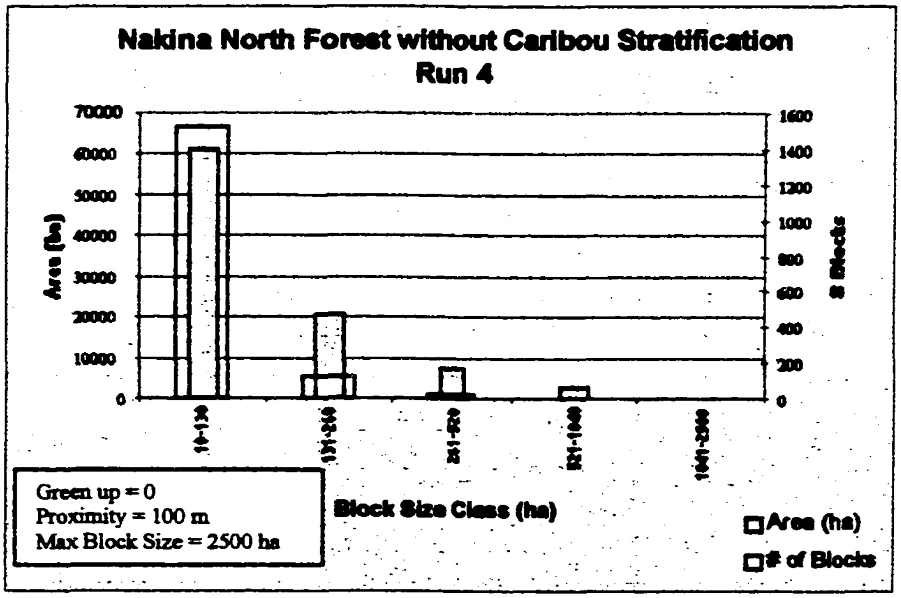

Nakina North Forest with Caribou Stratification
Run 31
Area (ha)
30000
25000
20000
15000
10000
5000
0
30
25
20
15
10
5
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 1250 ha
□ Area (ha)
□ # of Blocks

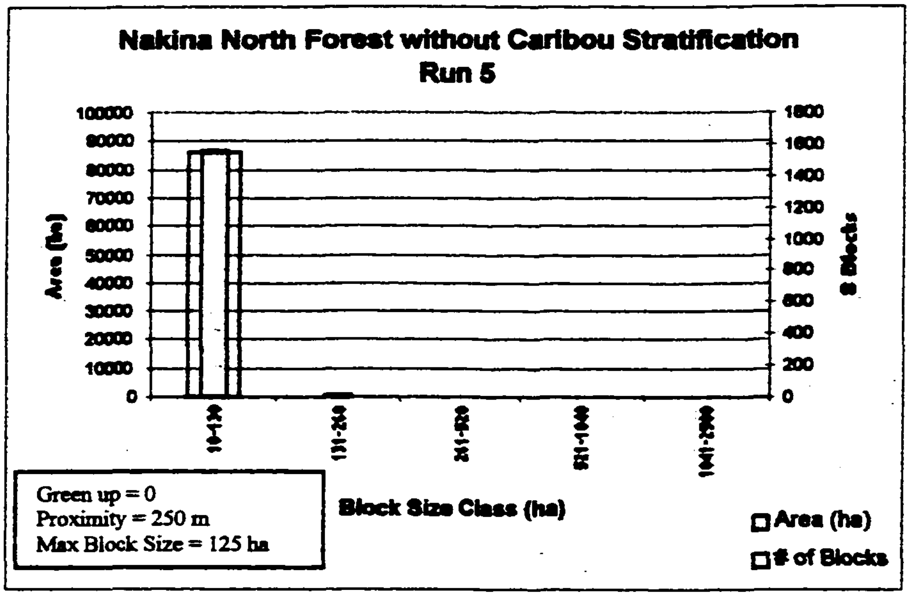

Nakina North Forest with Caribou Stratification
Run 32
Area (ha)
60000
50000
40000
30000
20000
10000
0
30
25
20
15
10
5
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 2500 ha
□ Area (ha)
□ # of Blocks

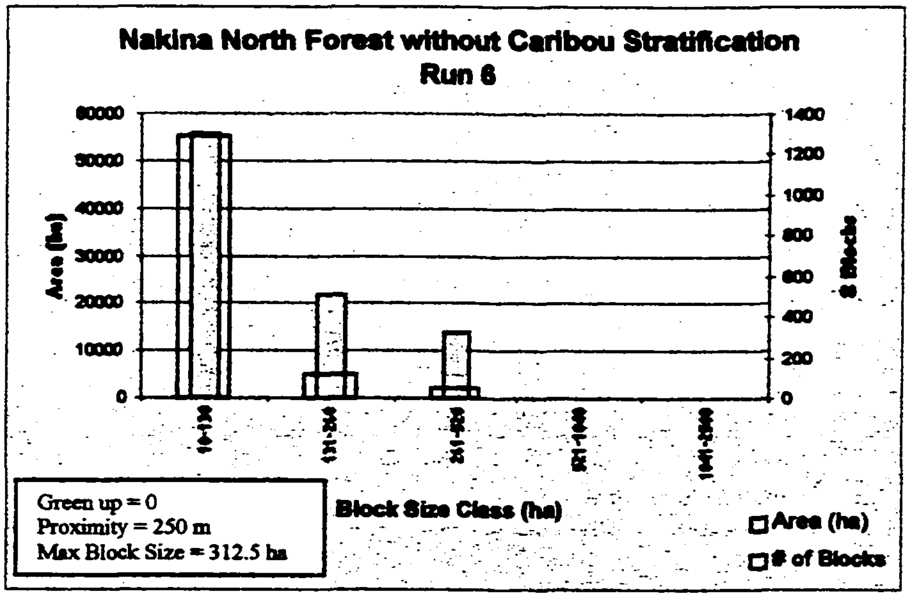

Nakina North Forest without Caribou Stratification
Run 1
Area (ha)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Blocks
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 0
Proximity = 100 m
Max Block Size = 125 ha
Area (ha)
# of Blocks

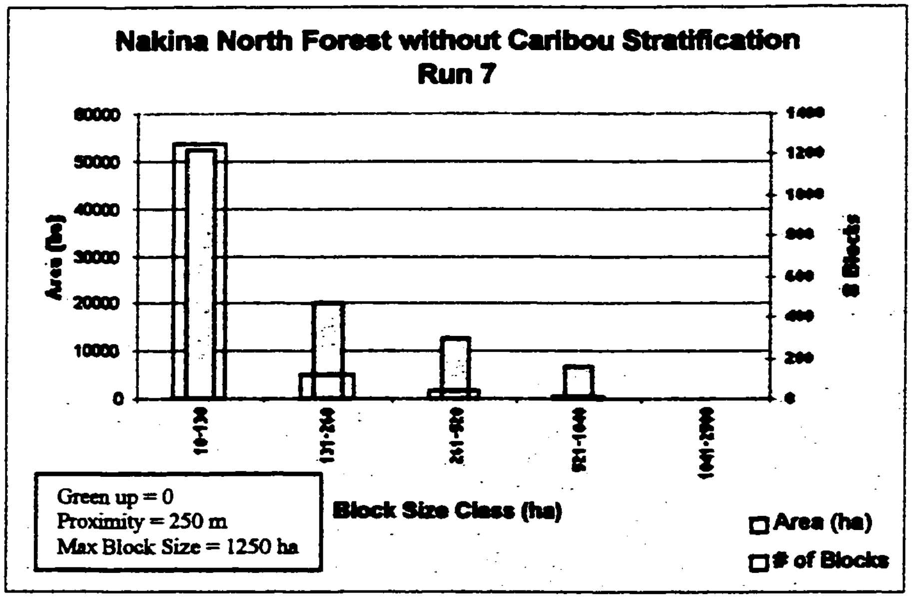

Nakina North Forest without Caribou Stratification
Run 2
Area (ha)
70000
60000
50000
40000
30000
20000
10000
0
Blocks
1600
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 0
Proximity = 100 m
Max Block Size = 312.5 ha
Area (ha)
# of Blocks

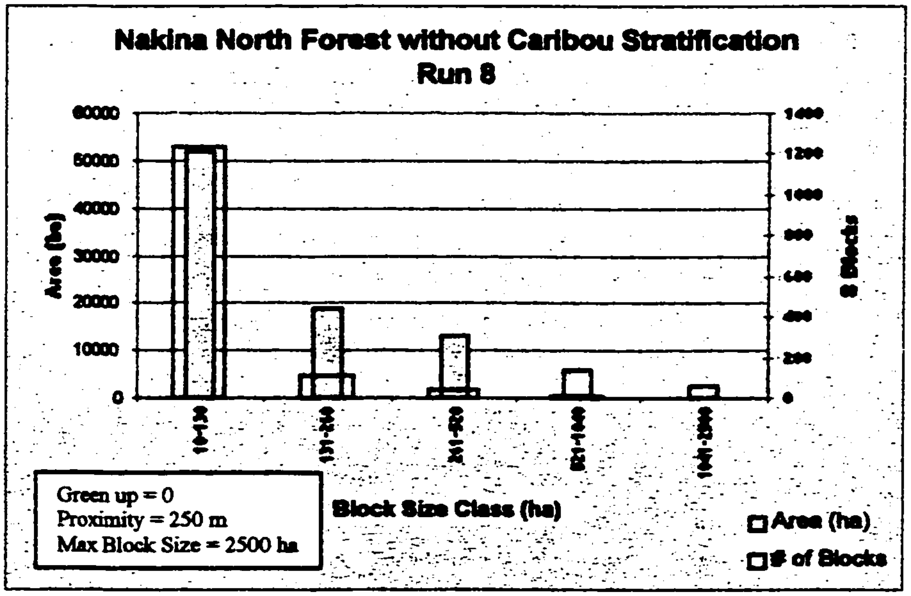

Nakina North Forest without Caribou Stratification
Run 3
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
1800
1600
1400
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 0
Proximity = 100 m
Max Block Size = 1250 ha
Block Size Class (ha)
☐Area (ha)
☐# of Blocks

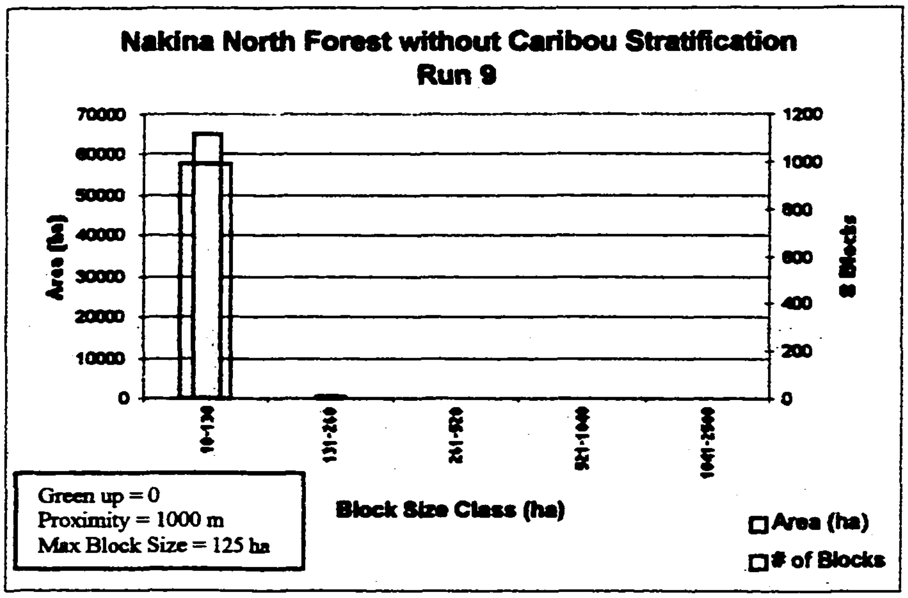

Nakina North Forest without Caribou Stratification
Run 4
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
1600
1400
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 0
Proximity = 100 m
Max Block Size = 2500 ha
Block Size Class (ha)
☐Area (ha)
☐# of Blocks

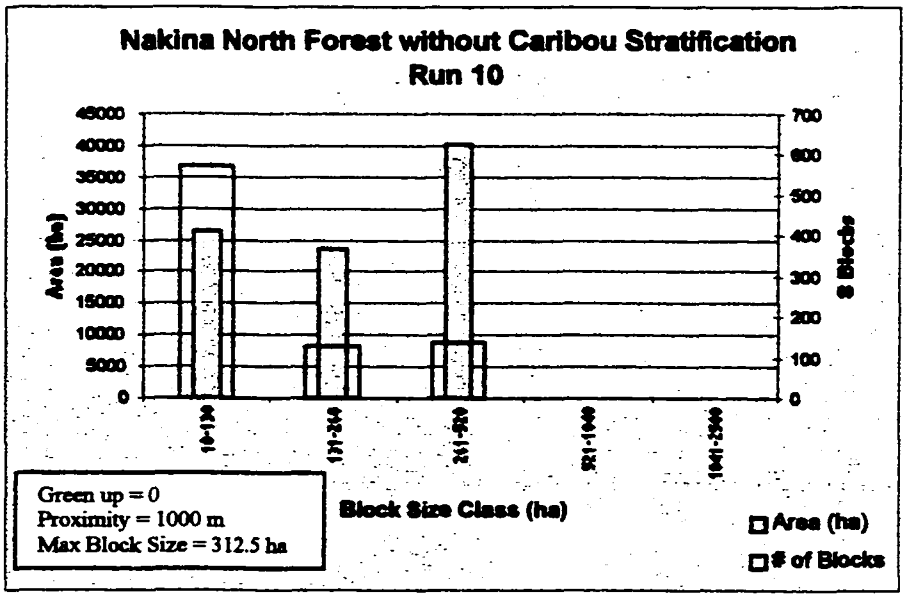

Nakina North Forest without Caribou Stratification
Run 5
Area (ha)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Blocks
1800
1600
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 0
Proximity = 250 m
Max Block Size = 125 ha
□ Area (ha)
□ # of Blocks

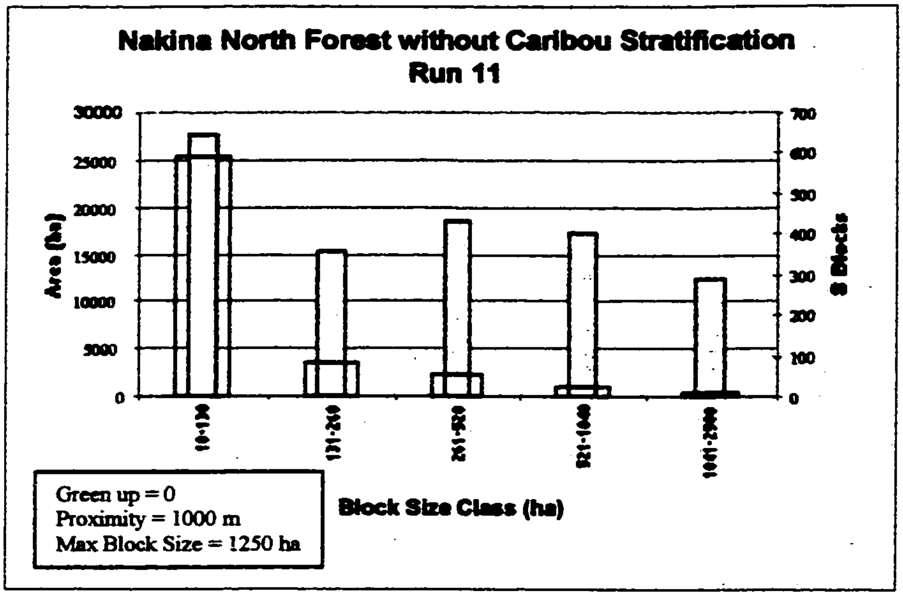

Nakina North Forest without Caribou Stratification
Run 6
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 0
Proximity = 250 m
Max Block Size = 312.5 ha
□ Area (ha)
□ # of Blocks


Nakina North Forest without Caribou Stratification
Run 7
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Green up = 0
Proximity = 250 m
Max Block Size = 1250 ha
Block Size Class (ha)
Area (ha)
# of Blocks


Nakina North Forest without Caribou Stratification
Run 8
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
1400
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Green up = 0
Proximity = 250 m
Max Block Size = 2500 ha
Block Size Class (ha)
Area (ha)
# of Blocks

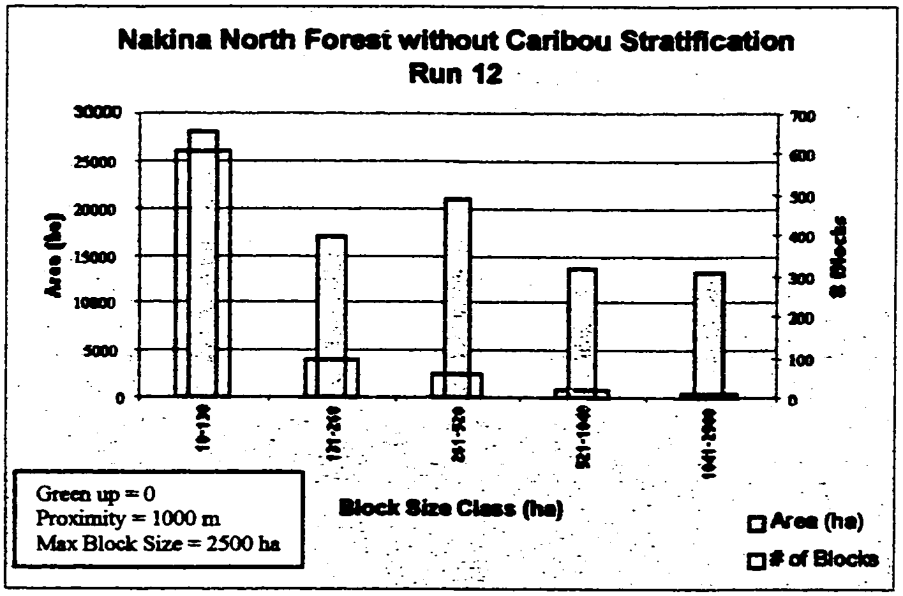

Nakina North Forest without Caribou Stratification
Run 9
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 0
Proximity = 1000 m
Max Block Size = 125 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks


Nakina North Forest without Caribou Stratification
Run 10
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
700
600
500
400
300
200
100
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 0
Proximity = 1000 m
Max Block Size = 312.5 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks



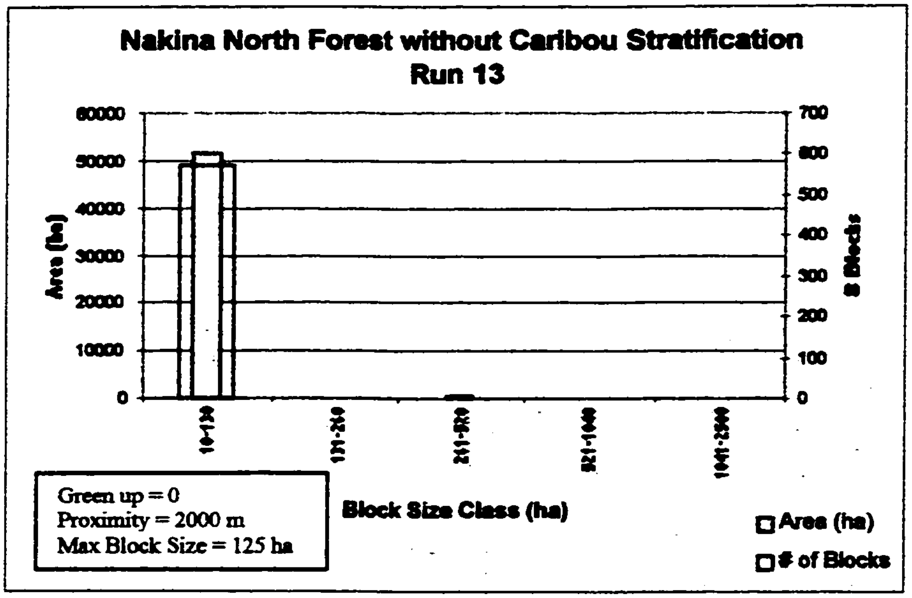
Nakina North Forest without Caribou Stratification
Run 11

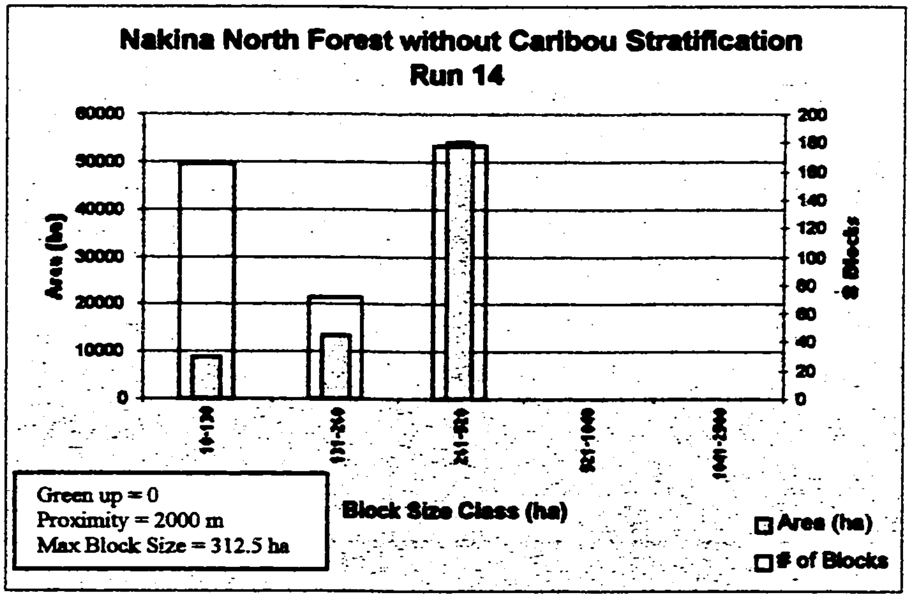
Green up = 0
Proximity = 1000 m
Max Block Size = 1250 ha

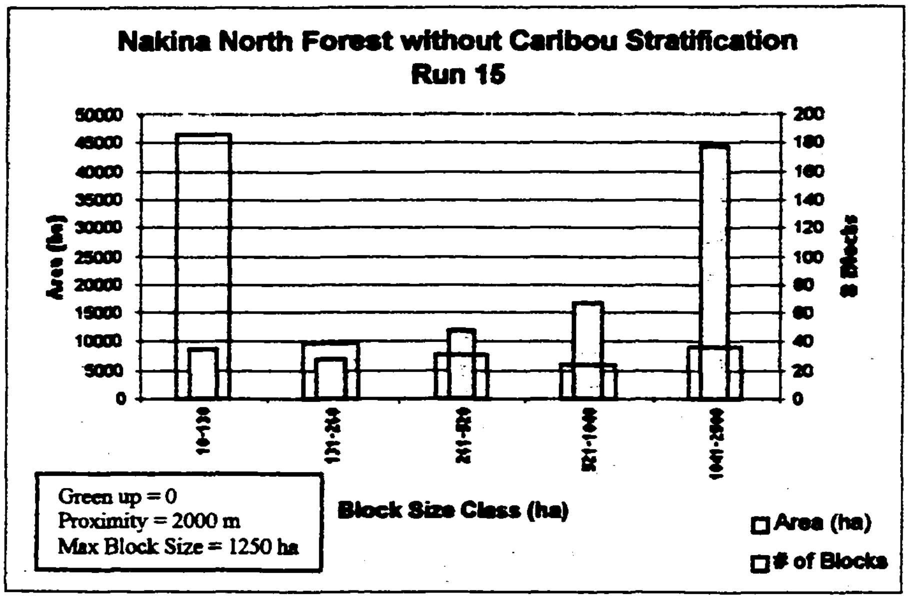


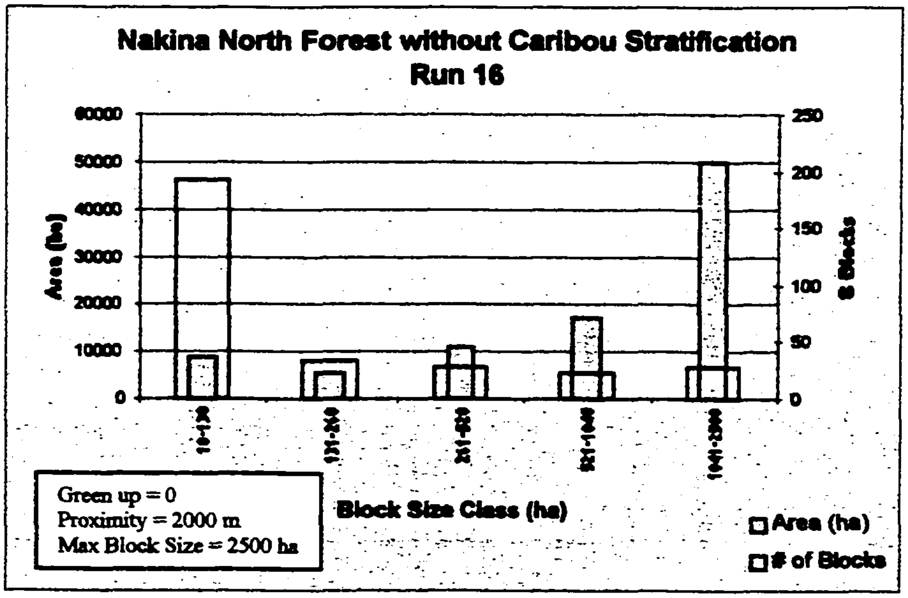
Nakina North Forest without Caribou Stratification
Run 12

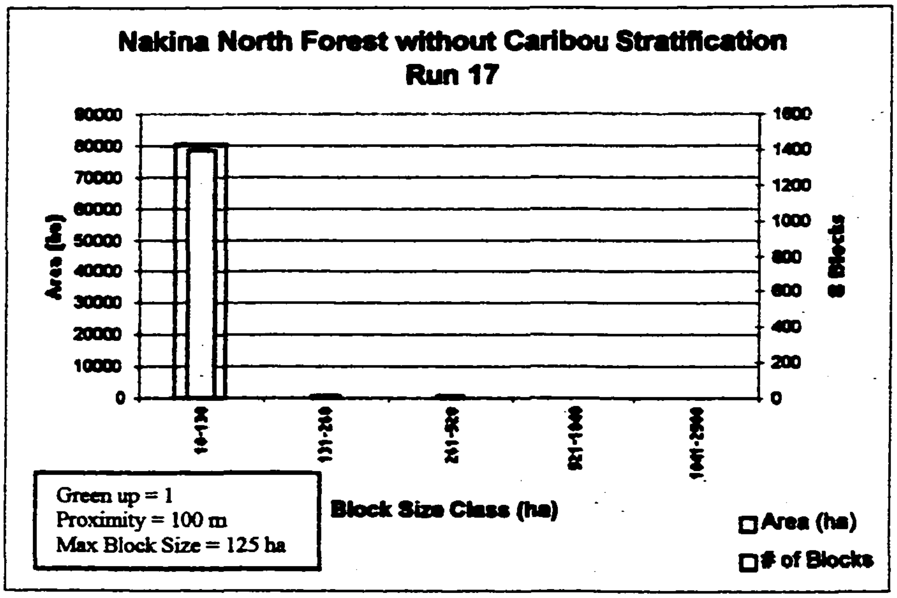
Green up = 0
Proximity = 1000 m
Max Block Size = 2500 ha

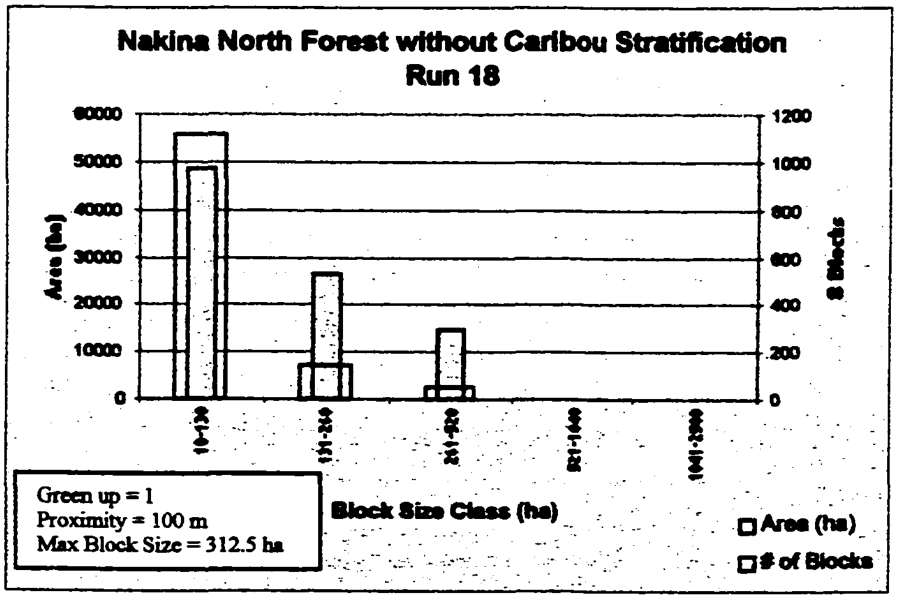

Nakina North Forest without Caribou Stratification
Run 13
60000
50000
40000
30000
20000
10000
0
Area (ha)
700
600
500
400
300
200
100
0
Blocks
10-120
121-240
241-520
521-1040
1041-2080
Green up = 0
Proximity = 2000 m
Max Block Size = 125 ha
Block Size Class (ha)
Area (ha)
# of Blocks

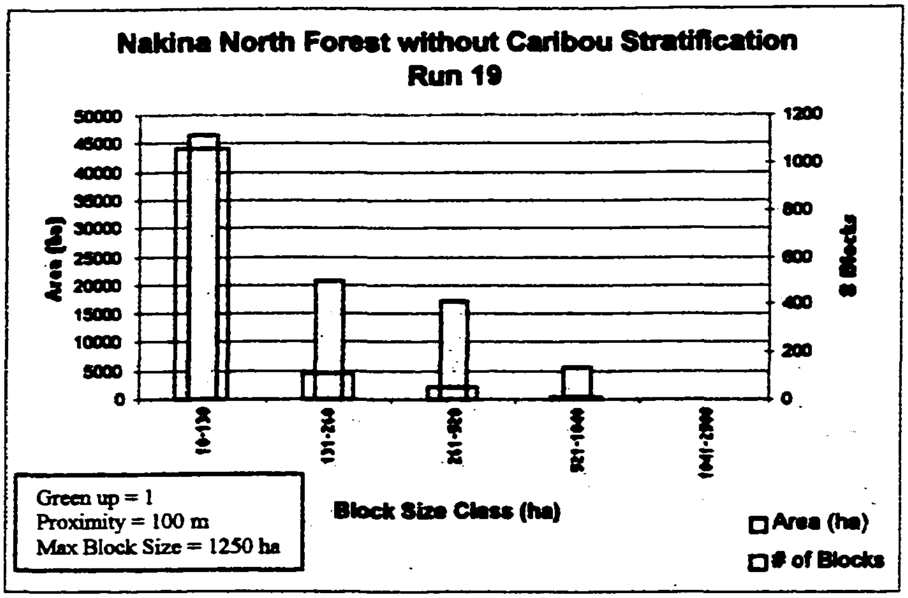

Nakina North Forest without Caribou Stratification
Run 14
60000
50000
40000
30000
20000
10000
0
Area (ha)
200
180
160
140
120
100
80
60
40
20
0
Blocks
10-120
121-240
241-520
521-1040
1041-2080
Green up = 0
Proximity = 2000 m
Max Block Size = 312.5 ha
Block Size Class (ha)
Area (ha)
# of Blocks

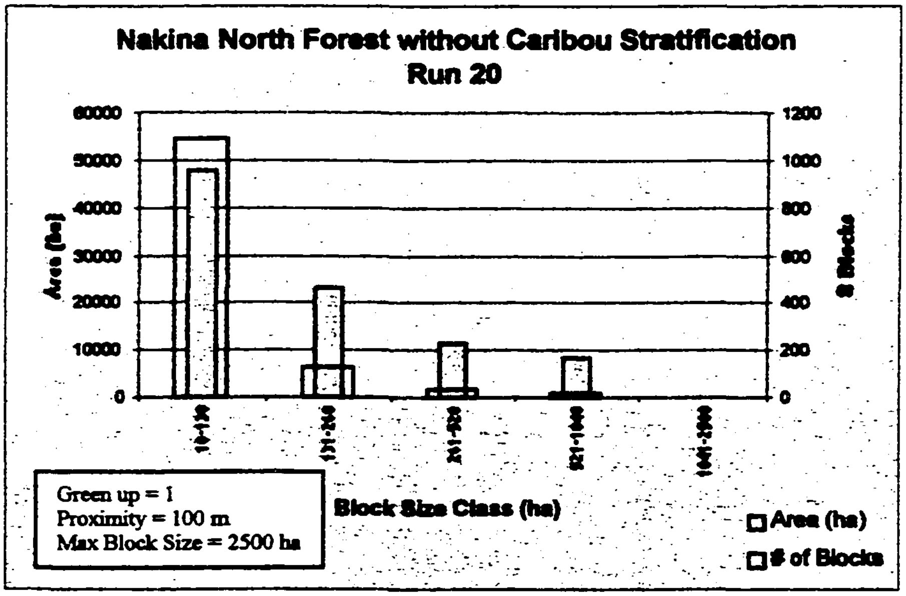

Nakina North Forest without Caribou Stratification
Run 15
Area (ha)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
200
180
160
140
120
100
80
60
40
20
0
10-120
121-240
241-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 0
Proximity = 2000 m
Max Block Size = 1250 ha
Area (ha)
# of Blocks

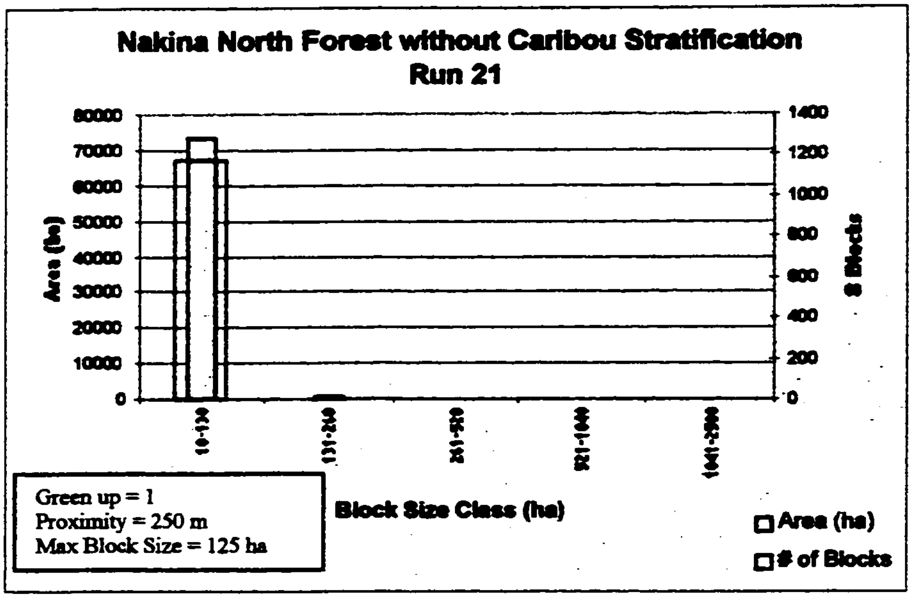

Nakina North Forest without Caribou Stratification
Run 16
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
250
200
150
100
50
0
10-120
121-240
241-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 0
Proximity = 2000 m
Max Block Size = 2500 ha
Area (ha)
# of Blocks

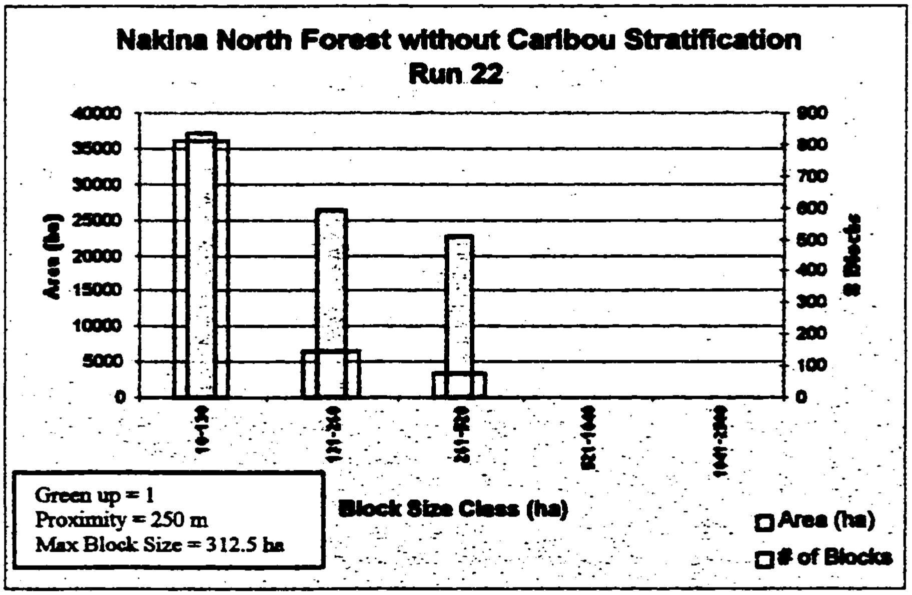

Nakina North Forest without Caribou Stratification
Run 17
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
1600
1400
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2080
Green up = 1
Proximity = 100 m
Max Block Size = 125 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

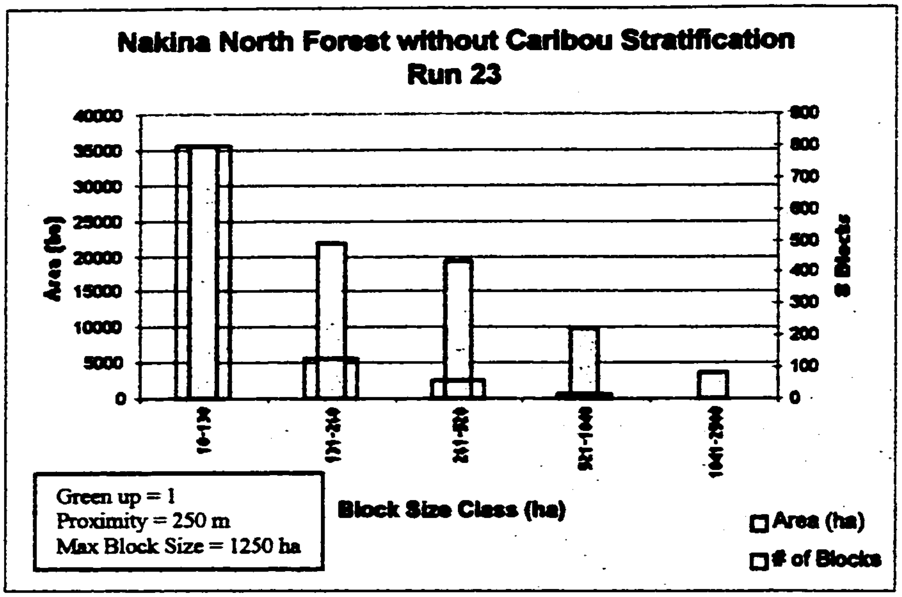

Nakina North Forest without Caribou Stratification
Run 18
60000
50000
40000
30000
20000
10000
0
Area (ha)
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2080
Green up = 1
Proximity = 100 m
Max Block Size = 312.5 ha
Block Size Class (ha)
□ Area (ha)
□ # of Blocks

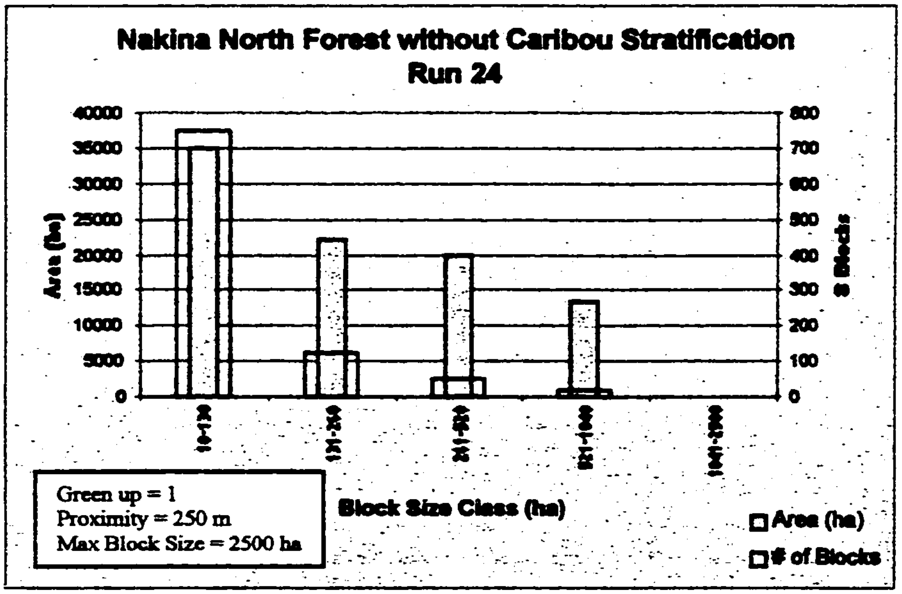

Nakina North Forest without Caribou Stratification
Run 19
Area (ha)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 100 m
Max Block Size = 1250 ha
☐ Area (ha)
☐ # of Blocks

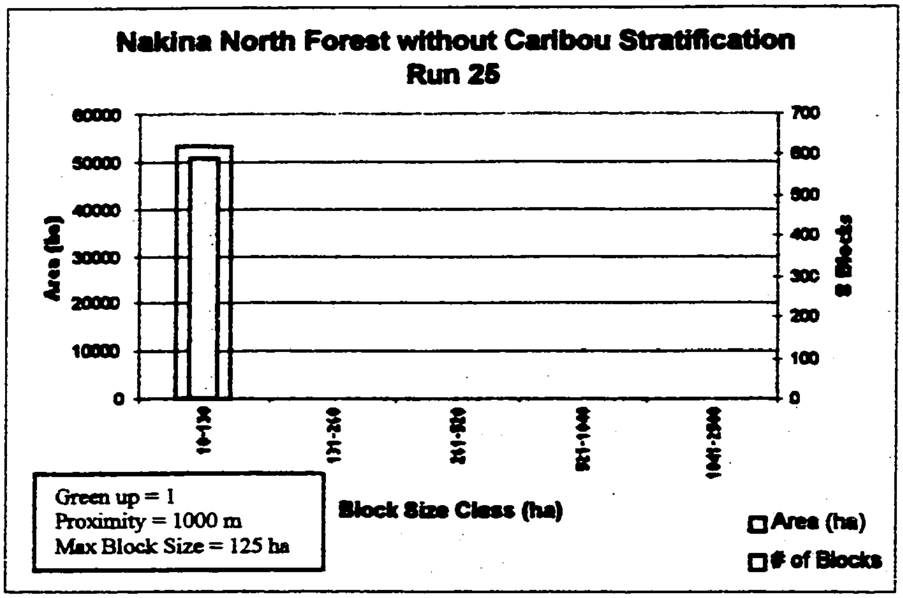

Nakina North Forest without Caribou Stratification
Run 20
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
1200
1000
800
600
400
200
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 100 m
Max Block Size = 2500 ha
☐ Area (ha)
☐ # of Blocks

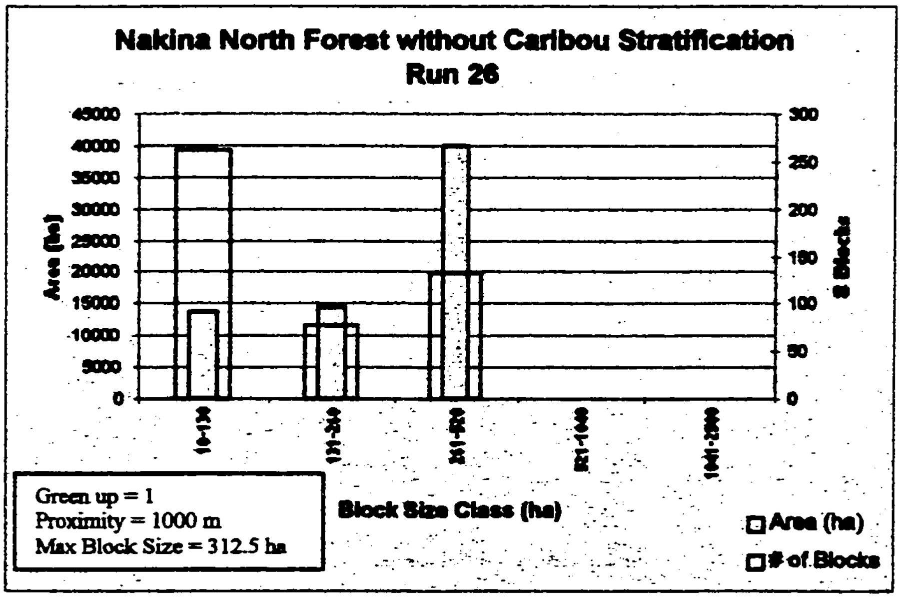

Nakina North Forest without Caribou Stratification
Run 21
80000
70000
60000
50000
40000
30000
20000
10000
0
Area (ha)
1400
1200
1000
800
600
400
200
0
Blocks
10-130
131-260
261-520
521-1040
1041-2080
Green up = 1
Proximity = 250 m
Max Block Size = 125 ha
Block Size Class (ha)
☐ Area (ha)
☐ # of Blocks

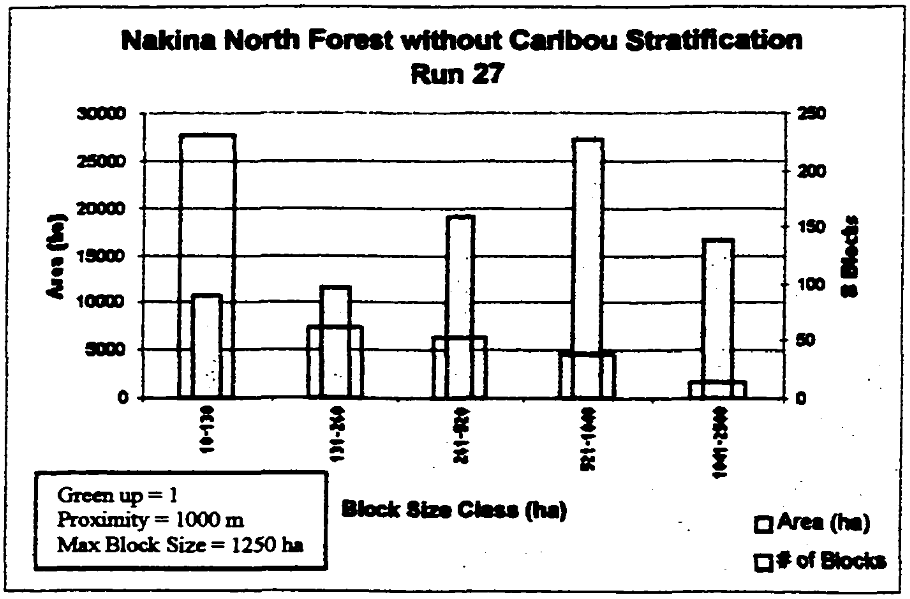

Nakina North Forest without Caribou Stratification
Run 22
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
900
800
700
600
500
400
300
200
100
0
Blocks
10-130
131-260
261-520
521-1040
1041-2080
Green up = 1
Proximity = 250 m
Max Block Size = 312.5 ha
Block Size Class (ha)
☐ Area (ha)
☐ # of Blocks

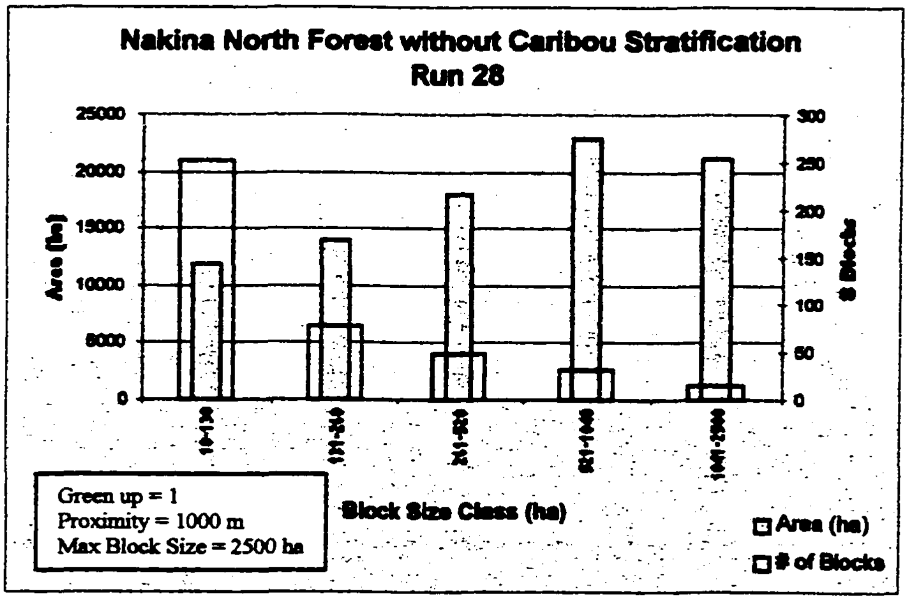

Nakina North Forest without Caribou Stratification
Run 23
Area (ha)
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
900
800
700
600
500
400
300
200
100
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 250 m
Max Block Size = 1250 ha
☐ Area (ha)
☐ # of Blocks

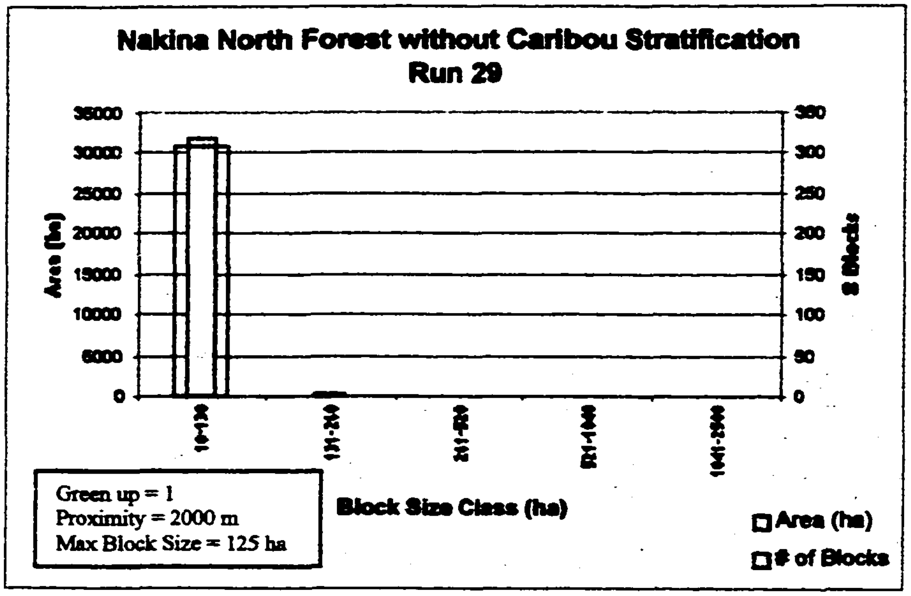

Nakina North Forest without Caribou Stratification
Run 24
Area (ha)
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
800
700
600
500
400
300
200
100
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 250 m
Max Block Size = 2500 ha
☐ Area (ha)
☐ # of Blocks


Nakina North Forest without Caribou Stratification
Run 25
Area (ha)
60000
50000
40000
30000
20000
10000
0
Blocks
700
600
500
400
300
200
100
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 1000 m
Max Block Size = 125 ha
Area (ha)
# of Blocks

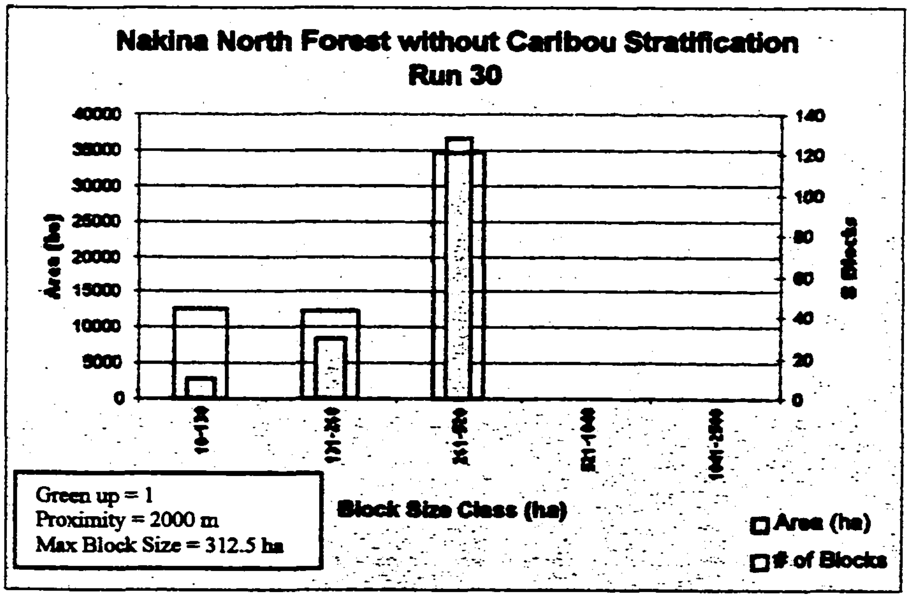

Nakina North Forest without Caribou Stratification
Run 26
Area (ha)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
300
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 1000 m
Max Block Size = 312.5 ha
Area (ha)
# of Blocks


Nakina North Forest without Caribou Stratification
Run 27
30000
25000
20000
15000
10000
5000
0
Area (ha)
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 1
Proximity = 1000 m
Max Block Size = 1250 ha
Block Size Class (ha)
Area (ha)
# of Blocks

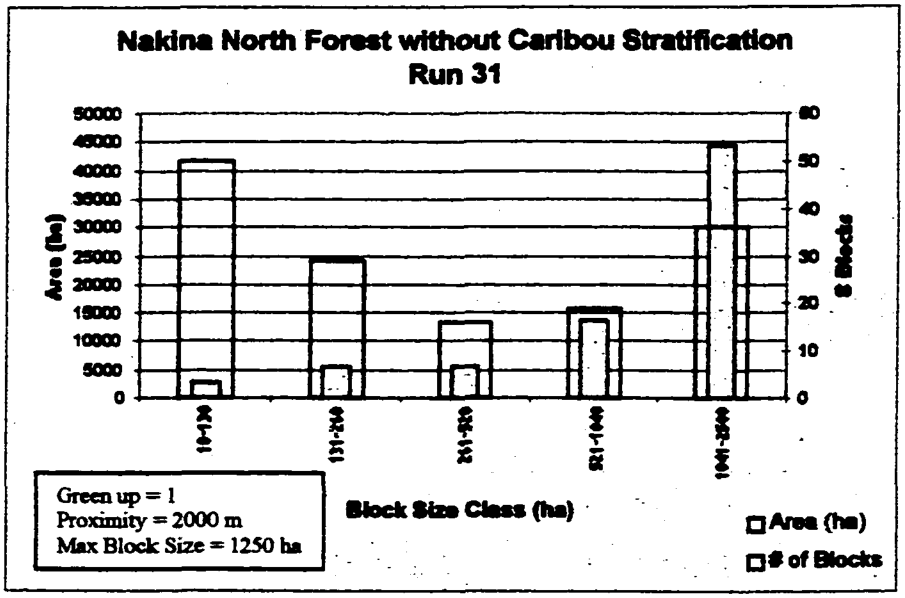

Nakina North Forest without Caribou Stratification
Run 28
25000
20000
15000
10000
5000
0
Area (ha)
300
250
200
150
100
50
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Green up = 1
Proximity = 1000 m
Max Block Size = 2500 ha
Block Size Class (ha)
Area (ha)
# of Blocks

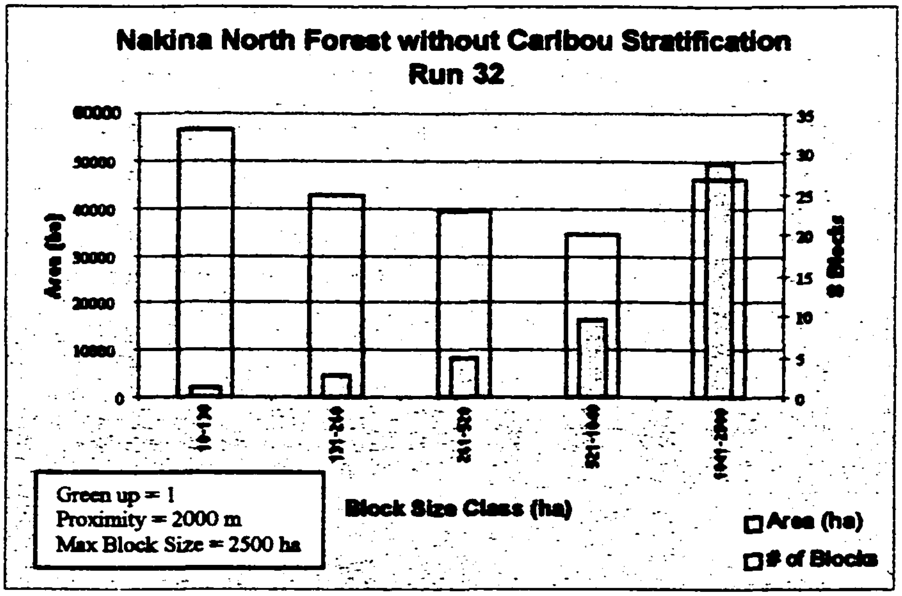


Nakina North Forest without Caribou Stratification
Run 29
Area (ha)
35000
30000
25000
20000
15000
10000
5000
0
Blocks
350
300
250
200
150
100
50
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 125 ha
□ Area (ha)
□ # of Blocks



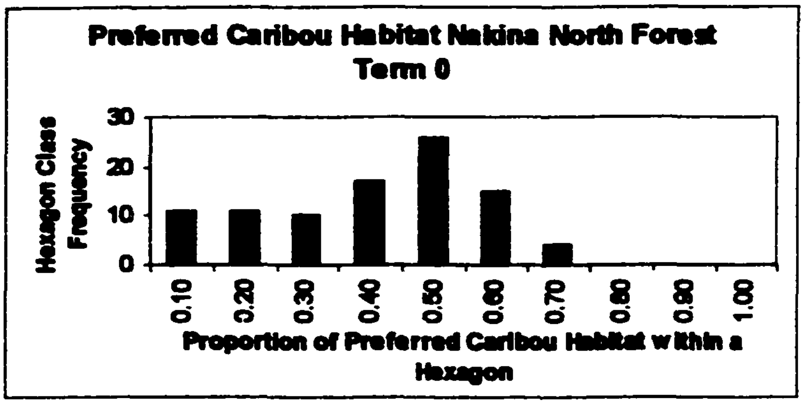
Nakina North Forest without Caribou Stratification
Run 30
Area (ha)
40000
35000
30000
25000
20000
15000
10000
5000
0
Blocks
140
120
100
80
60
40
20
0
10-130
131-260
261-520
521-1040
1041-2080
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 312.5 ha
□ Area (ha)
□ # of Blocks

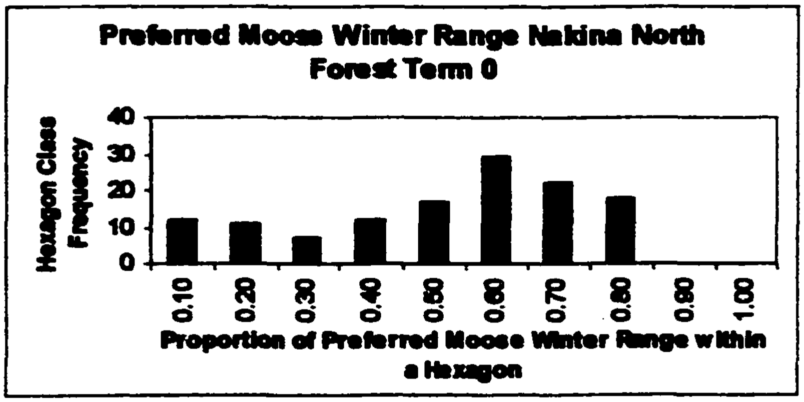

Nakina North Forest without Caribou Stratification
Run 31
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Area (ha)
60
50
40
30
20
10
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 1250 ha
☐ Area (ha)
☐ # of Blocks

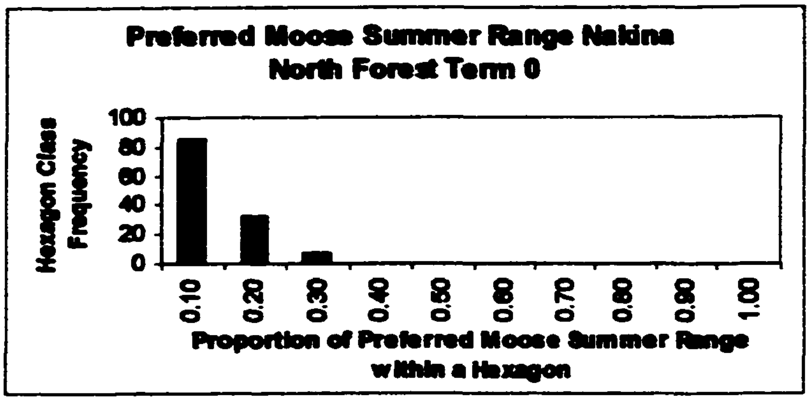

Nakina North Forest without Caribou Stratification
Run 32
60000
50000
40000
30000
20000
10000
0
Area (ha)
35
30
25
20
15
10
5
0
Blocks
10-130
131-260
261-520
521-1040
1041-2500
Block Size Class (ha)
Green up = 1
Proximity = 2000 m
Max Block Size = 2500 ha
☐ Area (ha)
☐ # of Blocks

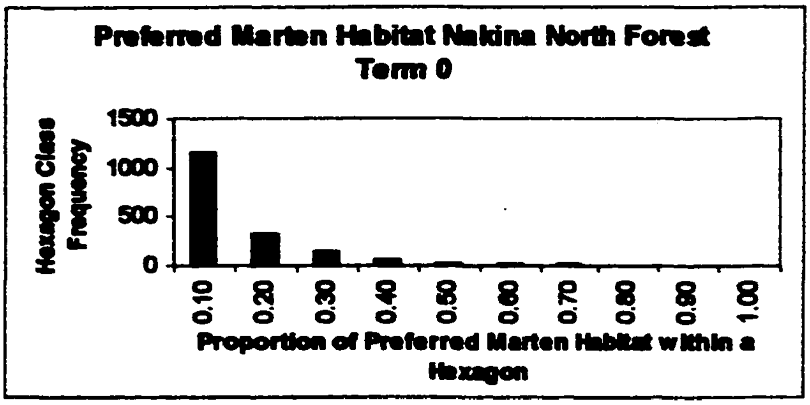
APPENDIX IV

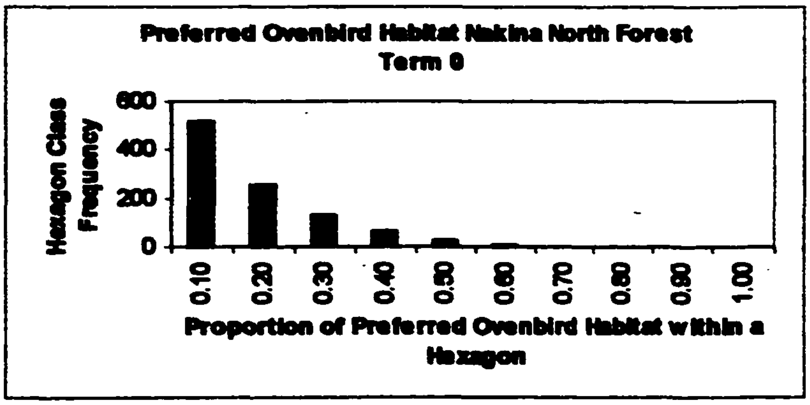
HISTOGRAMS OF HABITAT VALUES PRE-HARVEST





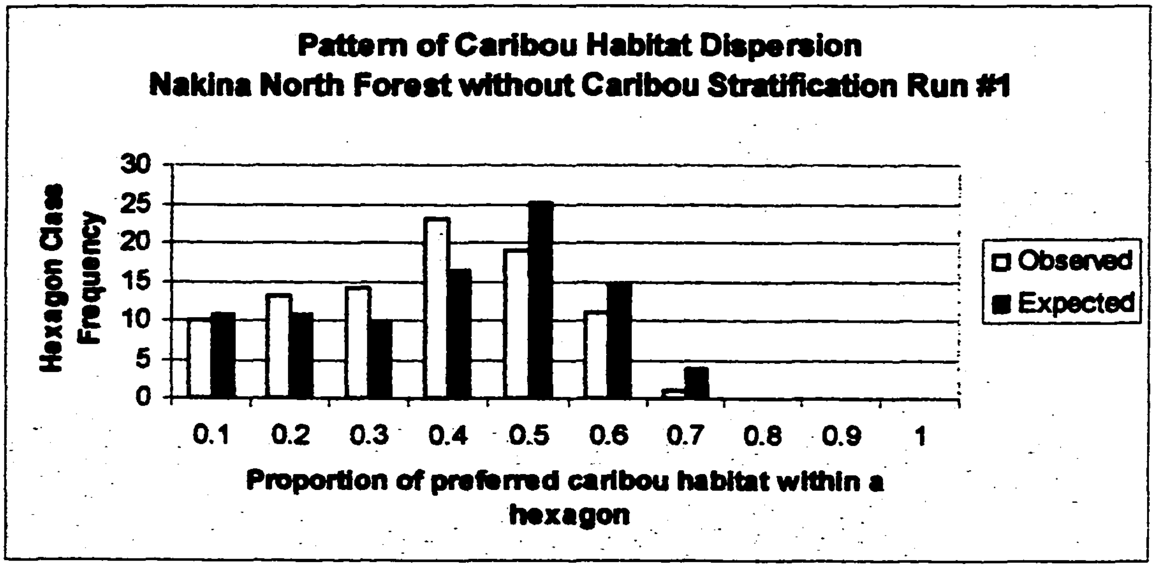

Preferred Moose Summer Range Nakina North Forest Term 0
Hexagon Class Frequency
100
80
60
40
20
0
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Proportion of Preferred Moose Summer Range within a Hexagon

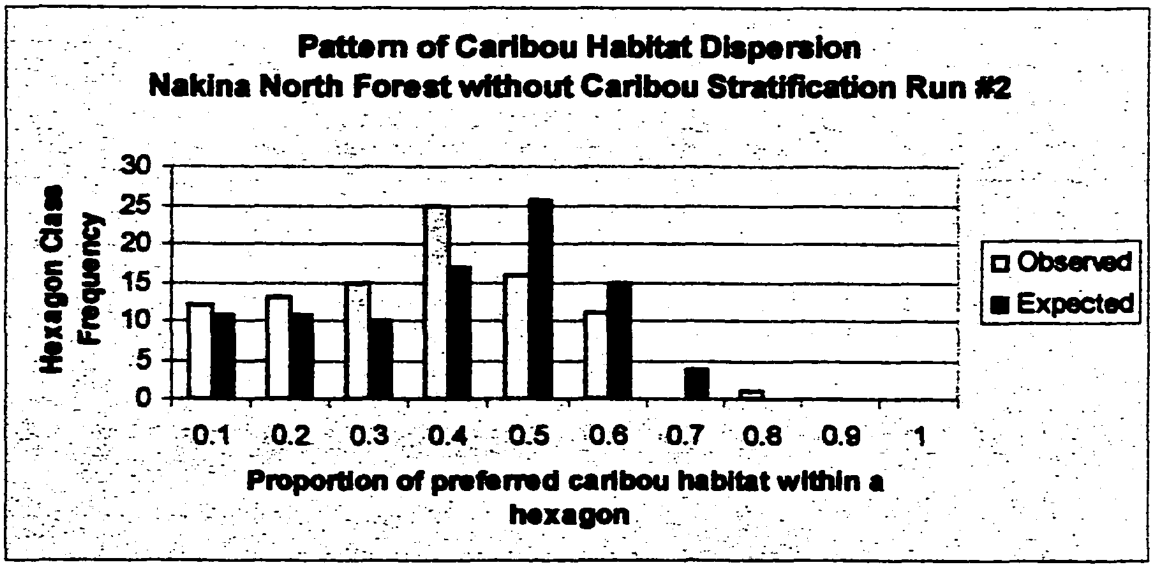

Preferred Marten Habitat Nakina North Forest Term 0
Hexagon Class Frequency
1500
1000
500
0
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Proportion of Preferred Marten Habitat within a Hexagon

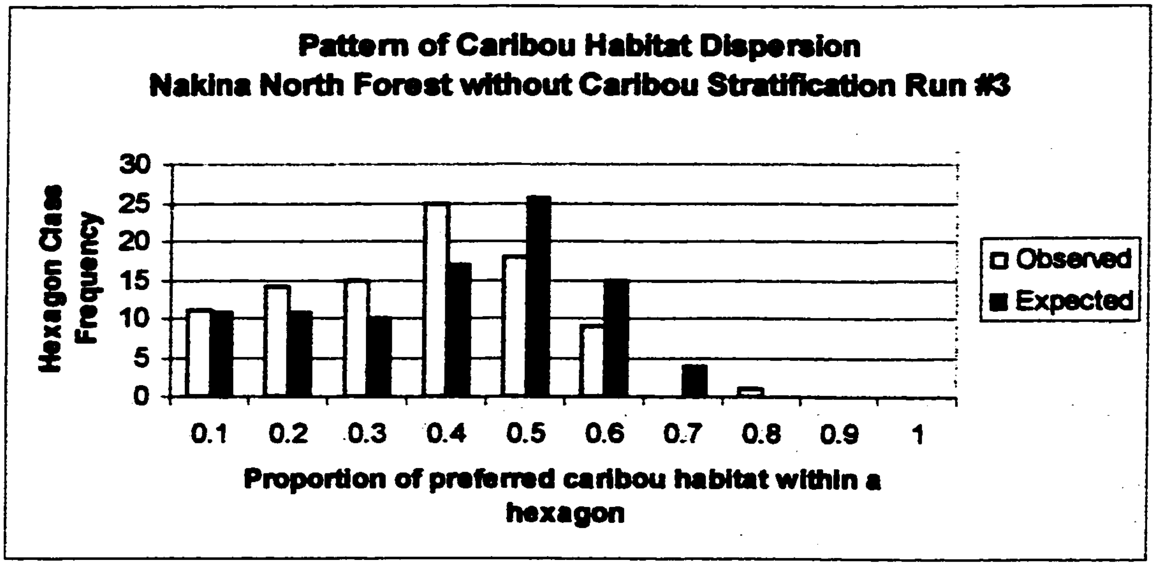

Preferred Ovenbird Habitat Nakina North Forest Term 0
Hexagon Class Frequency
600
400
200
0
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Proportion of Preferred Ovenbird Habitat within a Hexagon

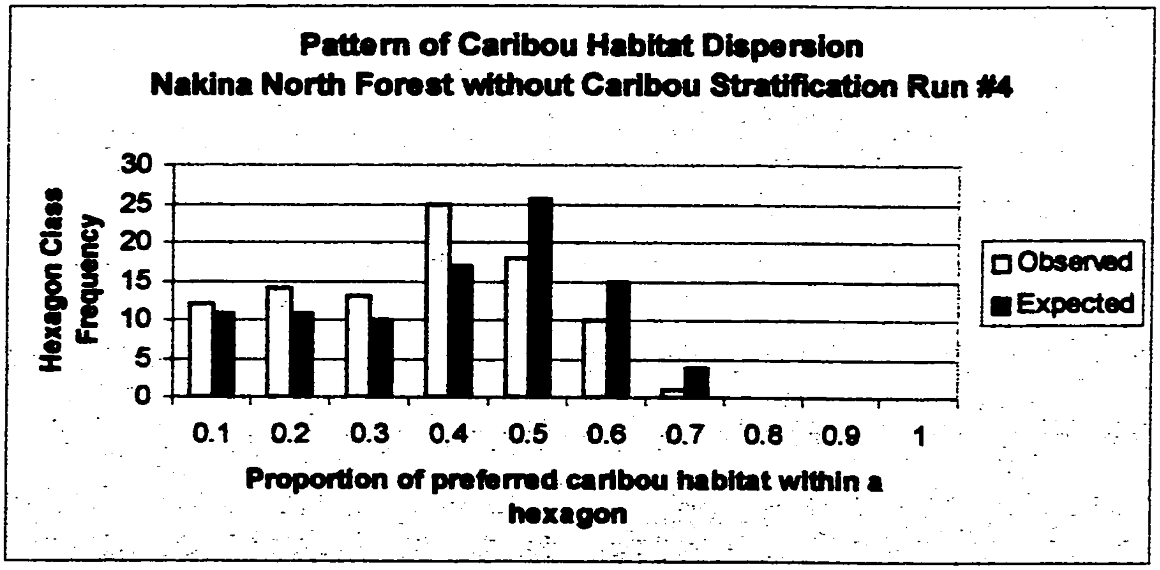
APPENDIX V

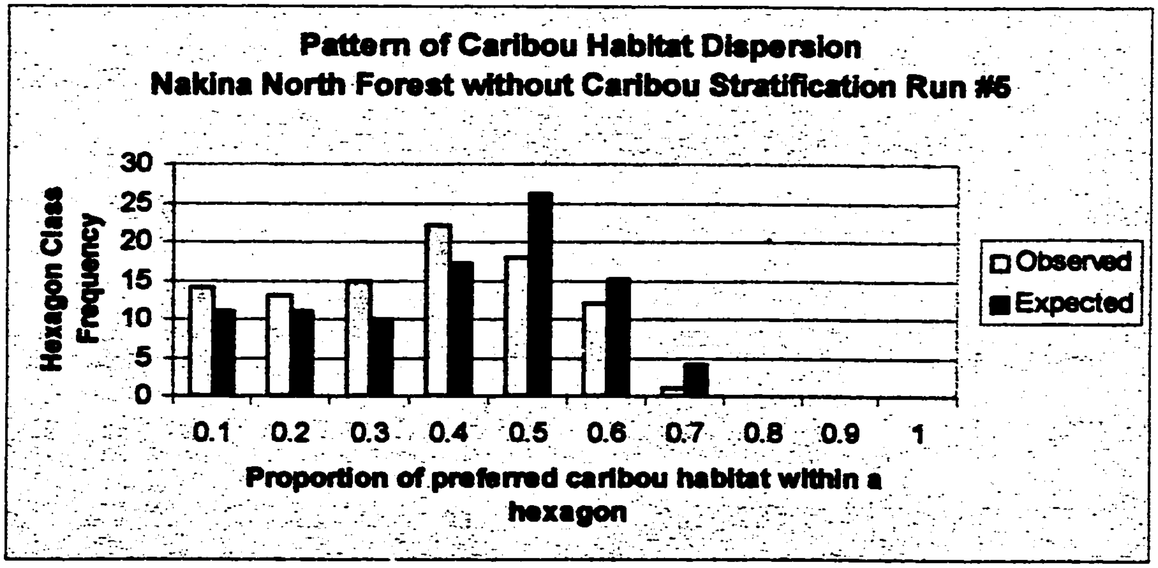
PATTERNS OF HABITAT DISPERSION POST-HARVEST

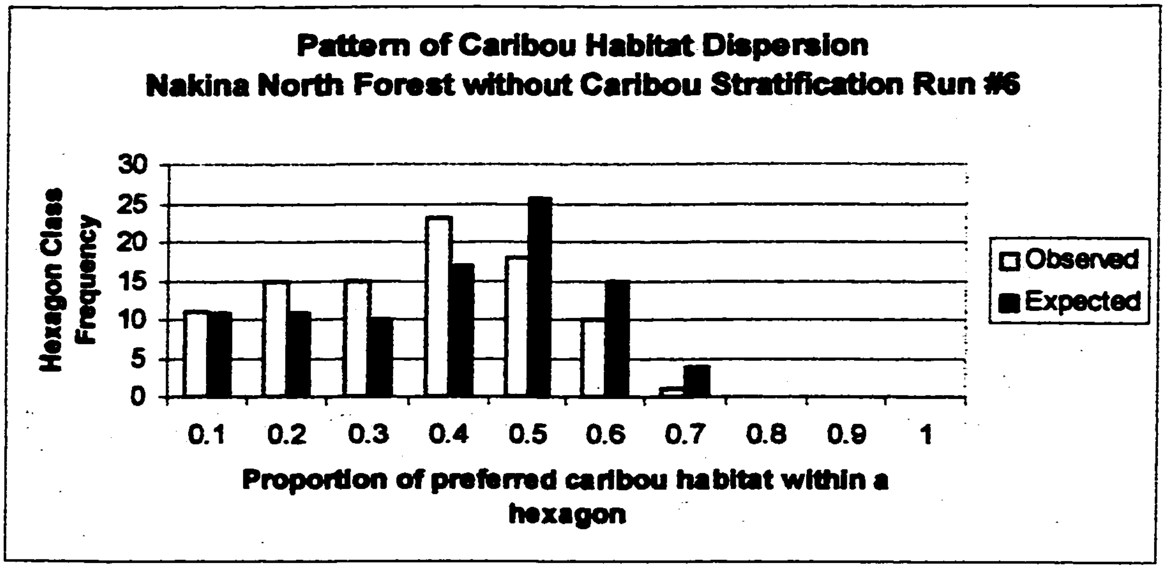


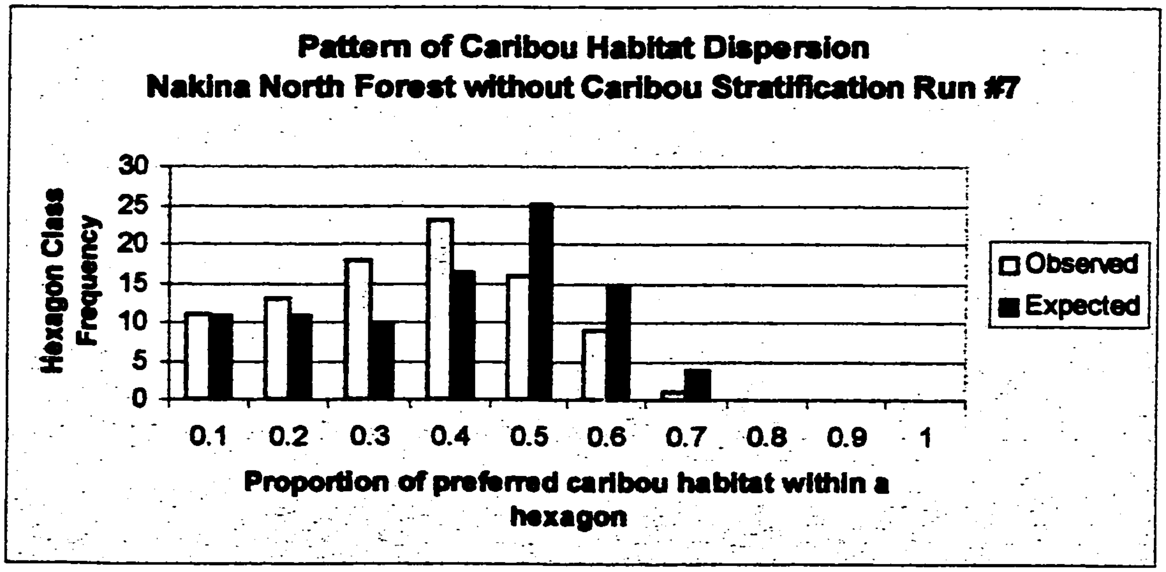


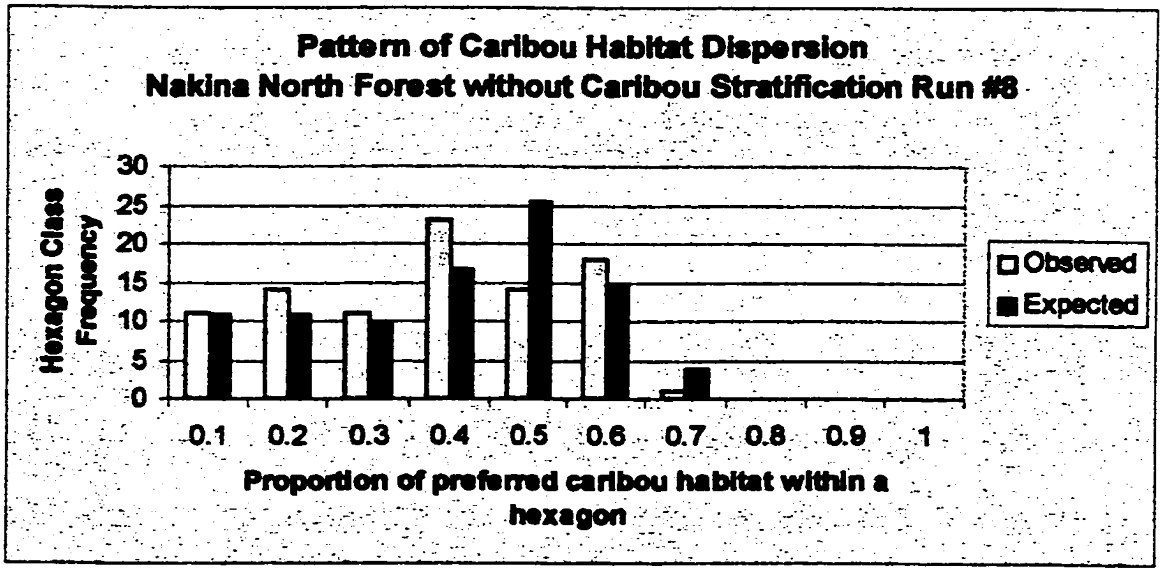

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #3
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

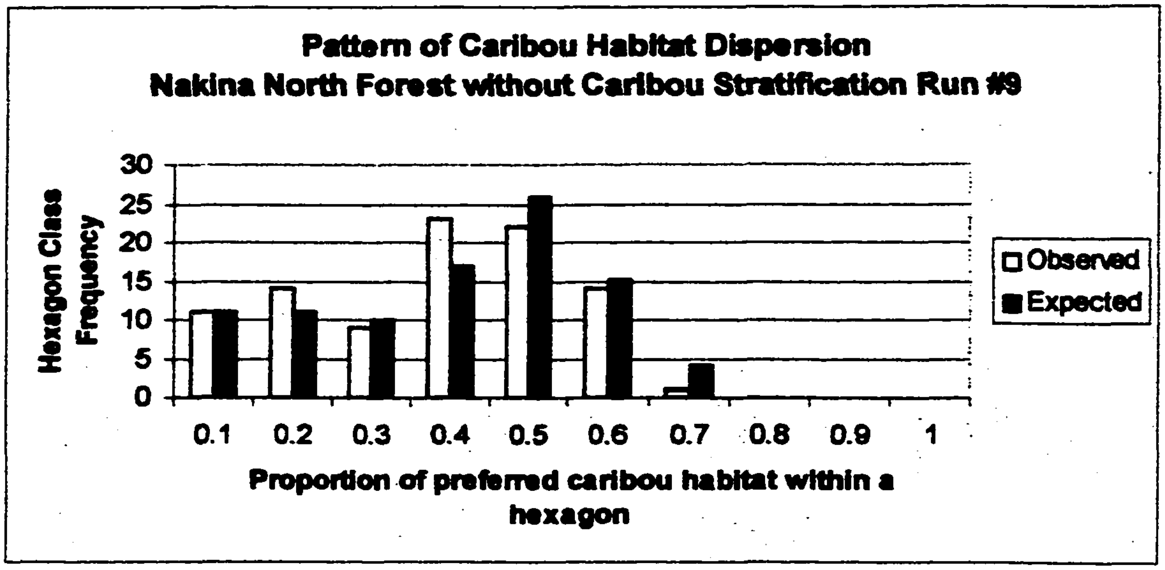

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #4
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

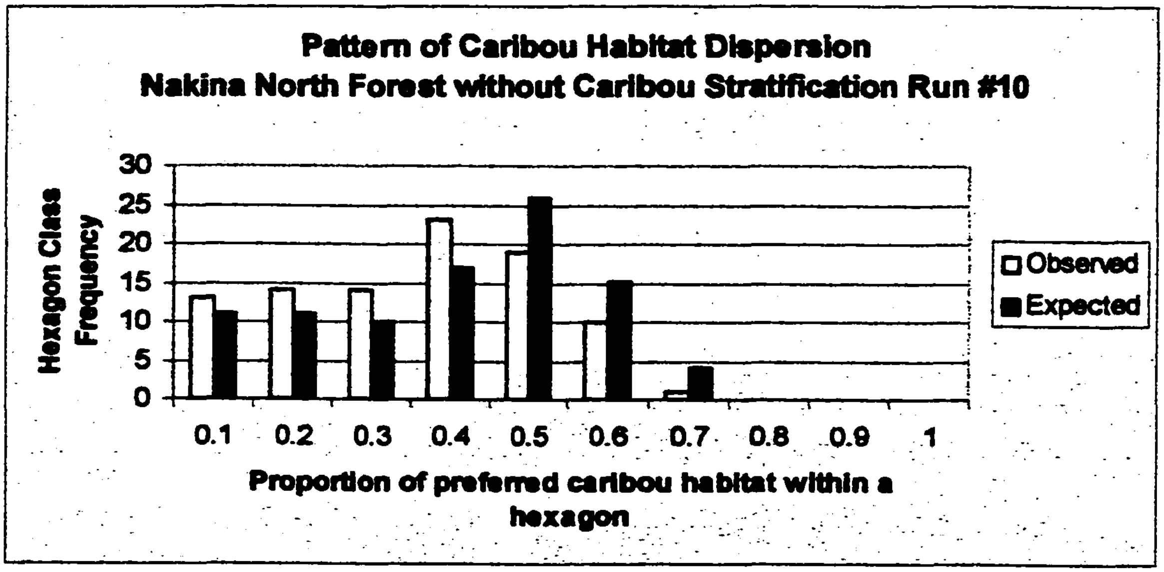

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #5
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

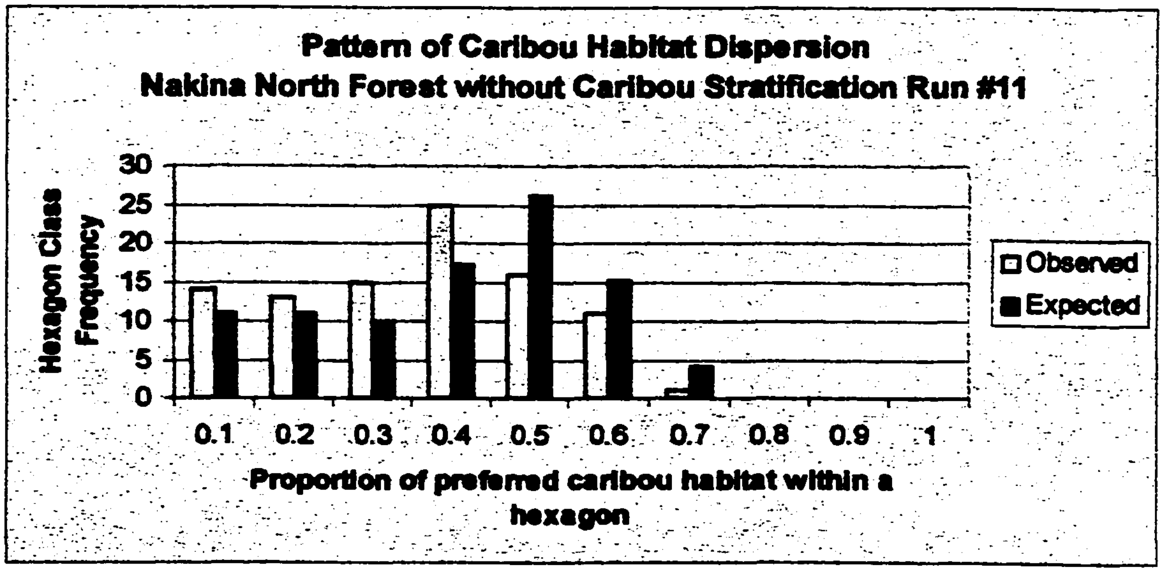

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #6
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

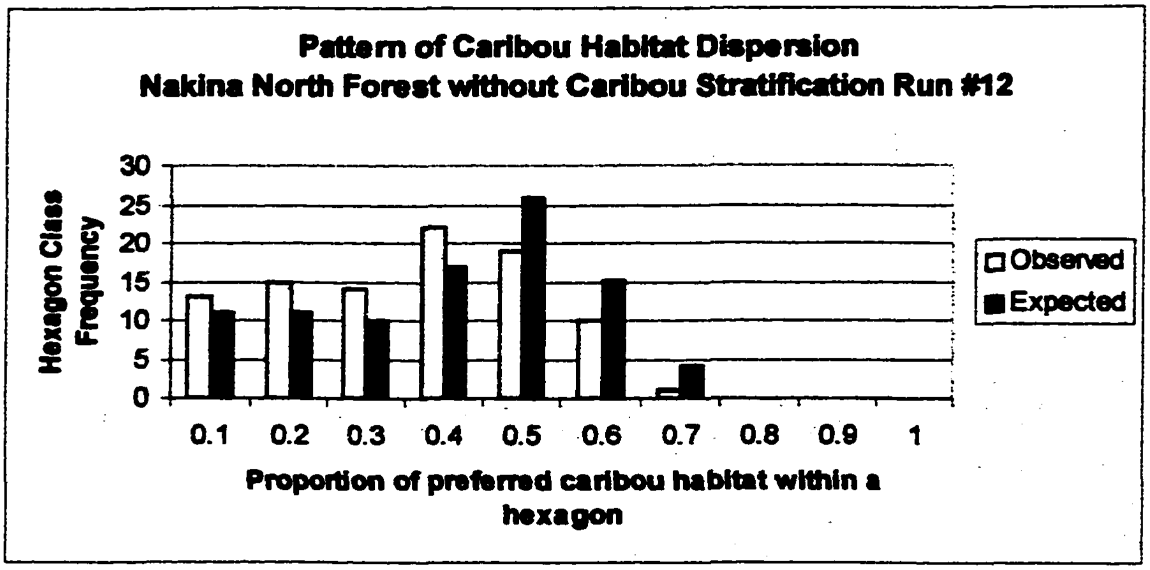

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #7
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

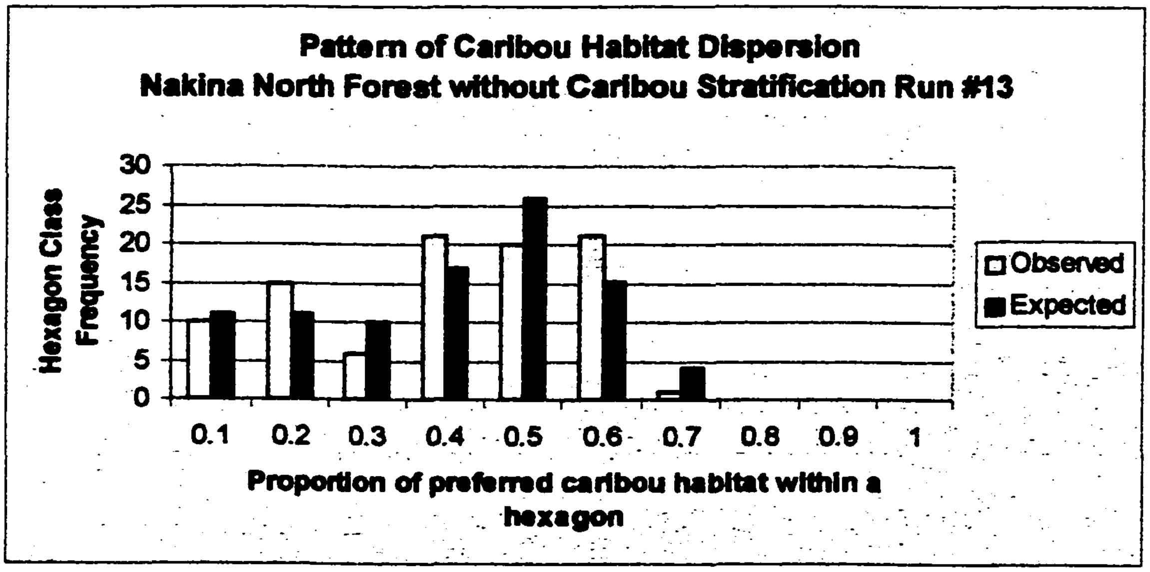

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #8
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

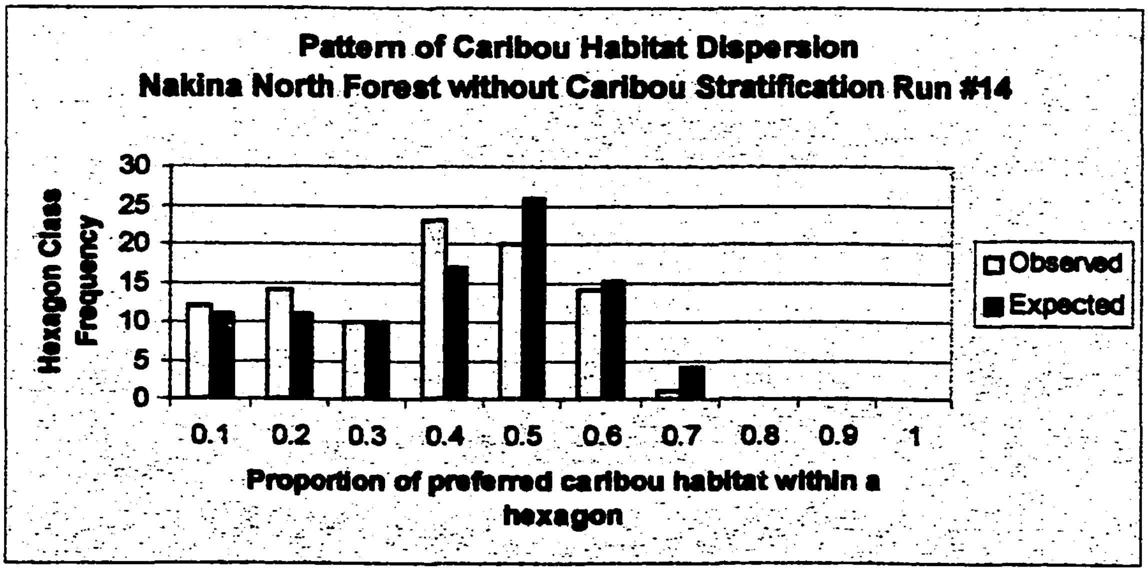

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #9
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

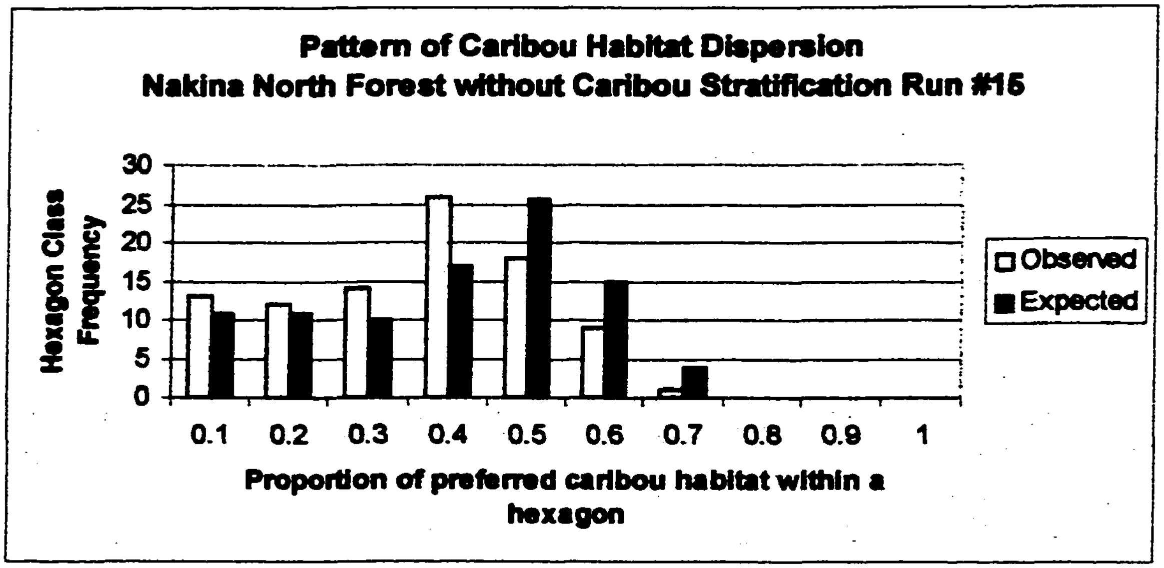

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #10
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

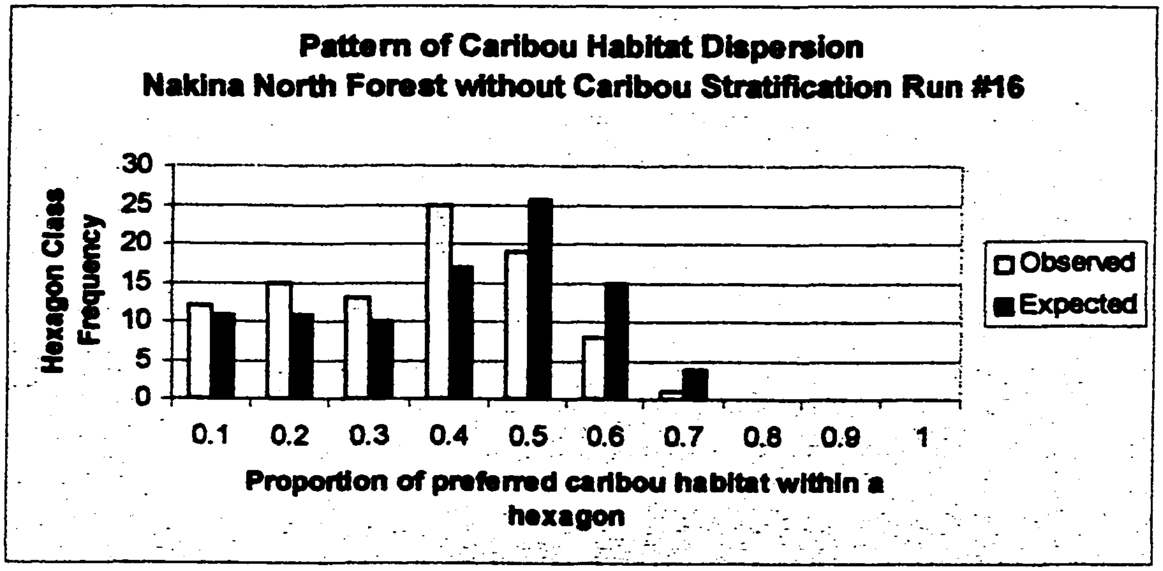

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #11
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

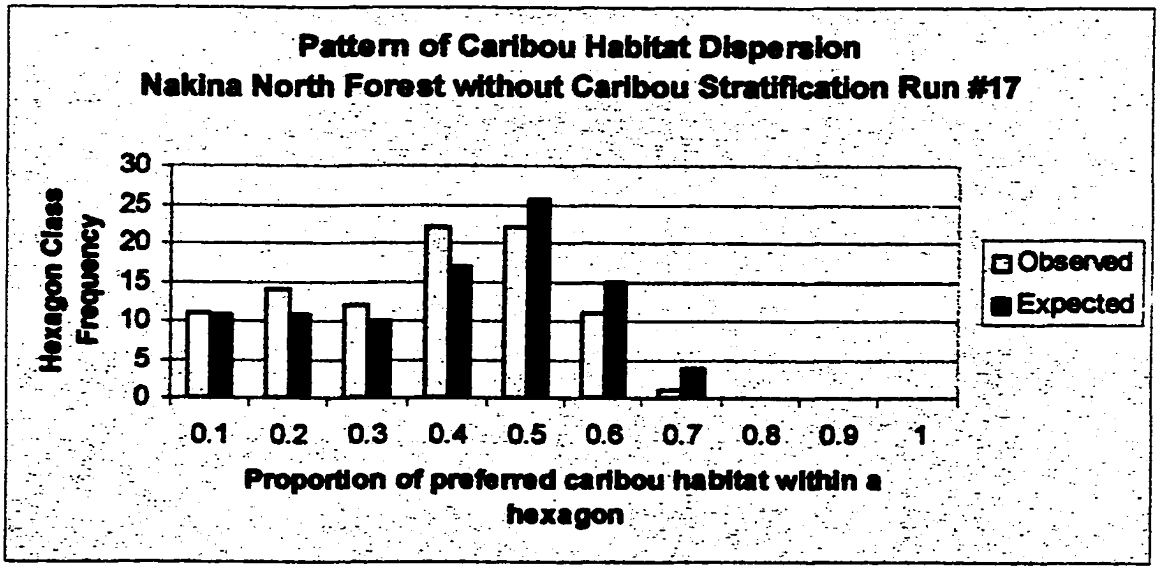

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #12
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

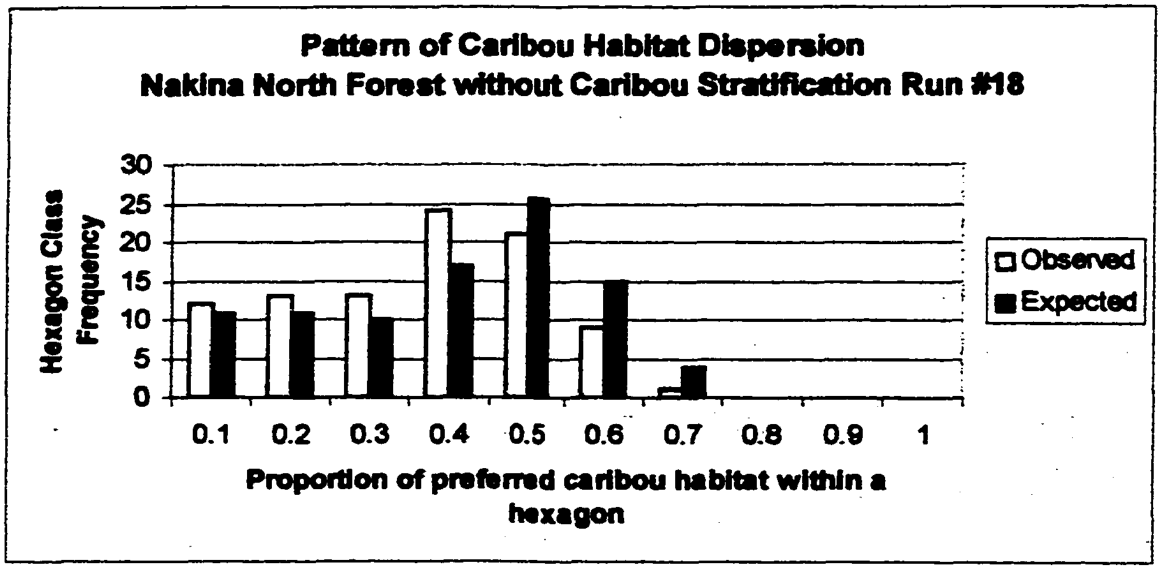

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #13
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

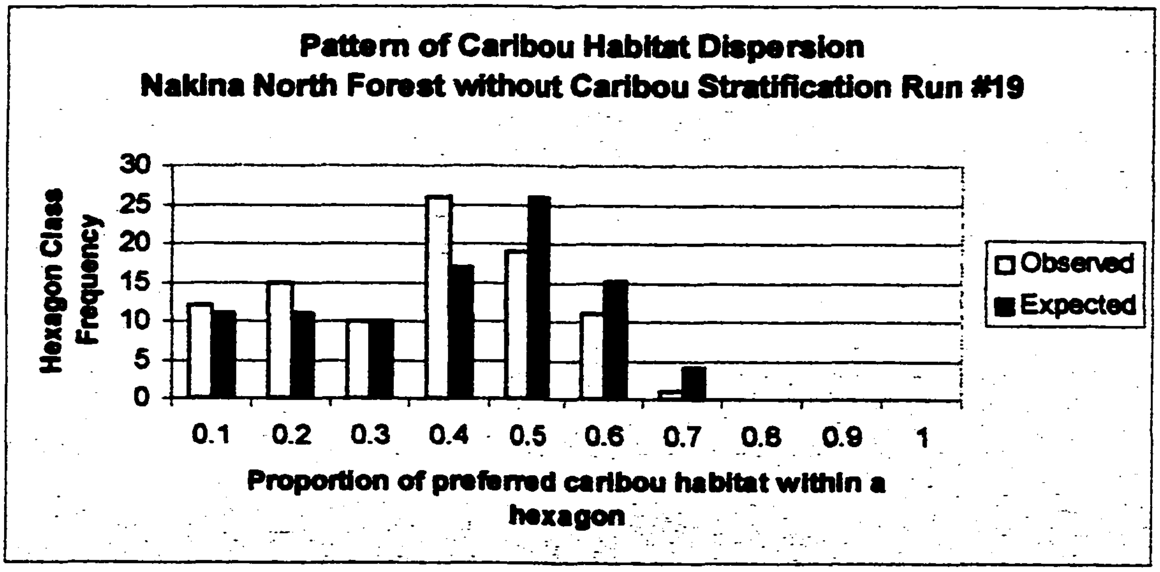

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #14
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

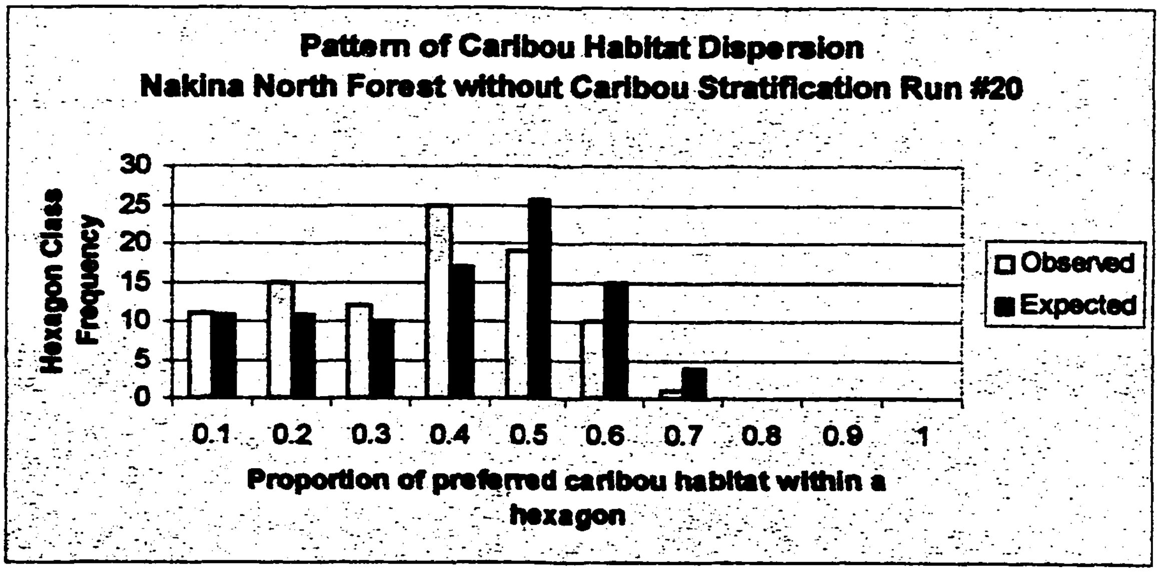

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #15
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

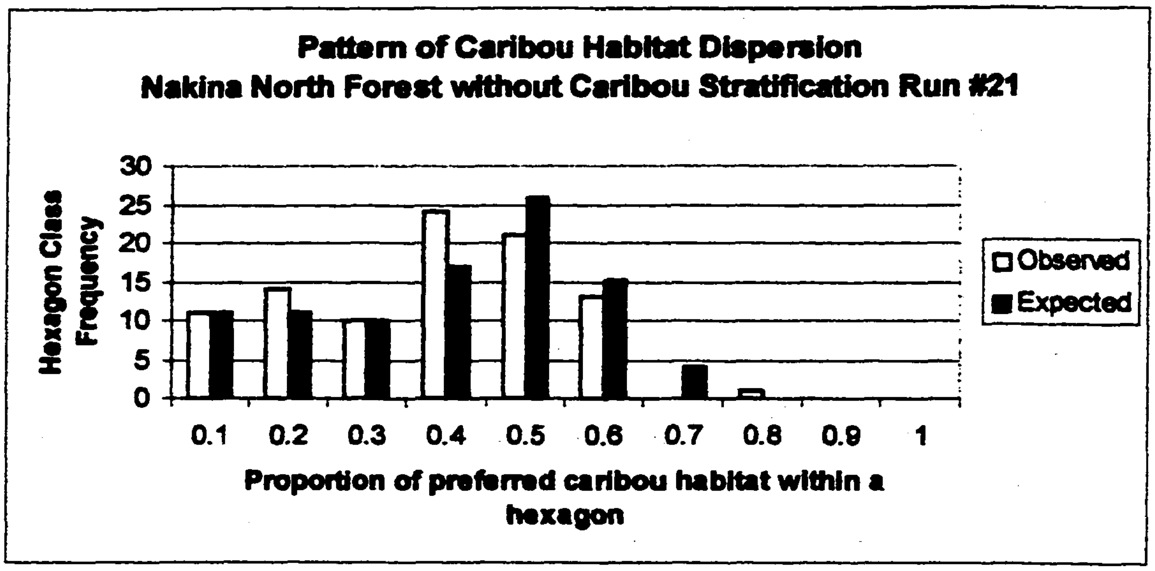

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #16
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

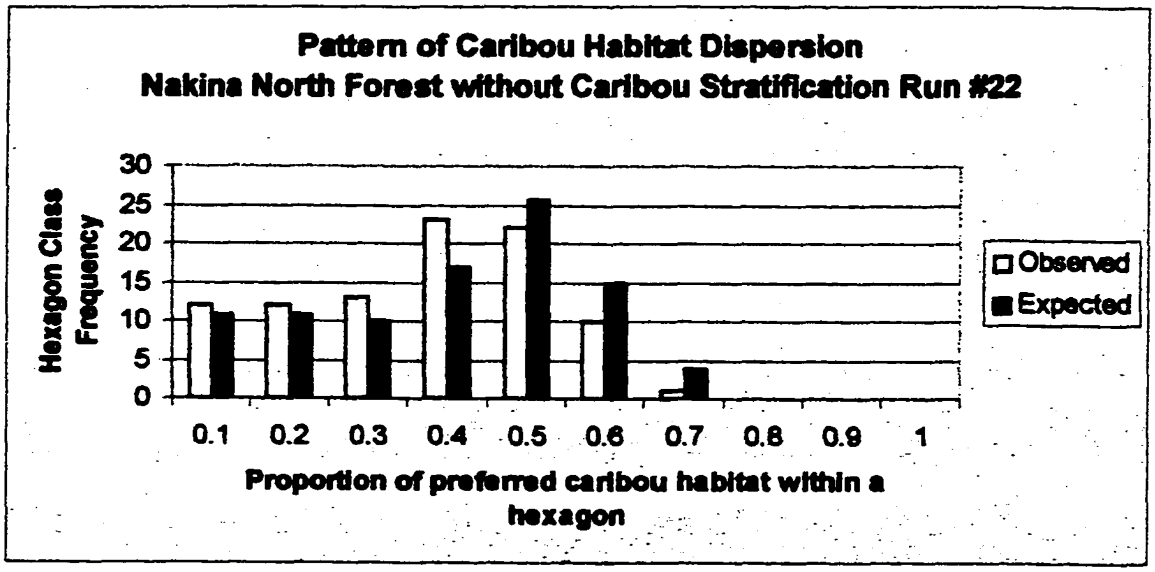

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #17
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

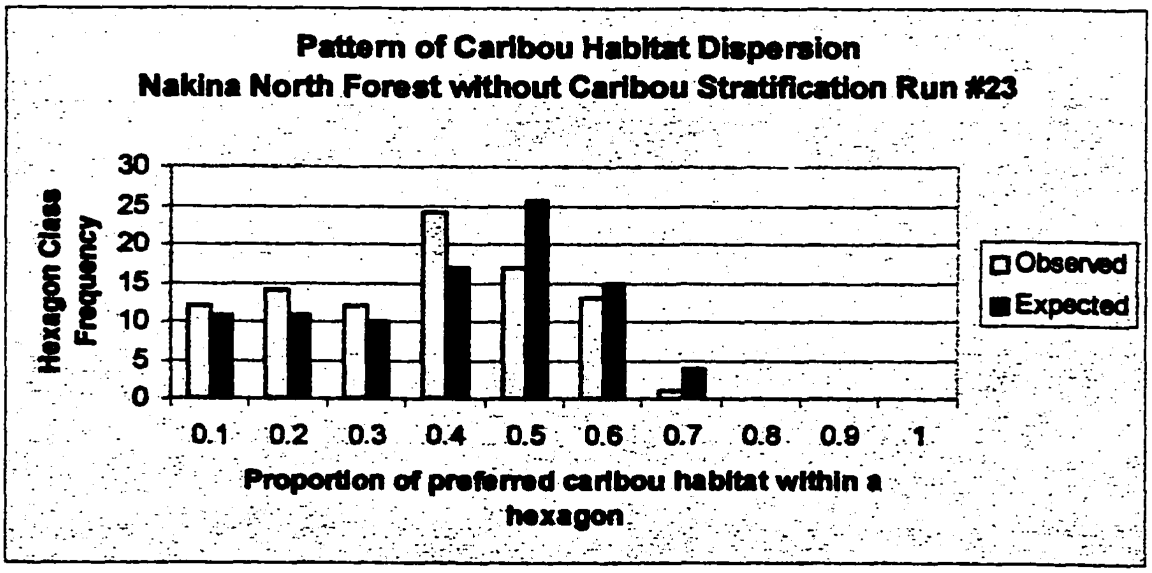

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #18

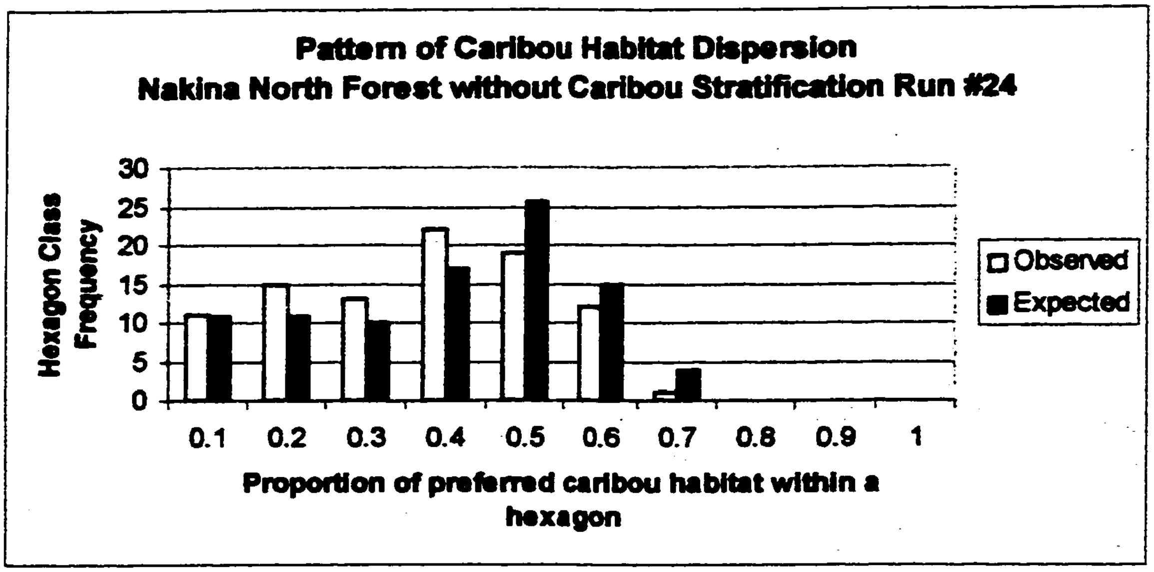

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #19


Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #20

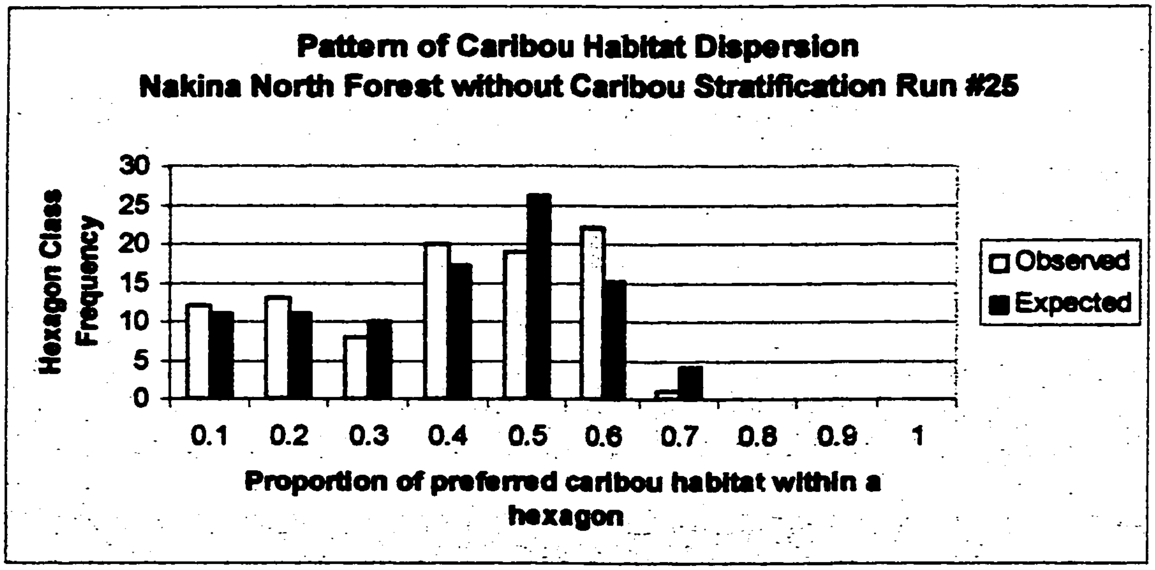

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #21
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected


Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #22
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

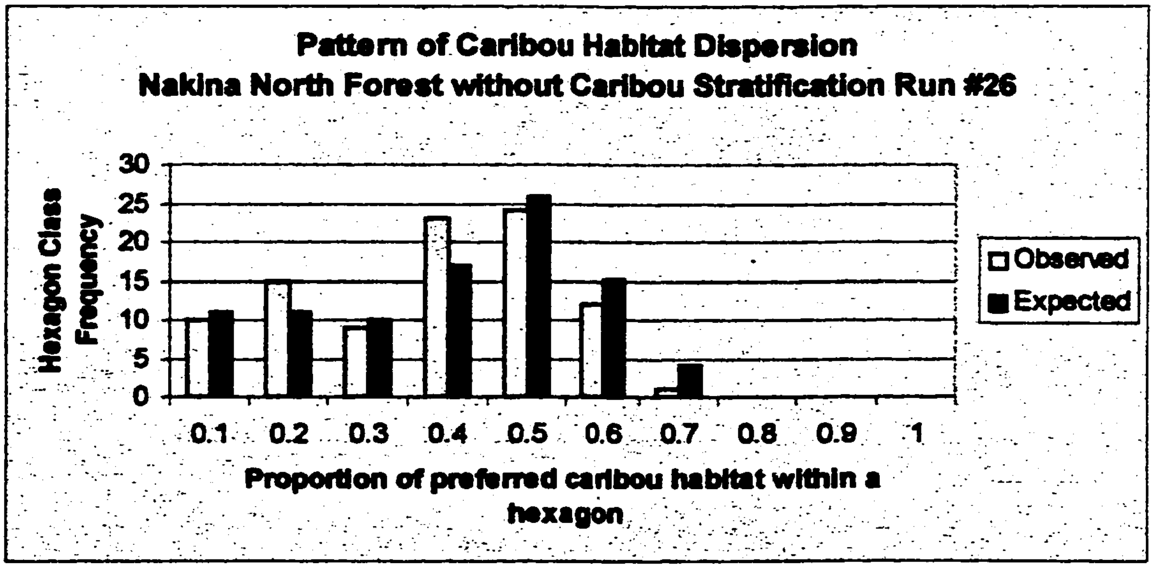

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #23
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected



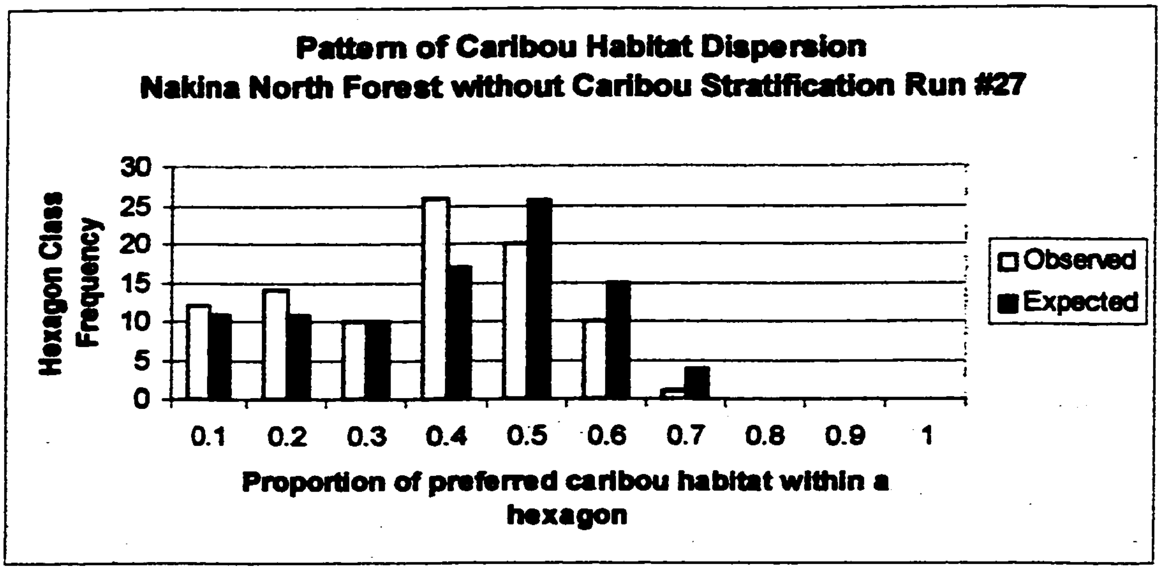
Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #24

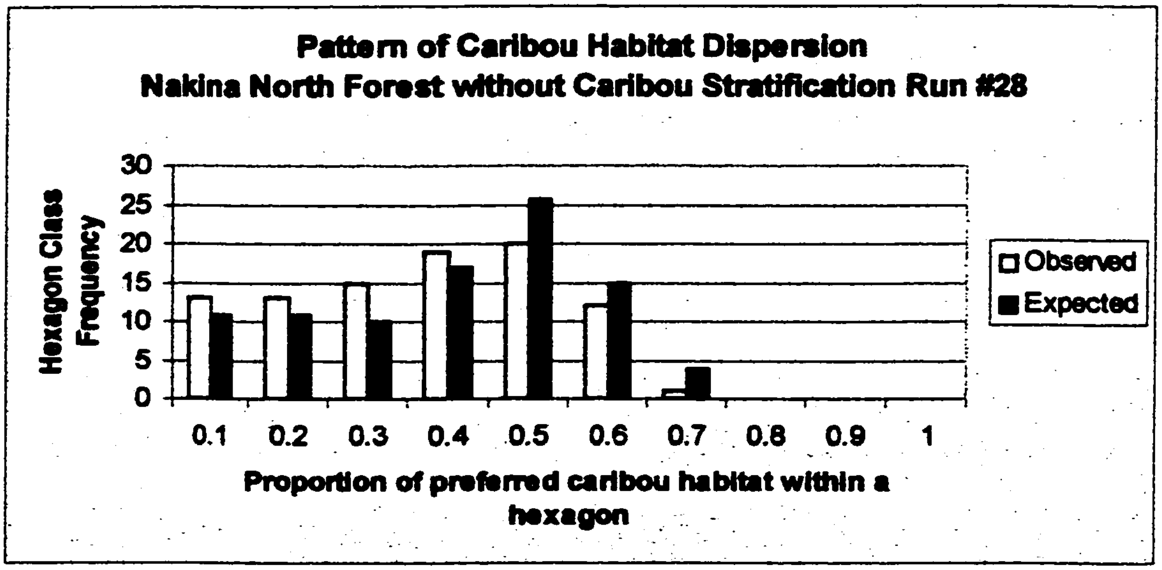


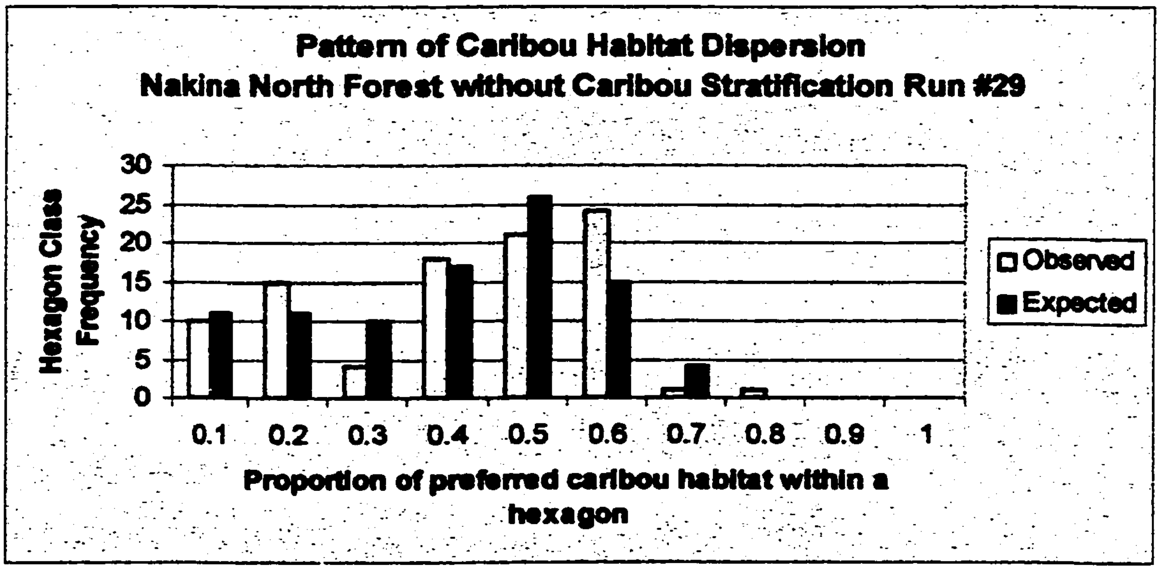
Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #25

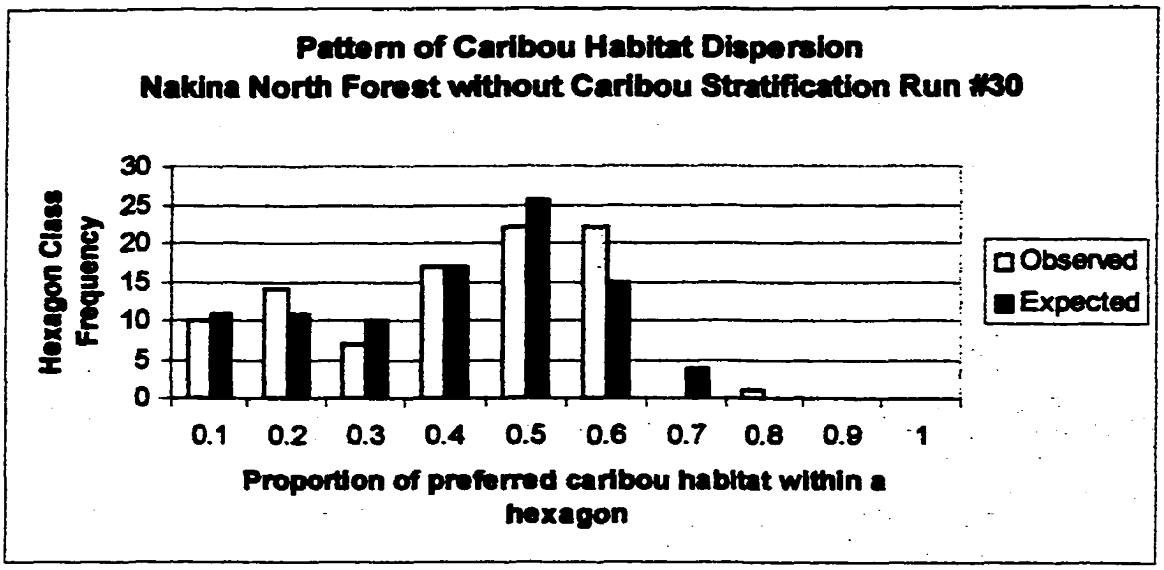


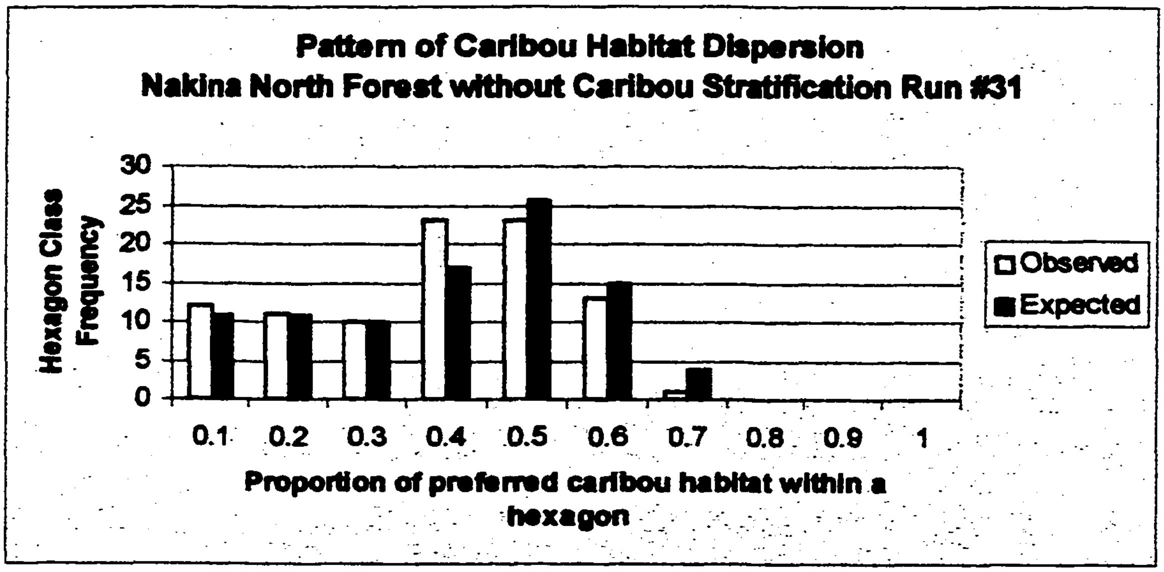
Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #26

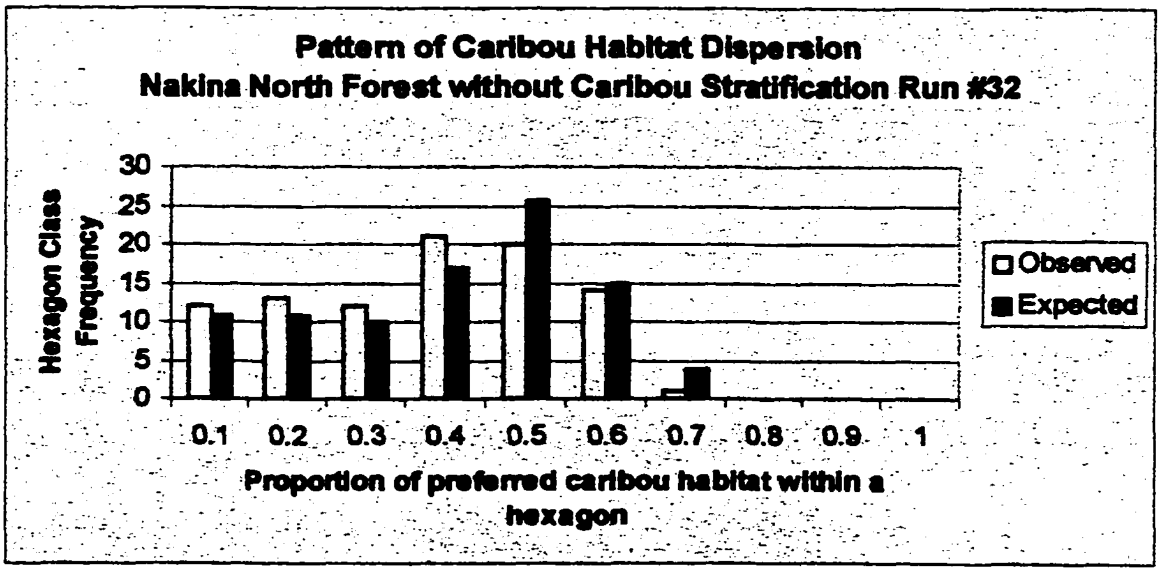

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #27

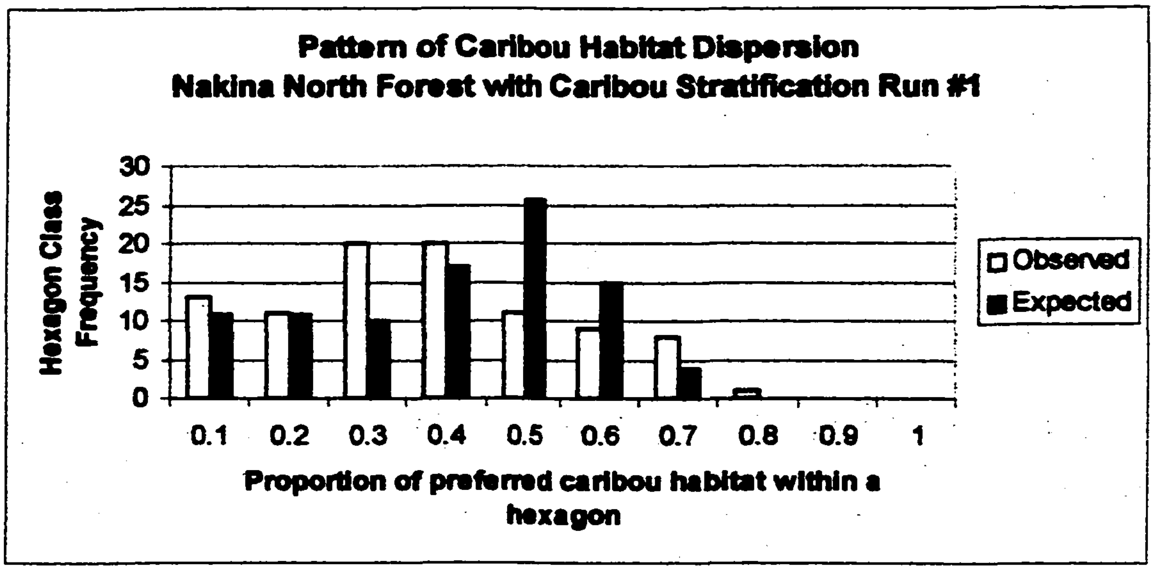

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #28

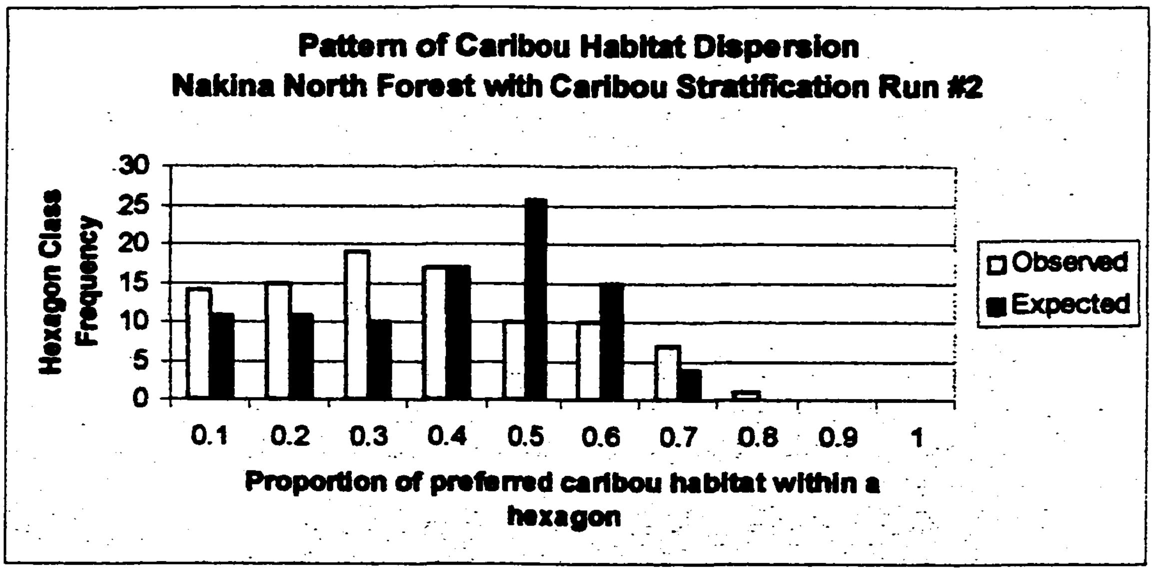

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #29

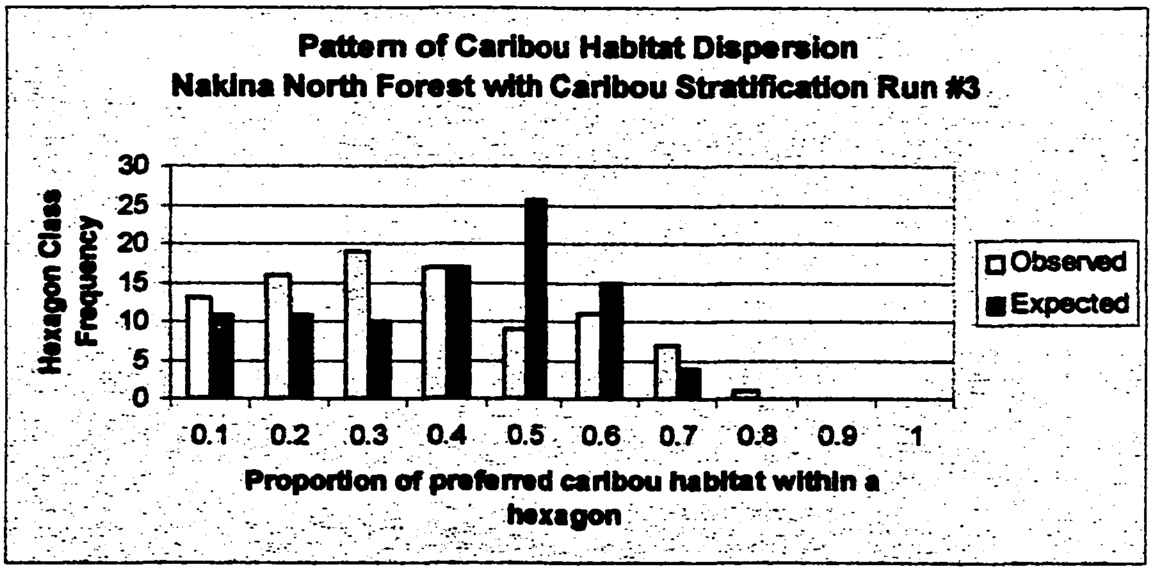

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #30

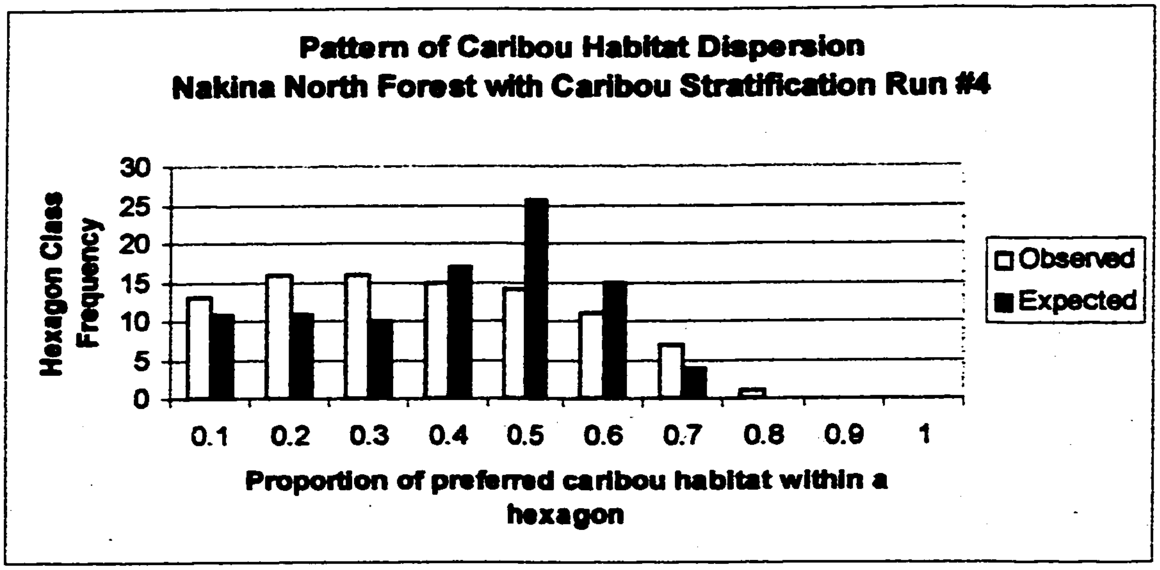

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #31

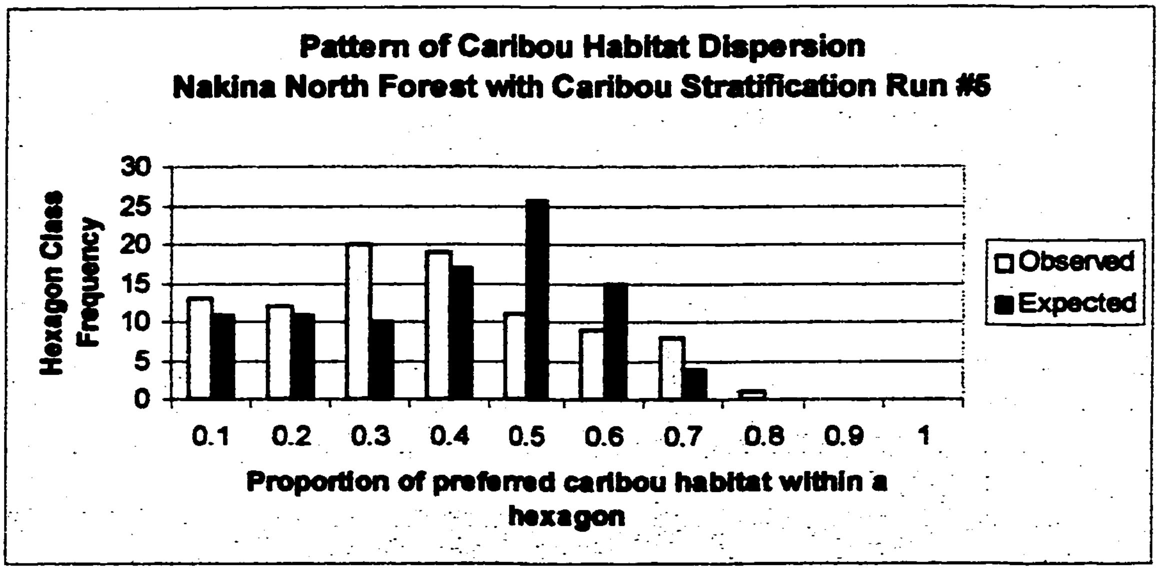

Pattern of Caribou Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #32

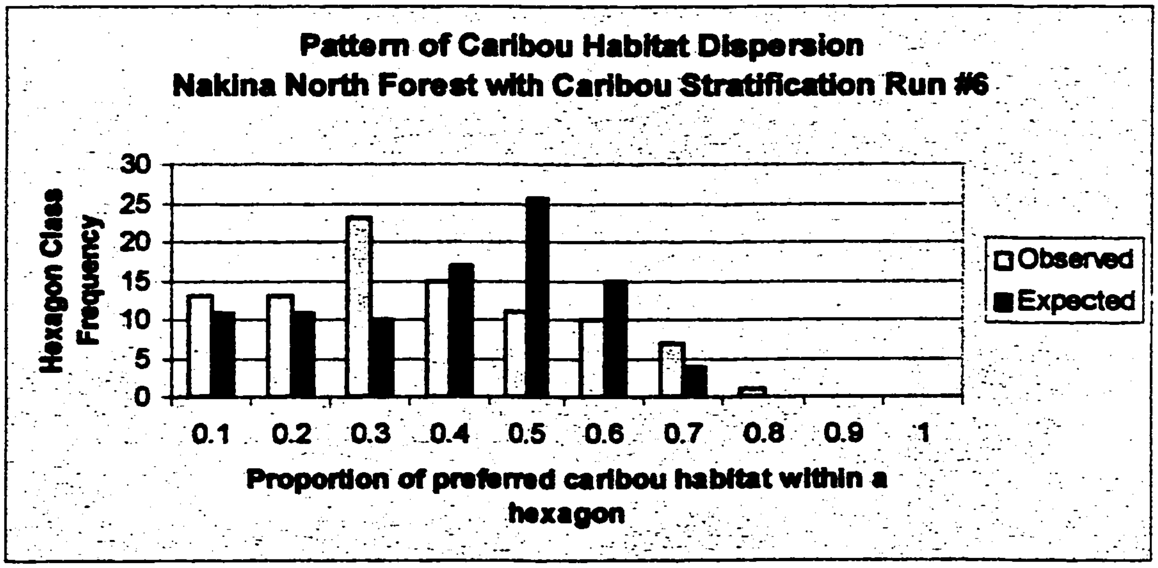

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #1
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

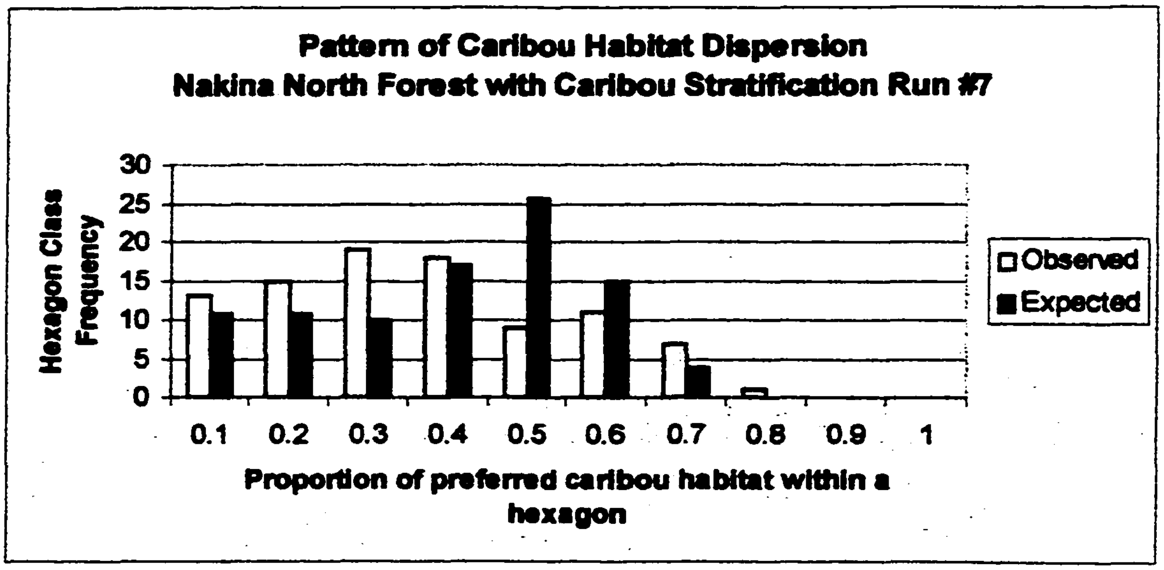

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #2
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

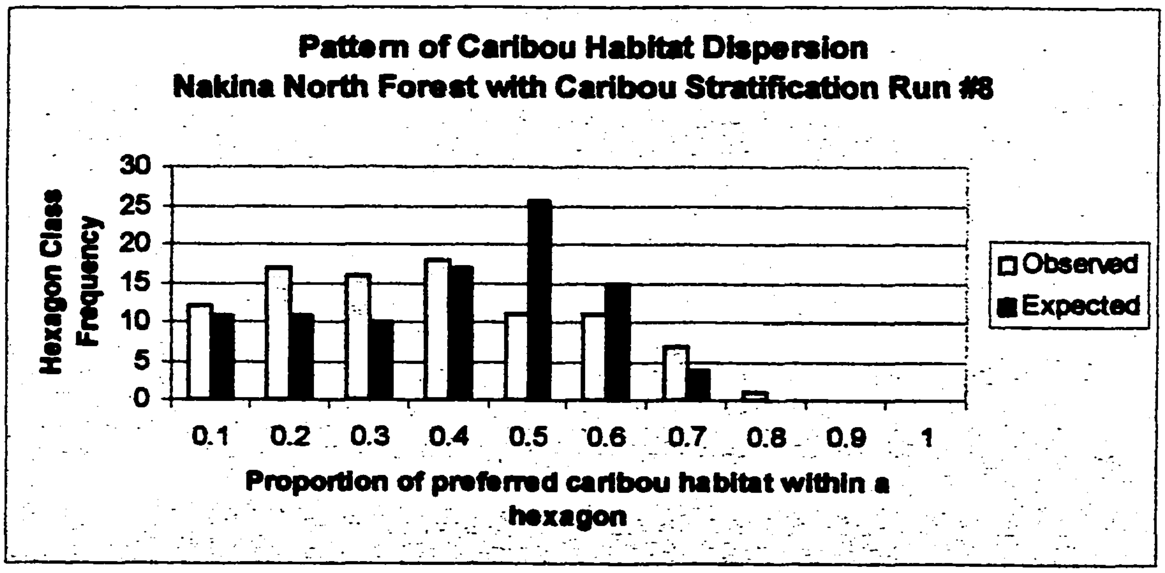

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #3
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

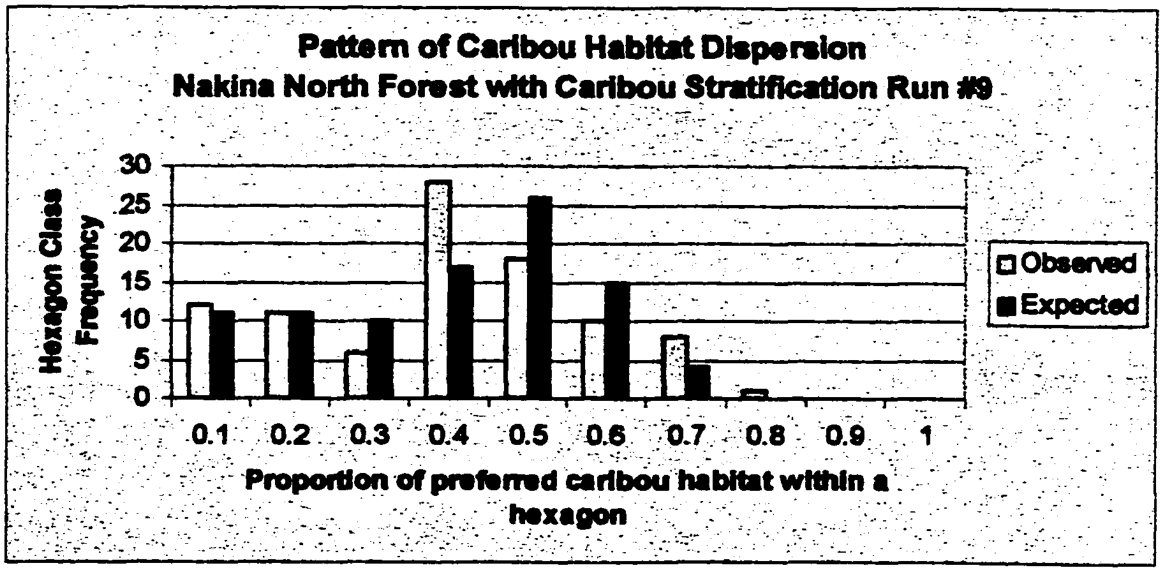

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #4
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

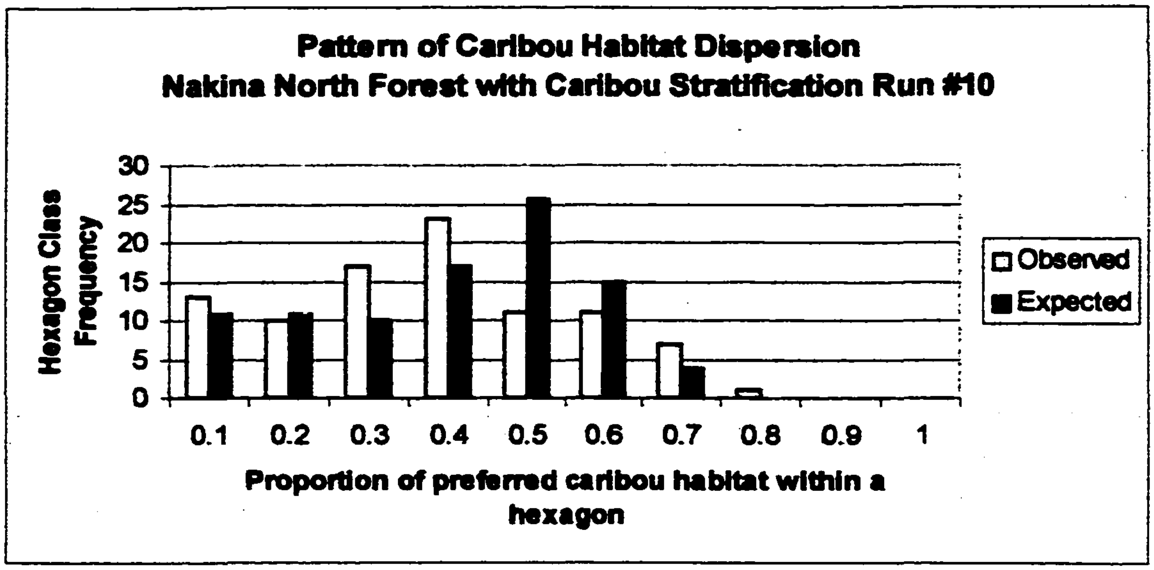

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #5
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

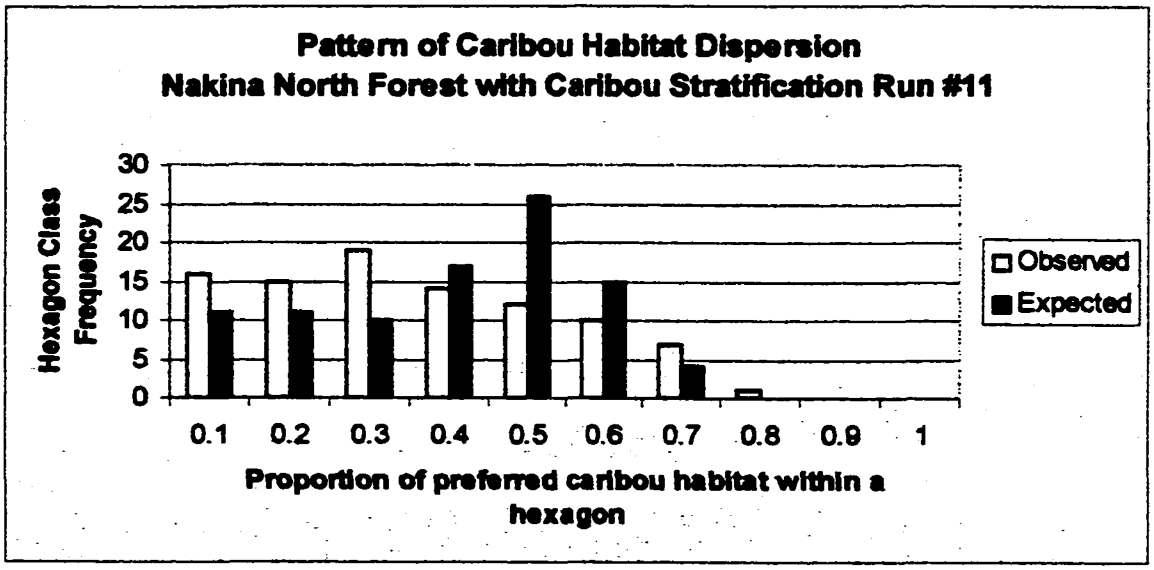

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #6
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

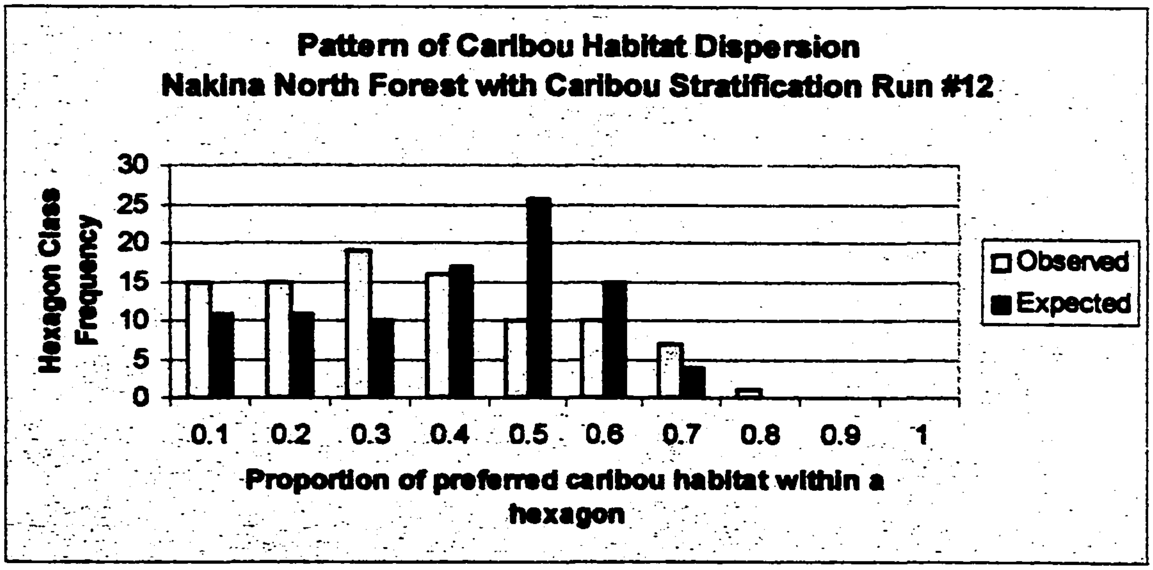

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #7
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

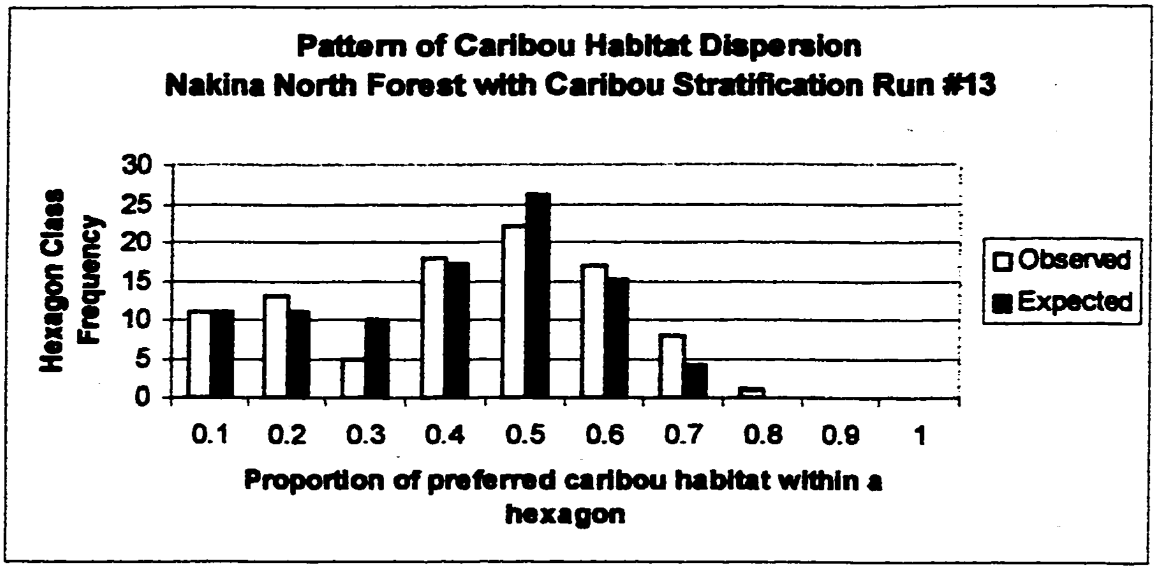

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #8
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

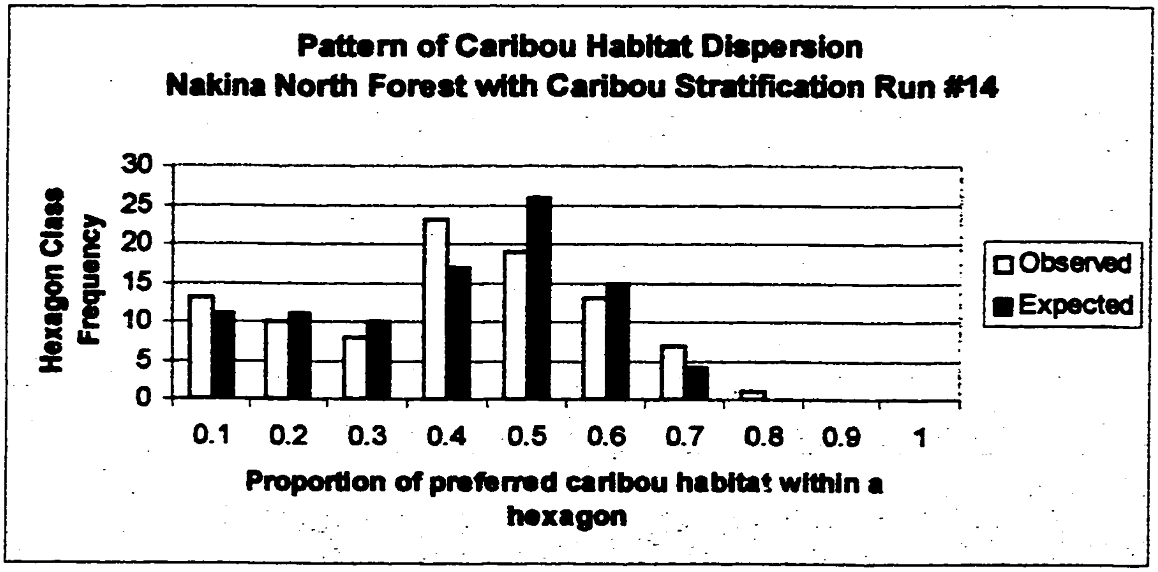

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #9
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

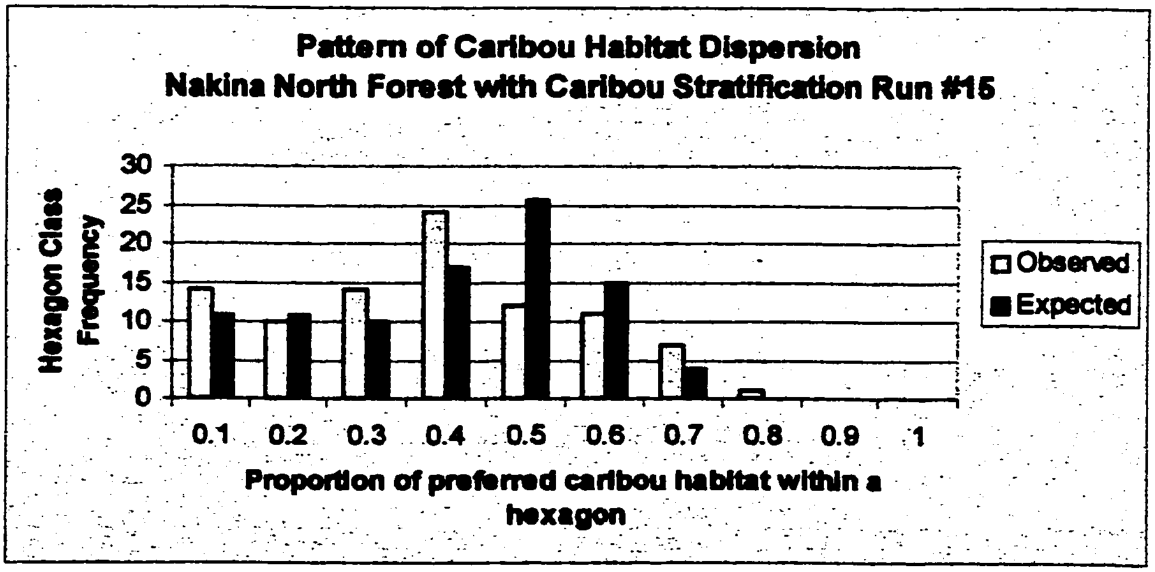

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #10
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

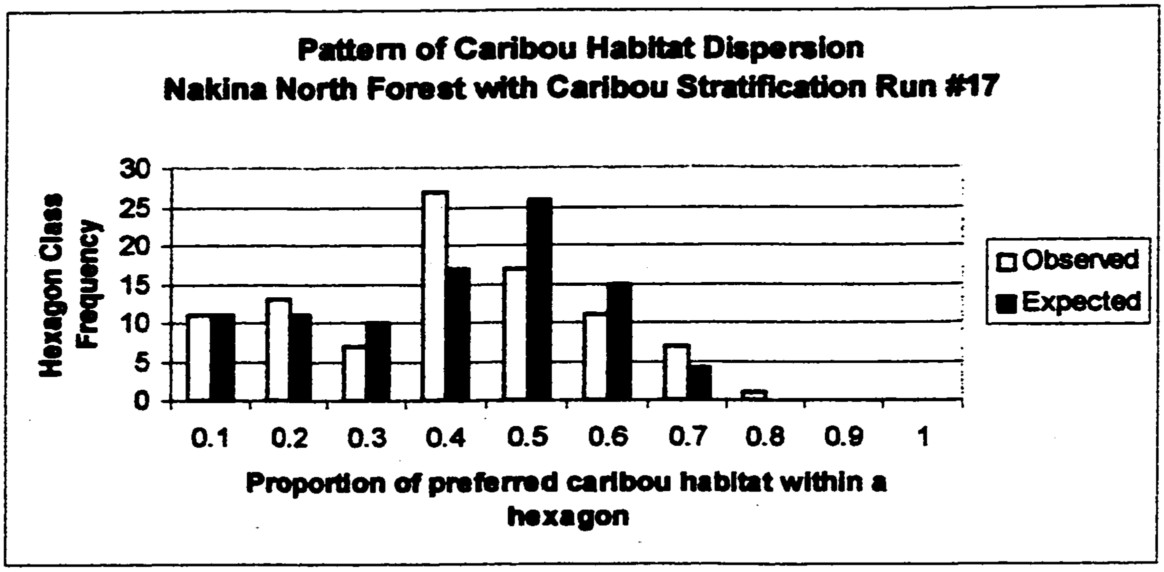

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #11
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

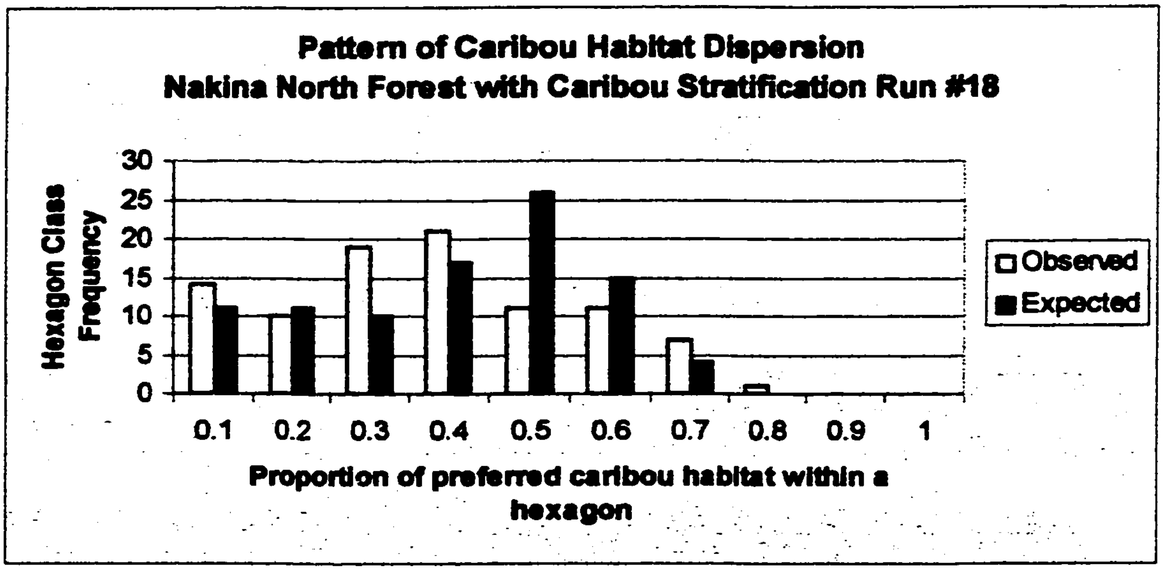

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #12
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

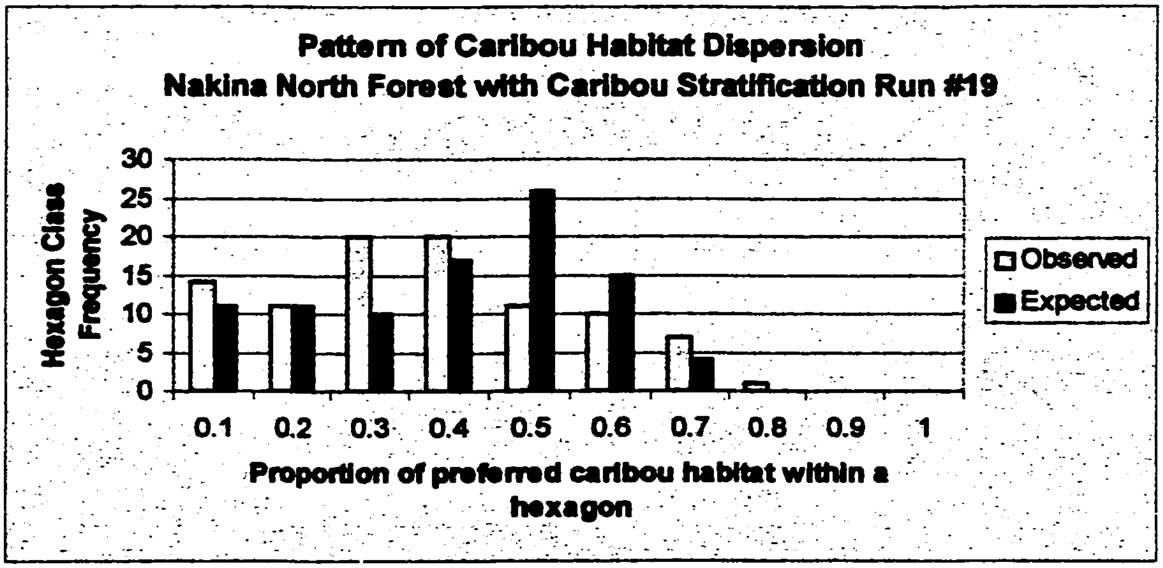

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #13
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

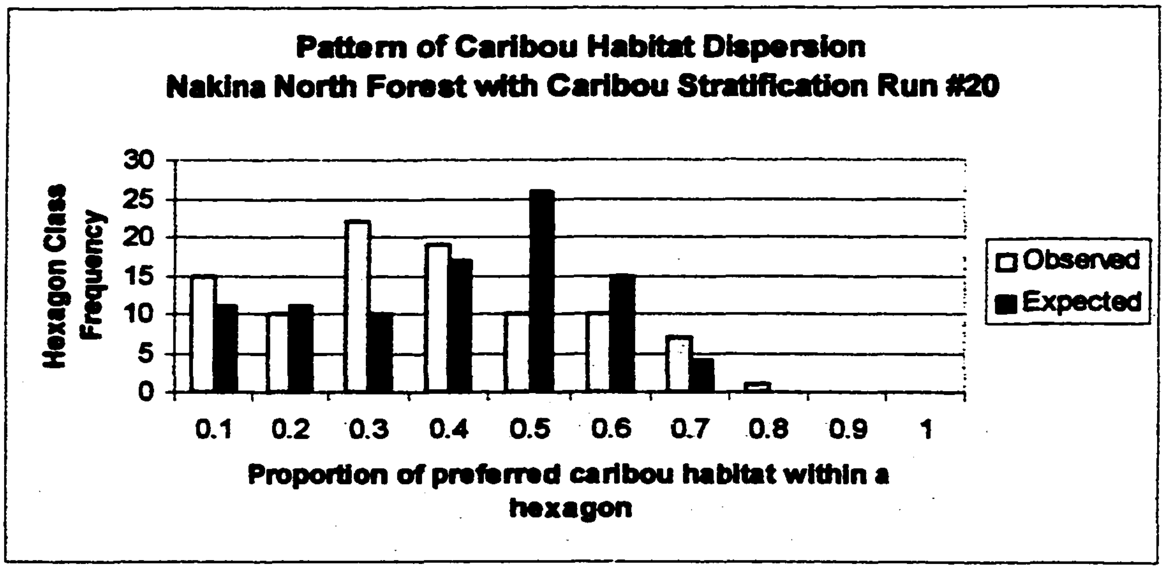

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #14
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

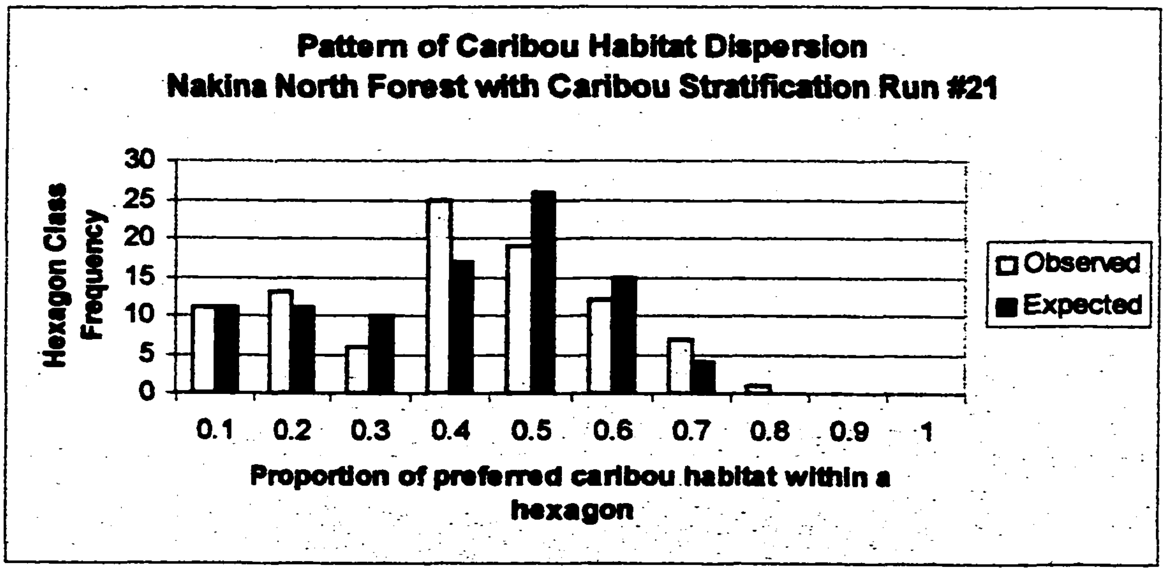

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #15
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

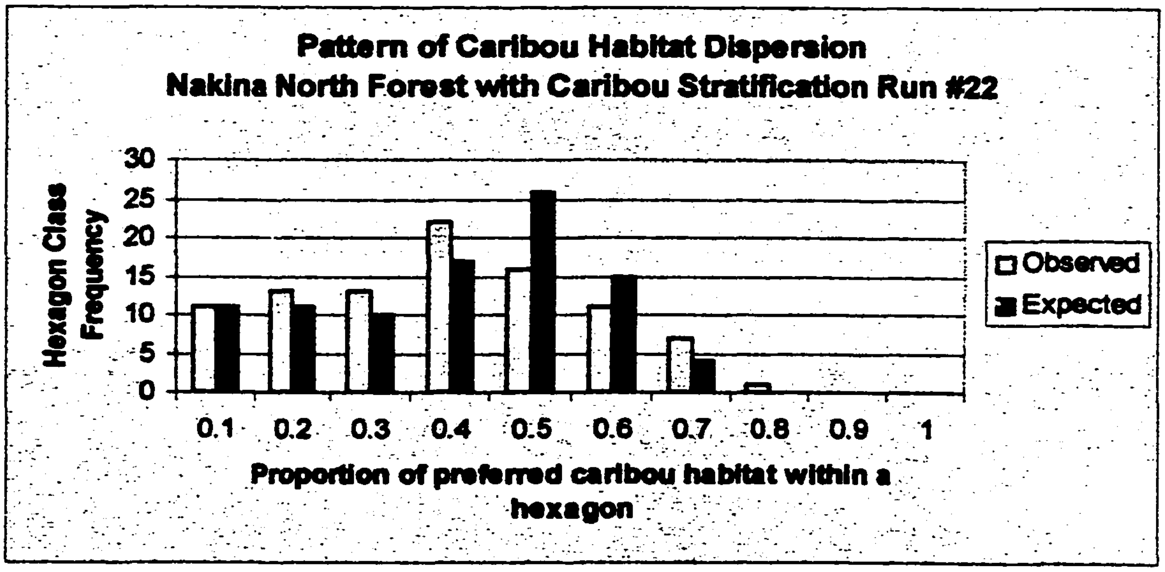

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #17
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

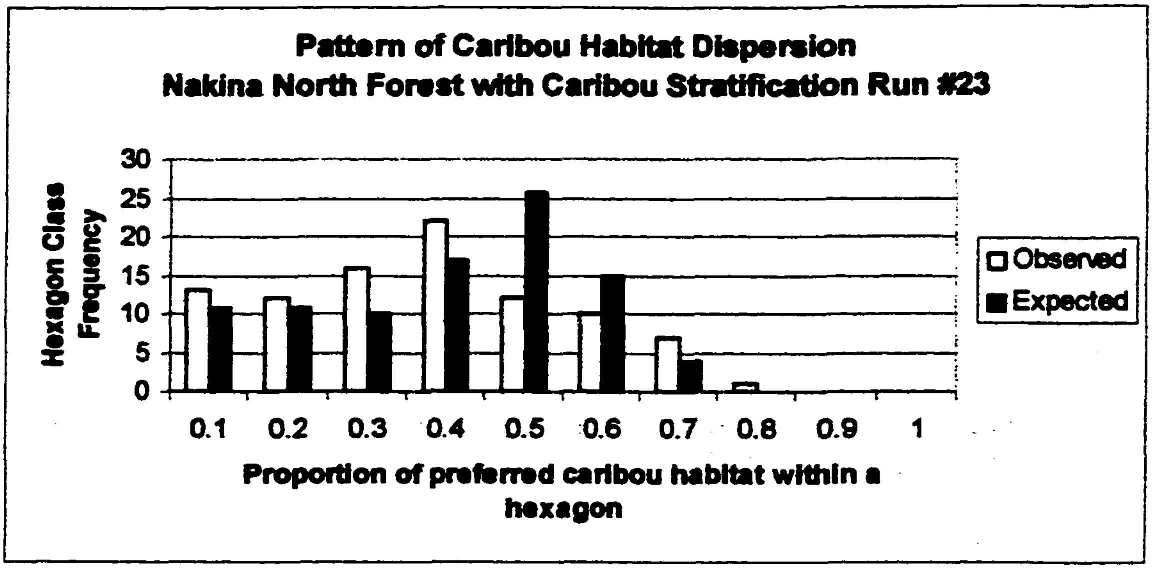

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #18
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

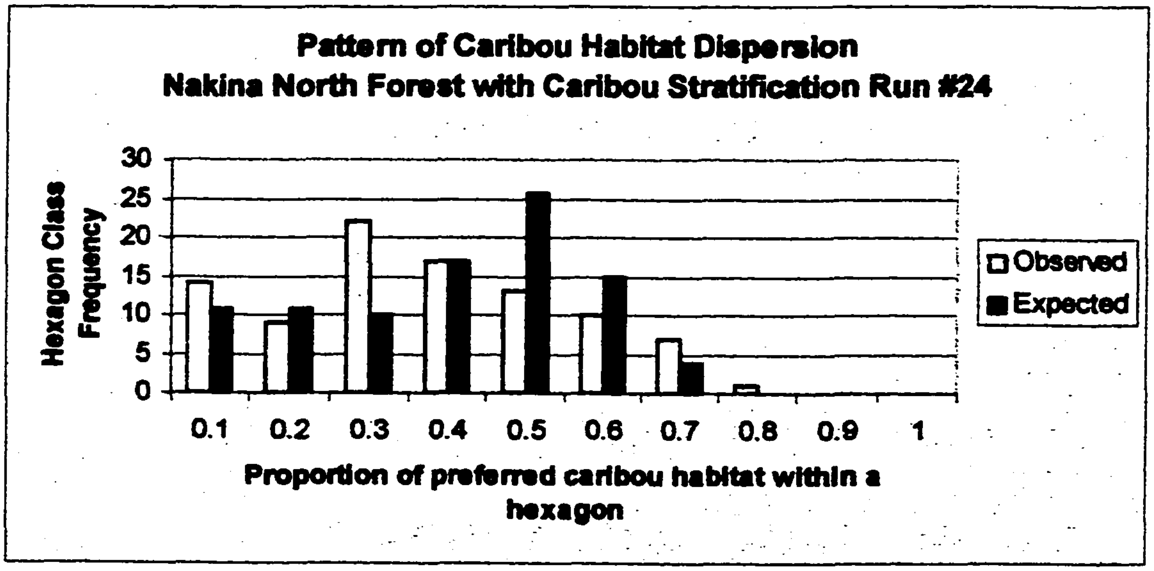

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #19
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
☐ Observed
■ Expected

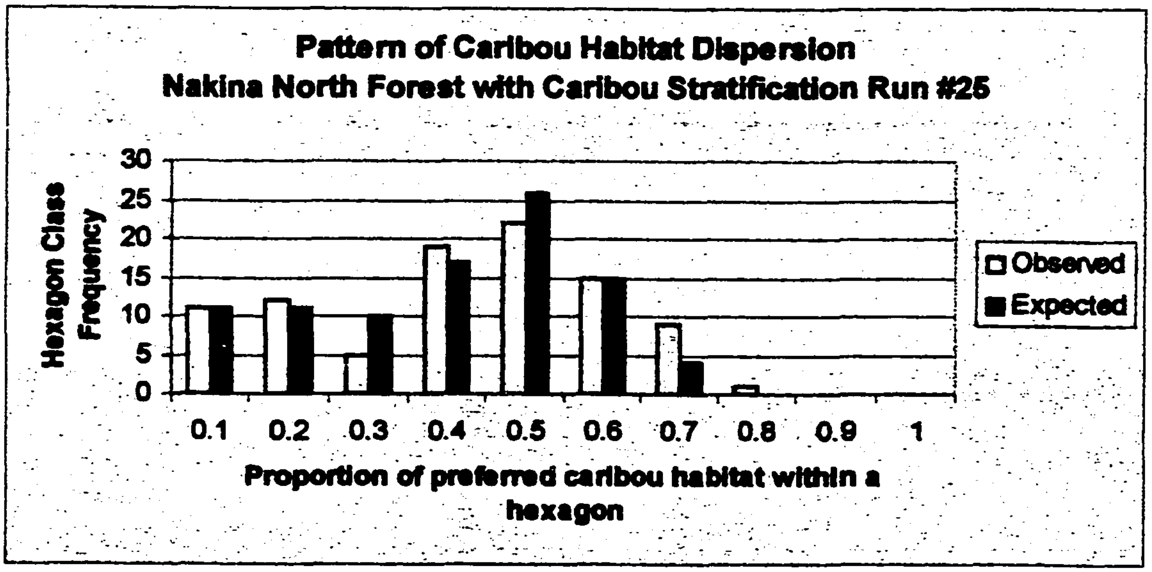

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #20
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

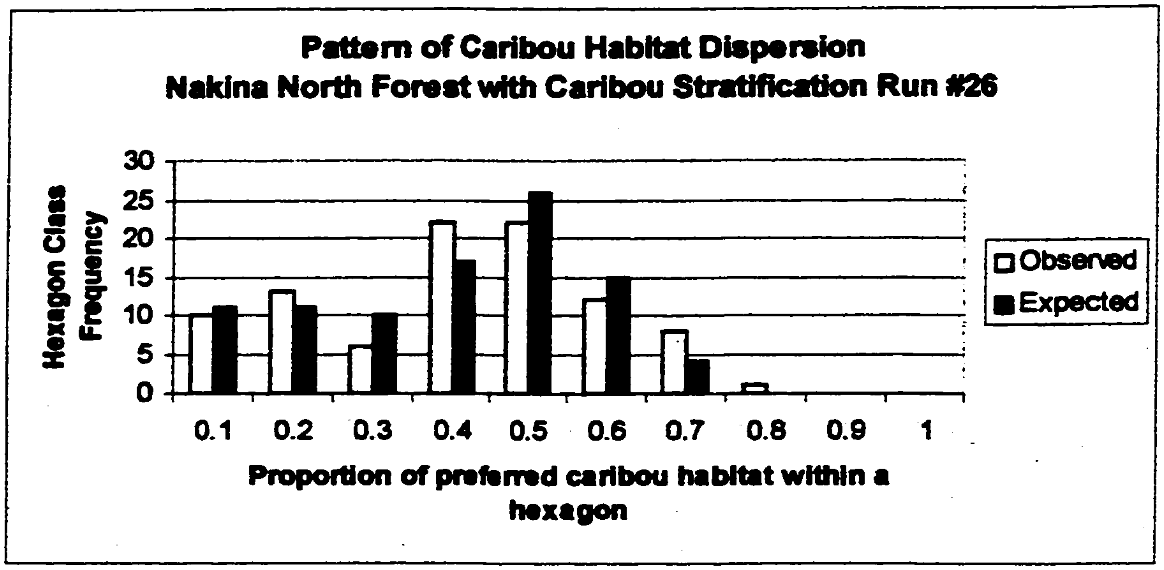

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #21
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

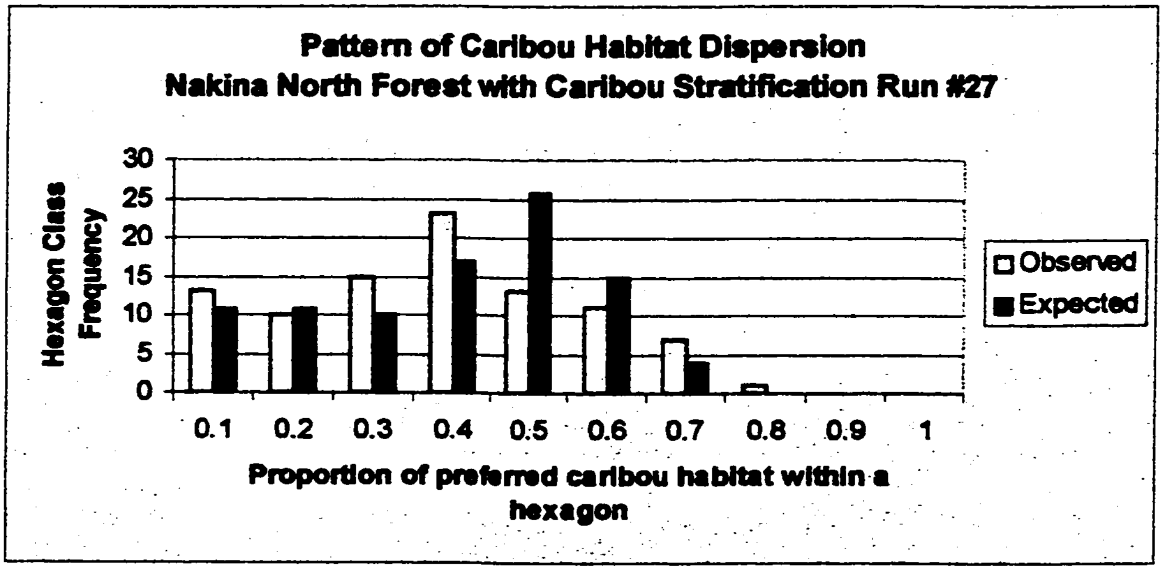

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #22
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
Observed
Expected

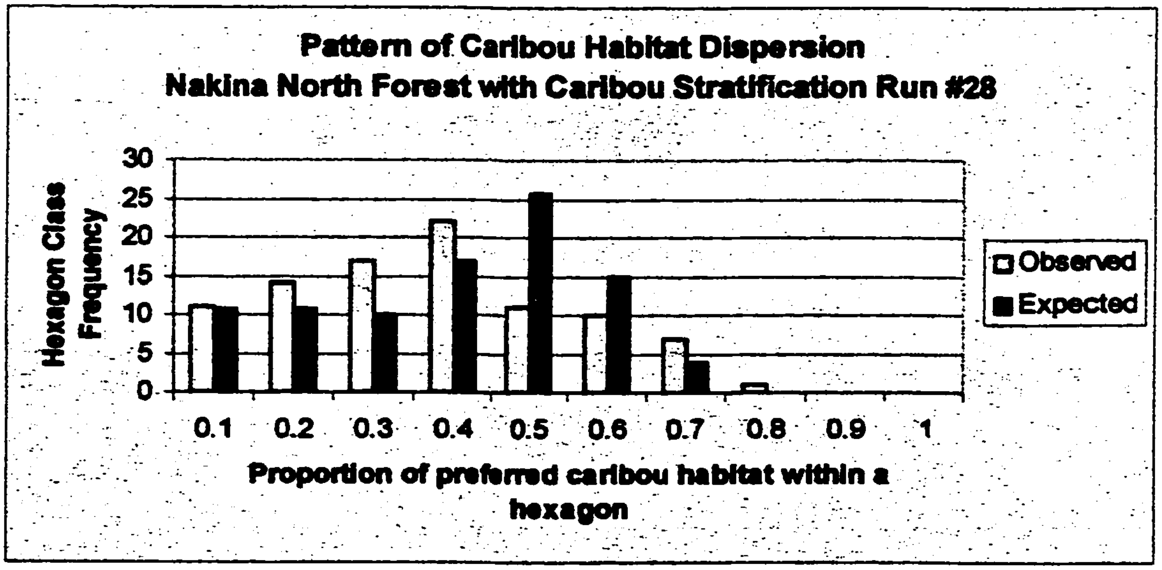

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #23
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

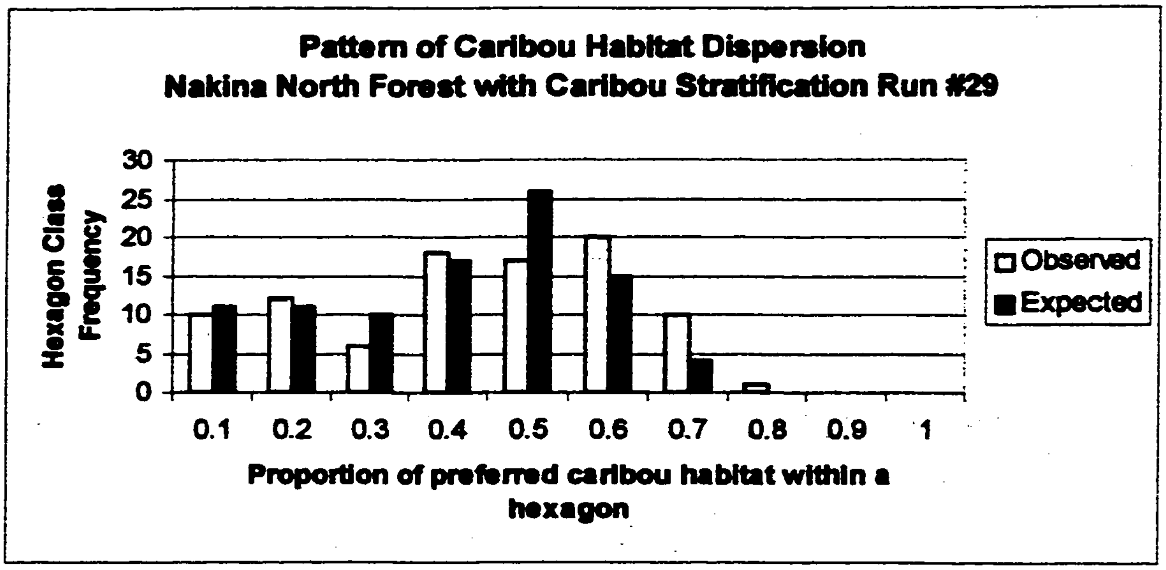

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #24
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

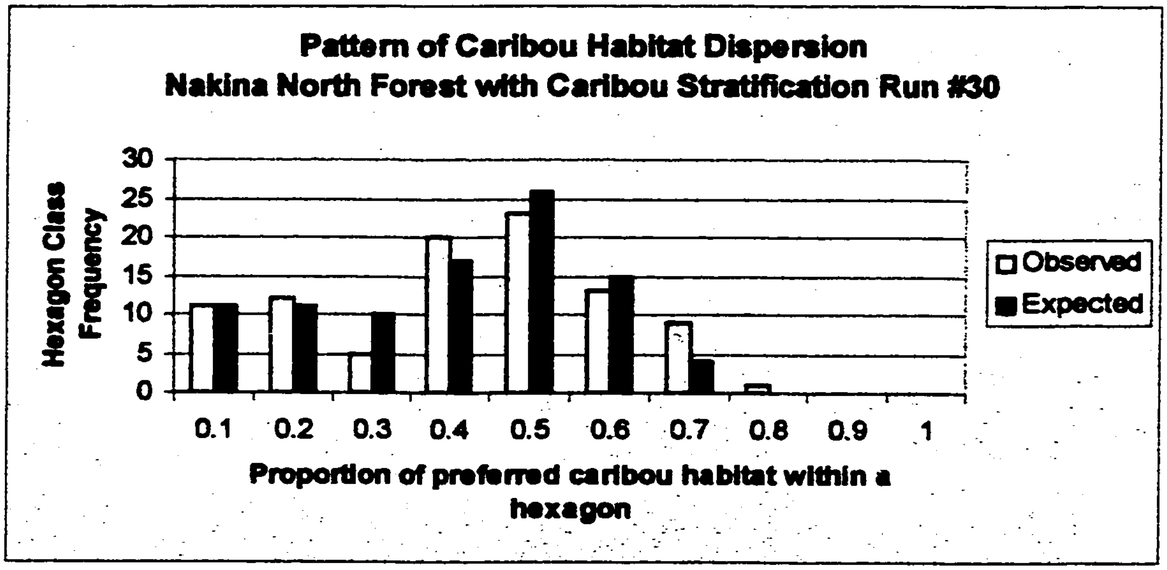

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #25
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

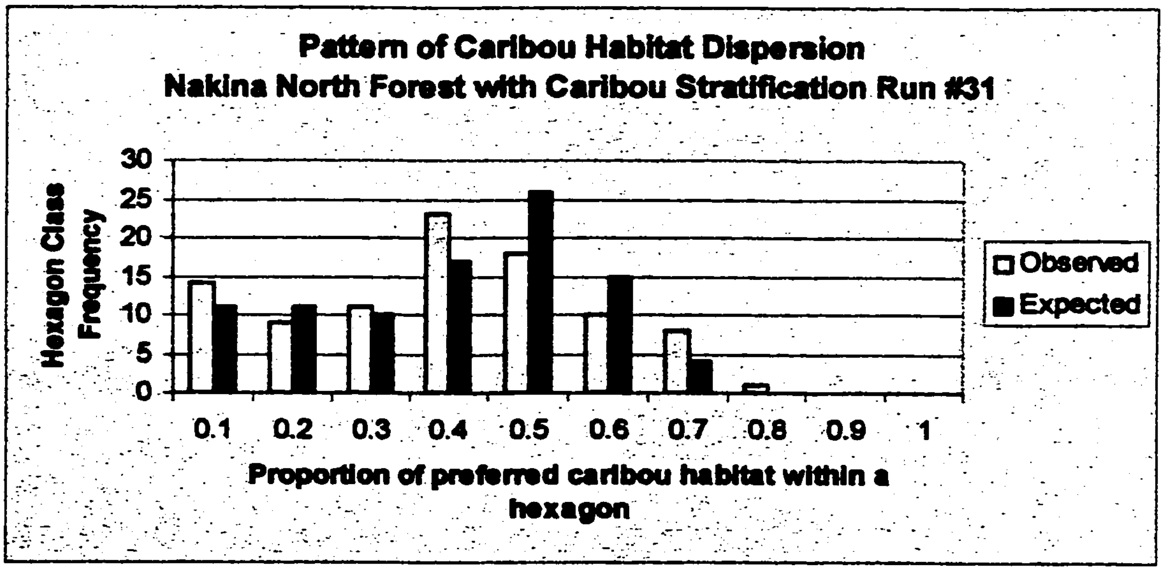

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #26
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

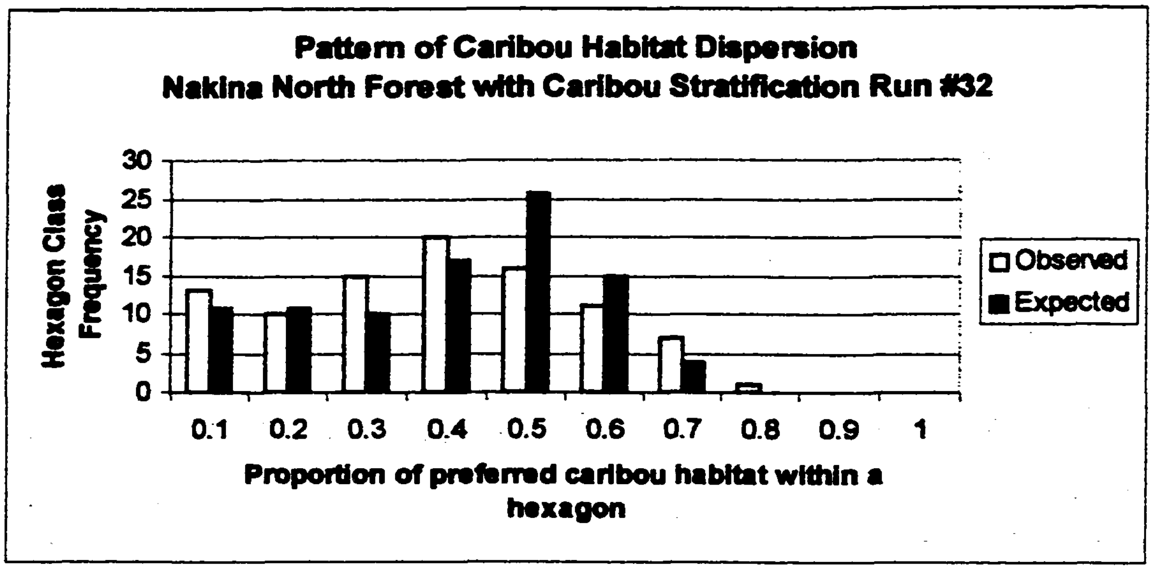

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #27
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

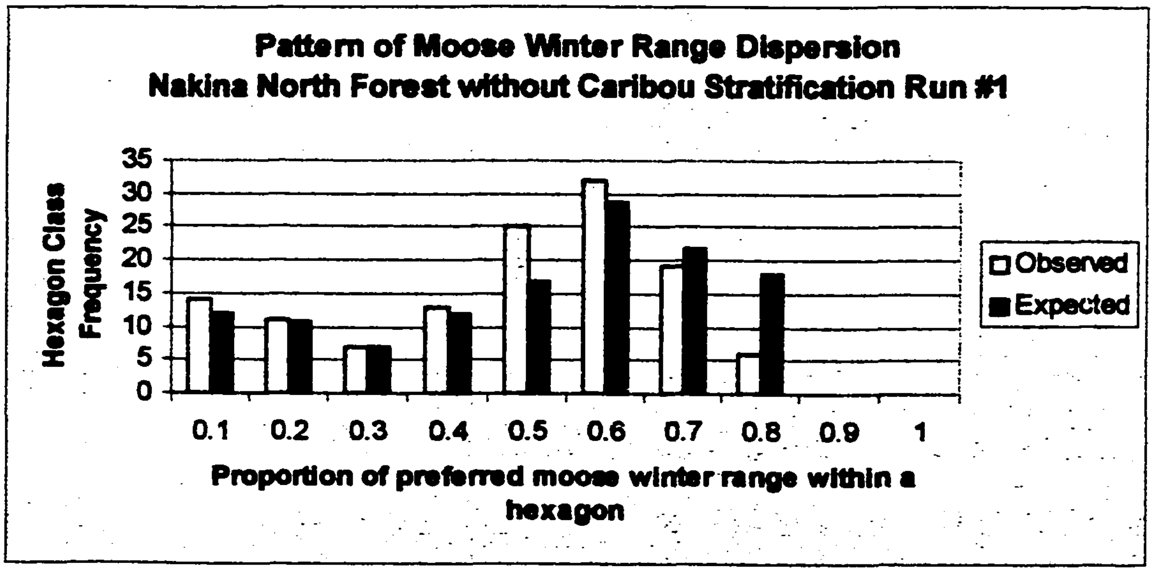

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #28
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

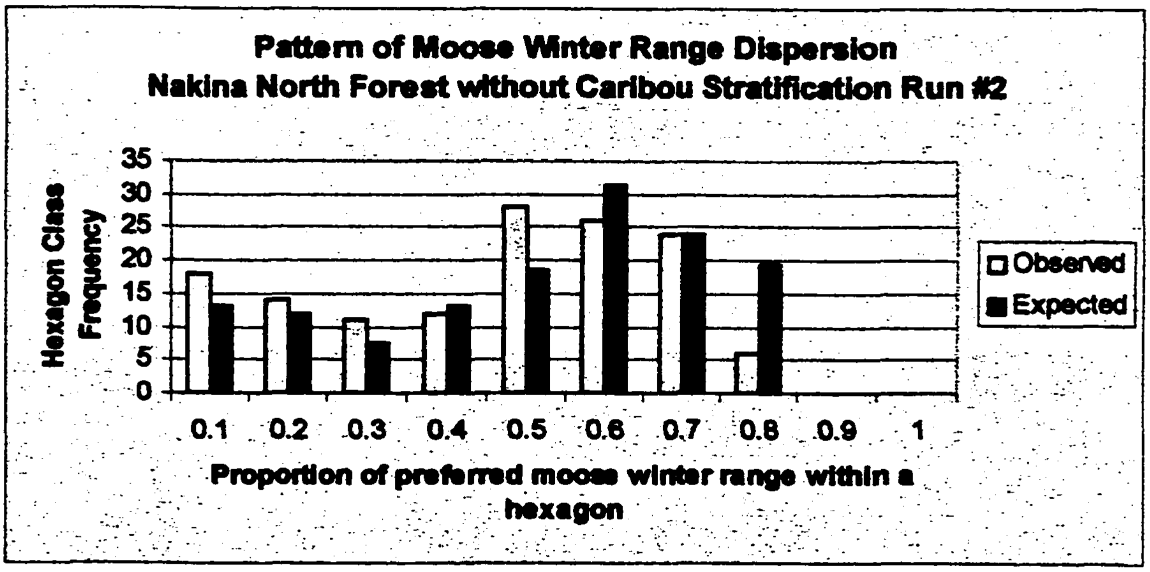

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #29
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

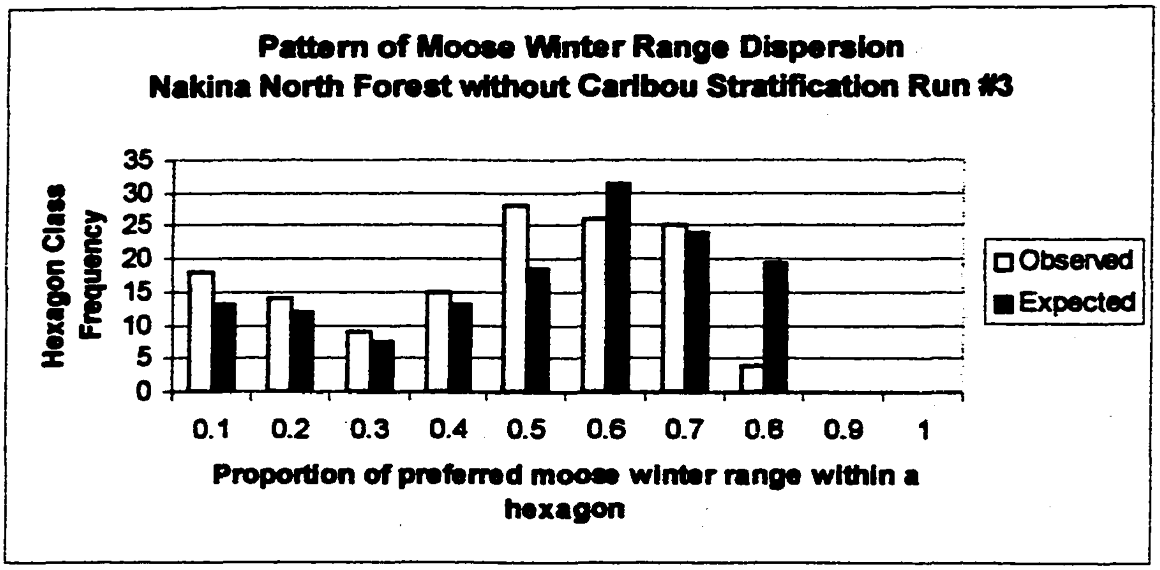

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #30
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

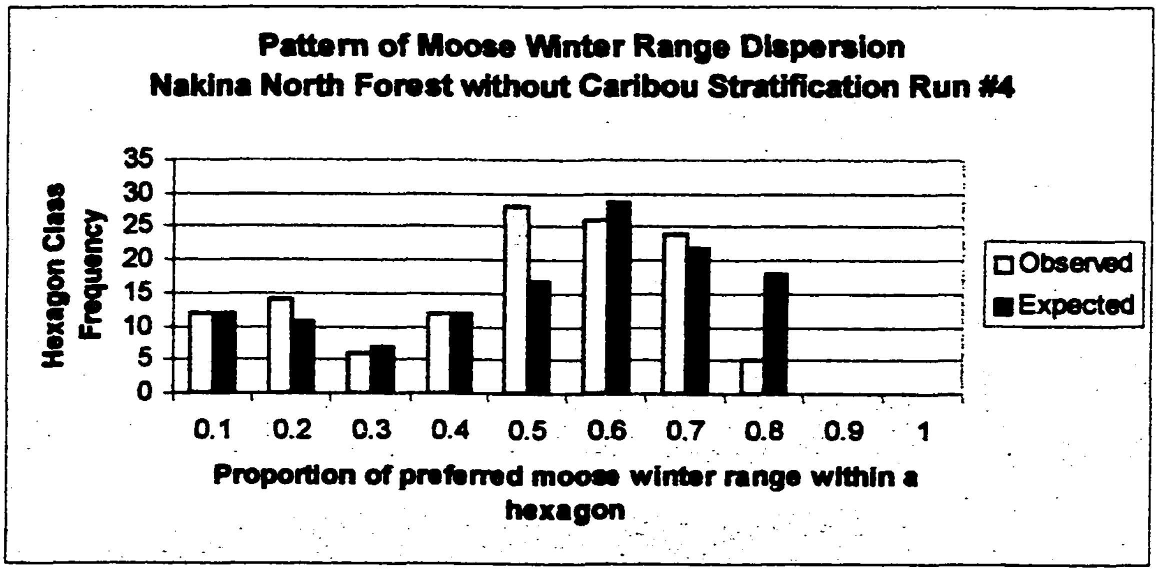

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #31
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

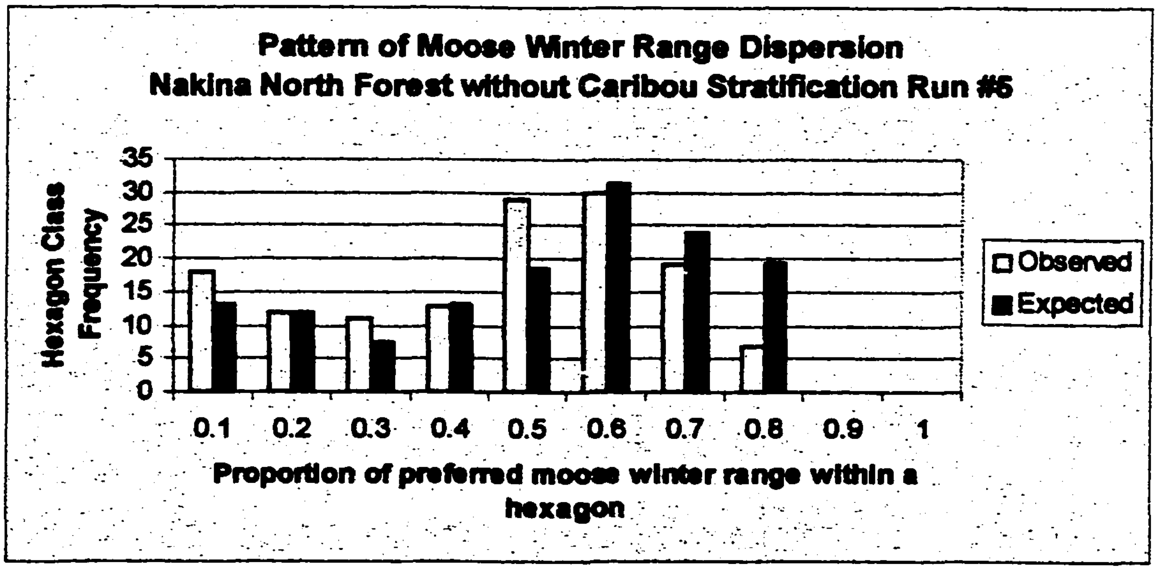

Pattern of Caribou Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #32
Hexagon Class Frequency
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred caribou habitat within a hexagon
□ Observed
■ Expected

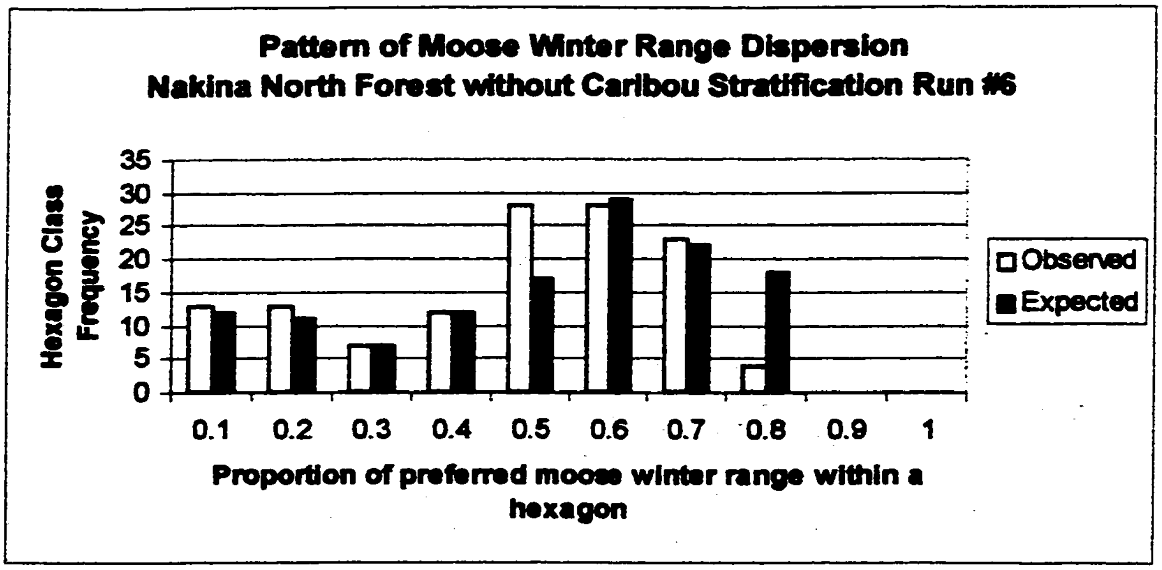

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #1
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

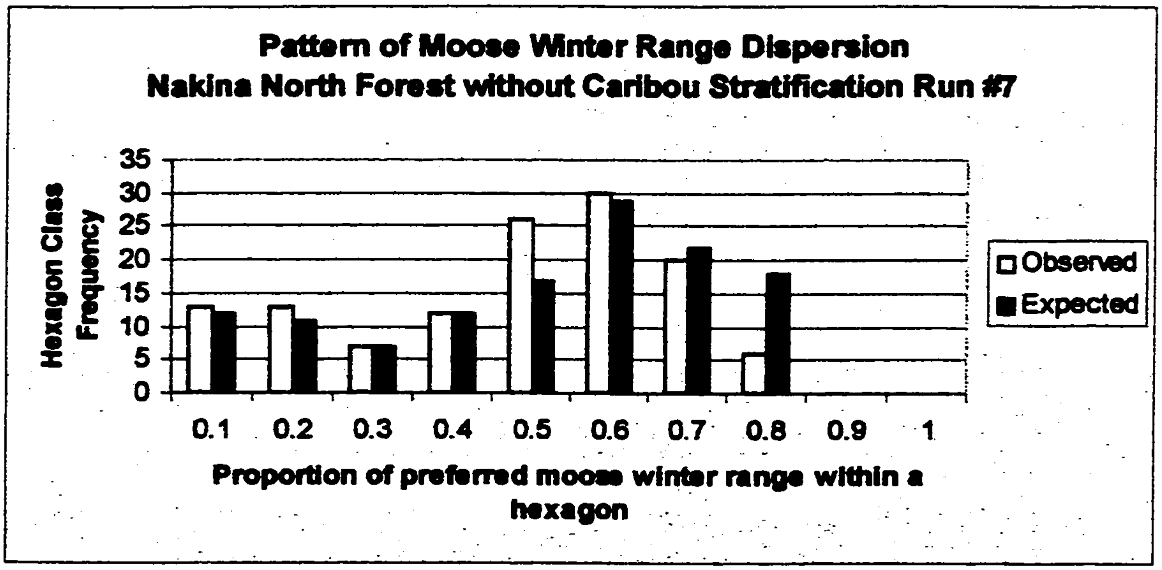

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #2
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

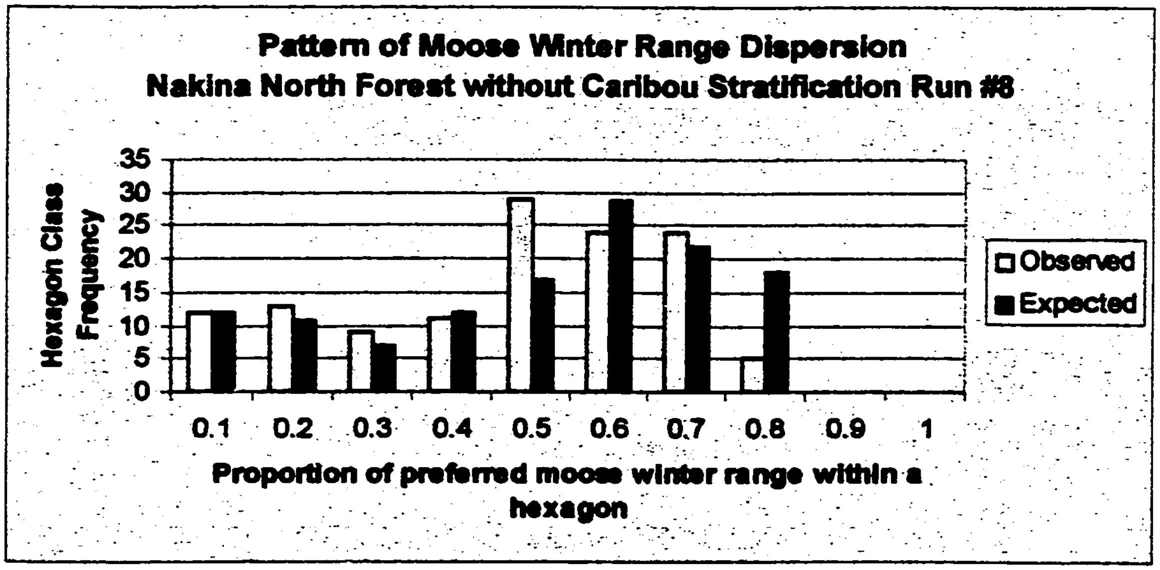

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #3

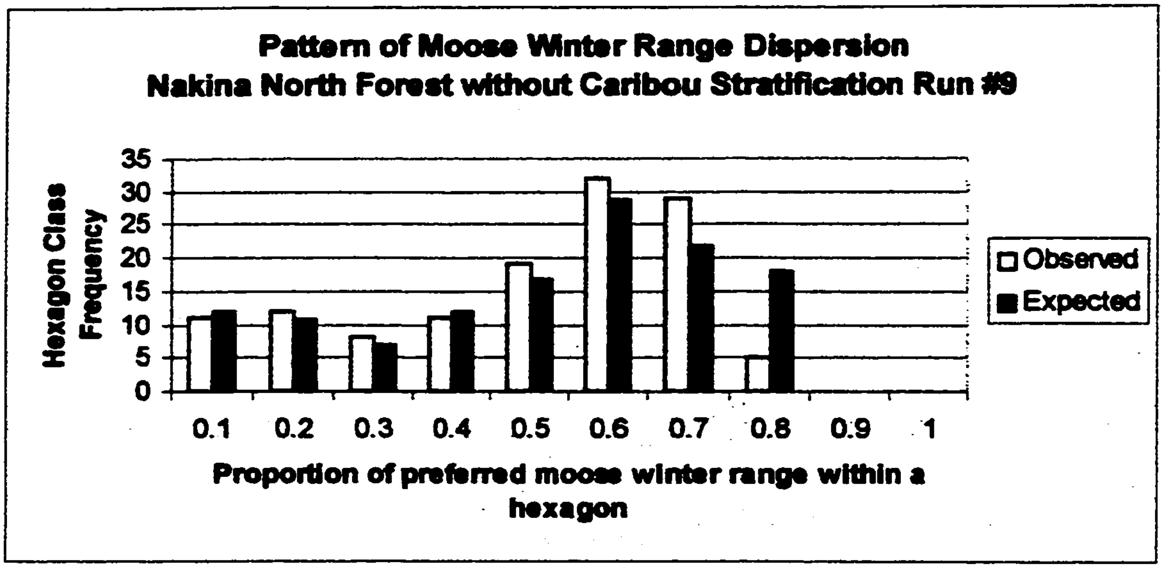

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #4

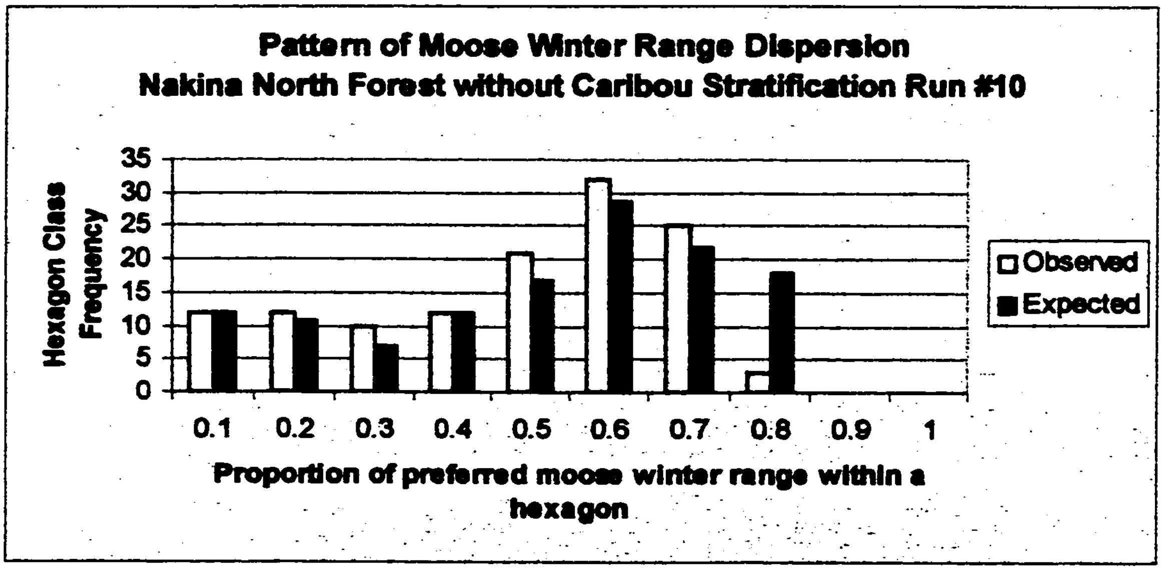

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #5

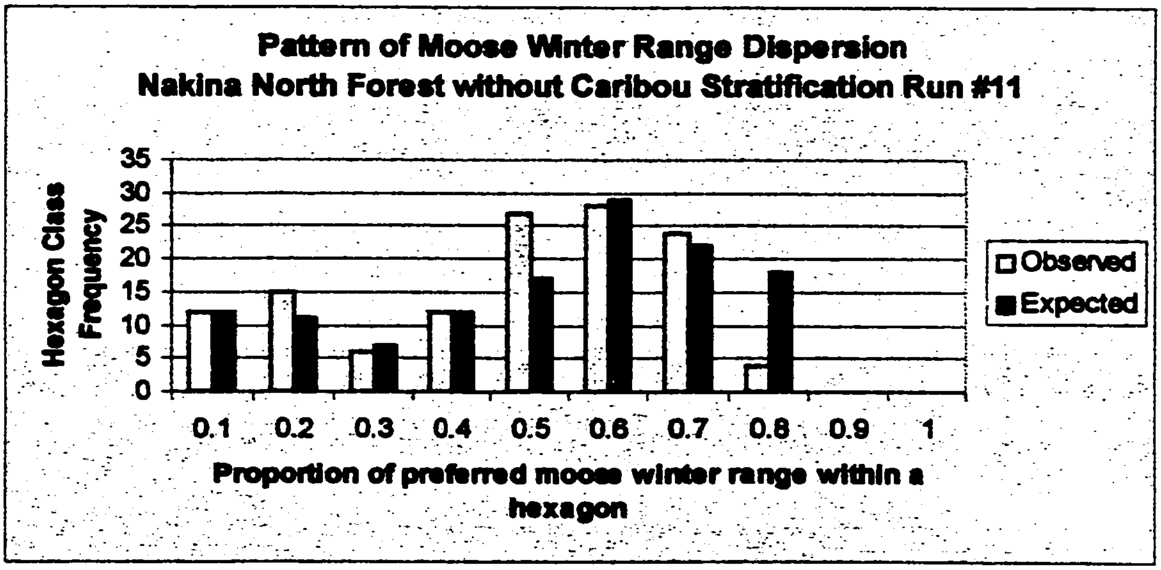

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #6
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

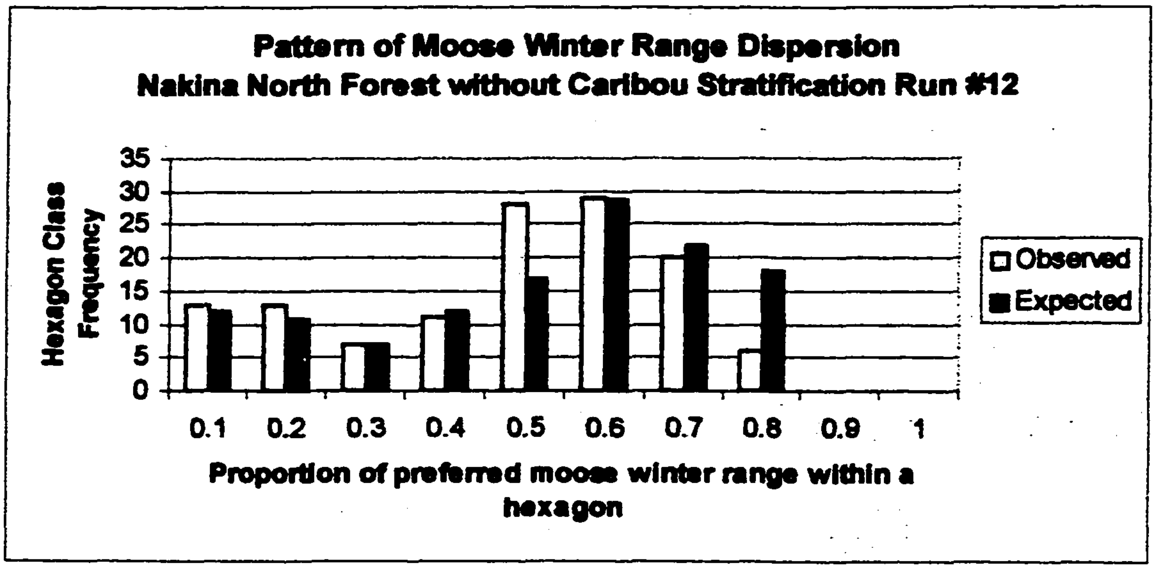

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #7
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

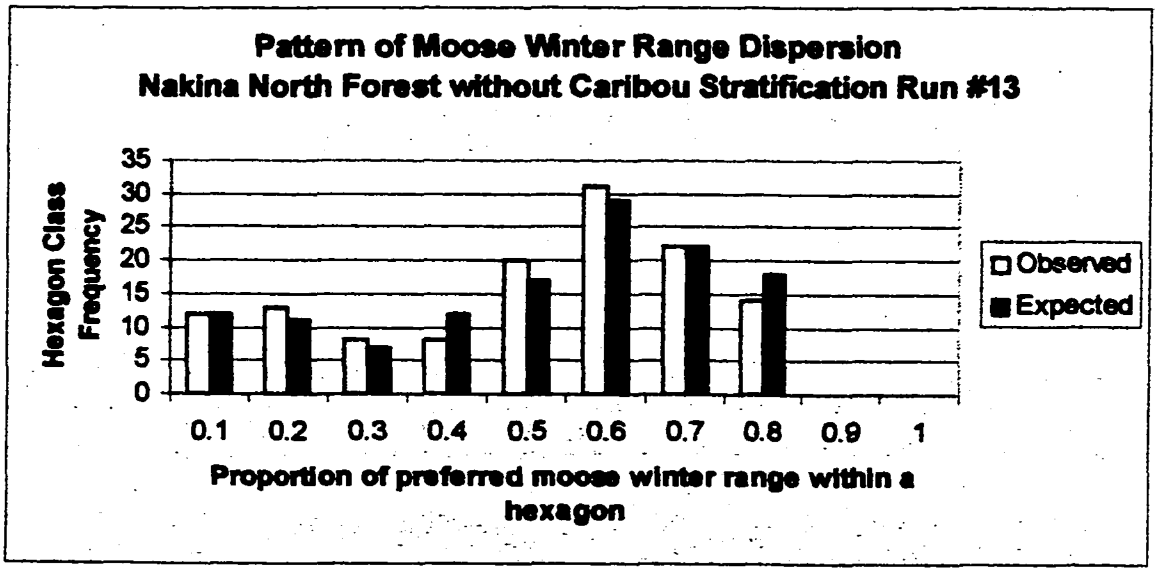

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #8
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

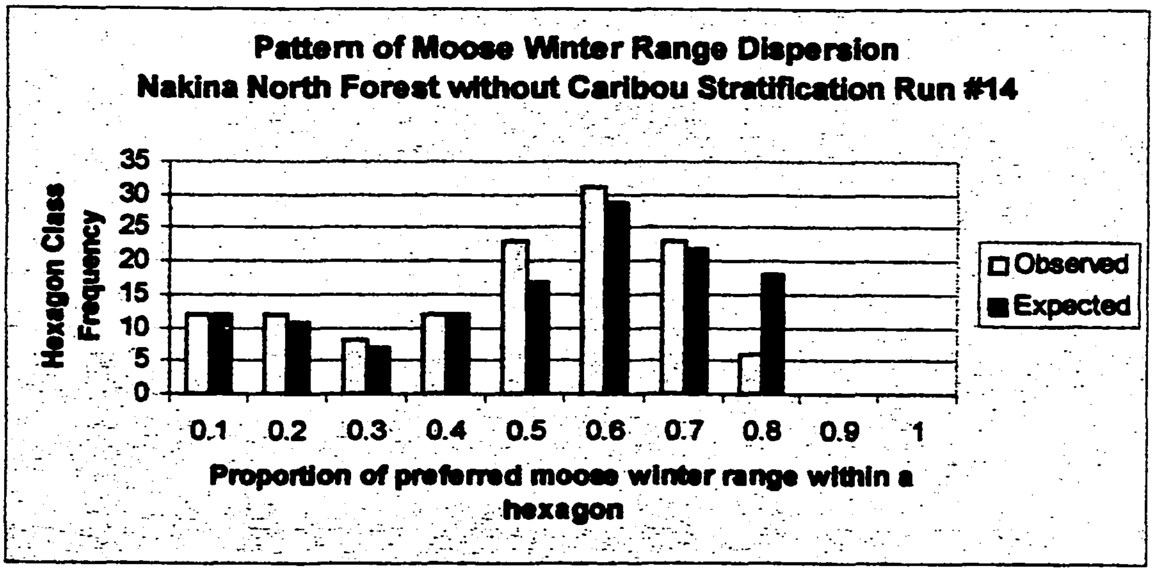

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #9
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

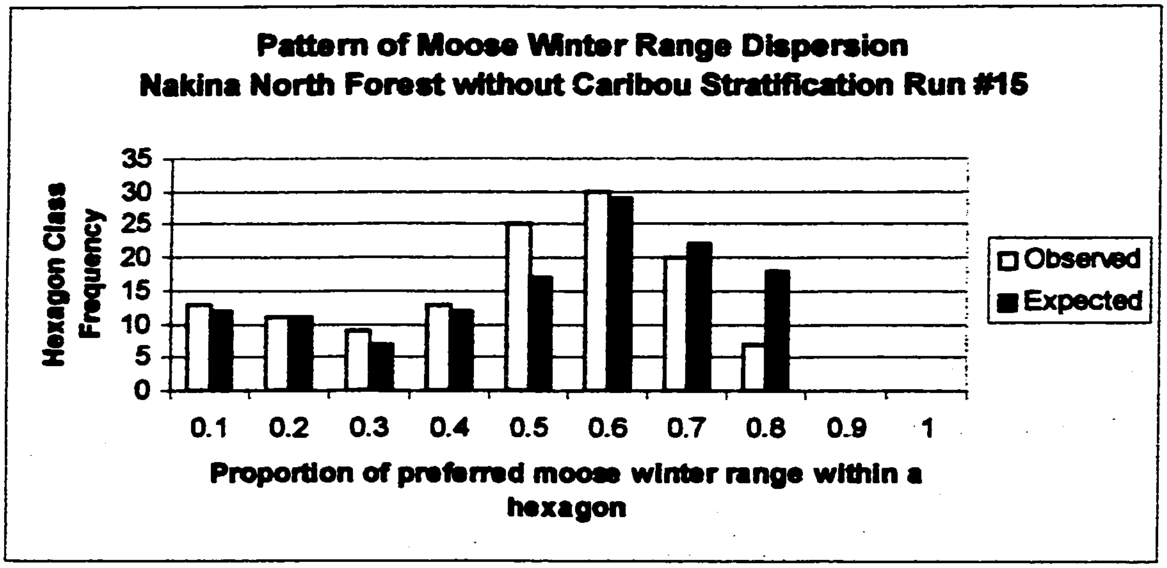

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #10
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

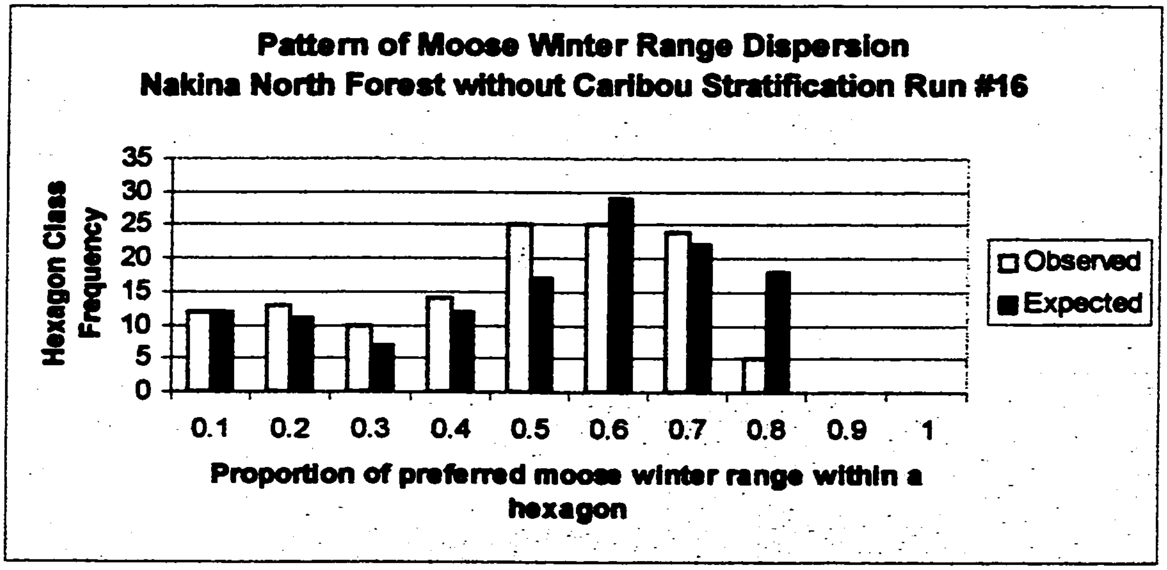

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #11
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

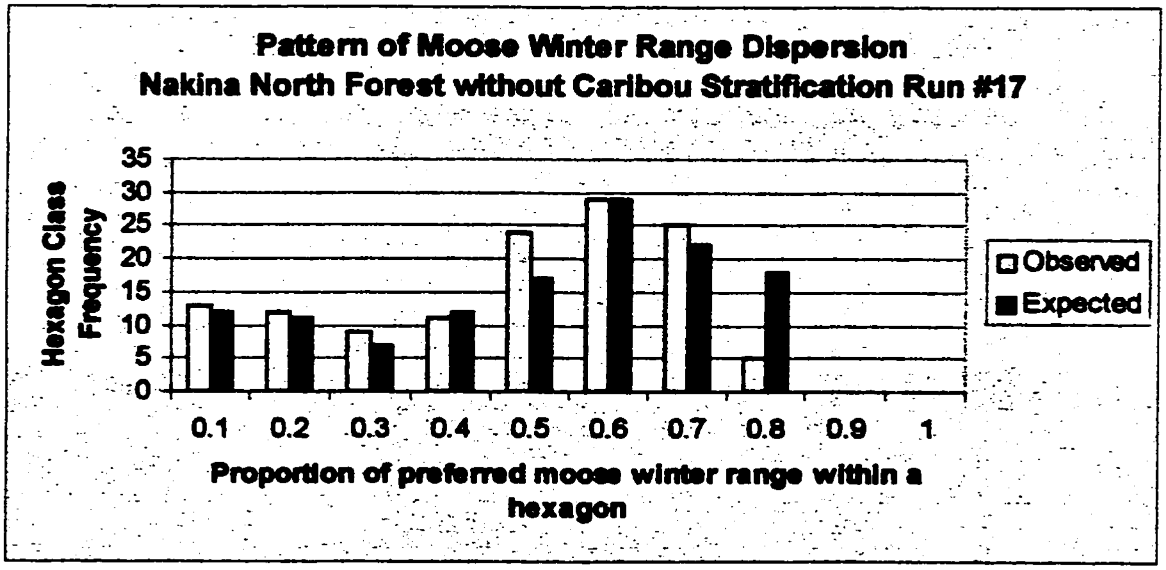

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #12

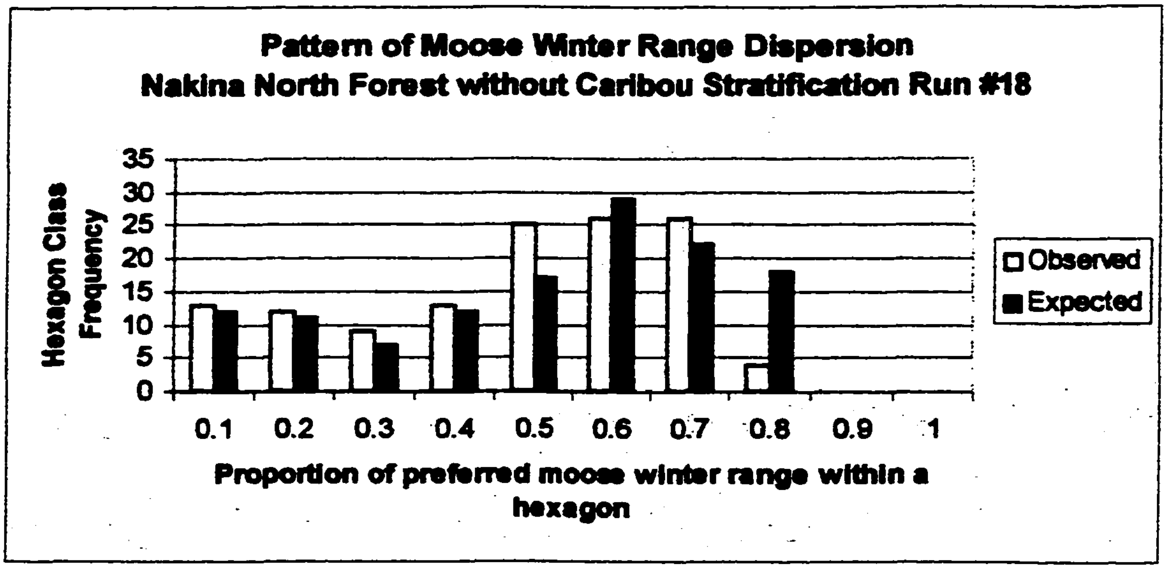

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #13

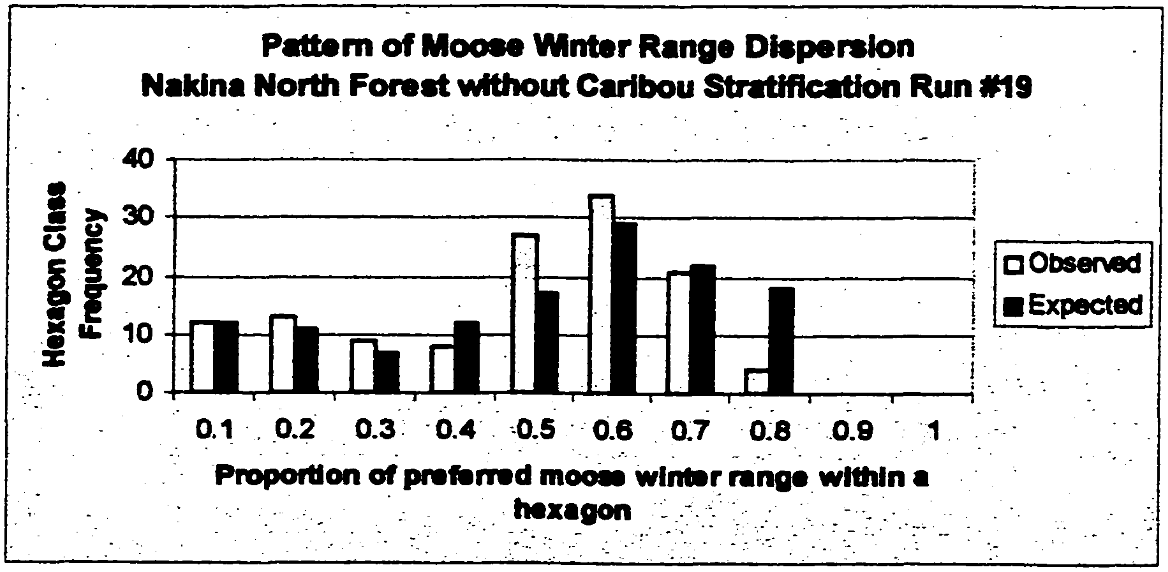

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #14

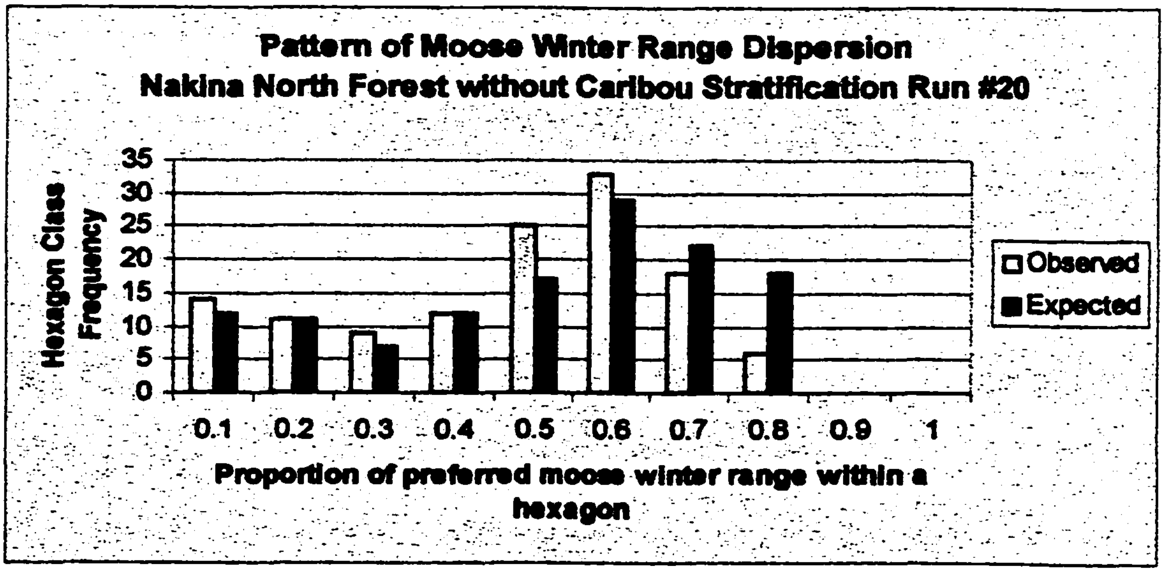

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #15

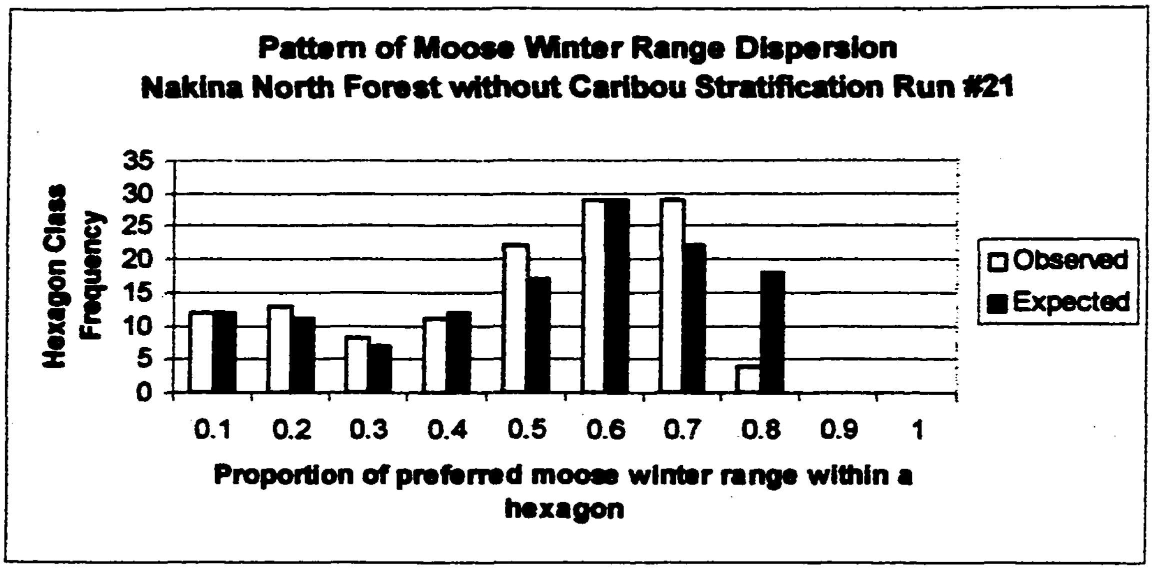

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #16

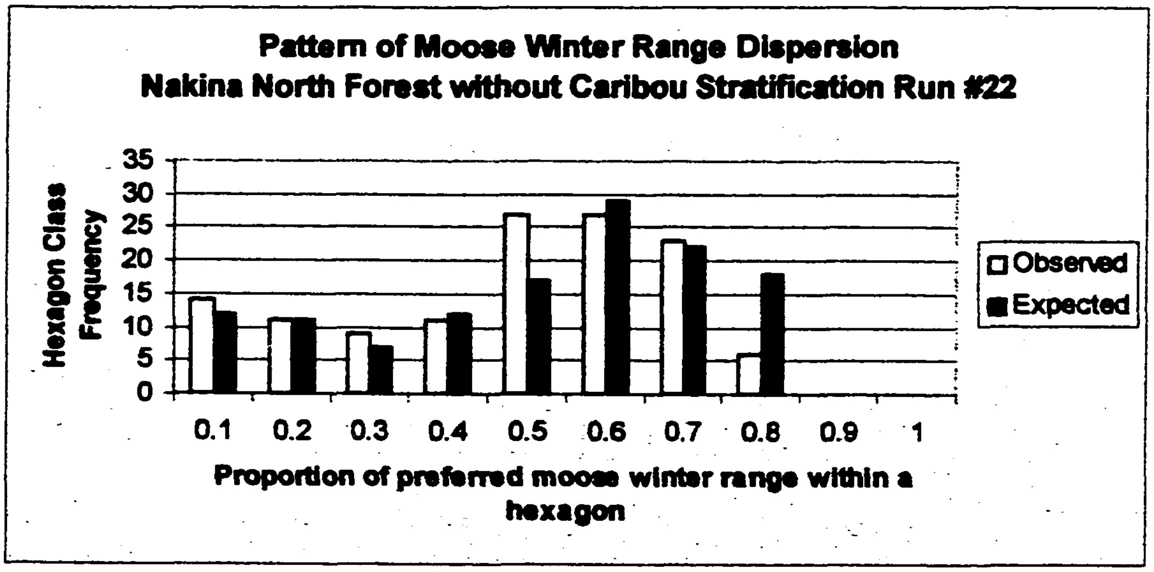

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #17

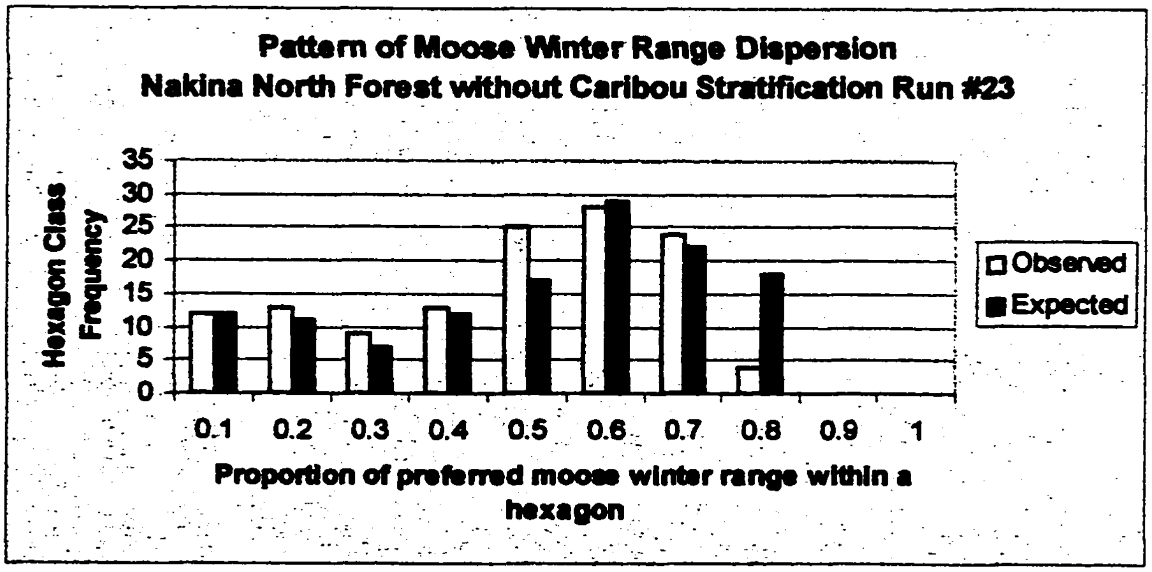

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #18
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

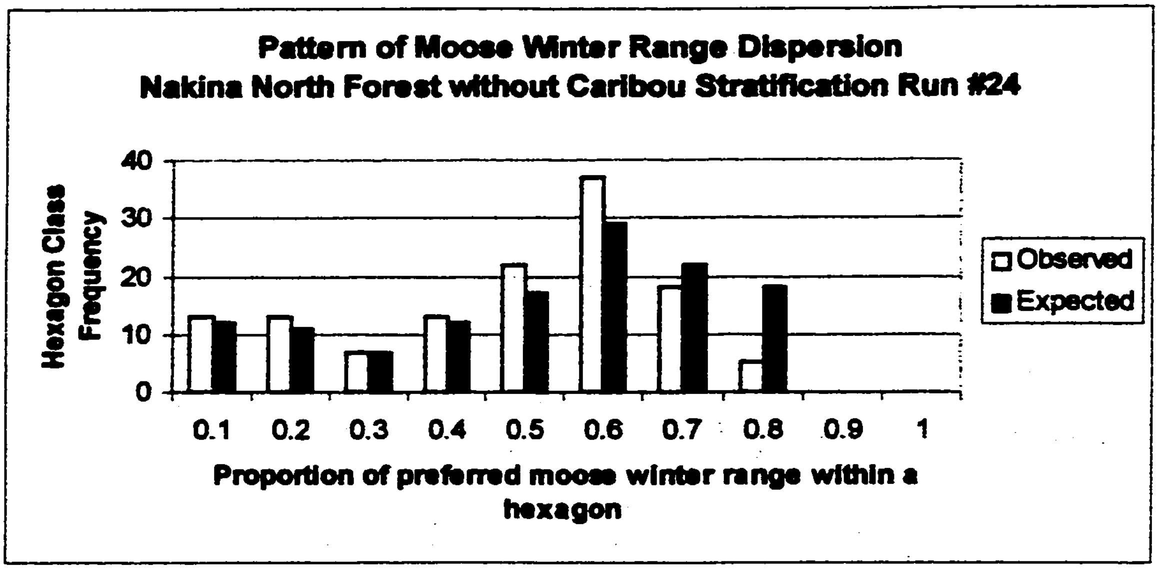

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #19
Hexagon Class Frequency
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected


Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #20
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

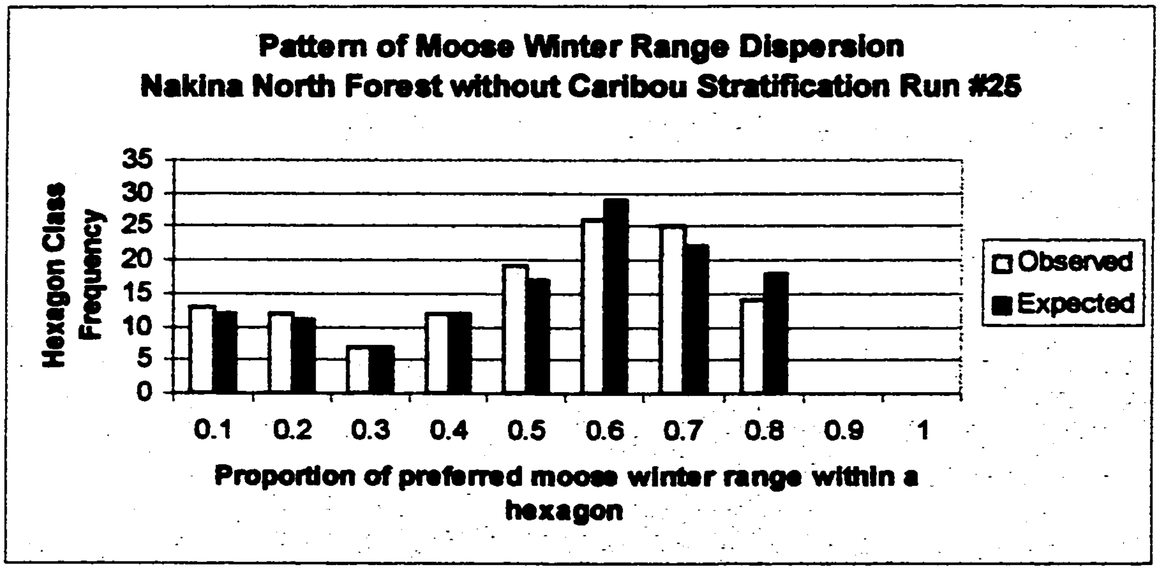

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #21


Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #22

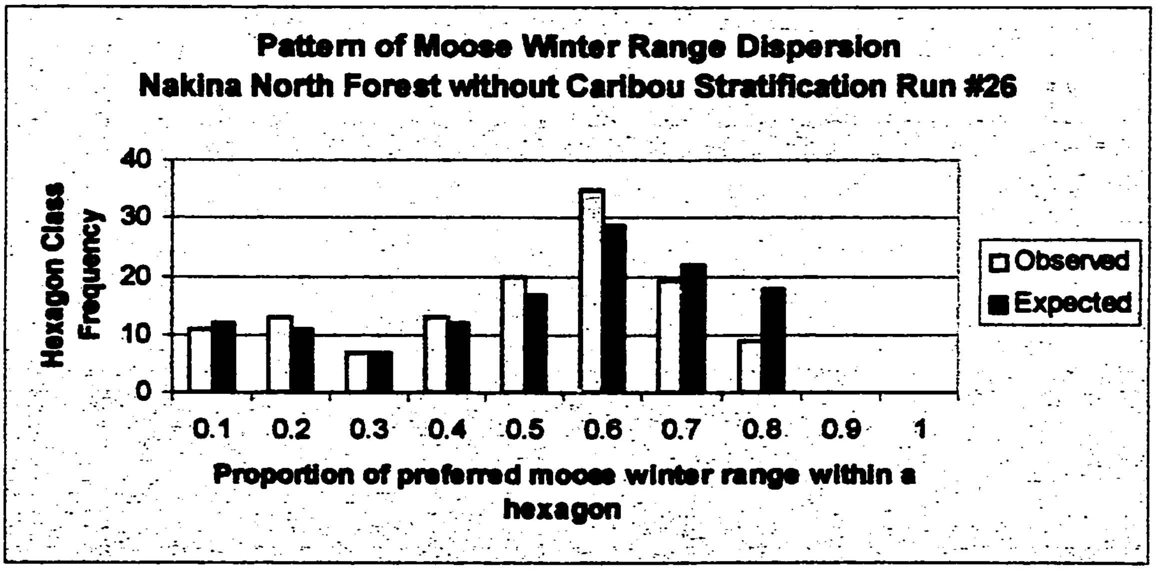

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #23



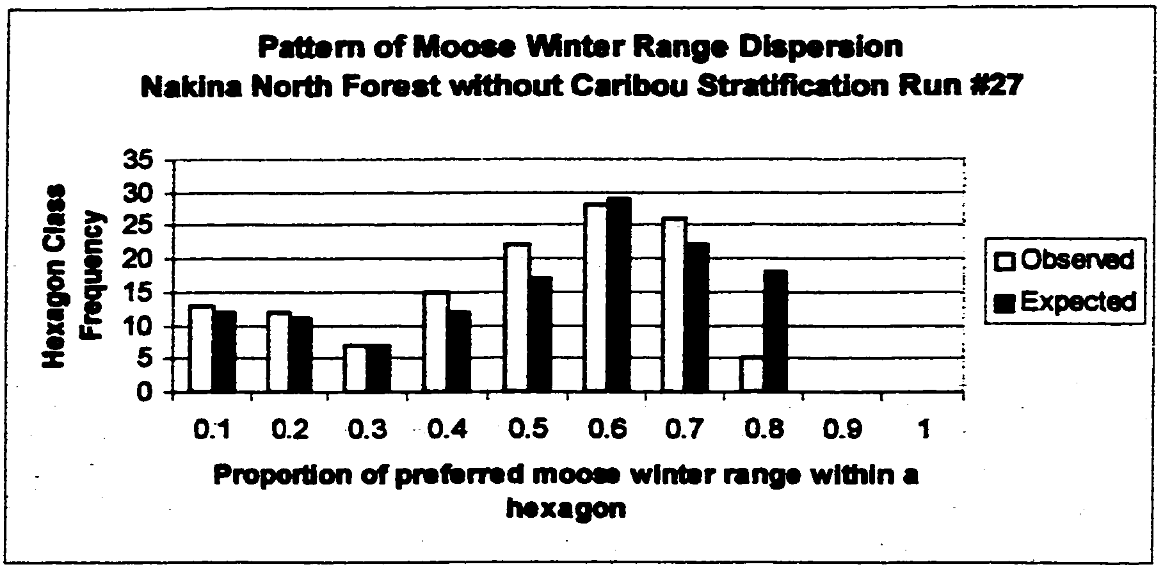
Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #24

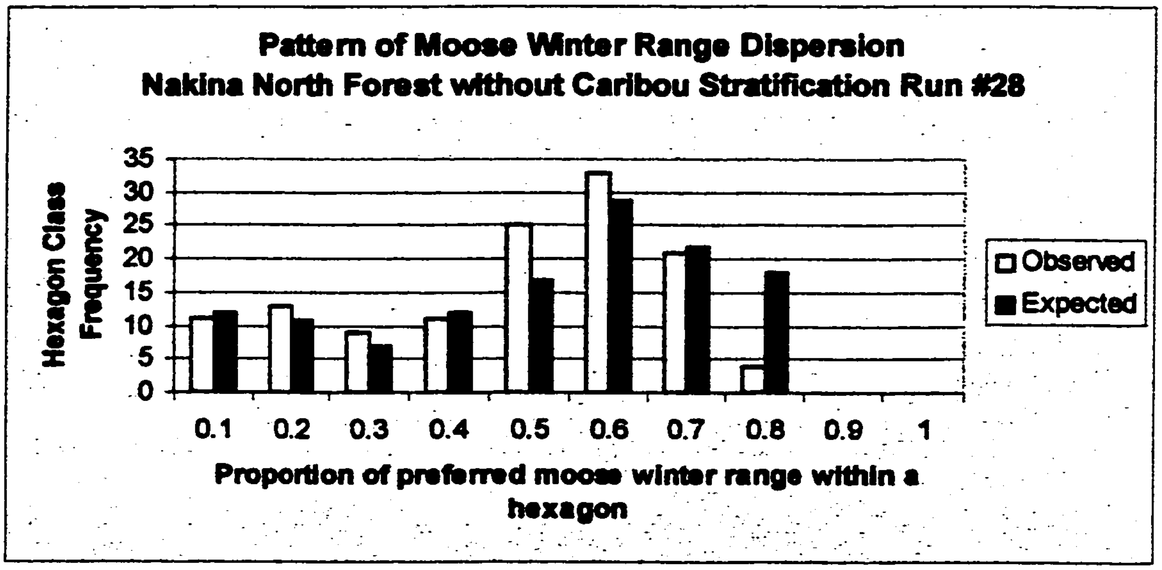


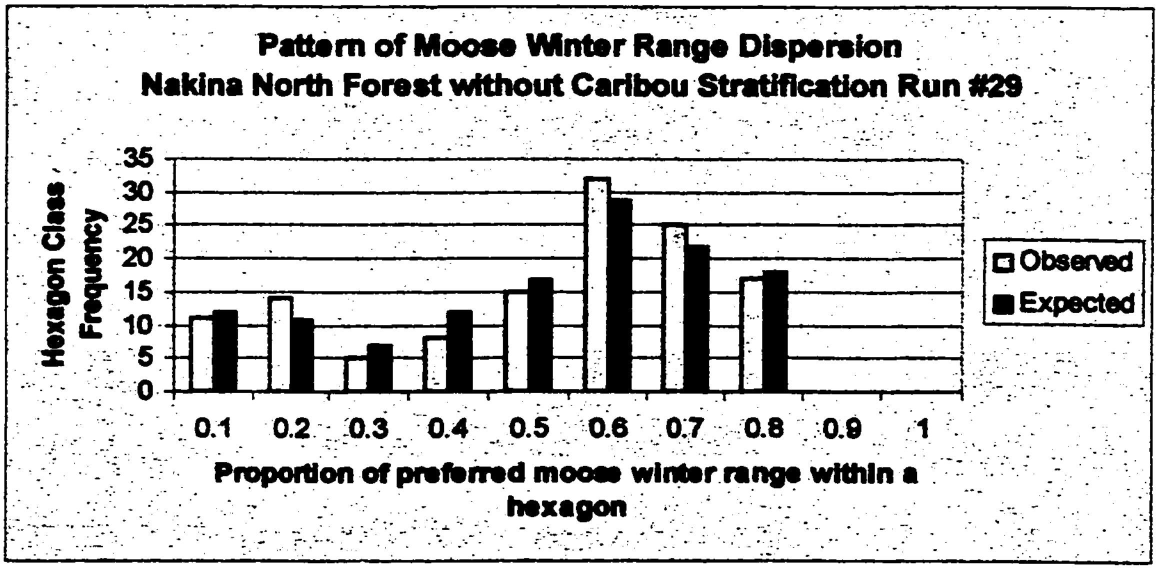
Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #25

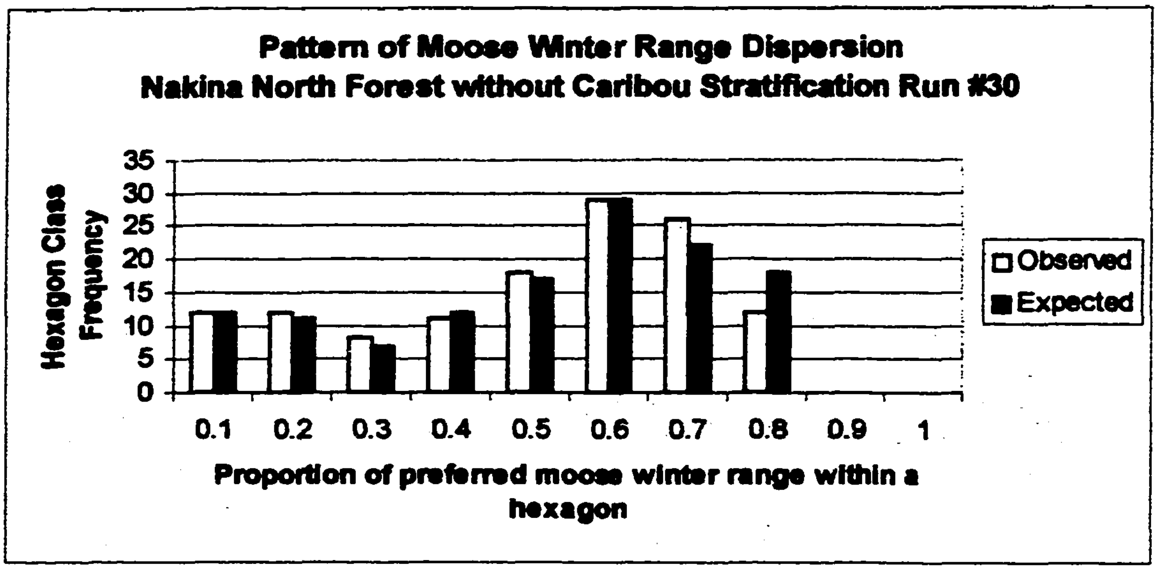


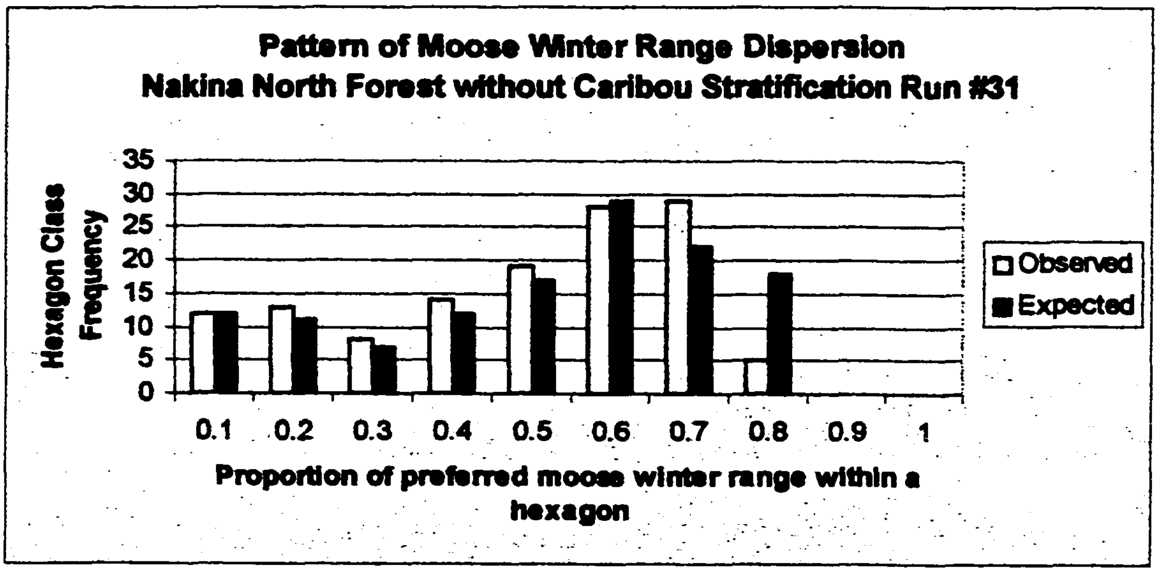
Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #26

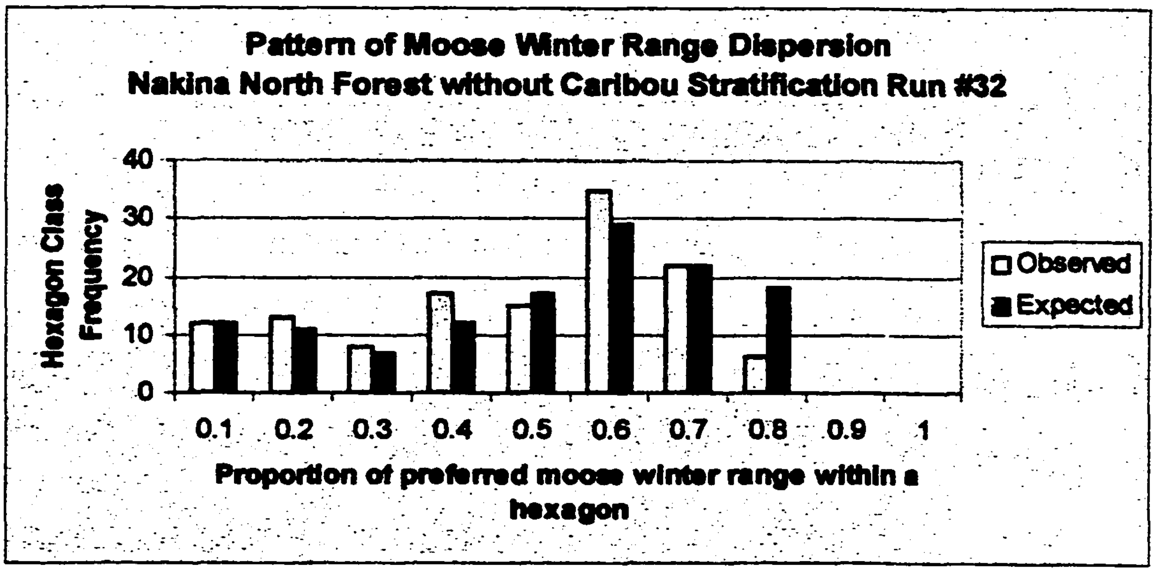

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #27
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

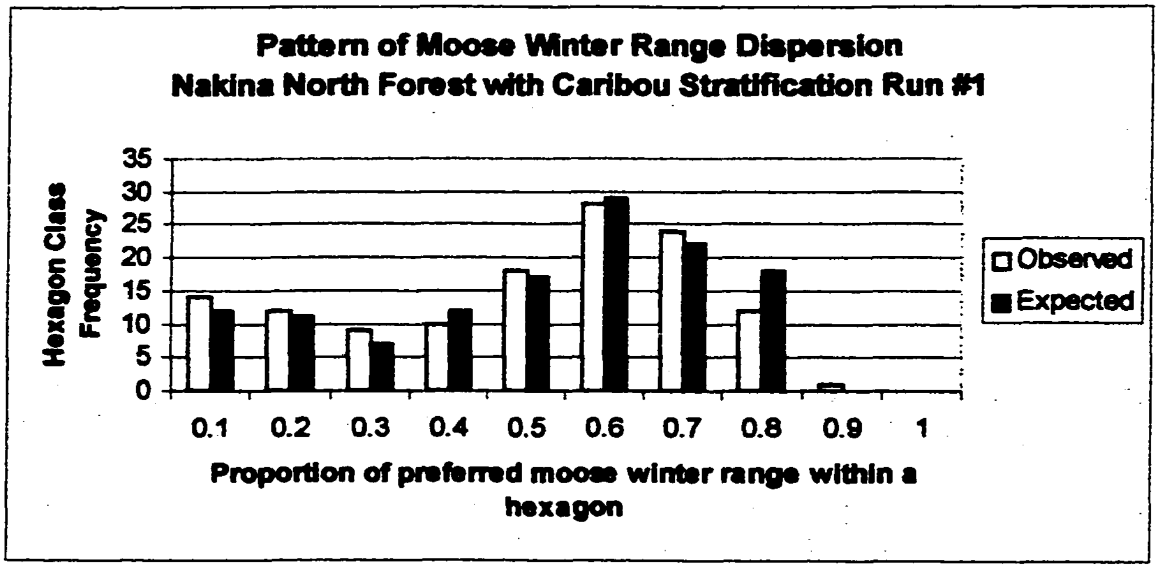

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #28
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

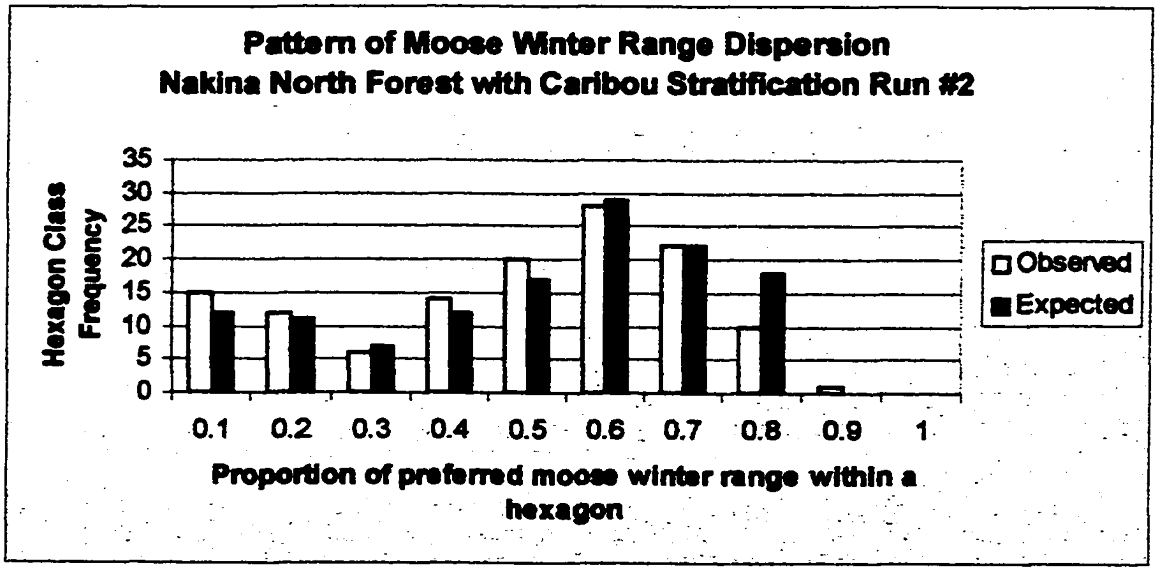

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #29
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

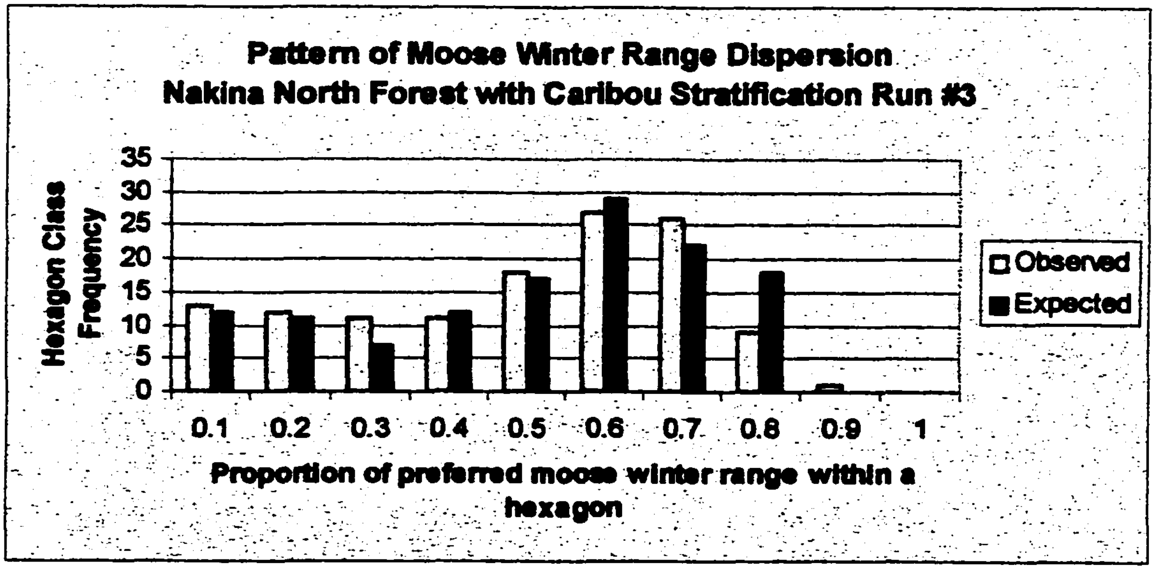

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #30
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

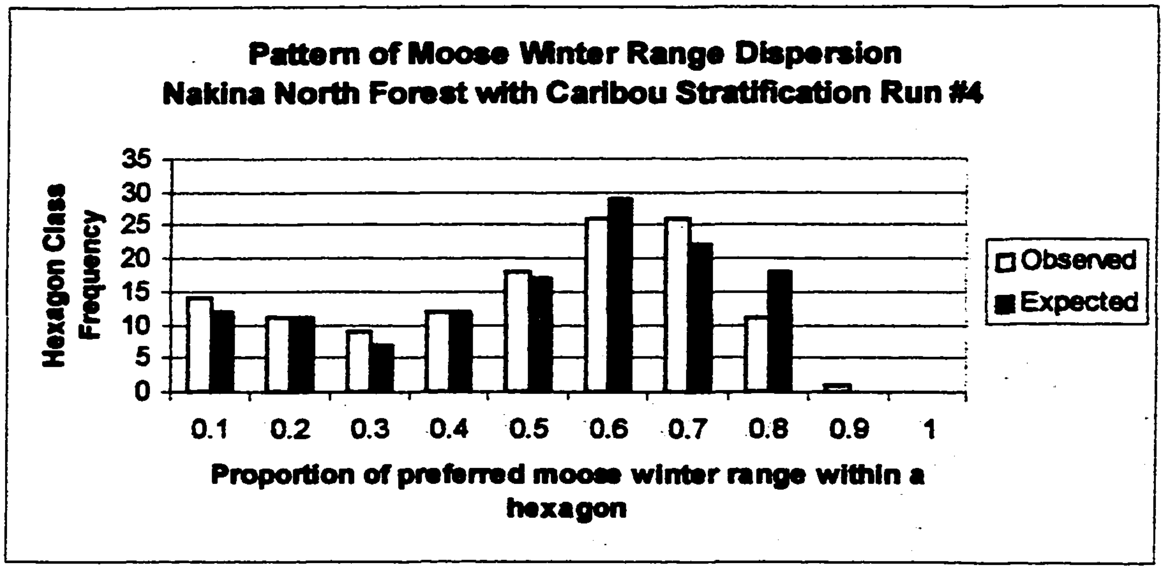

Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #31
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected


Pattern of Moose Winter Range Dispersion
Nakina North Forest without Caribou Stratification Run #32
Hexagon Class Frequency
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

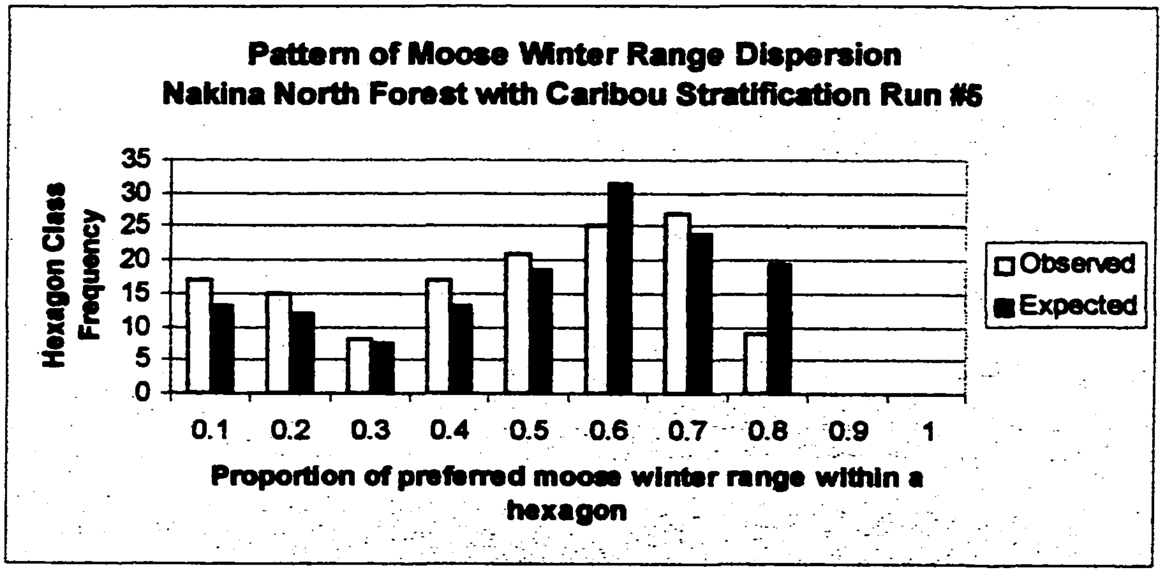

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #1
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected


Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #2
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

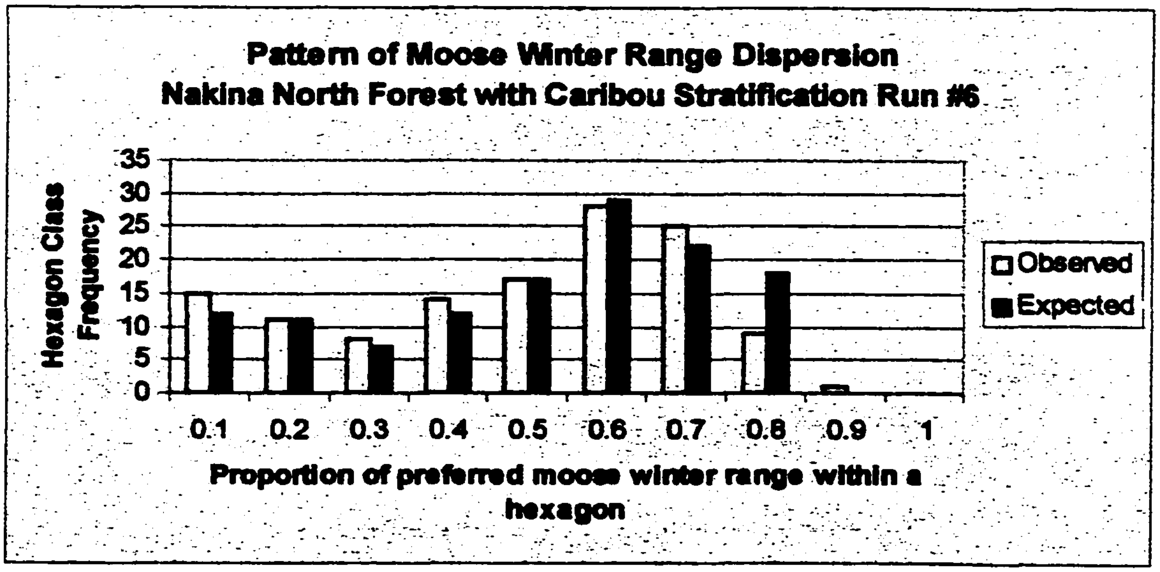

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #3
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected



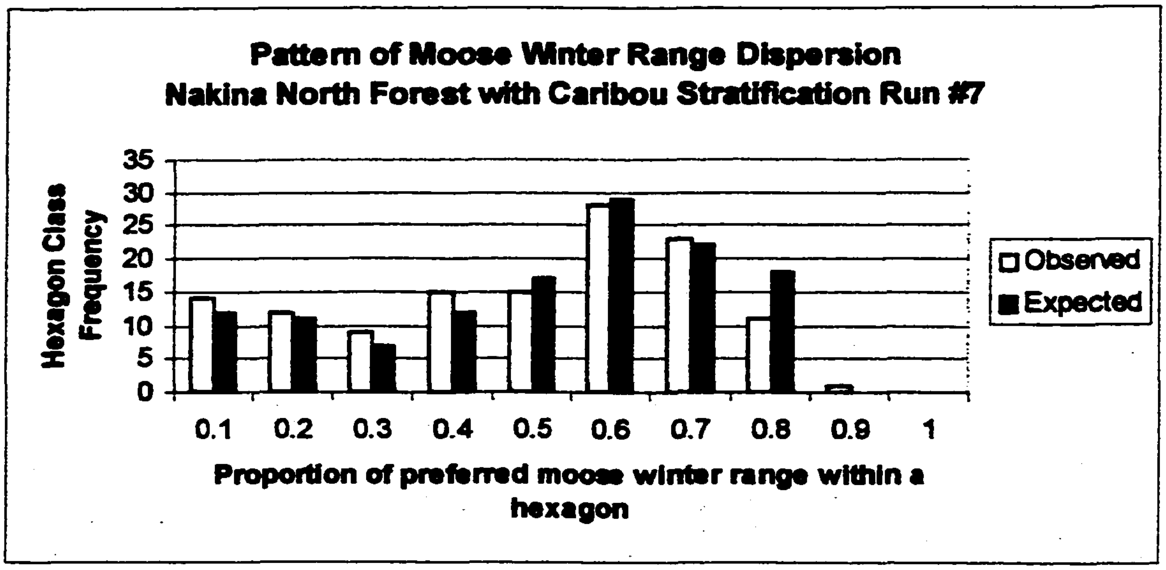
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #4

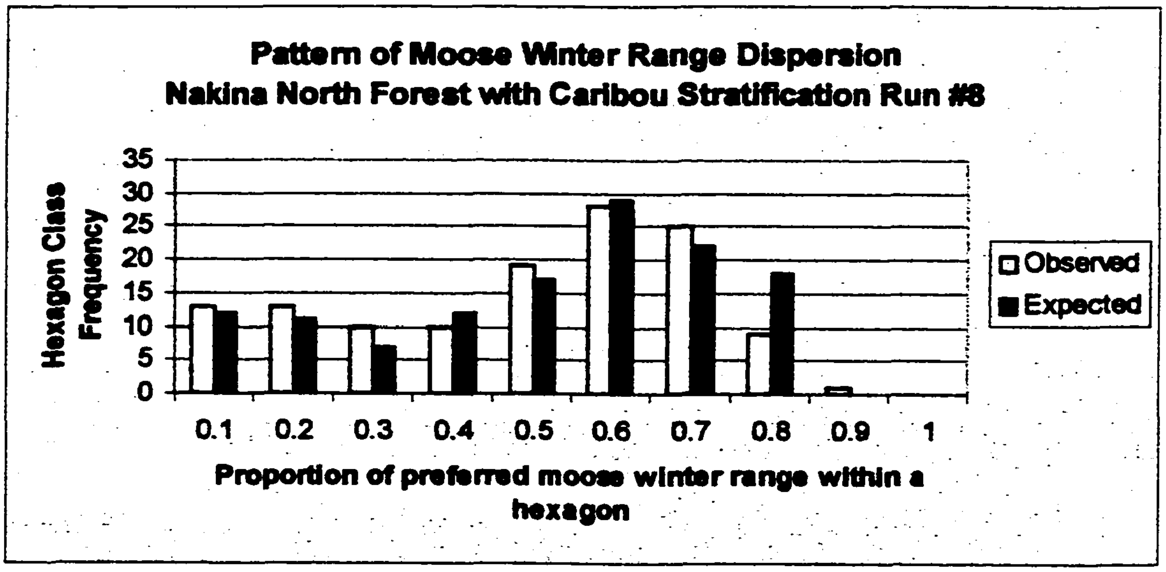


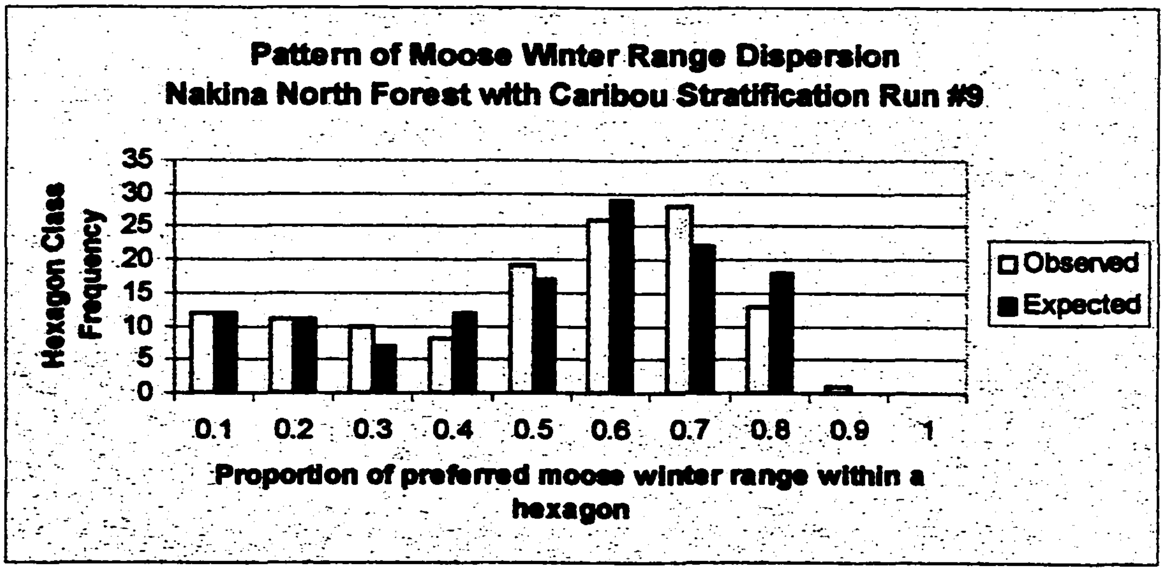
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #5

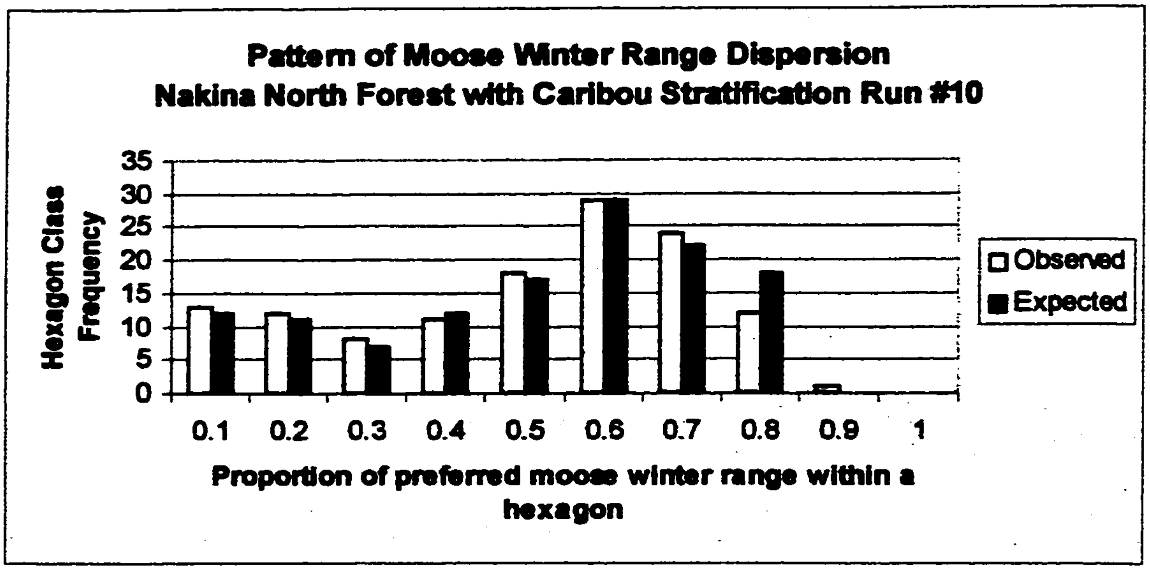


Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #6

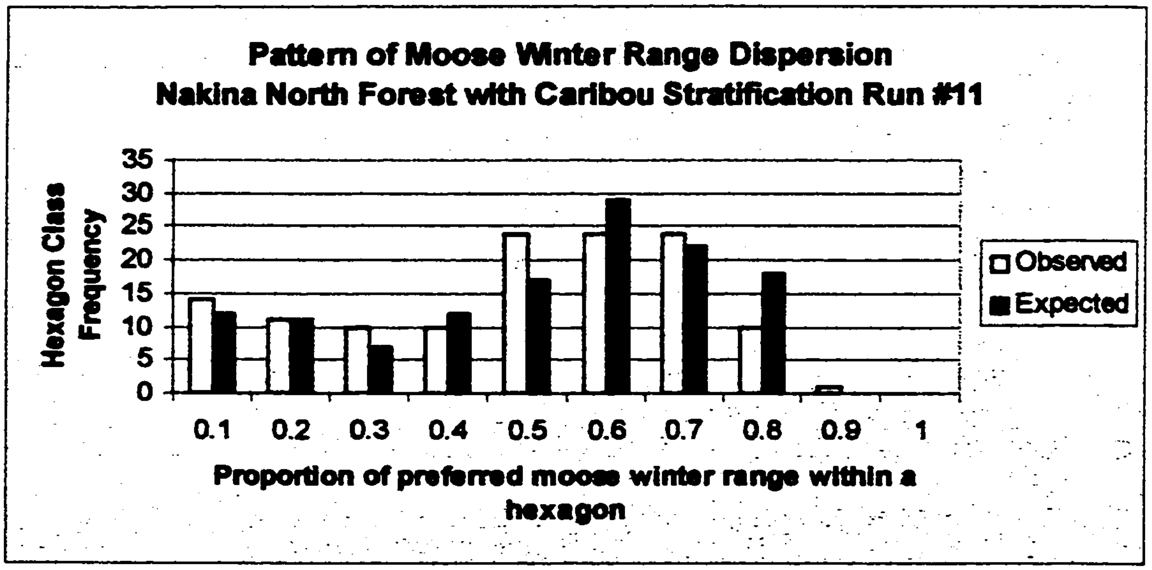

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #7
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected


Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #8
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

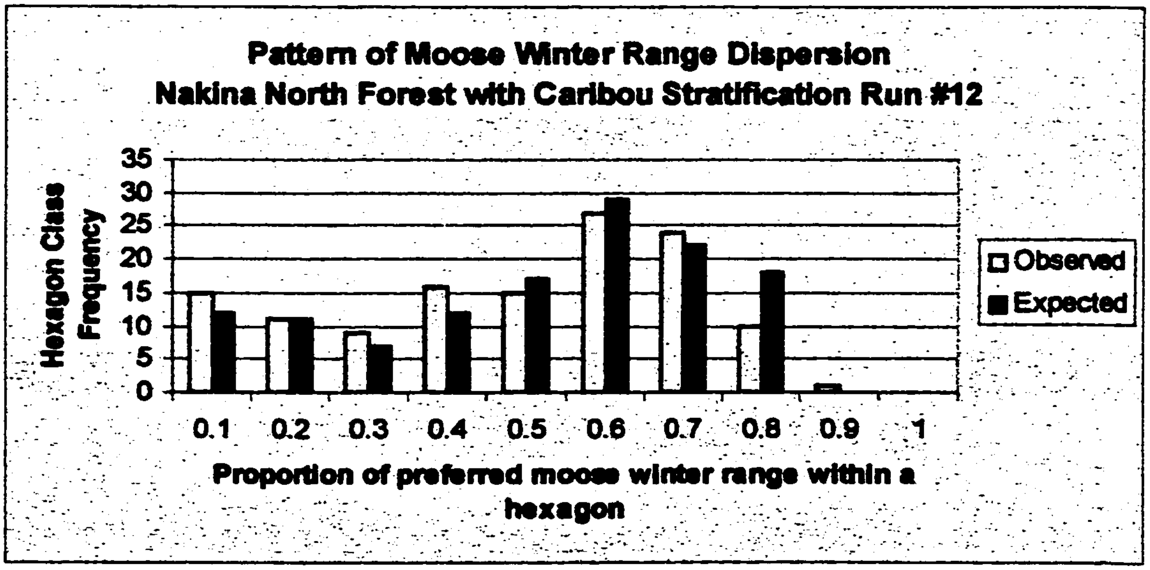

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #9
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected



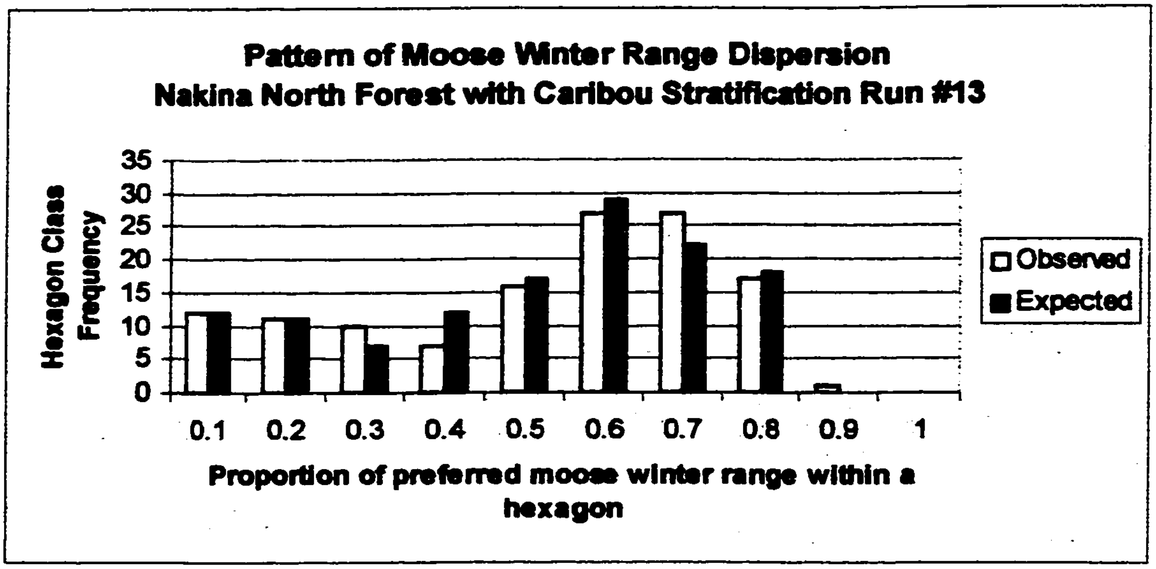
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #10

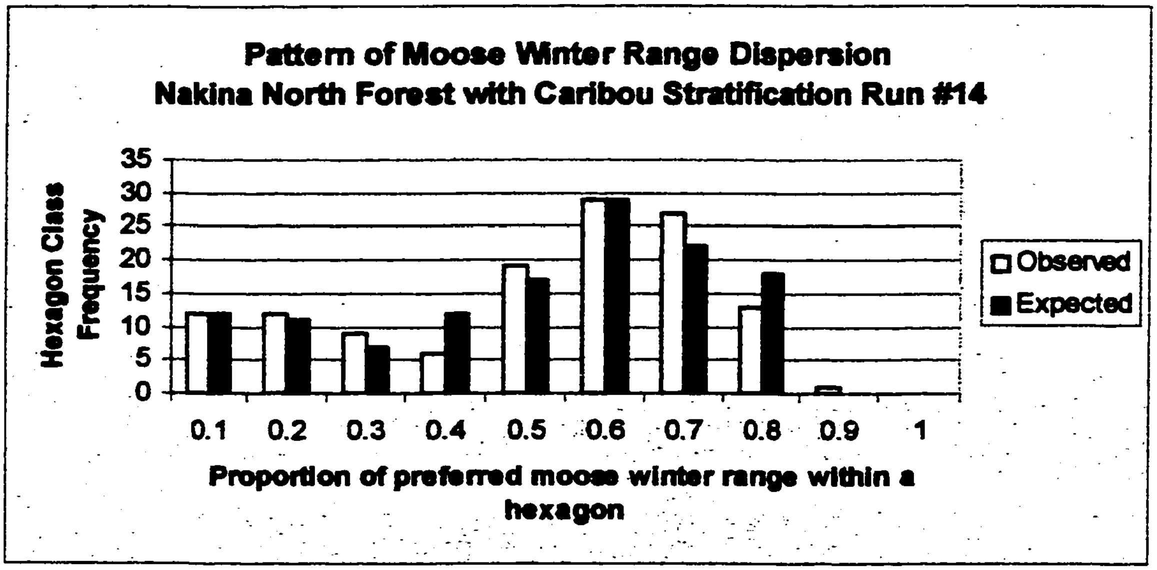


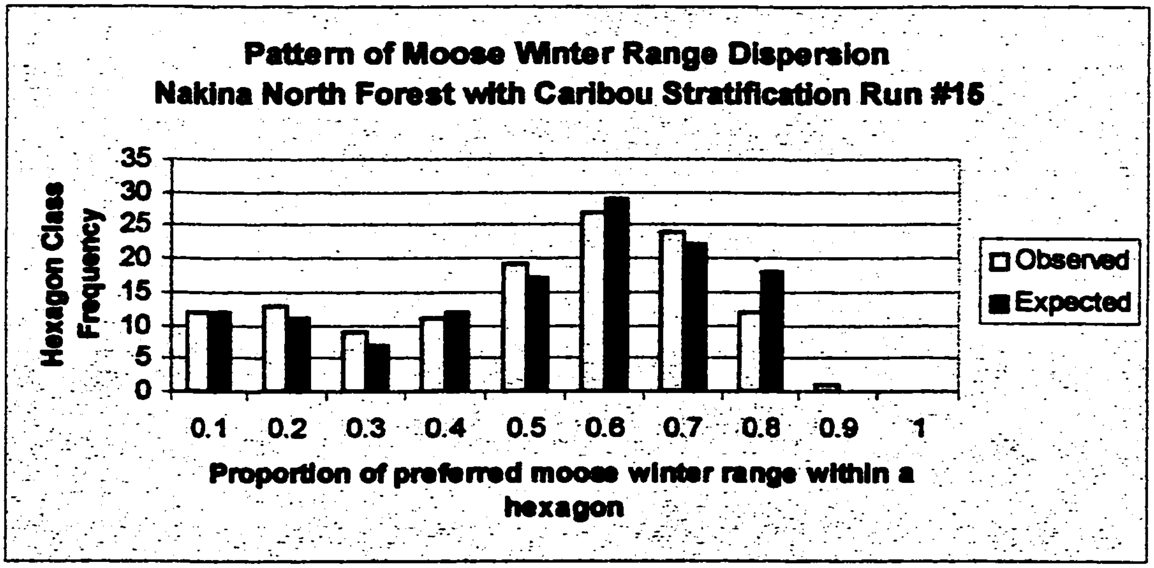
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #11

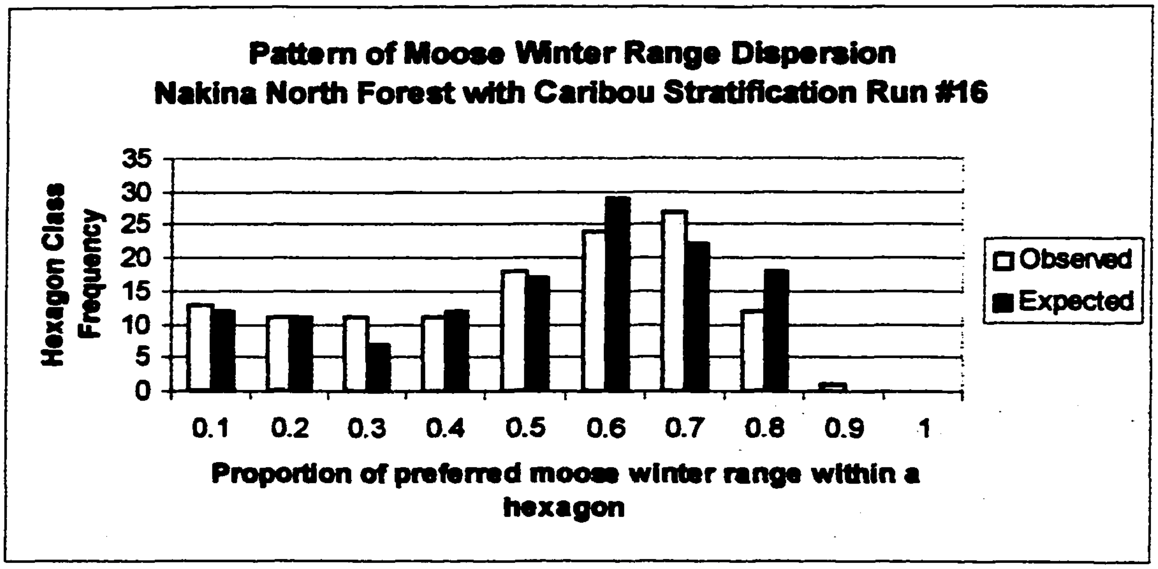


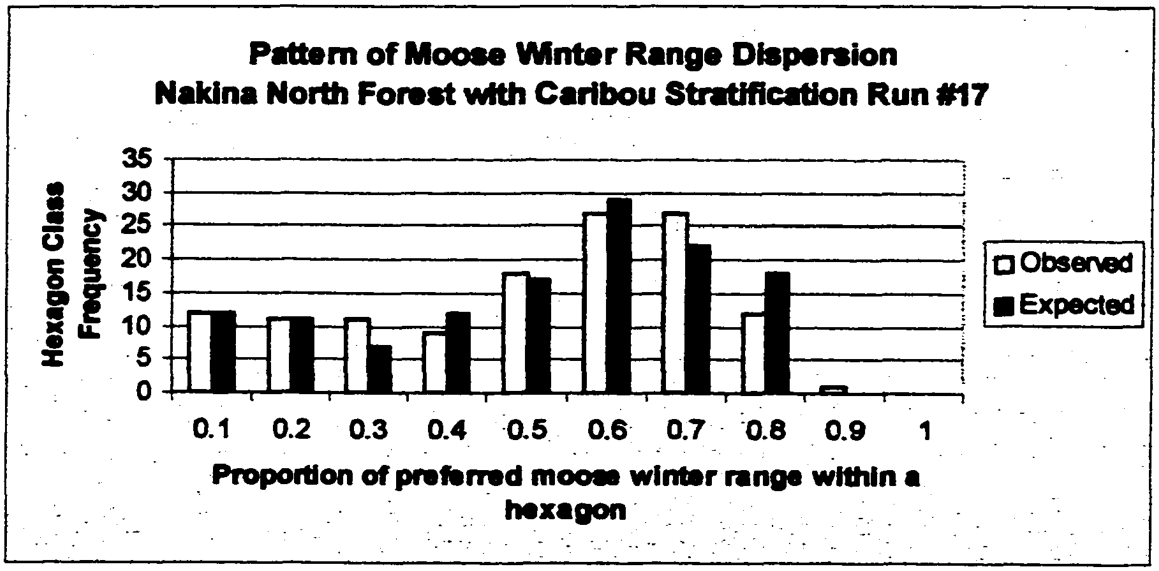
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #12

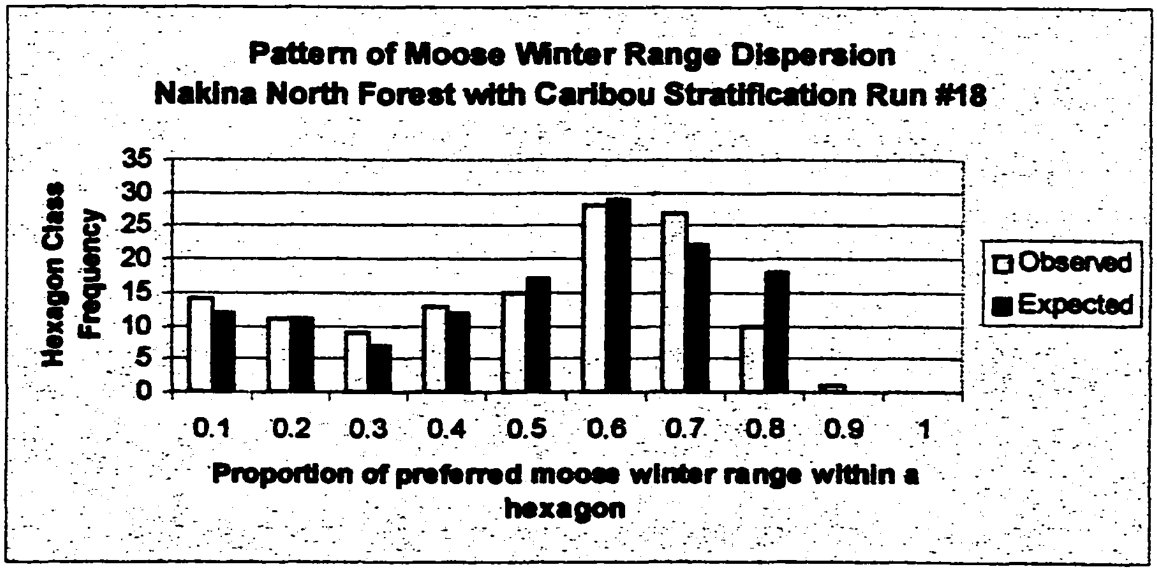

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #13
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

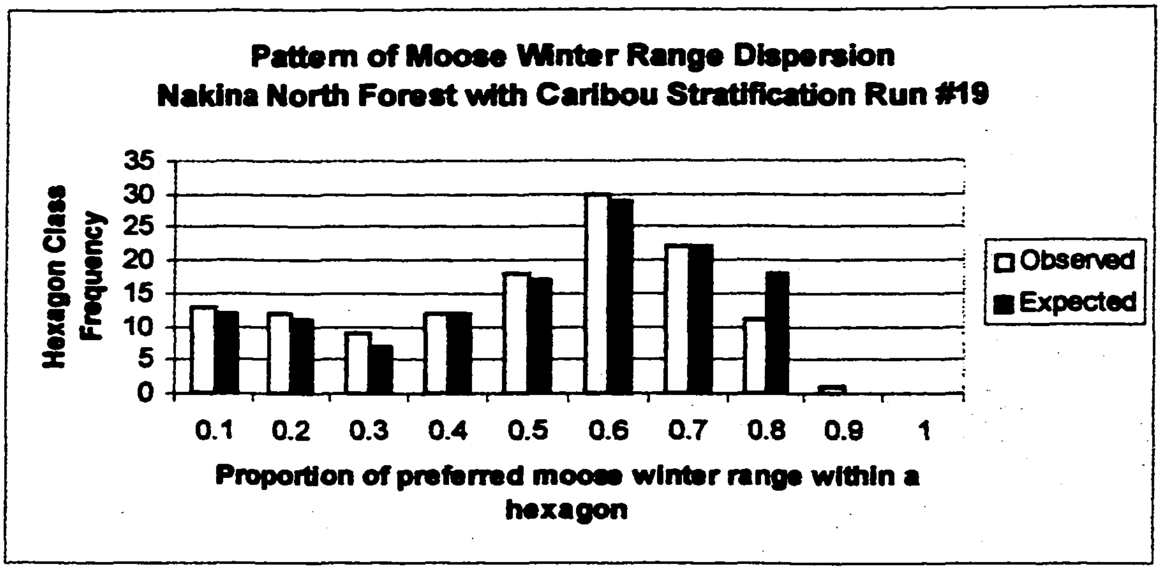

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #14
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

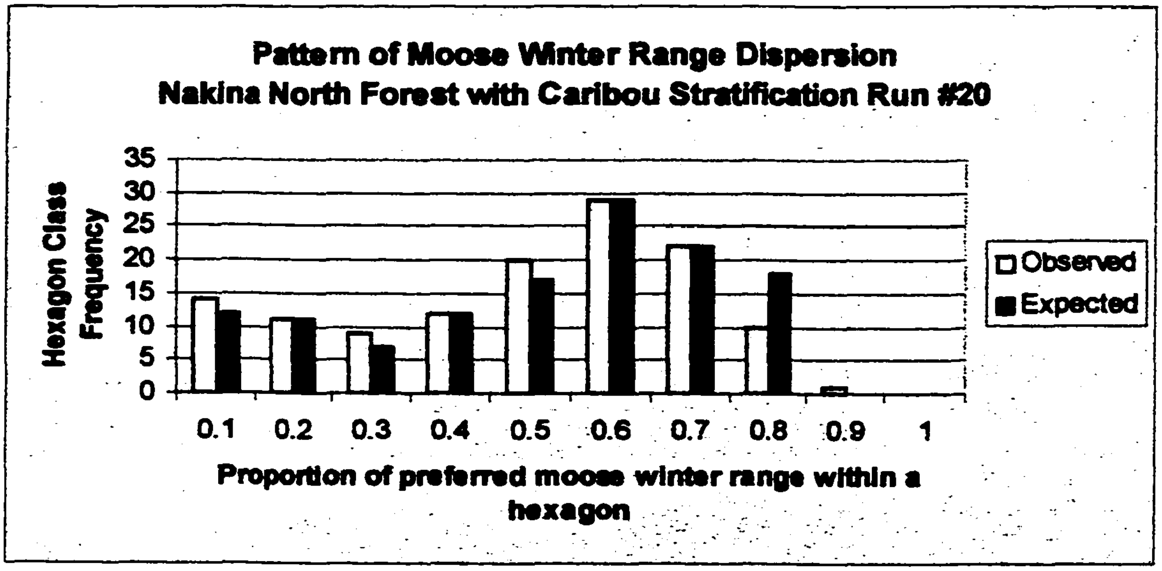

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #15
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

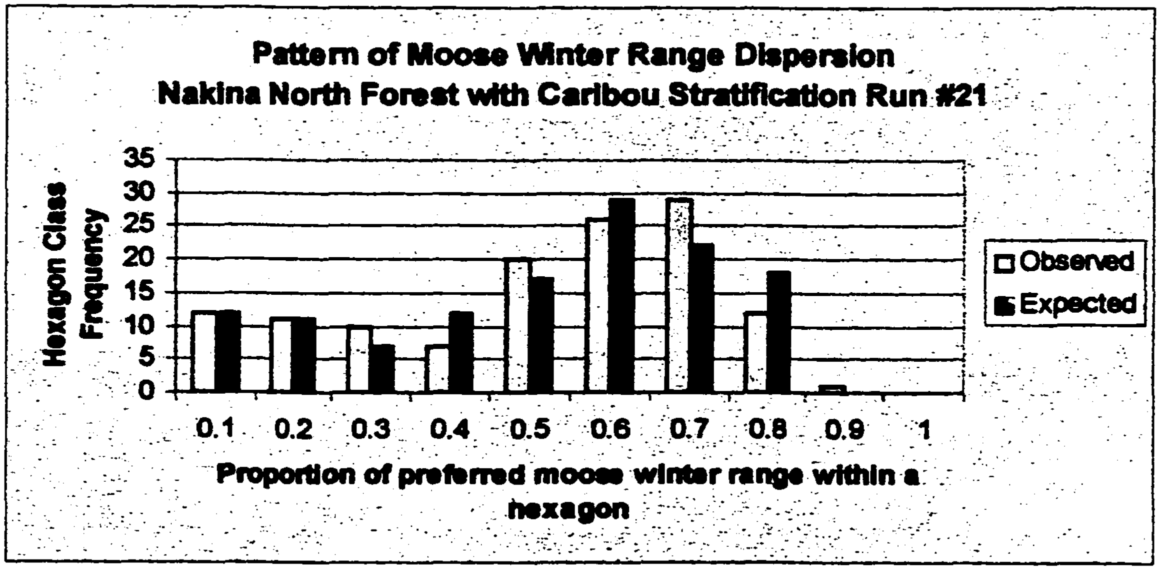

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #16
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

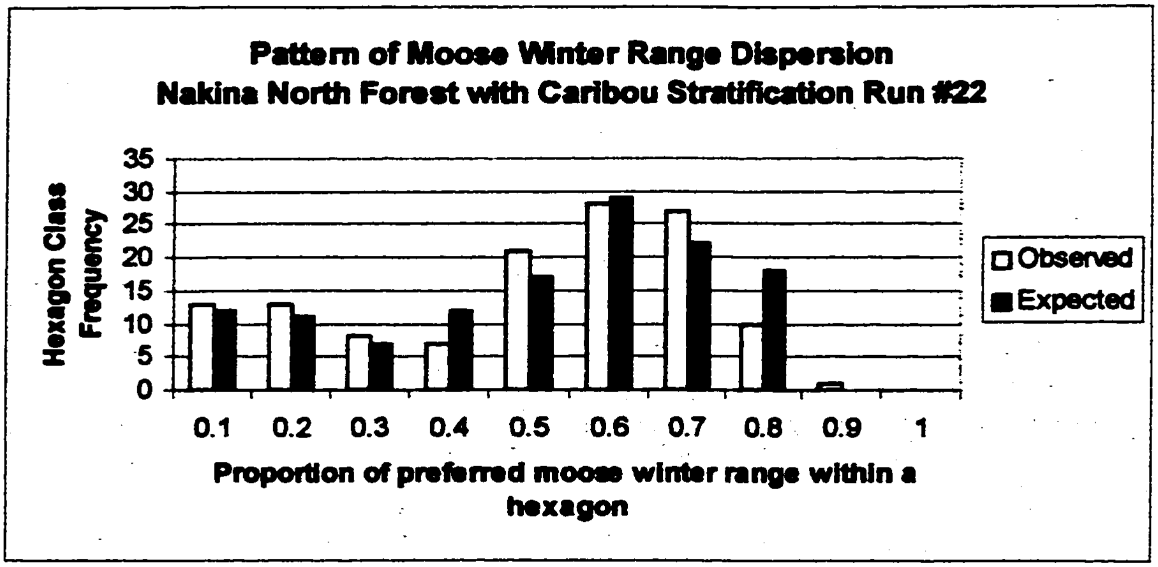

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #17
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

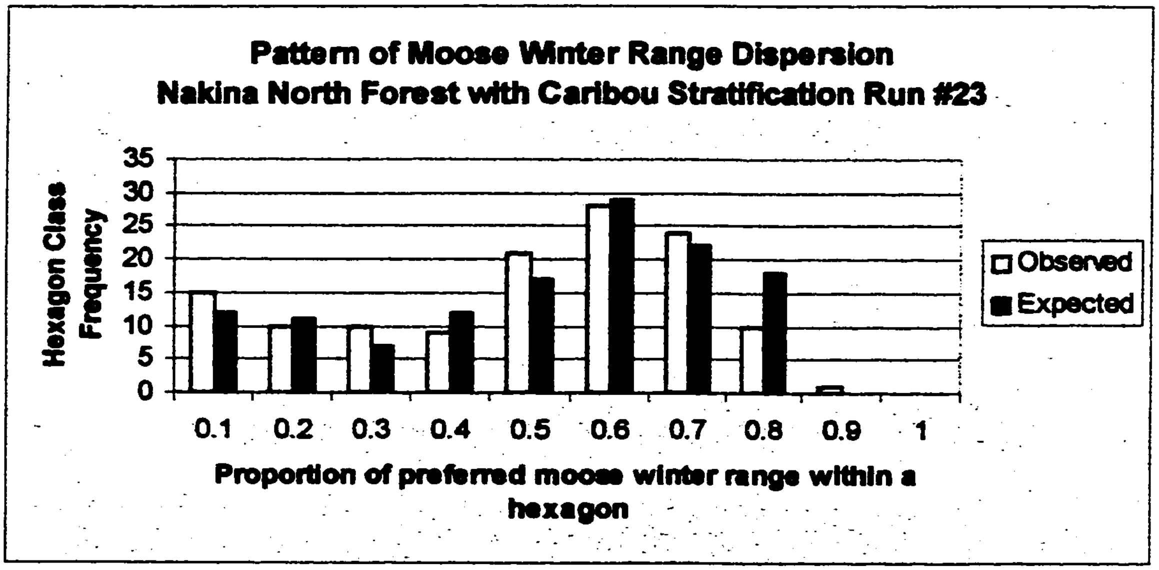

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #18
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

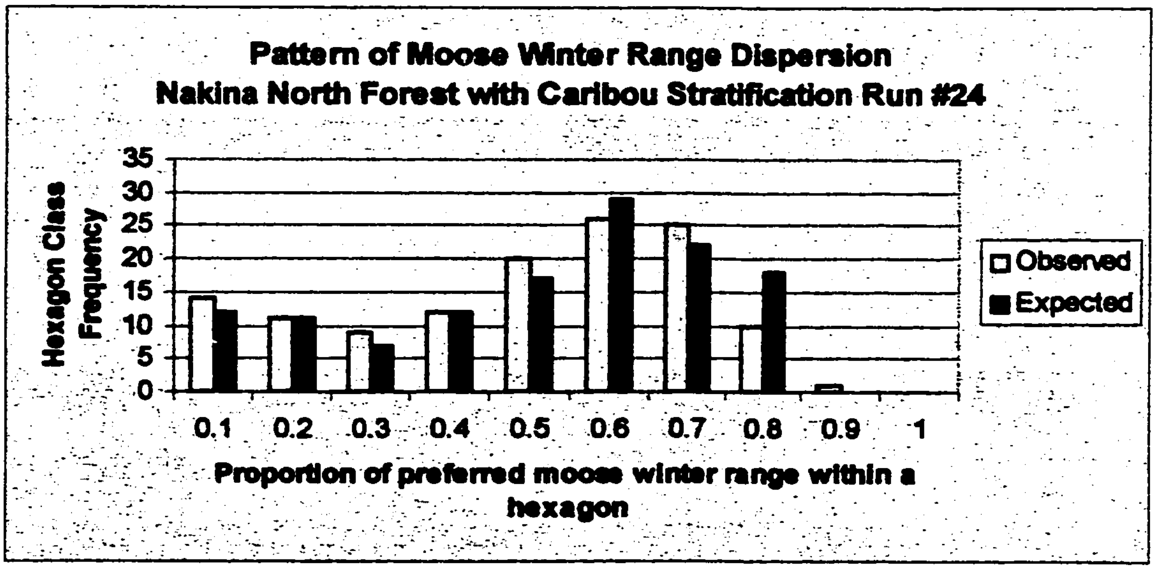

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #19

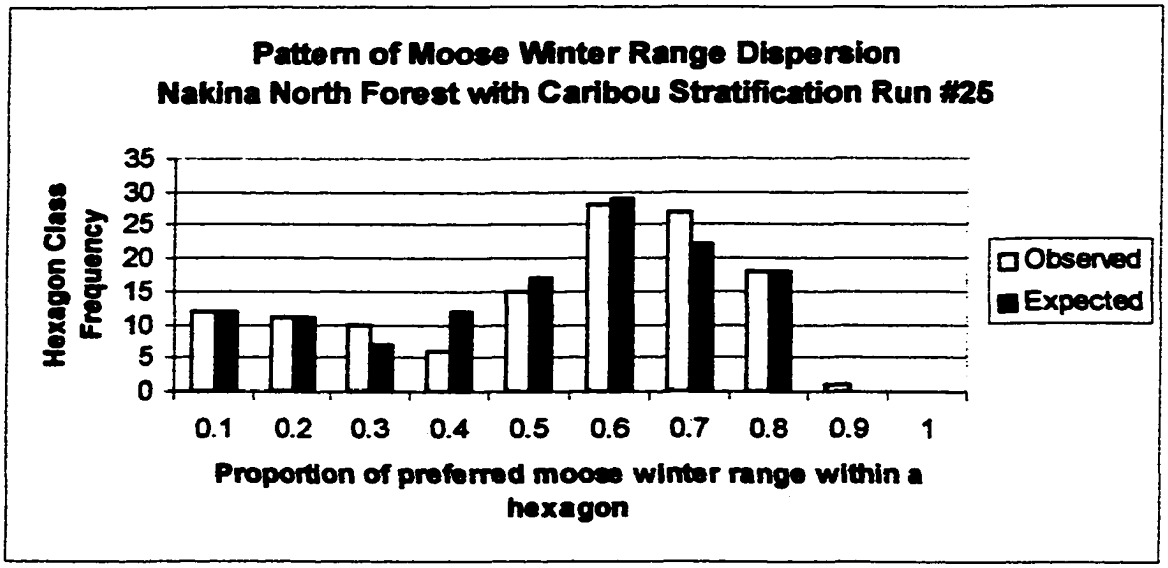

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #20

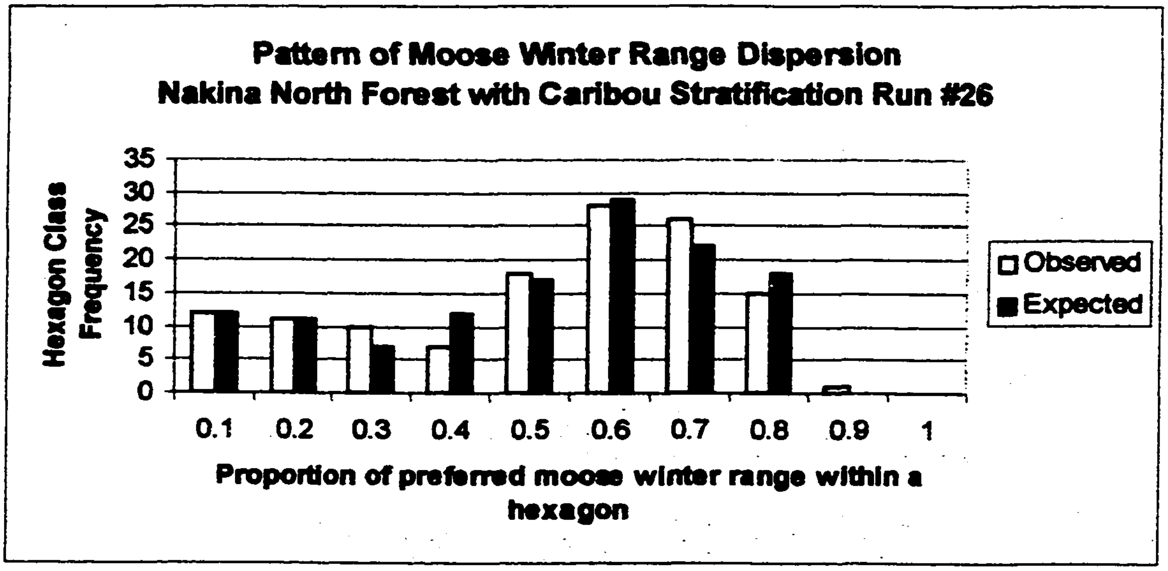

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #21

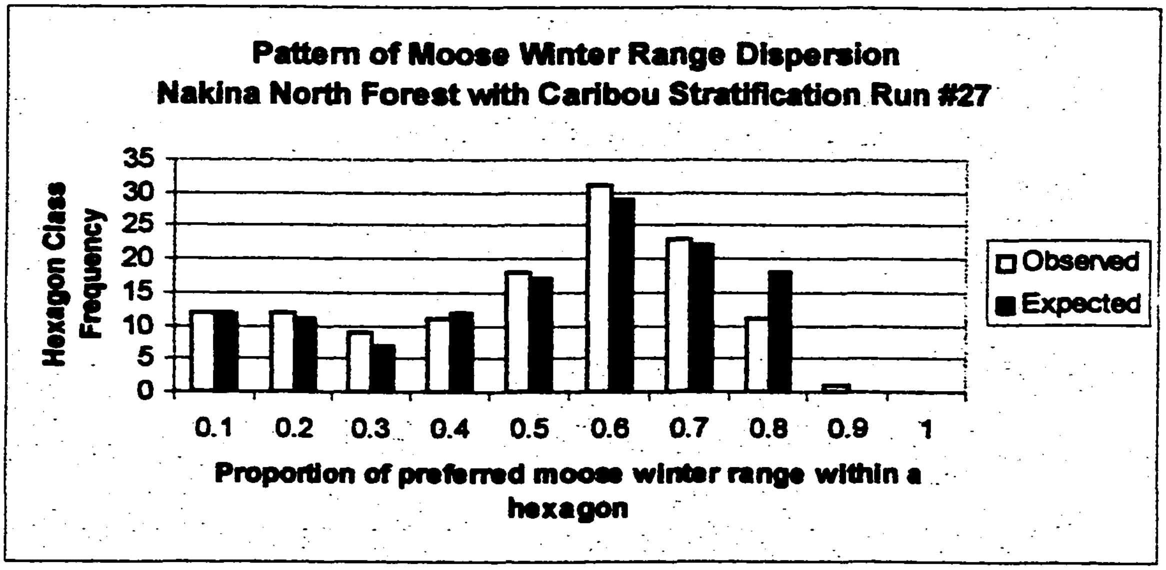

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #22
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

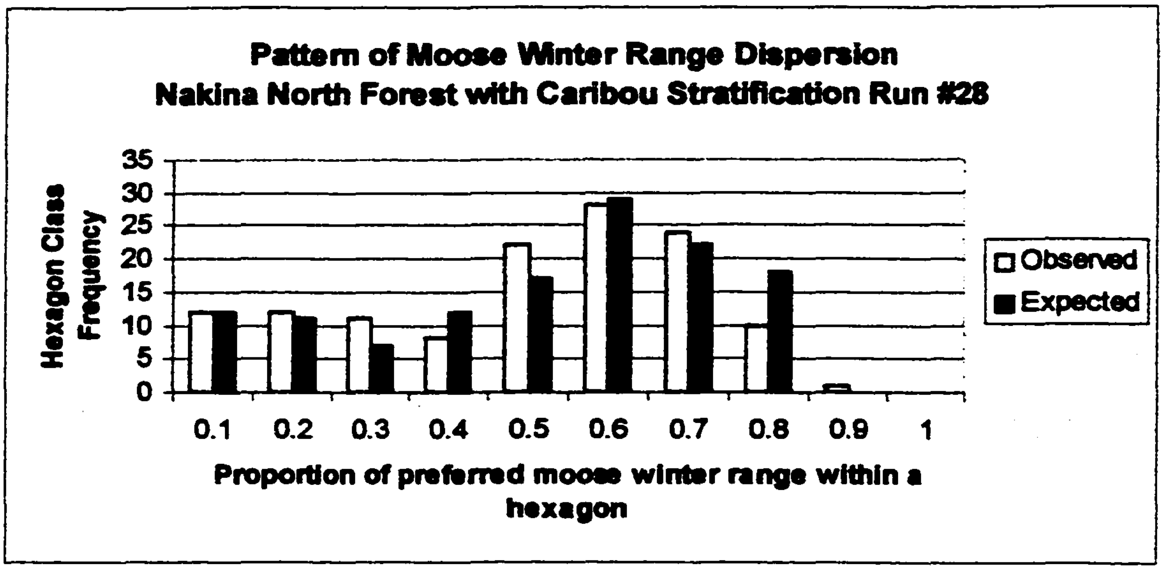

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #23
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

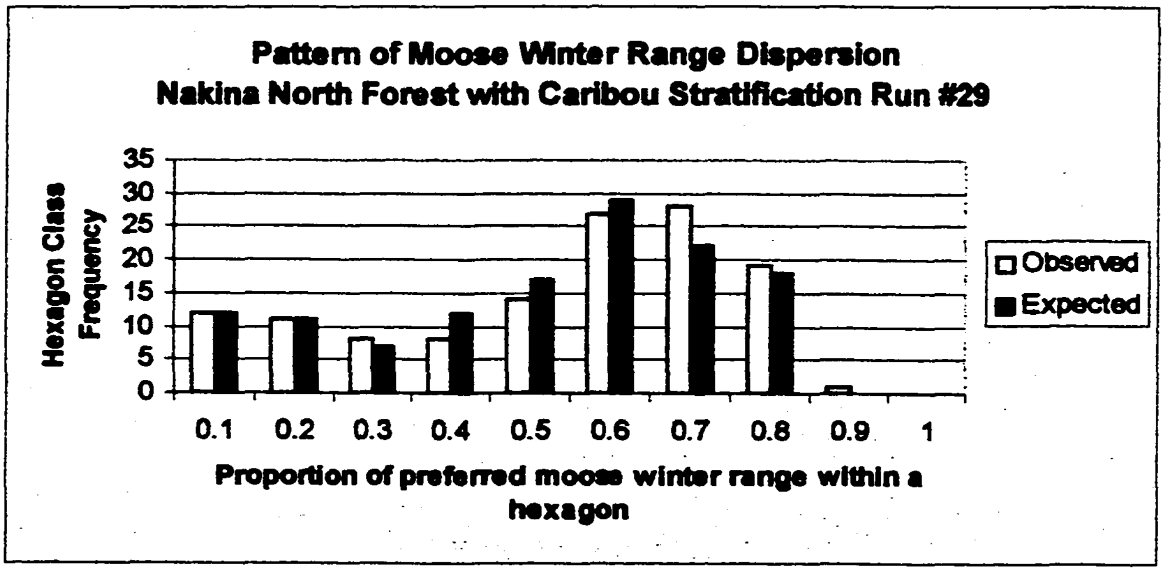

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #24
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
☐ Observed
■ Expected

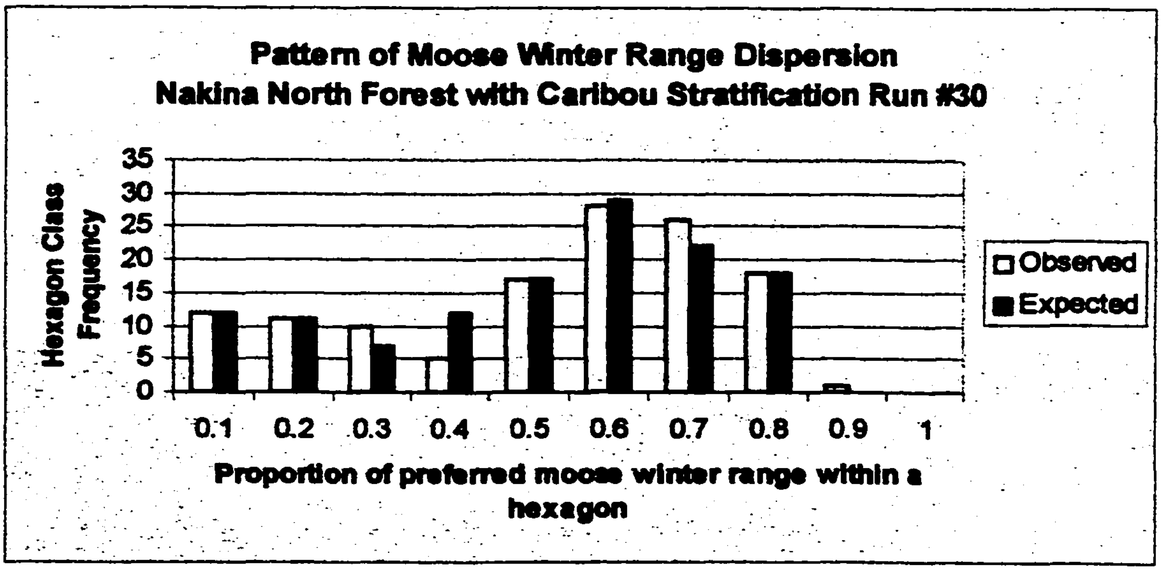

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #25
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

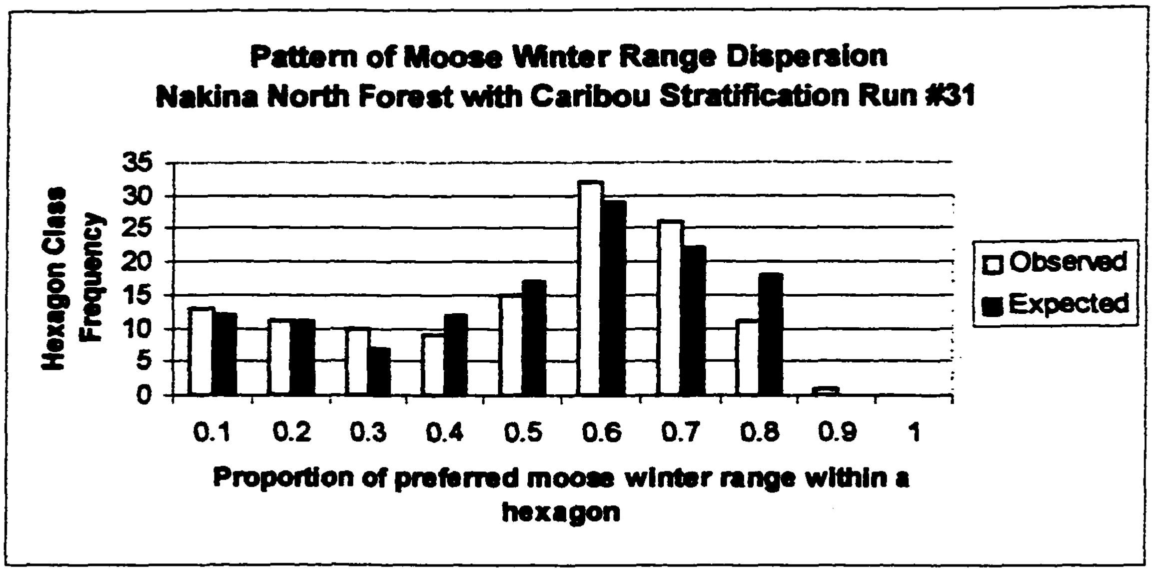

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #26
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected


Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #27
Hexagon Class Frequency
35
30
25
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose winter range within a hexagon
□ Observed
■ Expected

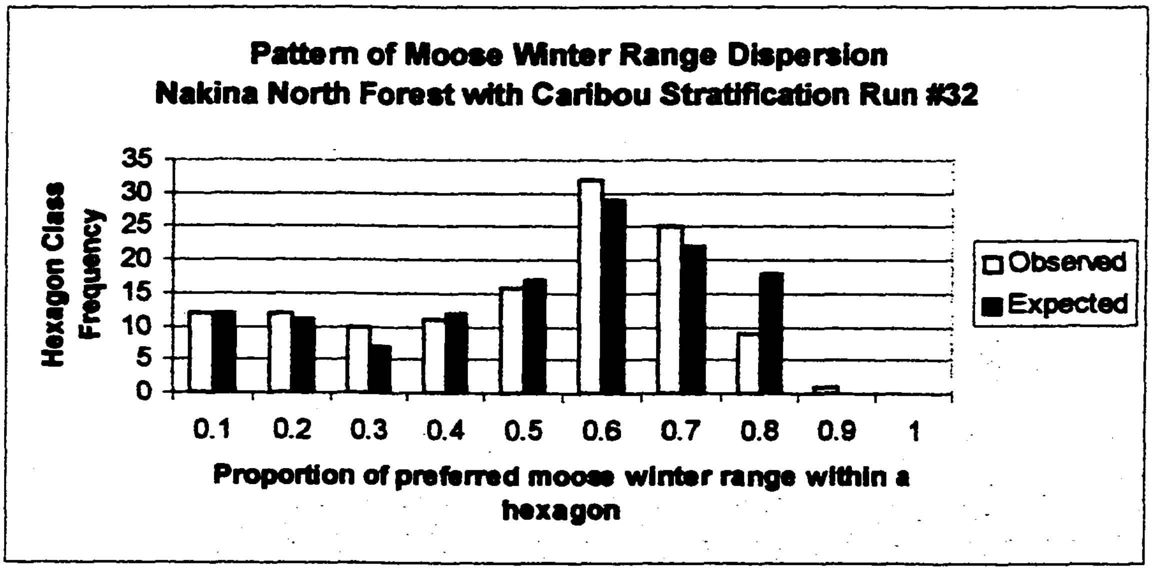

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #28


Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #29

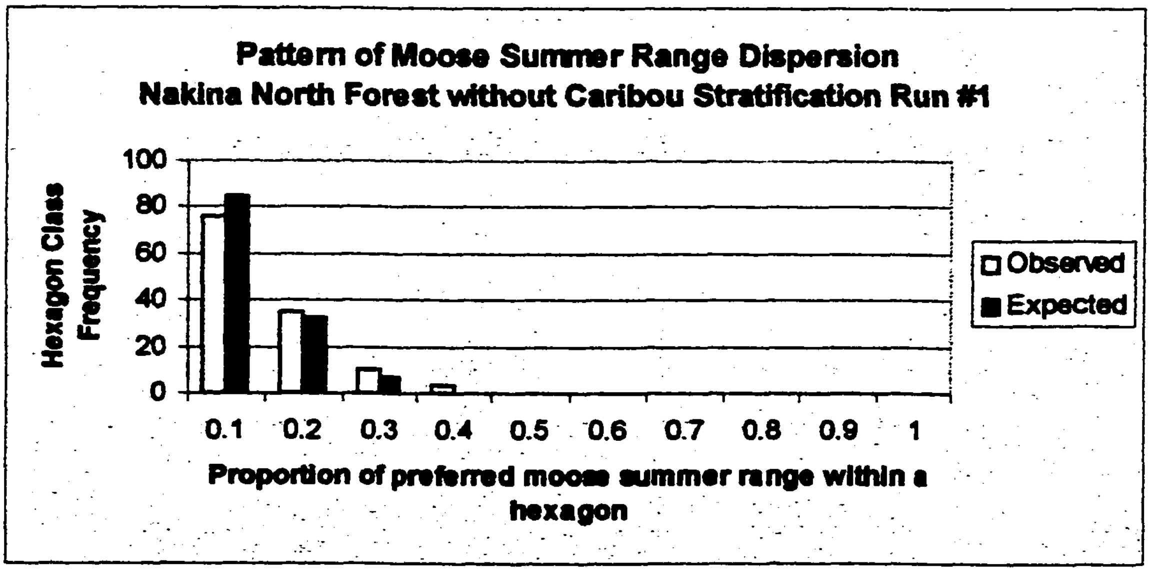

Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #30



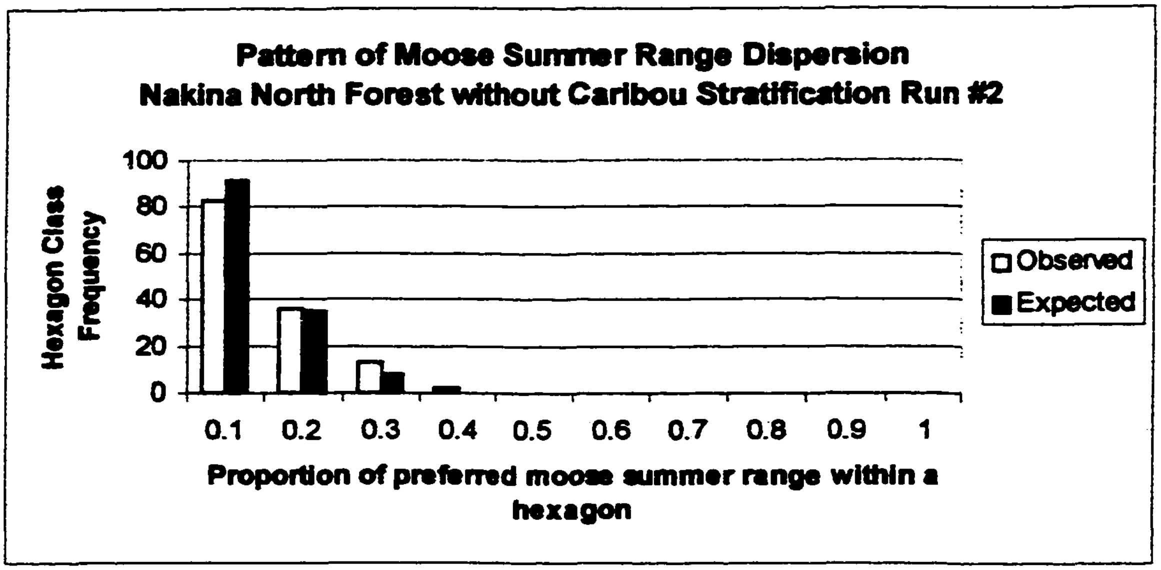
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #31

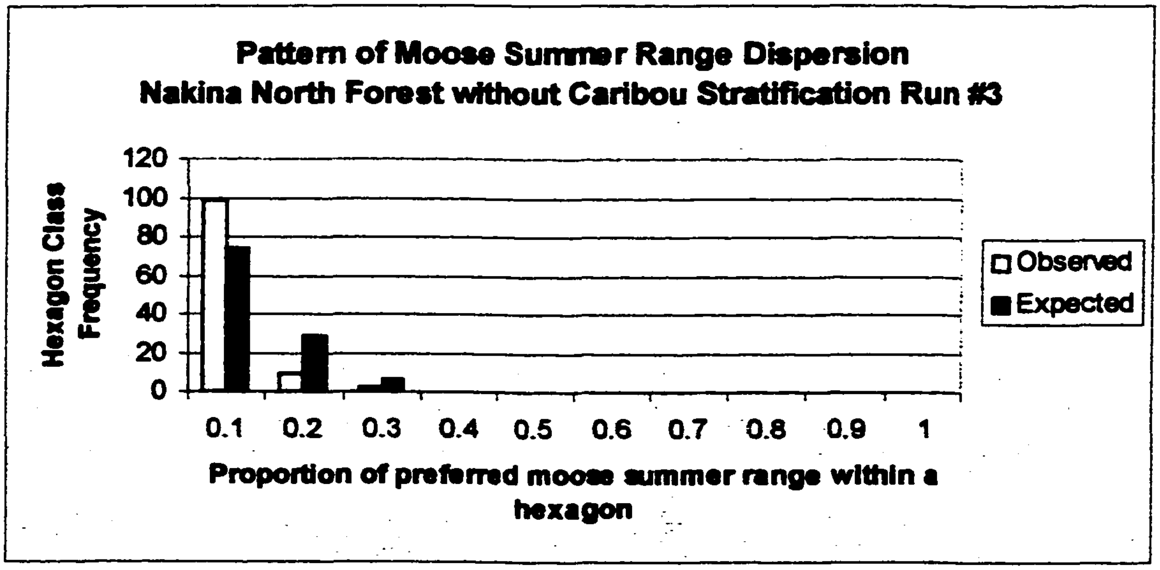


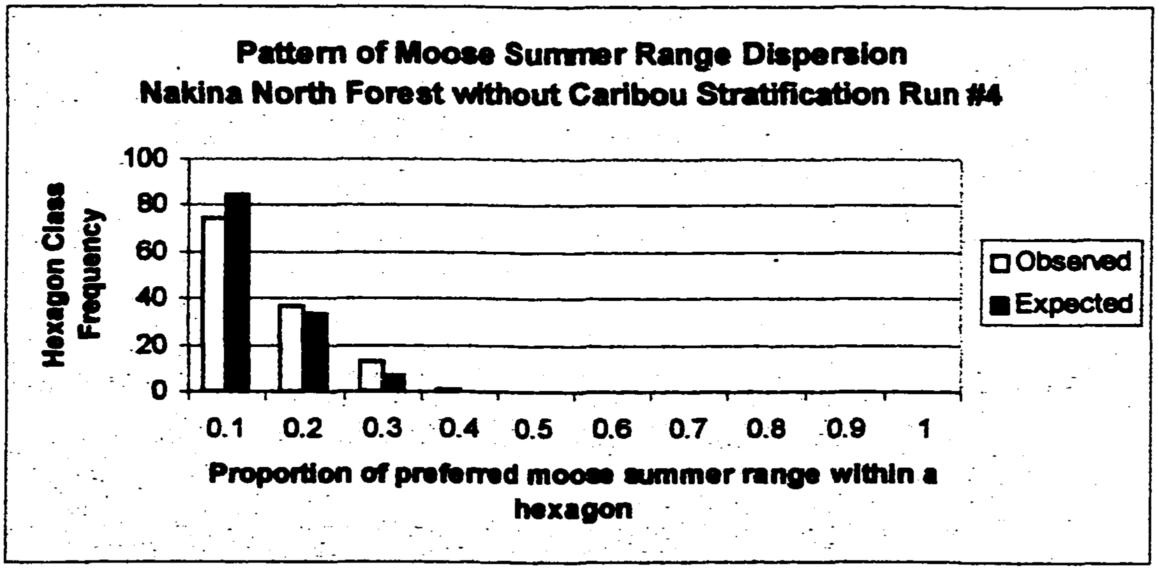
Pattern of Moose Winter Range Dispersion
Nakina North Forest with Caribou Stratification Run #32

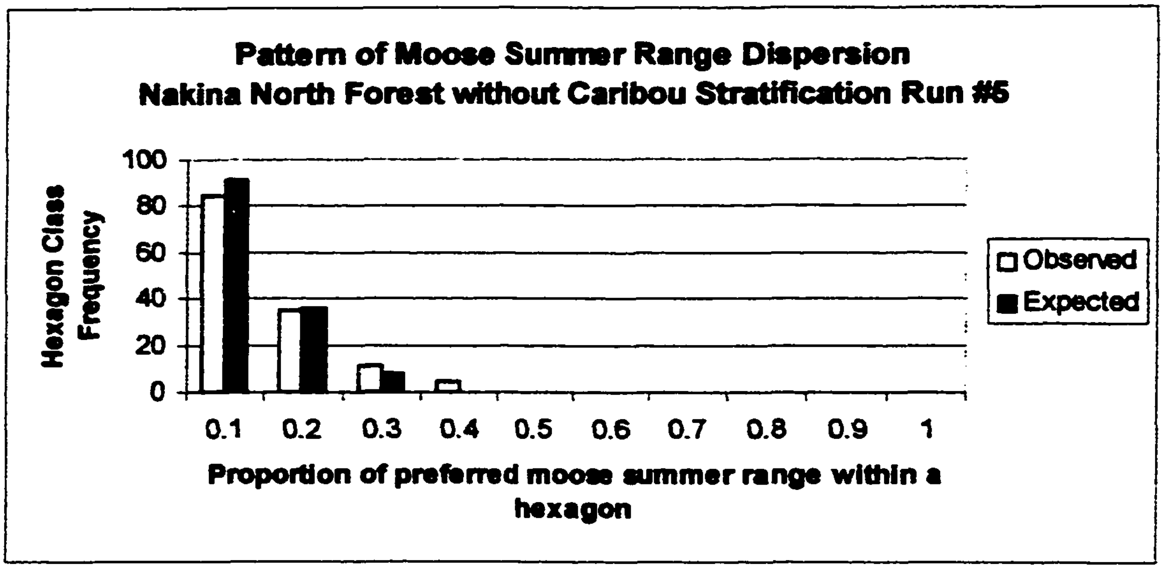


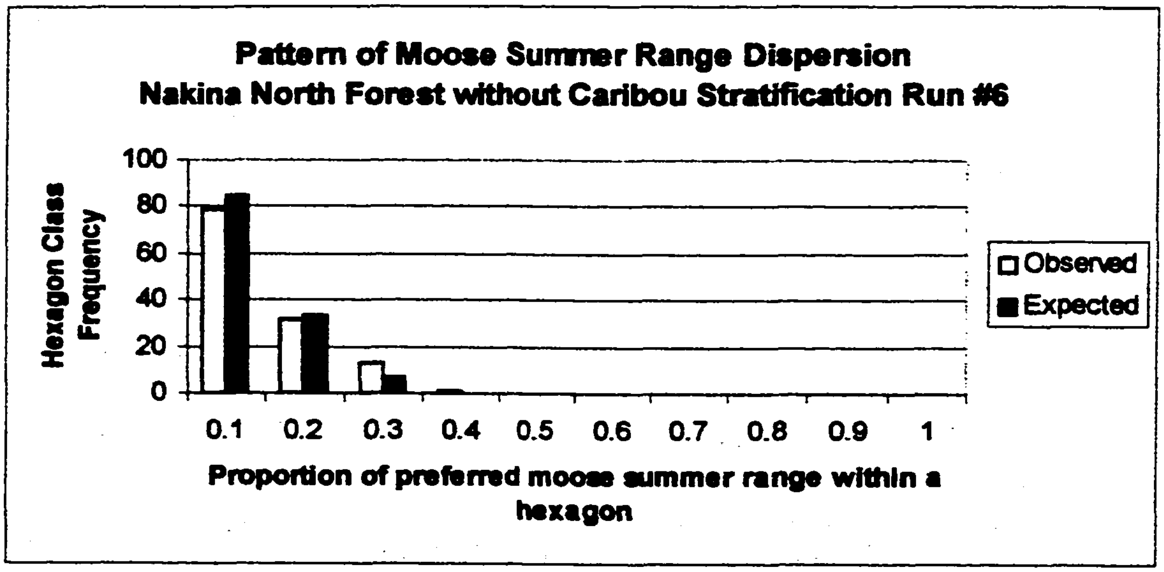
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #1

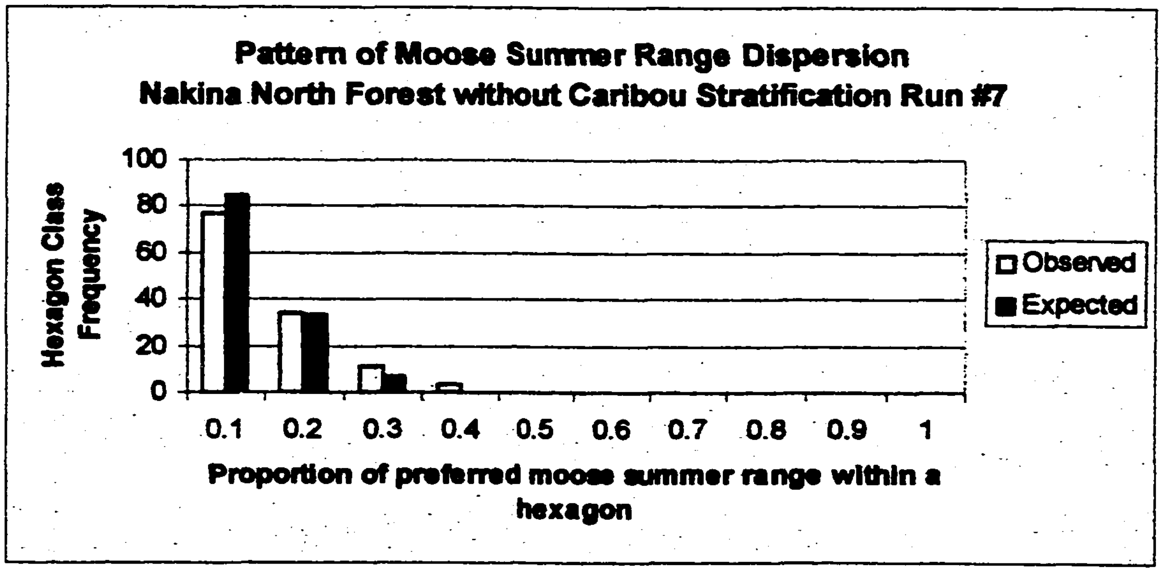

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #2
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

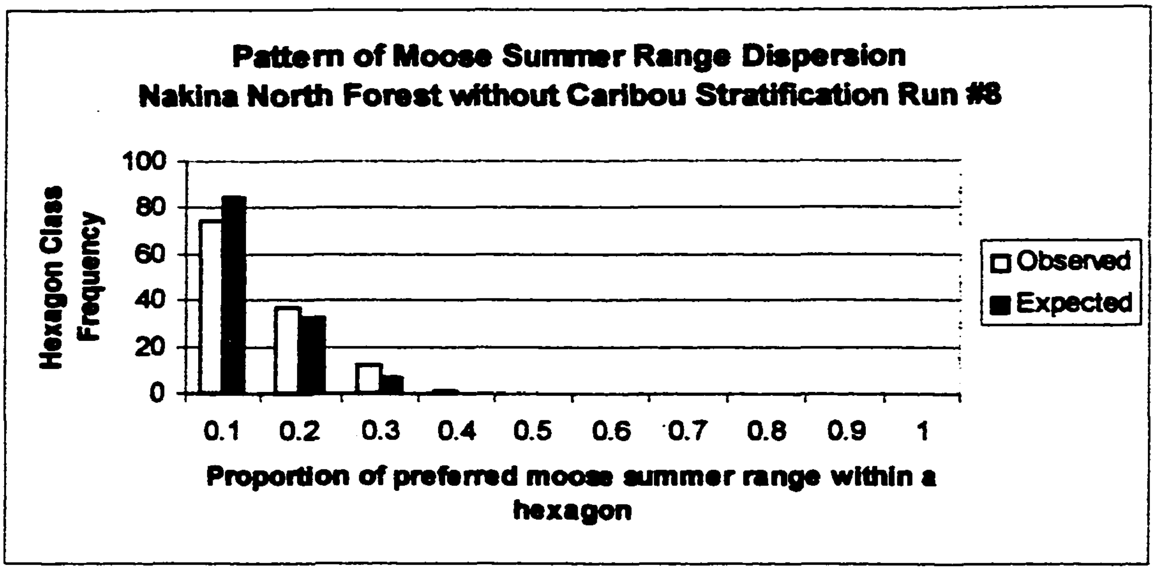

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #3
Hexagon Class Frequency
120
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

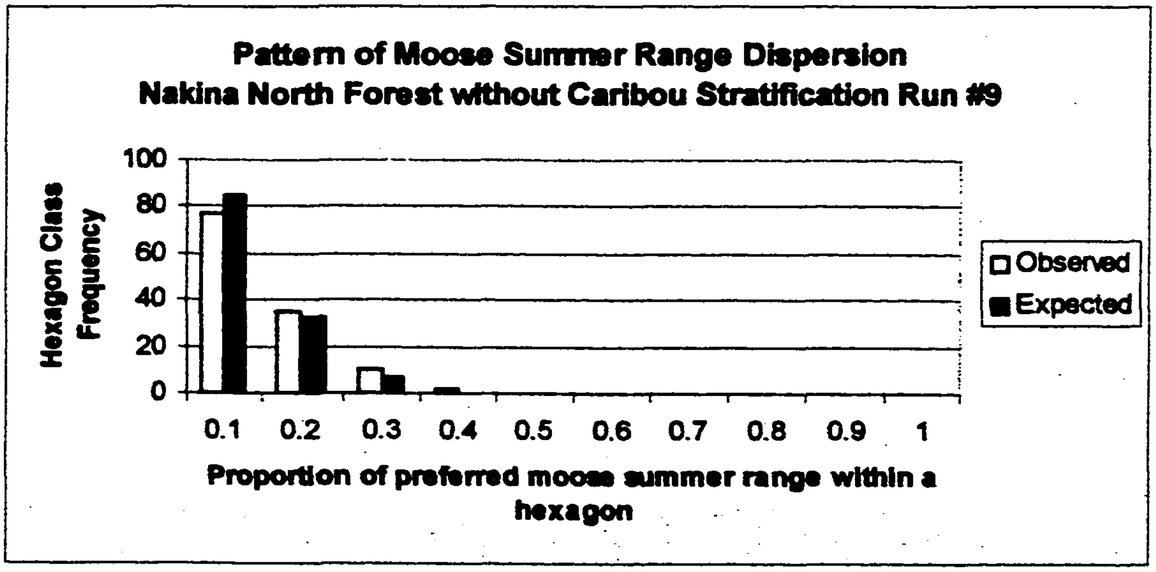

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #4
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

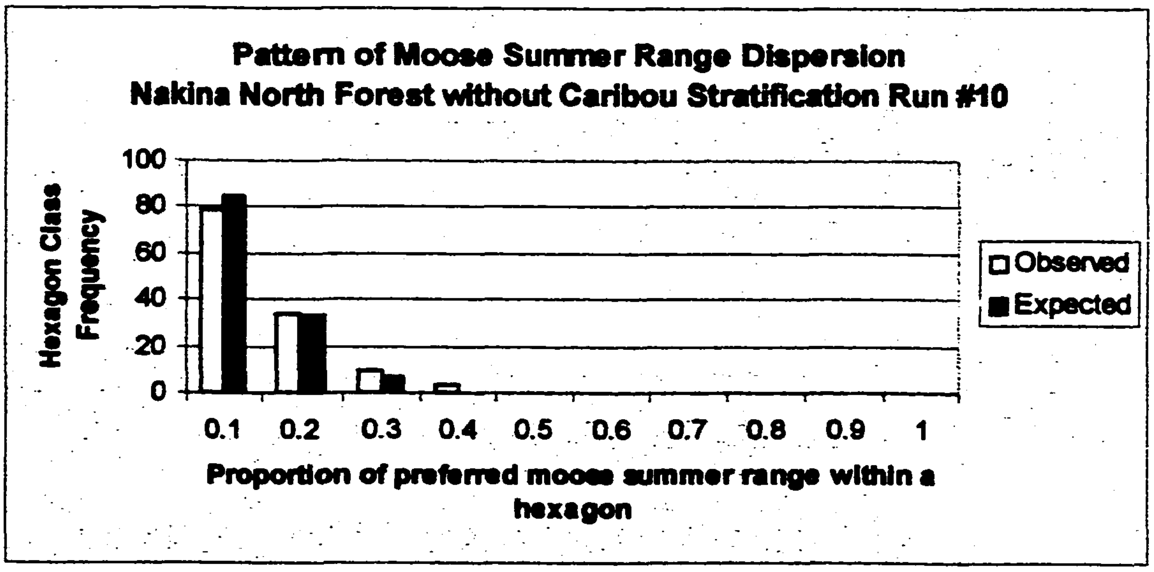

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #5
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

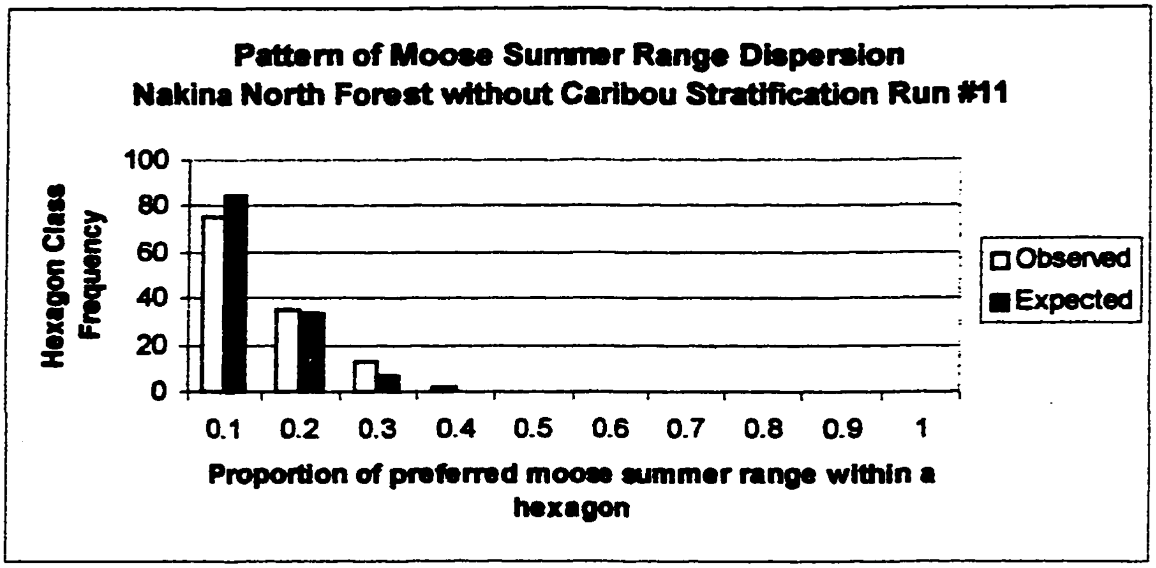

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #6
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

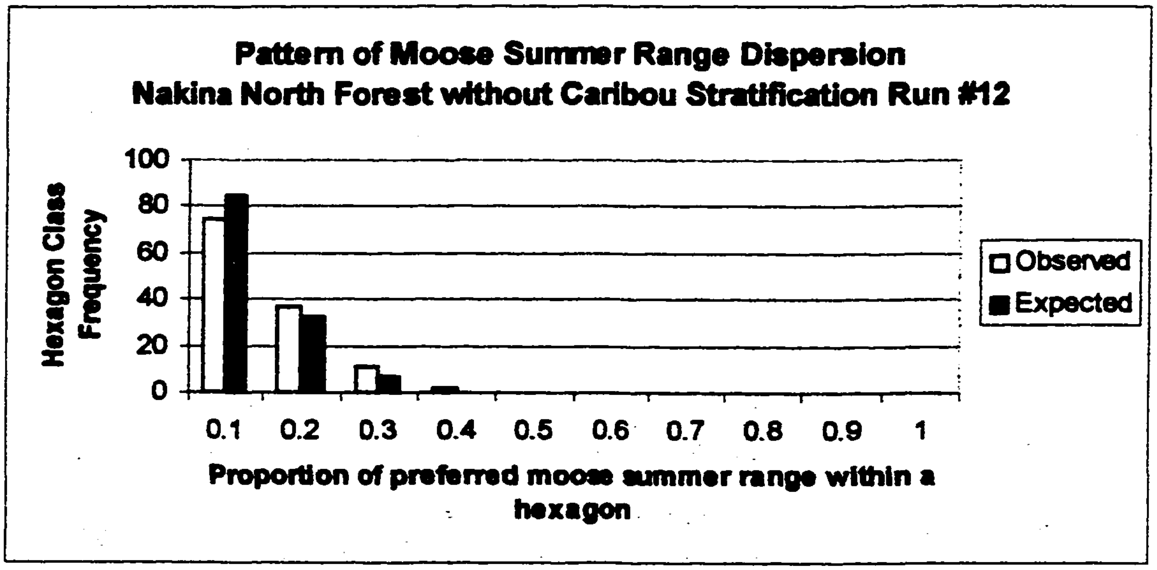

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #7
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

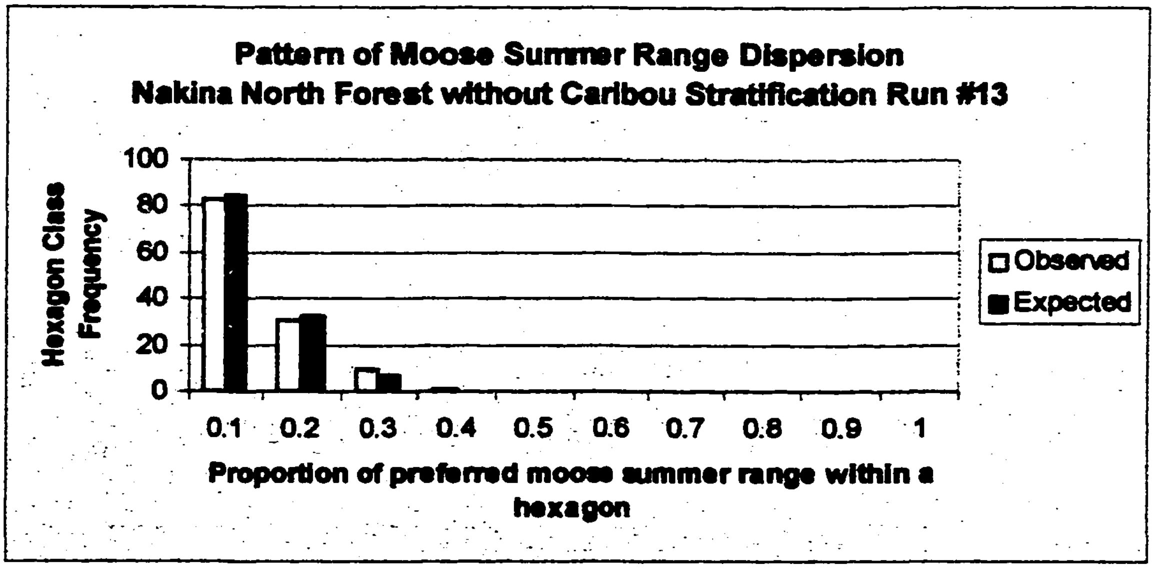

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #8

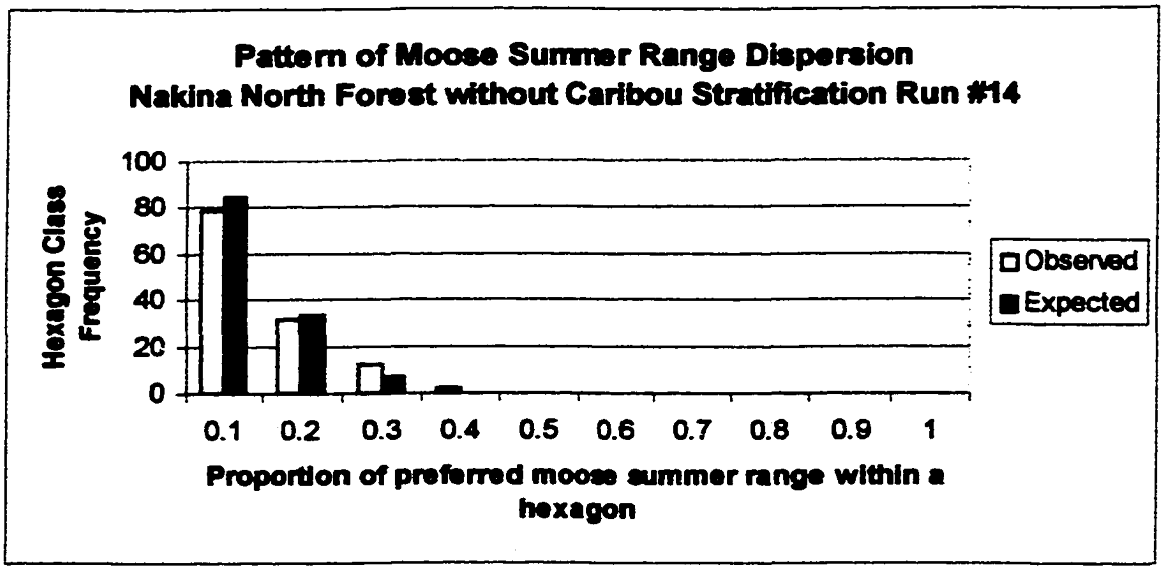

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #9

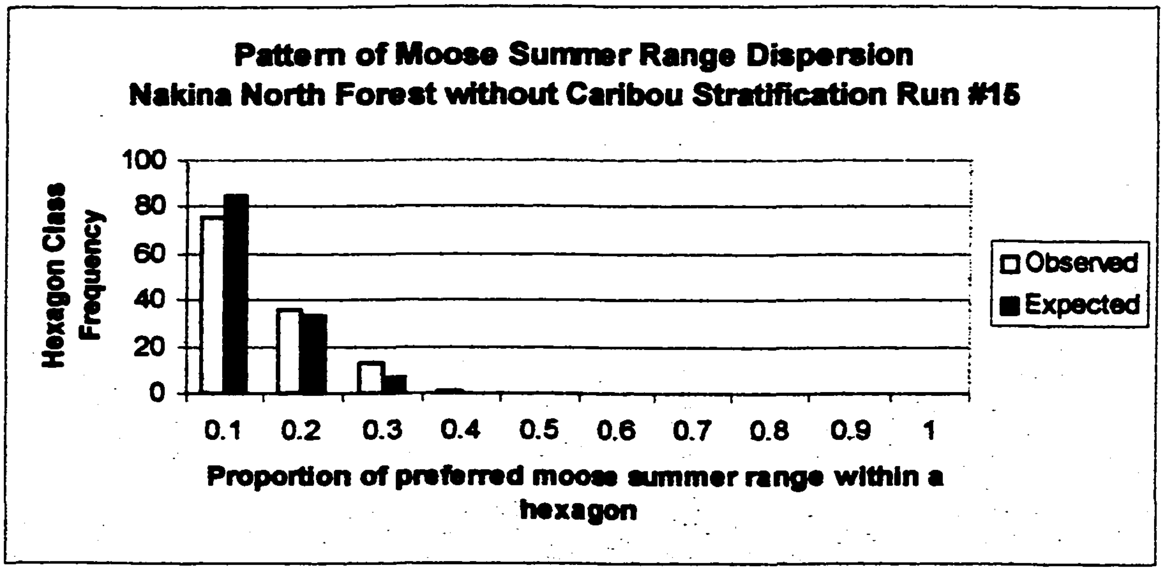

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #10

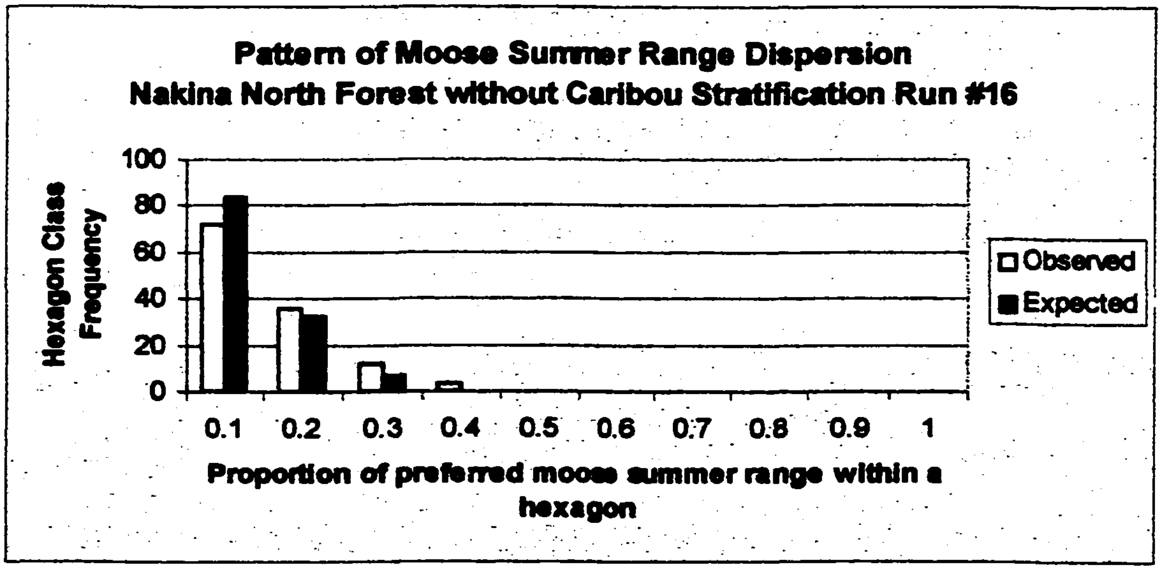

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #11
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

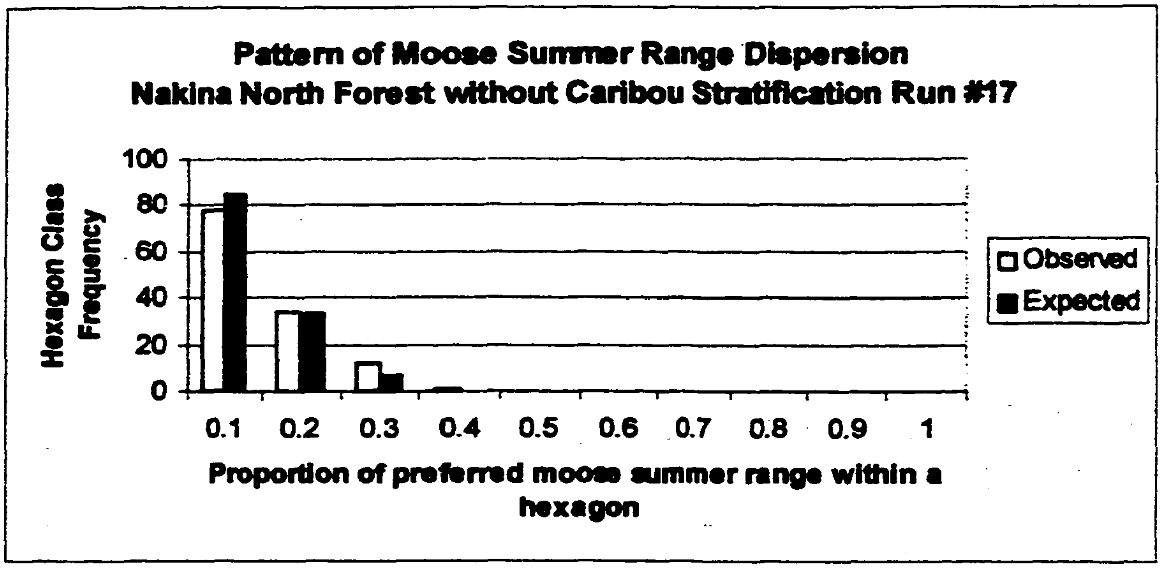

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #12
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

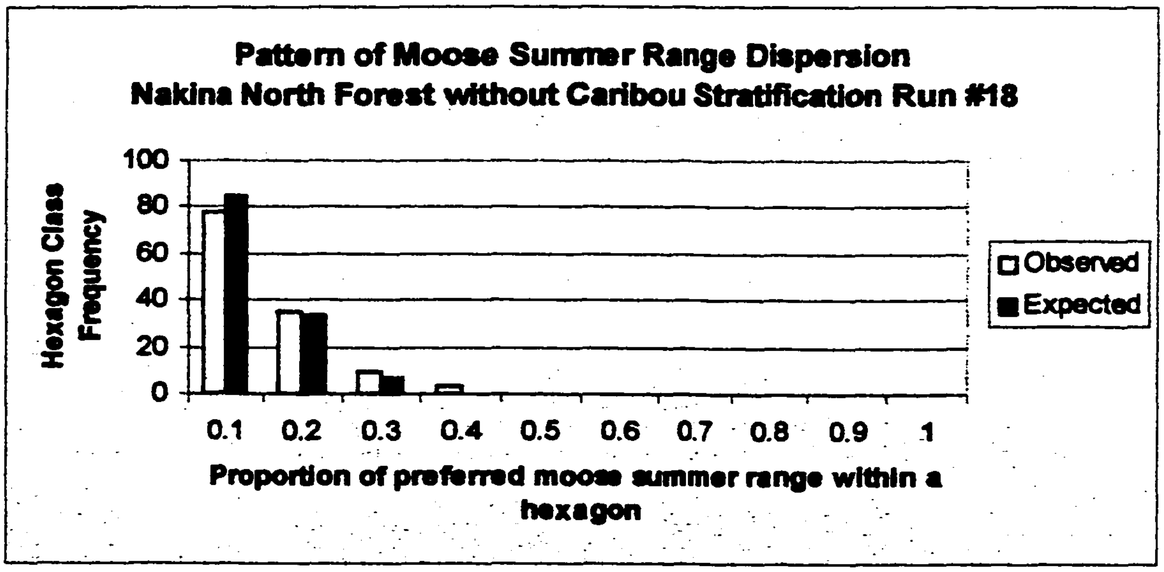

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #13
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

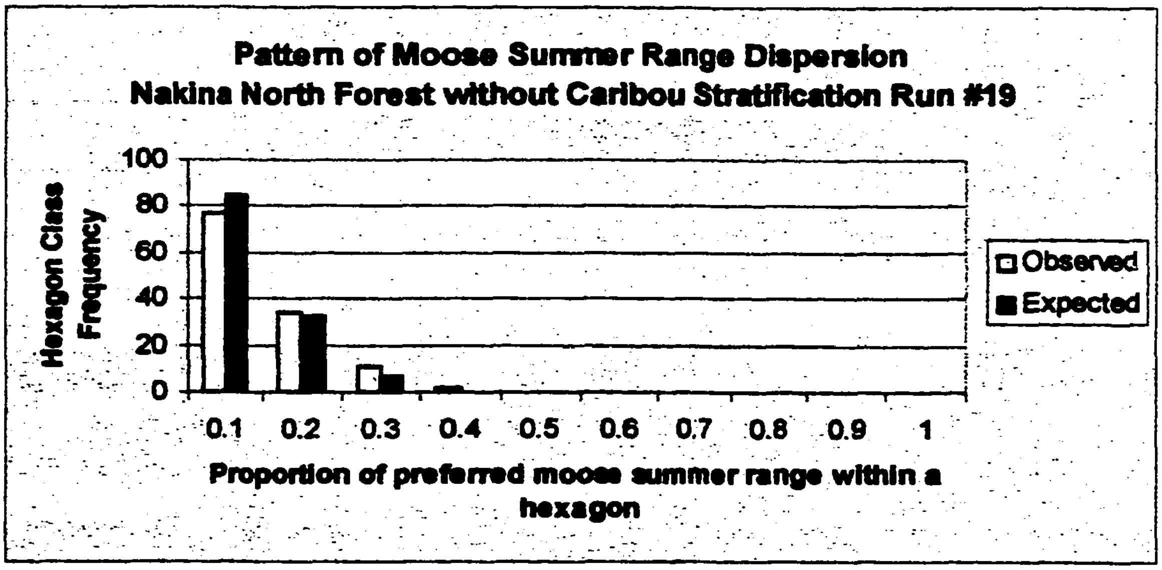

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #14

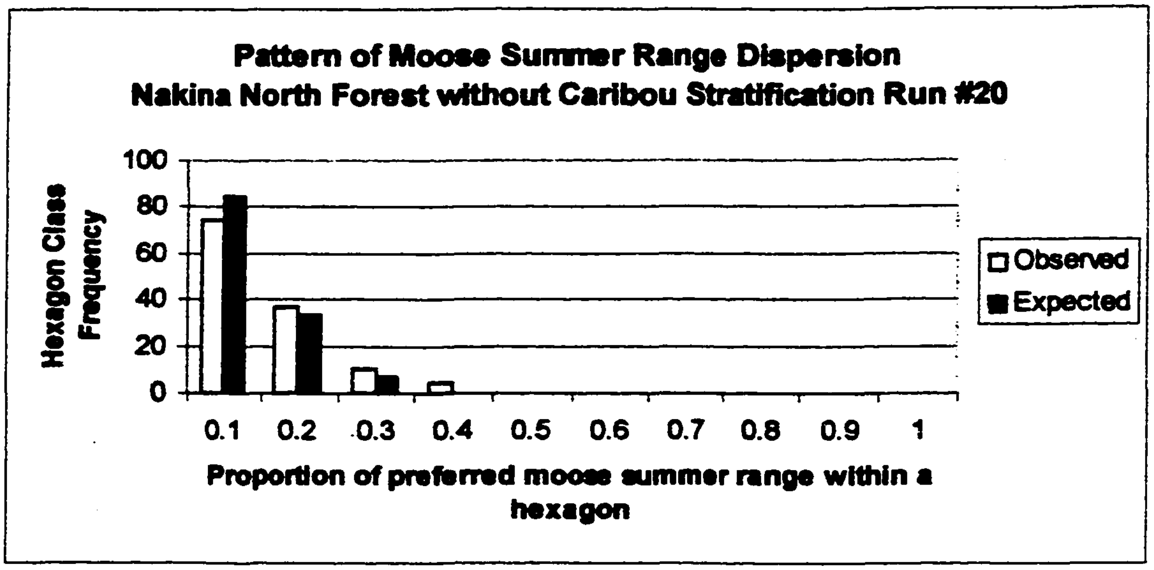

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #15


Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #16

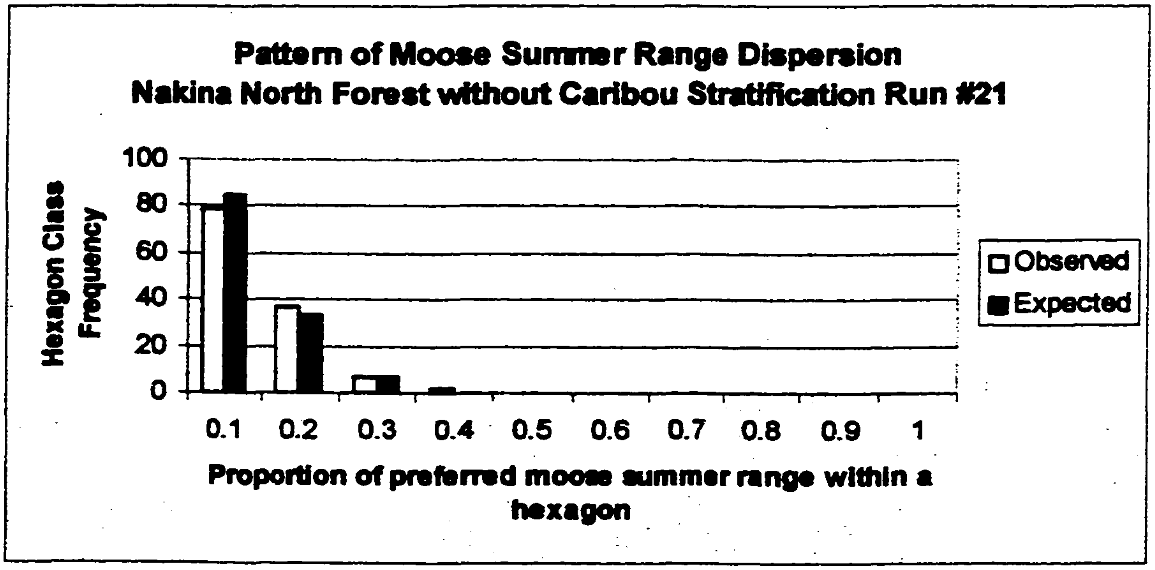

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #17
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected


Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #18
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected

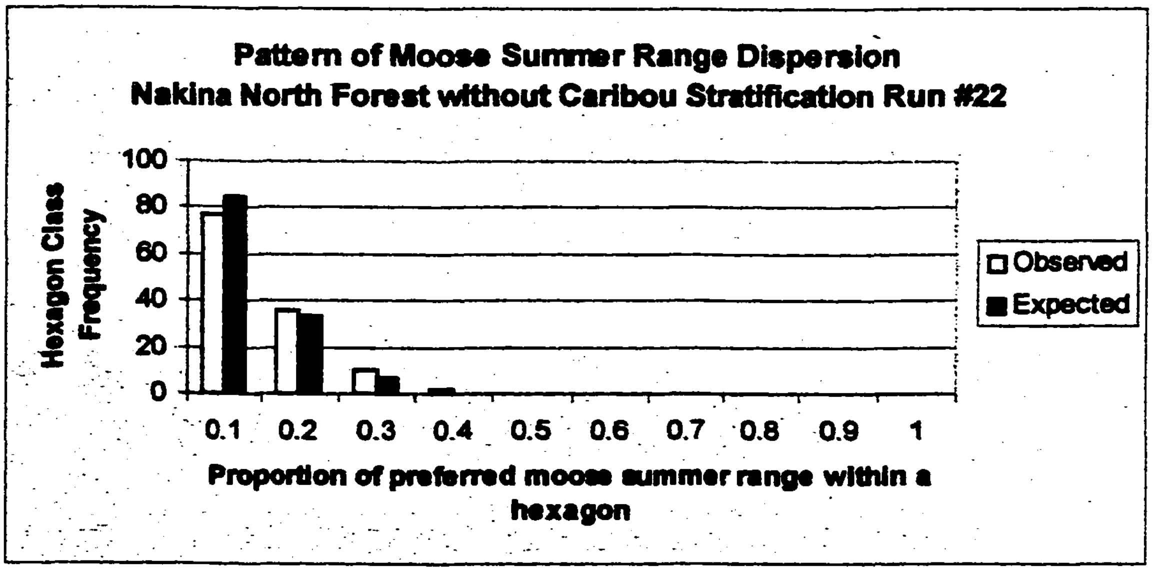

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #19
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected



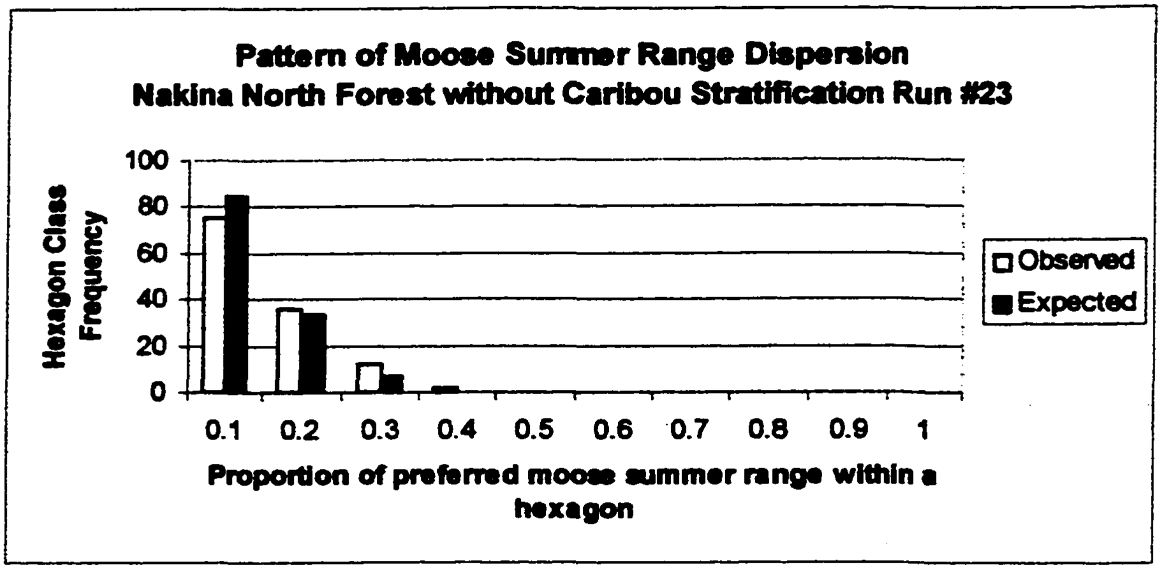
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #20



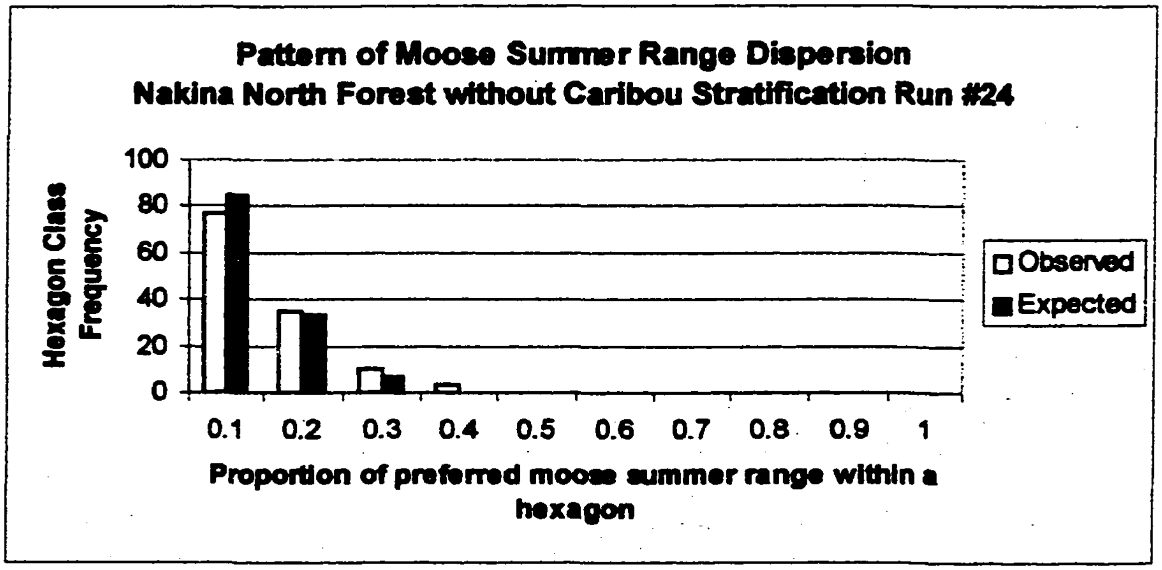
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #21



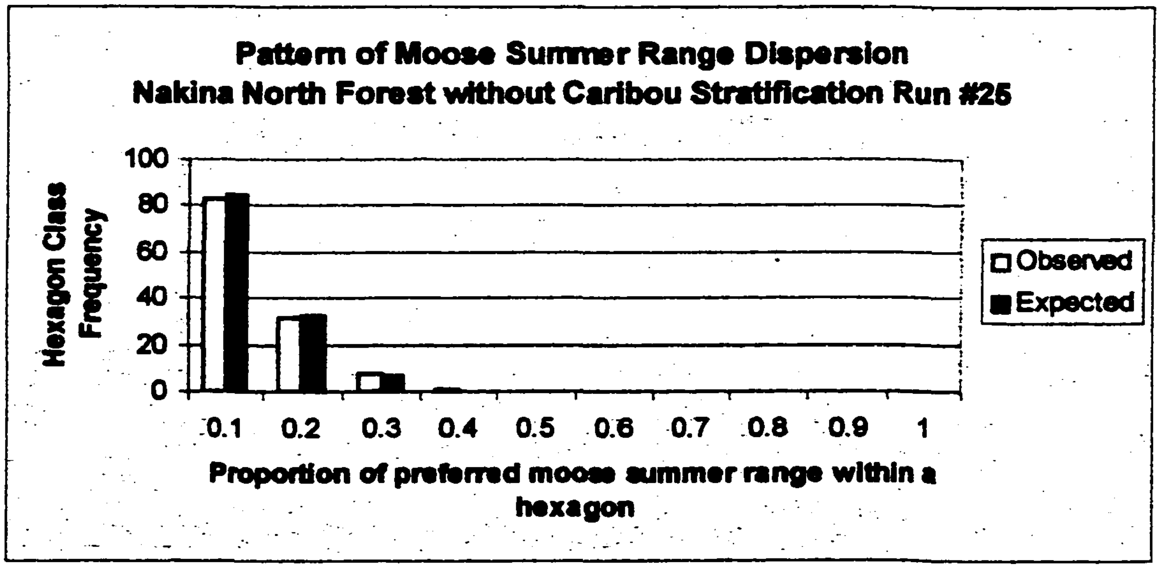
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #22



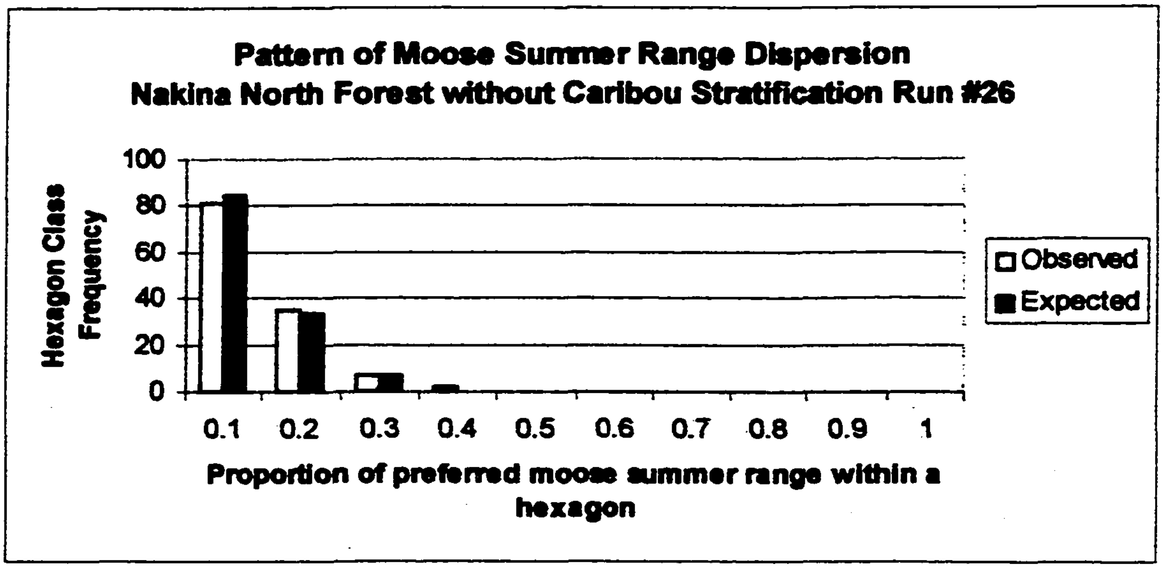
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #23



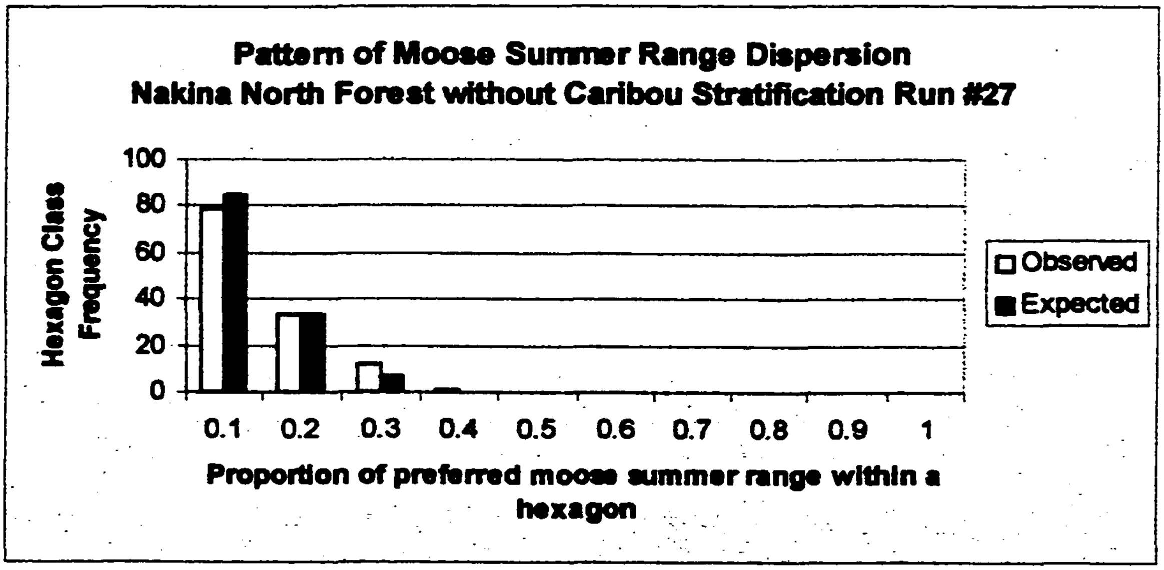
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #24



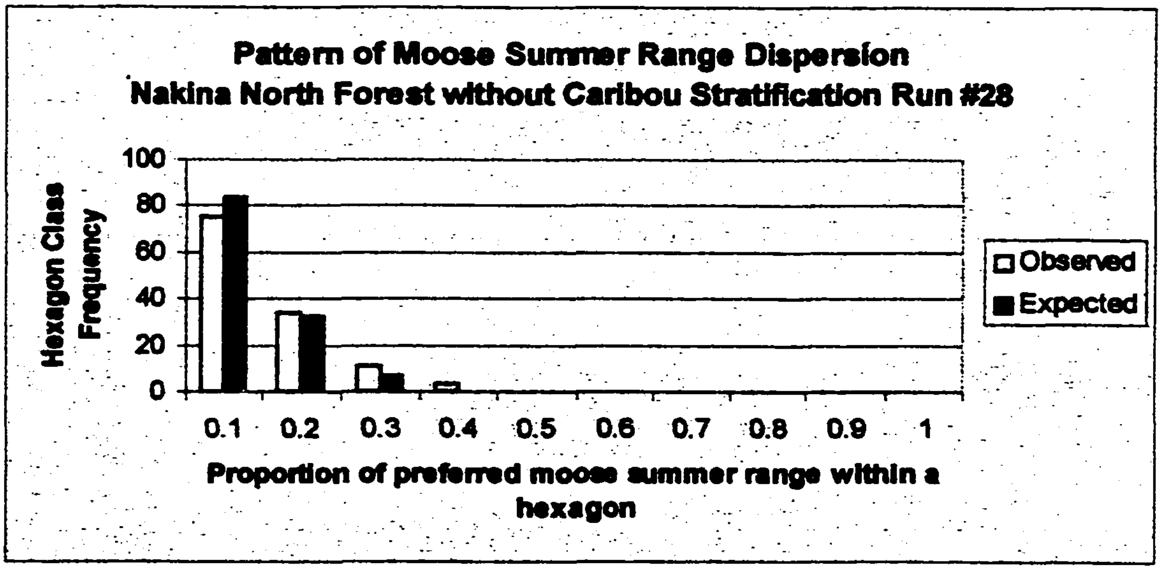
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #25



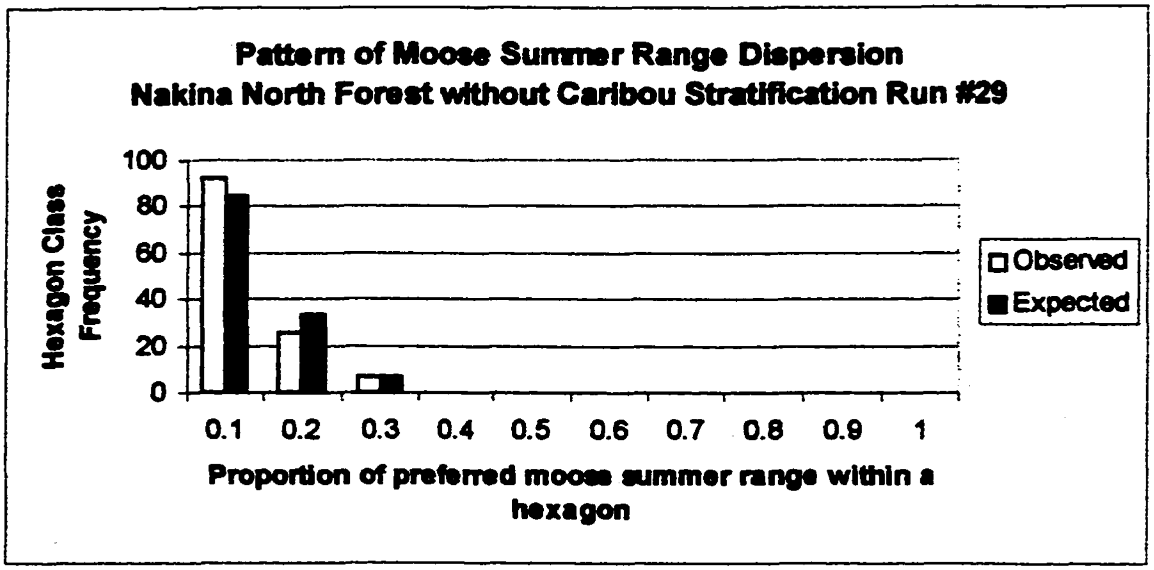
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #26

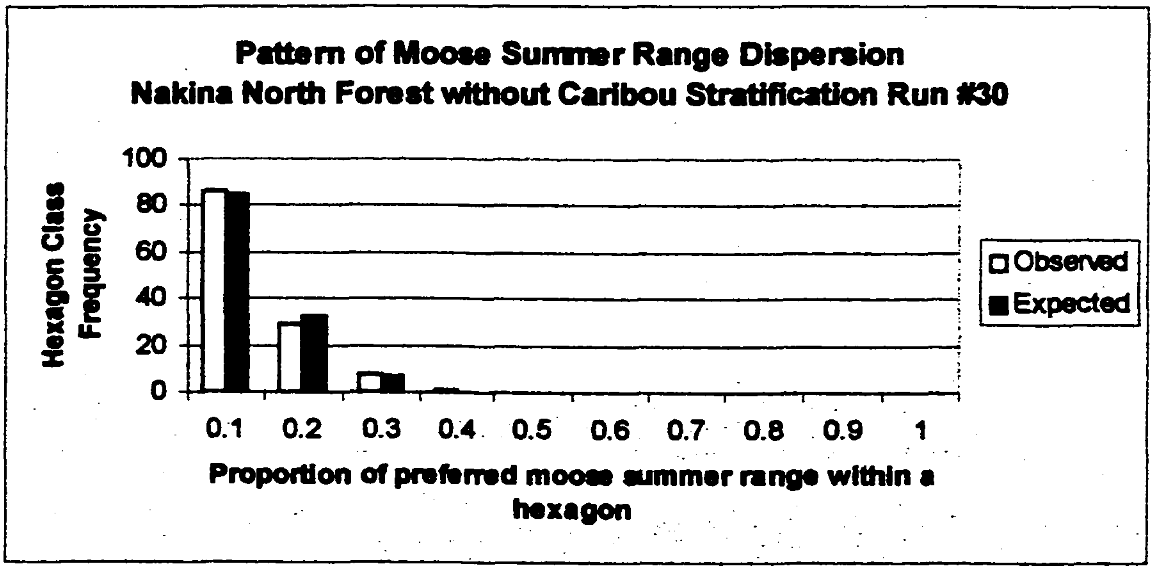


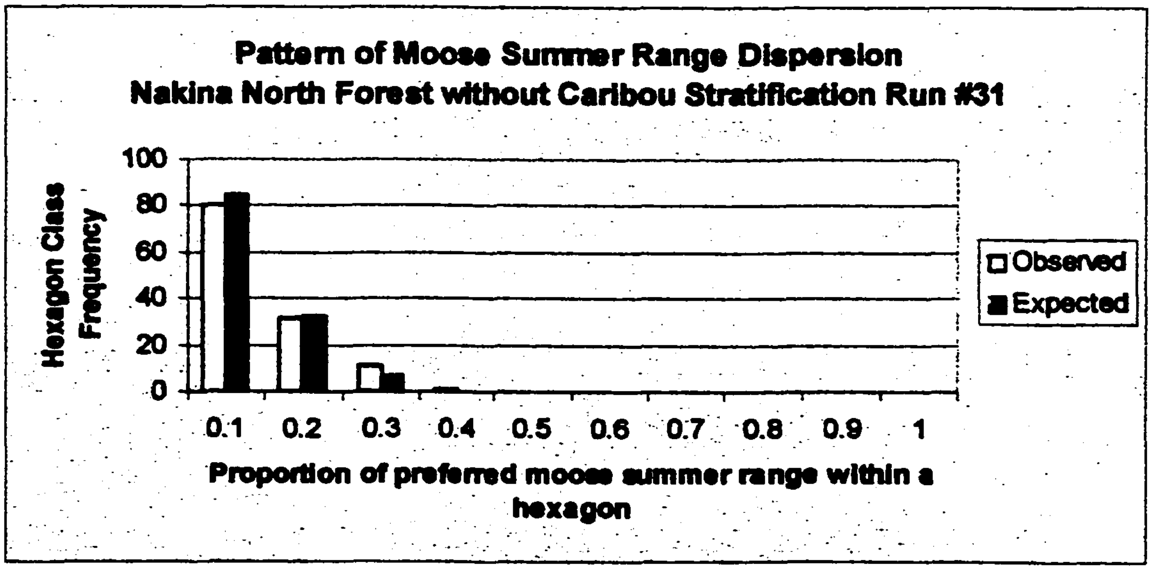
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #27

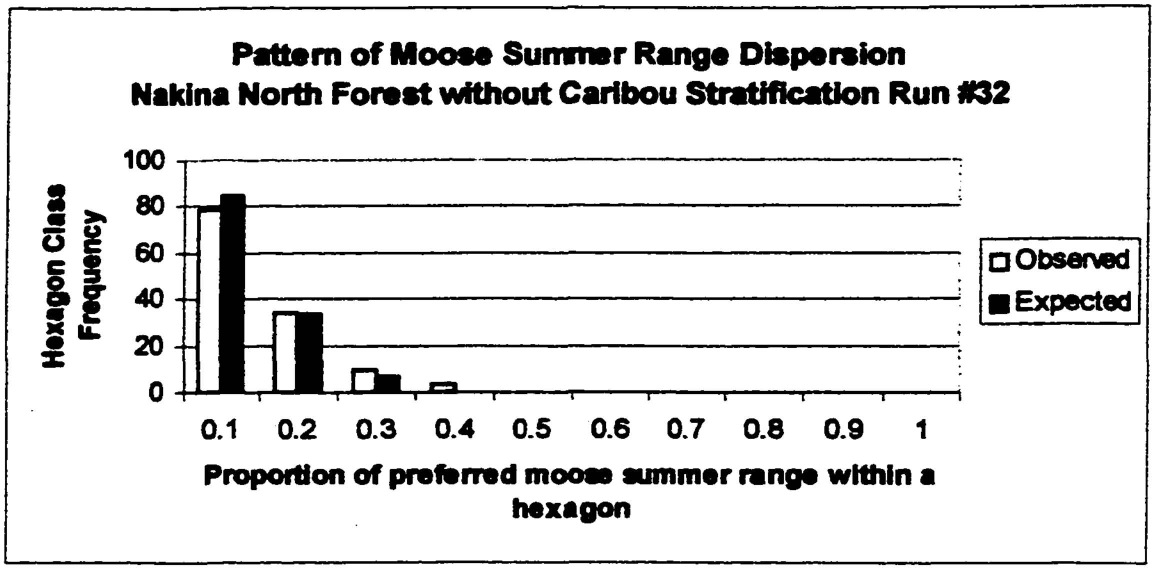


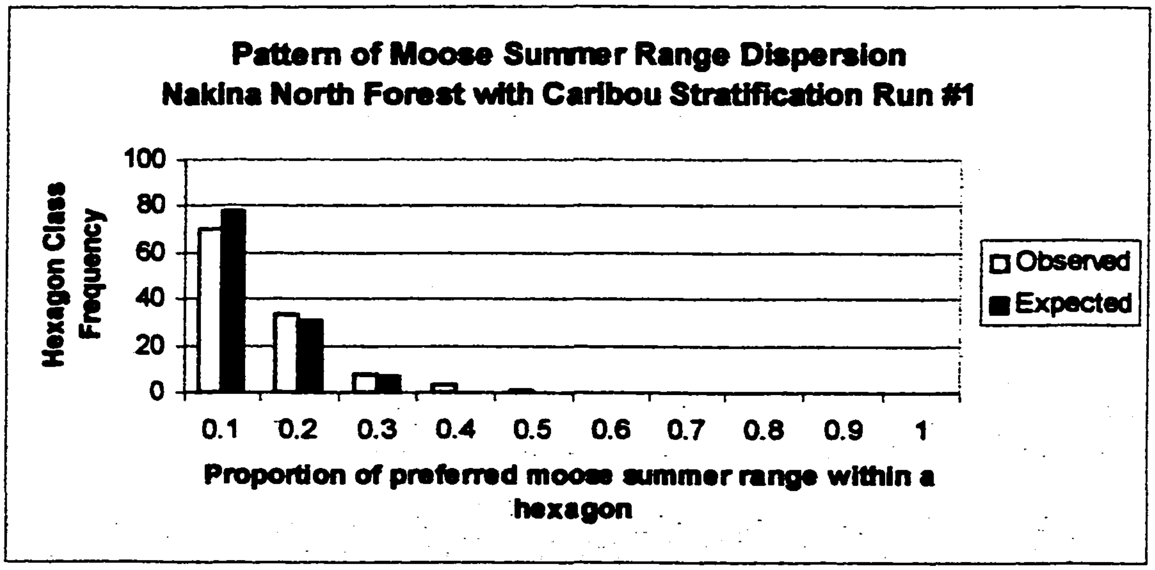
Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #28

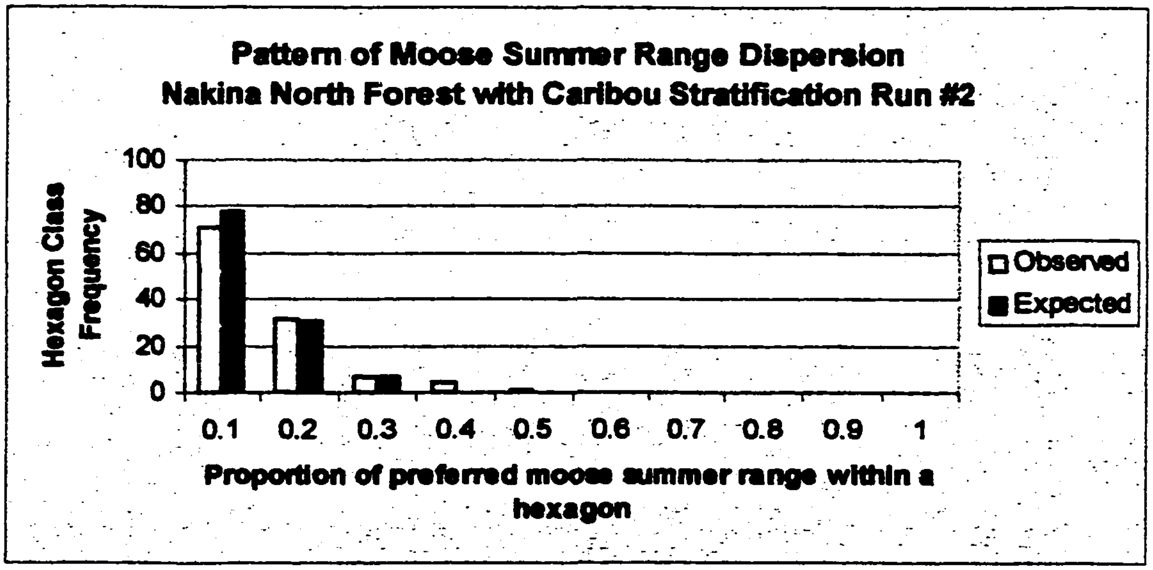

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #29
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

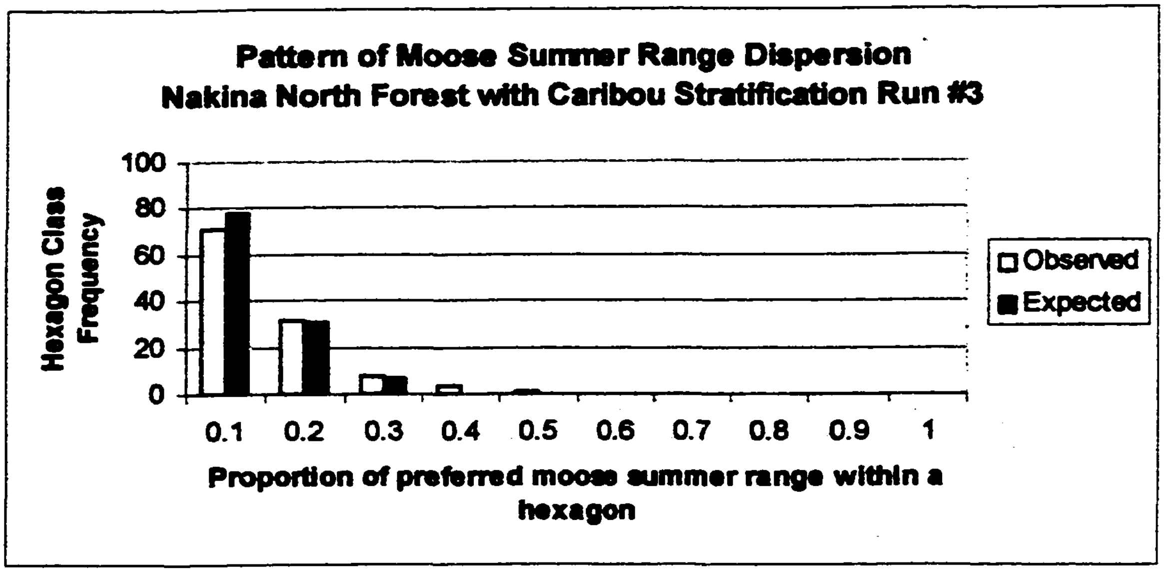

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #30
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

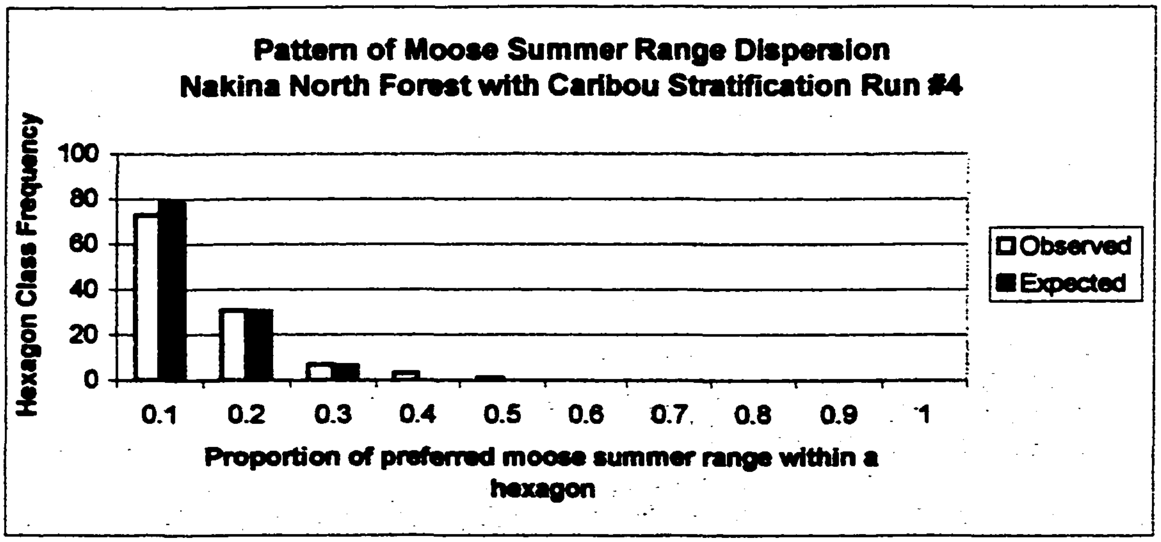

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #31
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

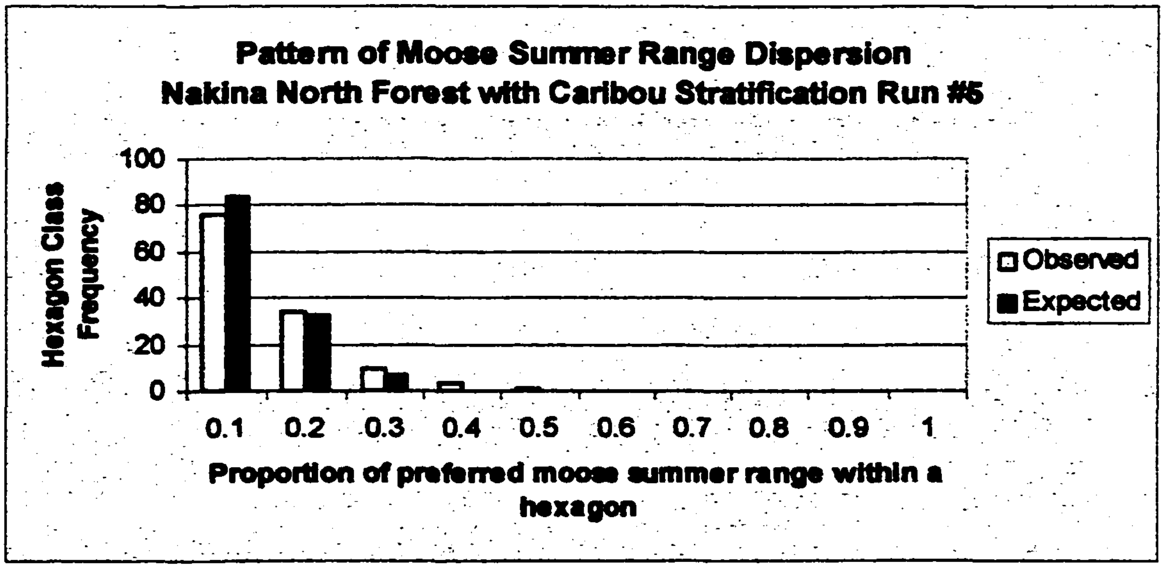

Pattern of Moose Summer Range Dispersion
Nakina North Forest without Caribou Stratification Run #32

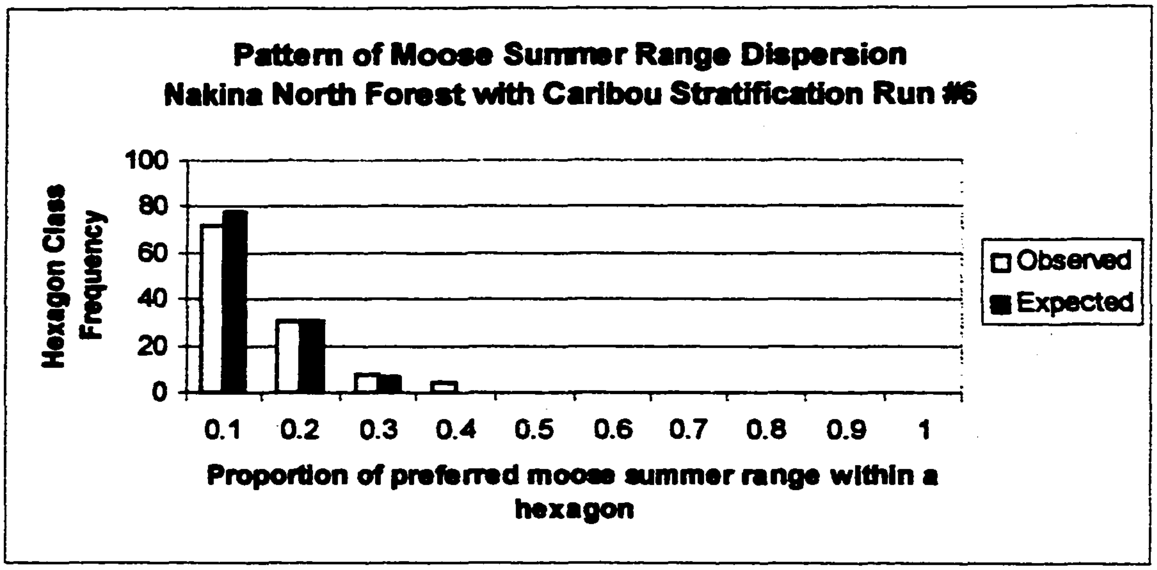

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #1

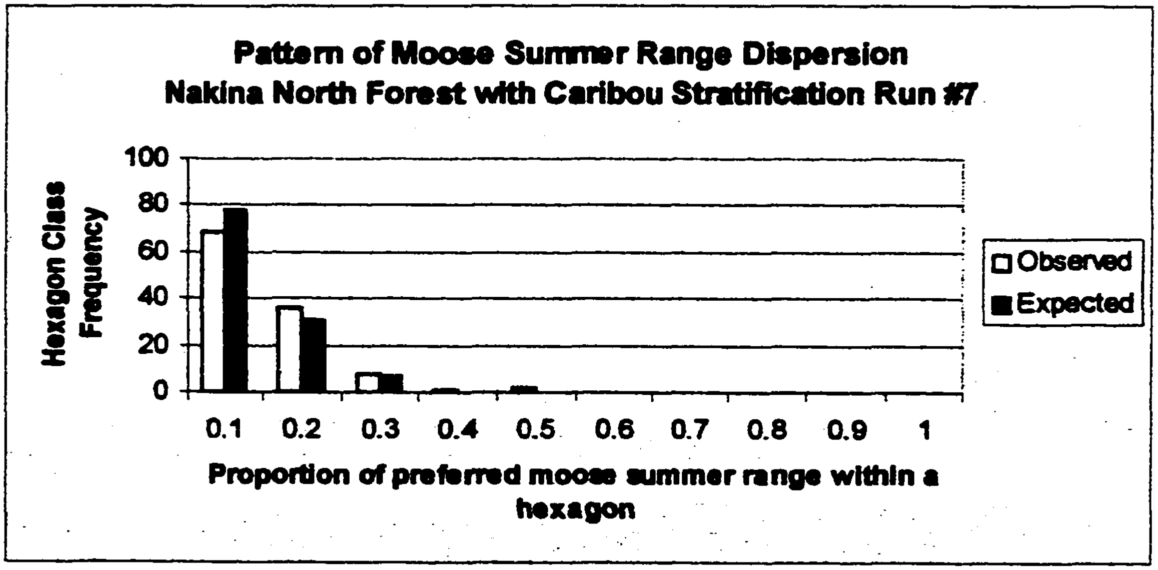

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #2

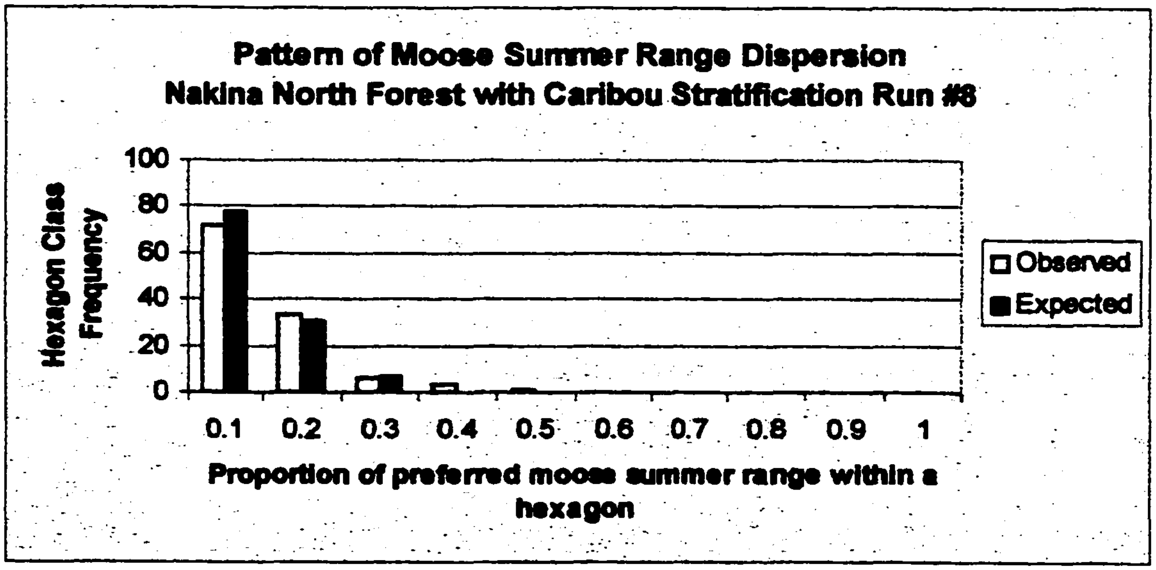

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #3
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

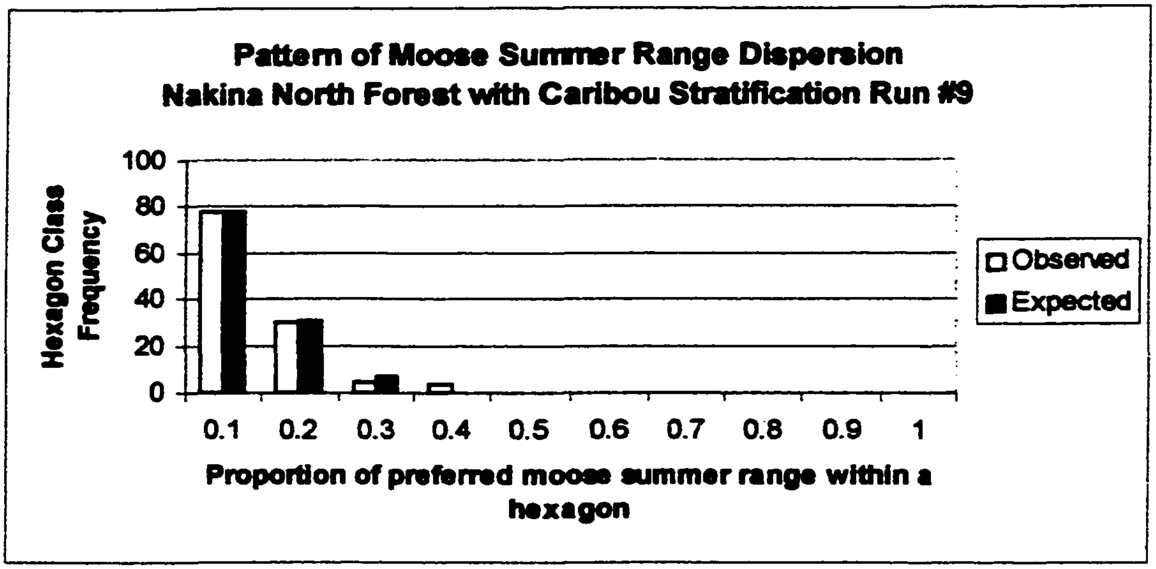

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #4
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

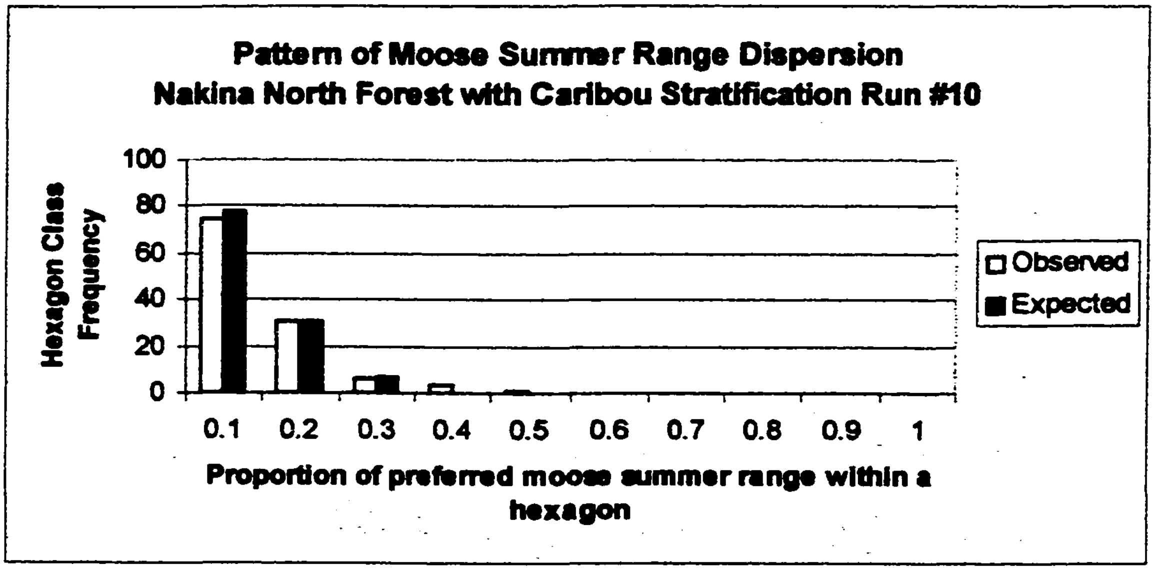

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #5
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

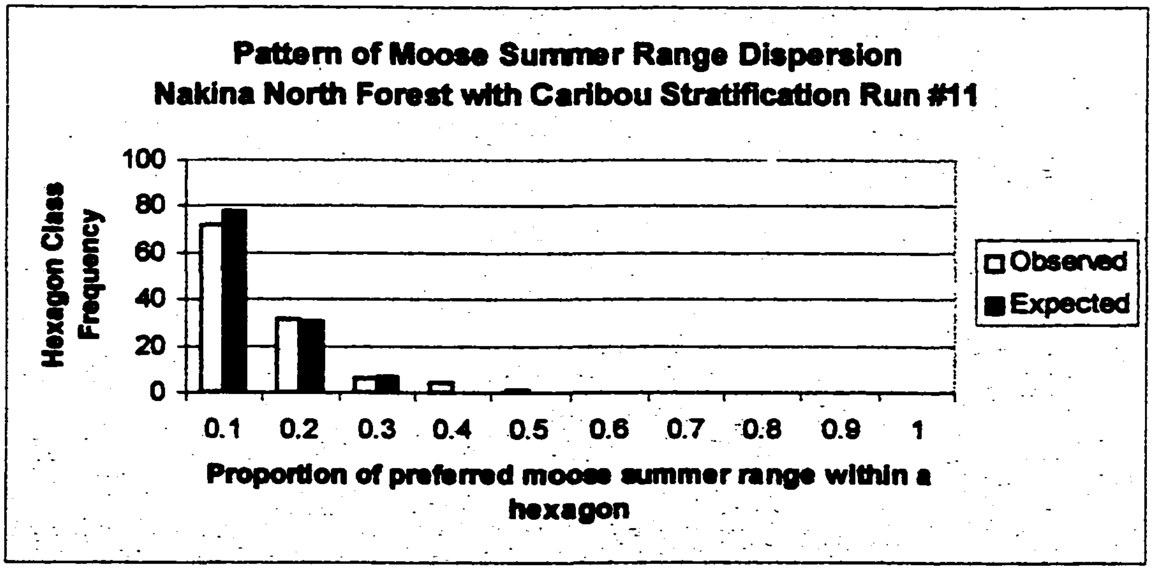

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #6
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

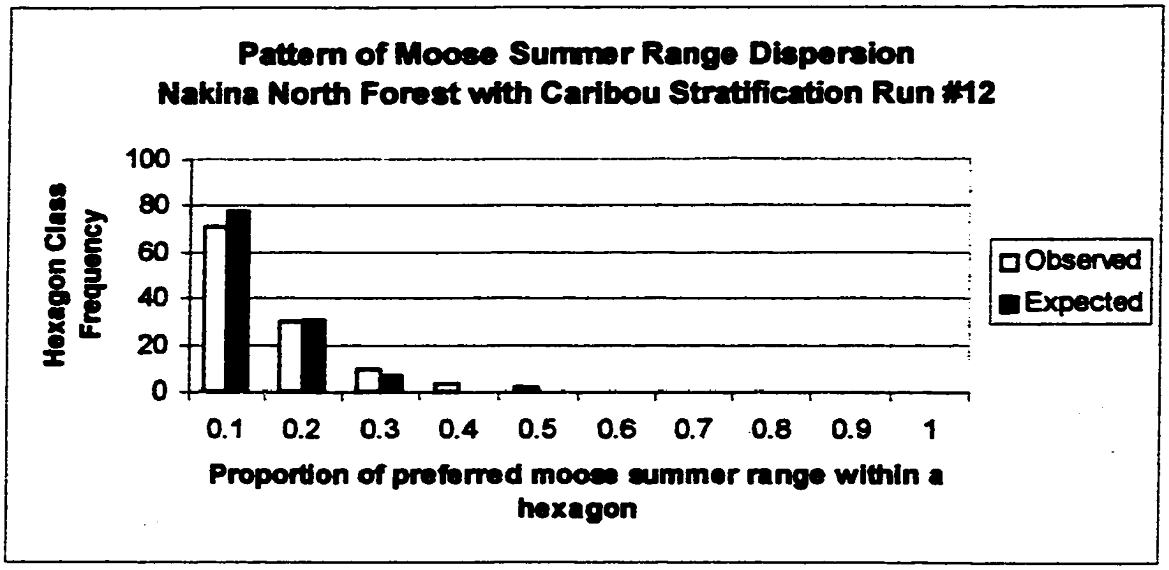

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #7
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

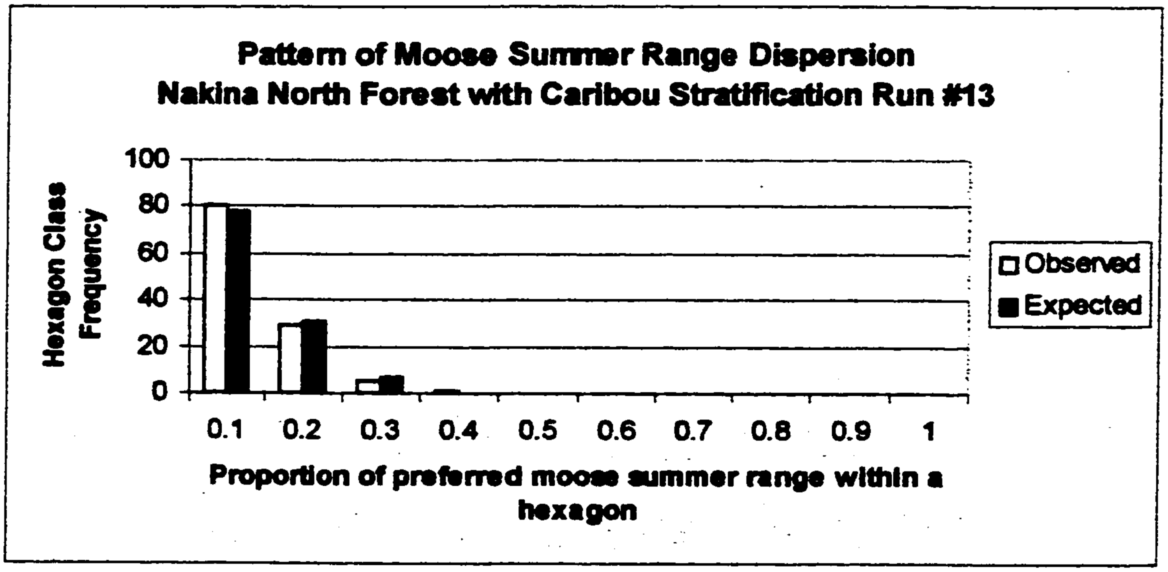

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #8
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

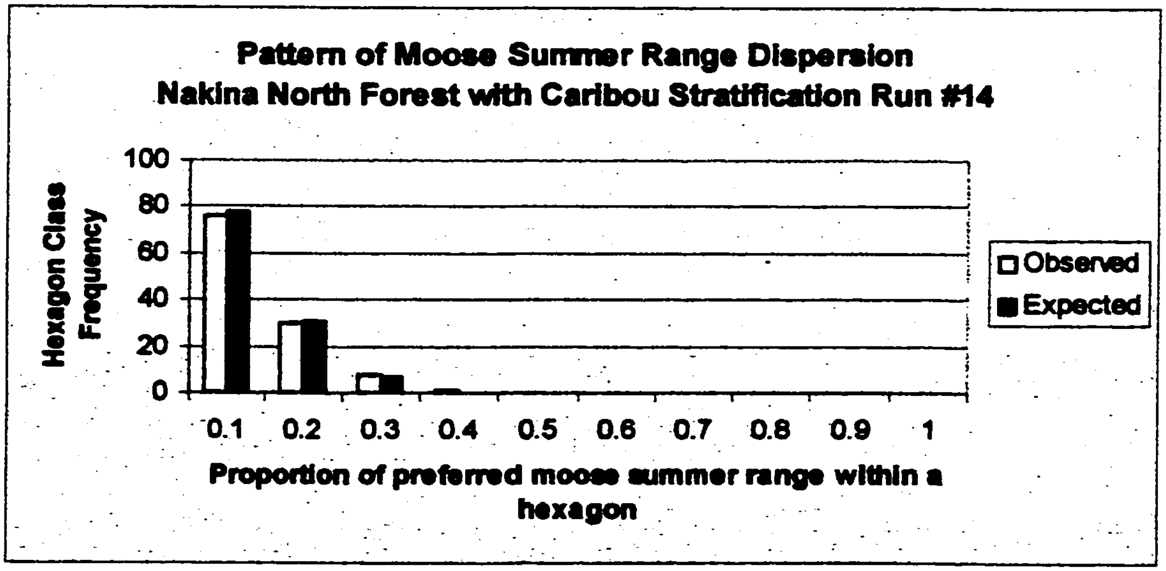

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #9
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

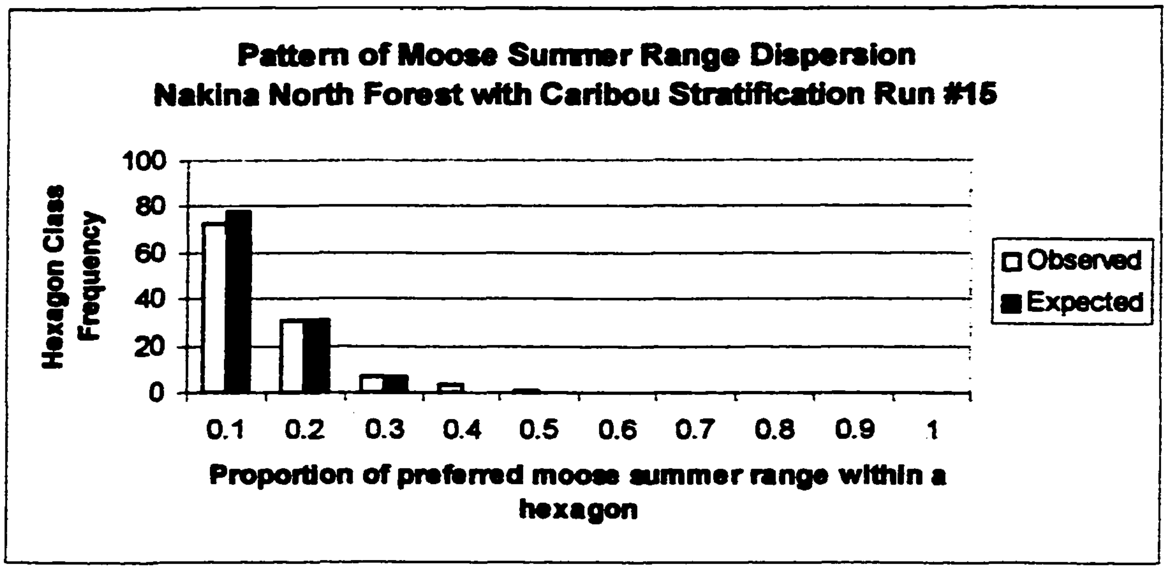

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #10
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

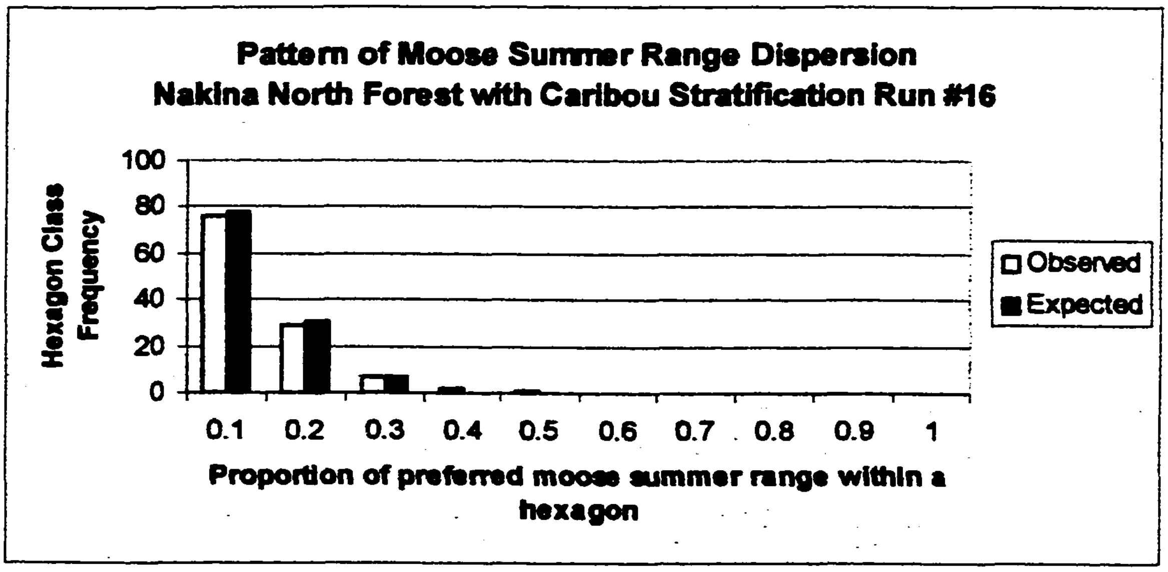

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #11
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

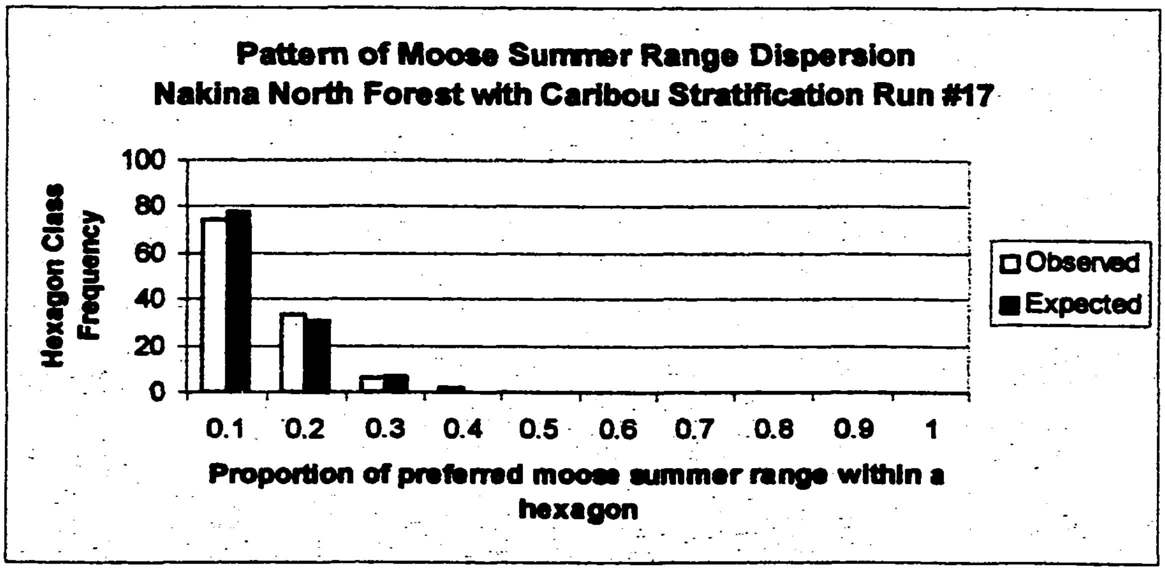

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #12
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

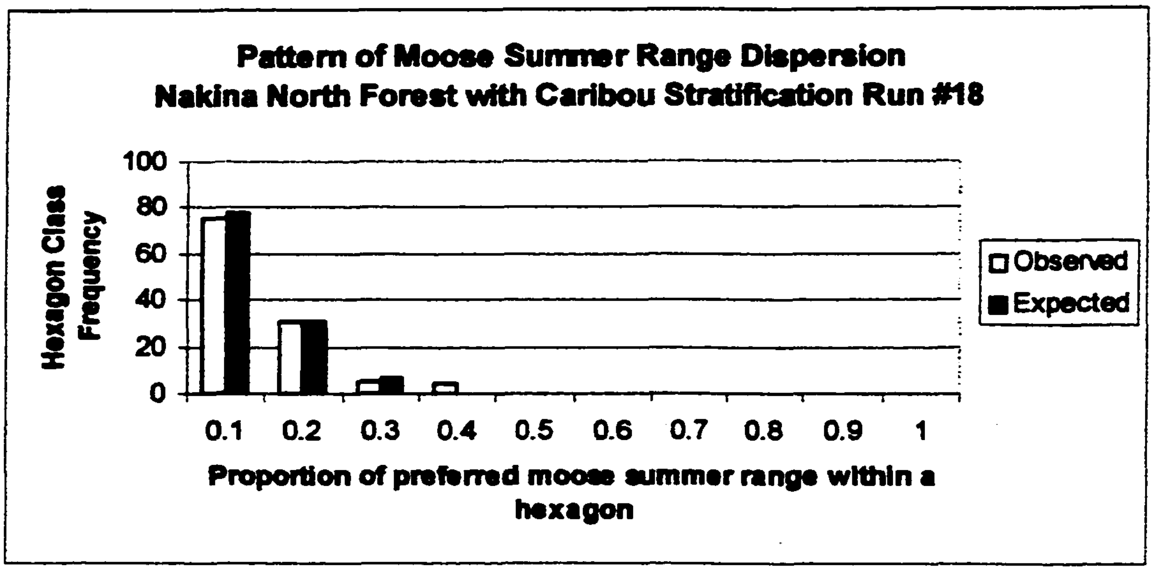

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #13
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

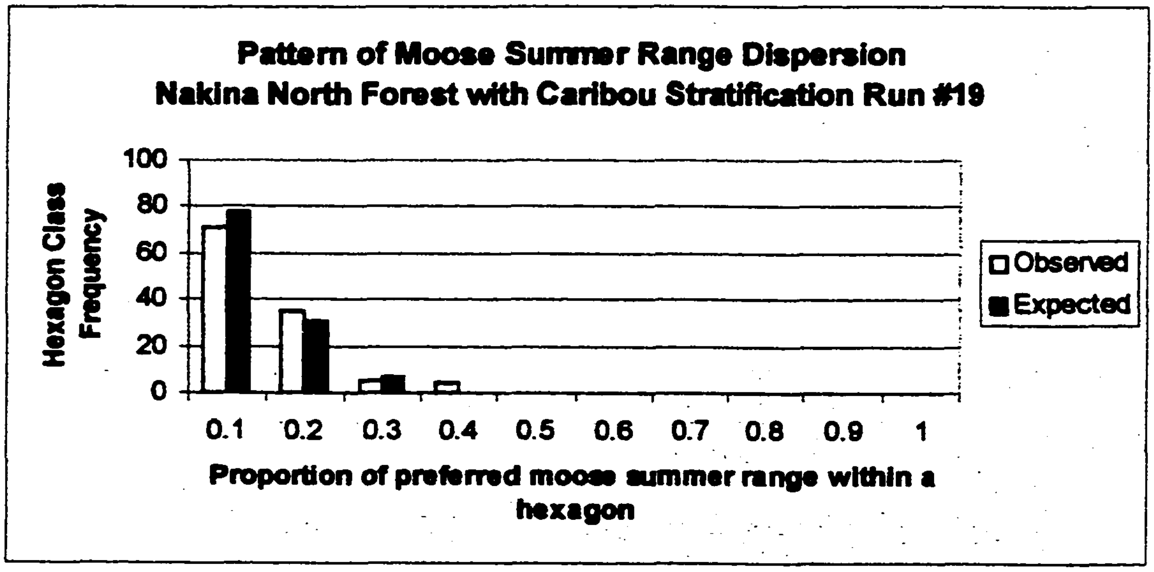

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #14
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

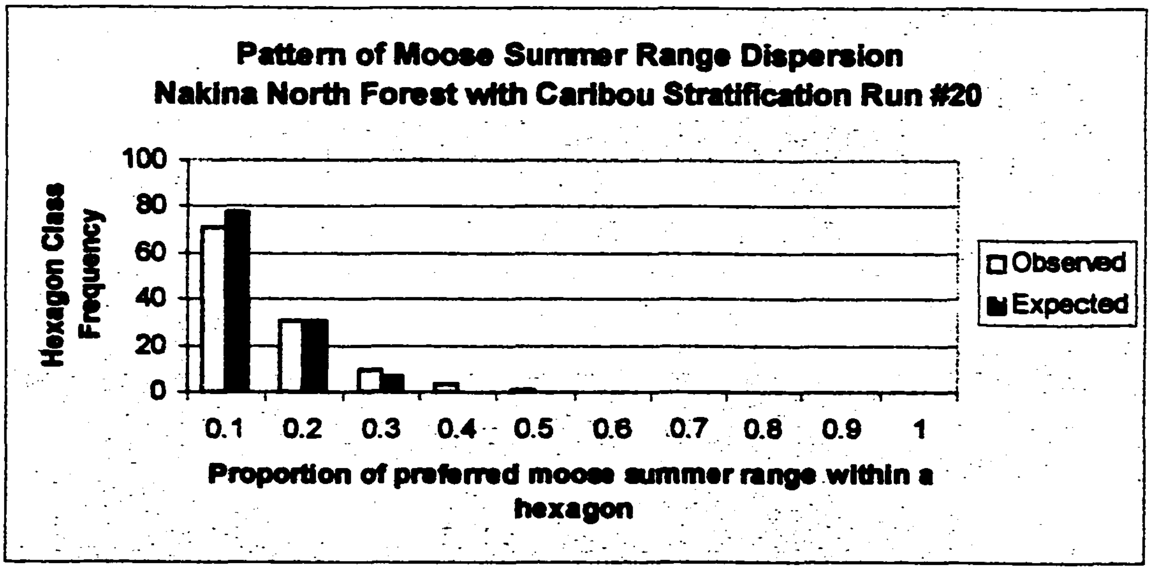

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #15

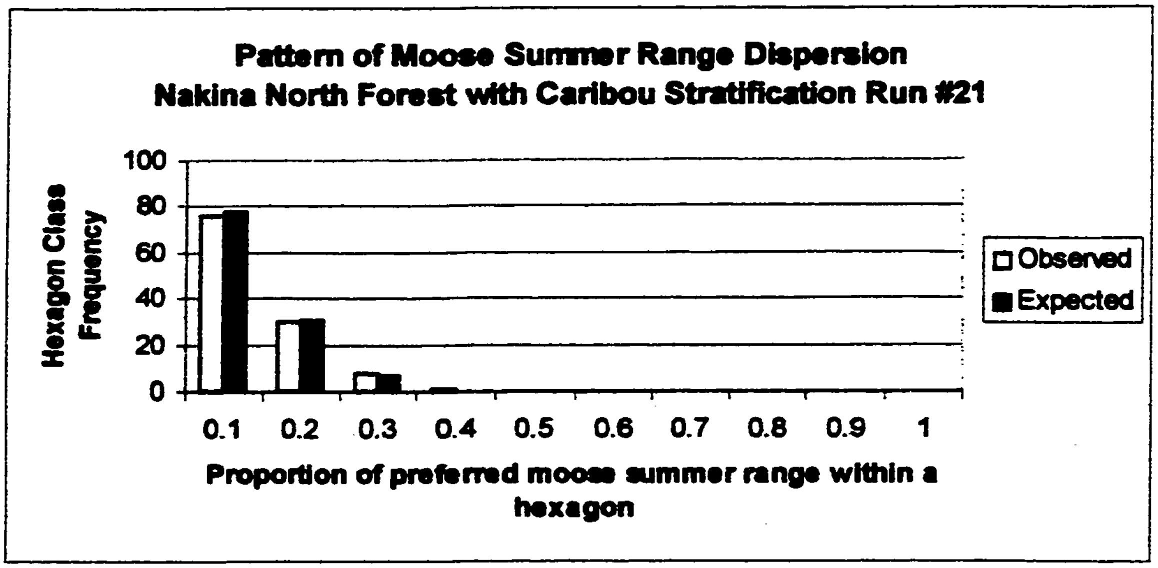

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #16

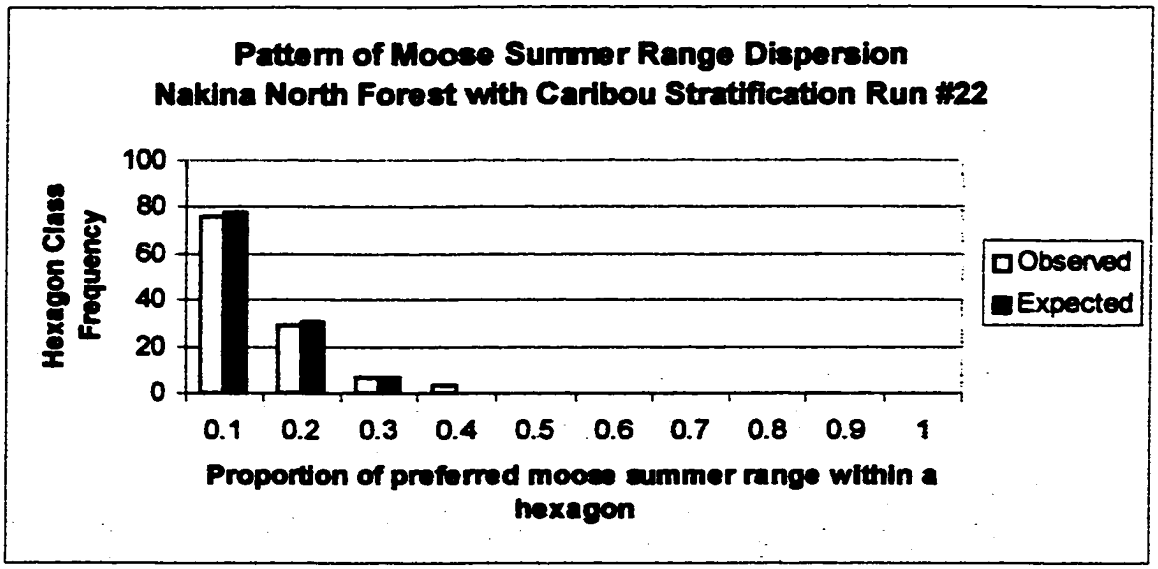

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #17

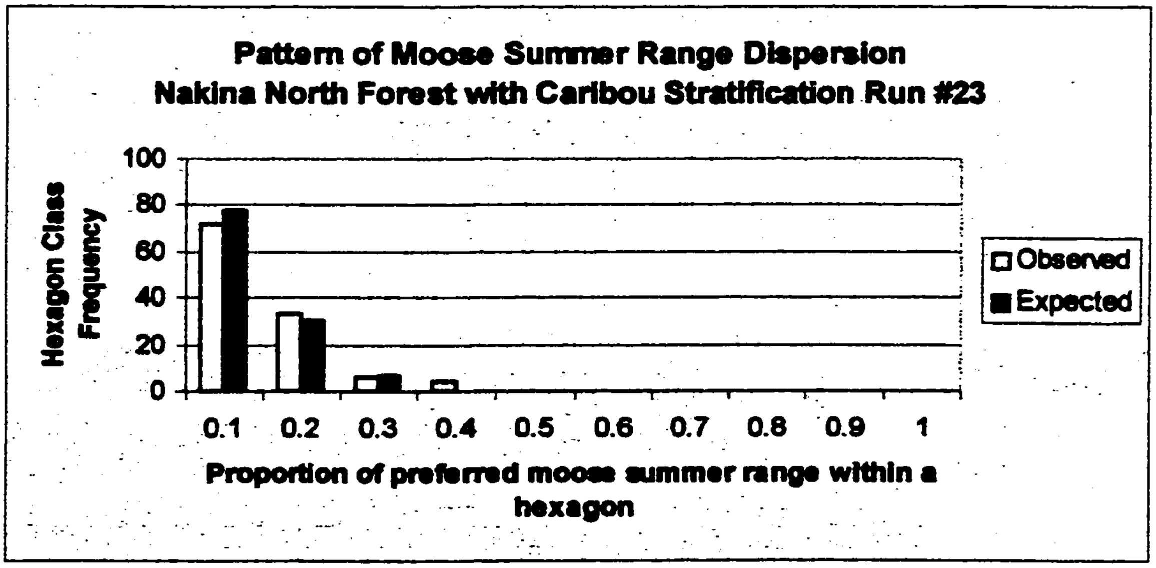

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #18
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected

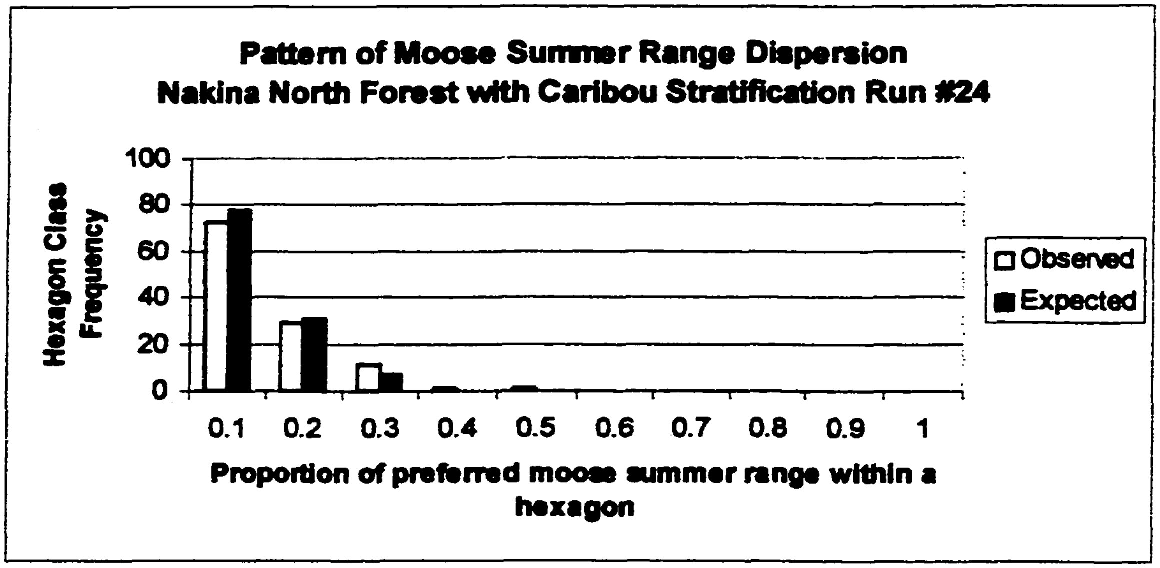

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #19
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected

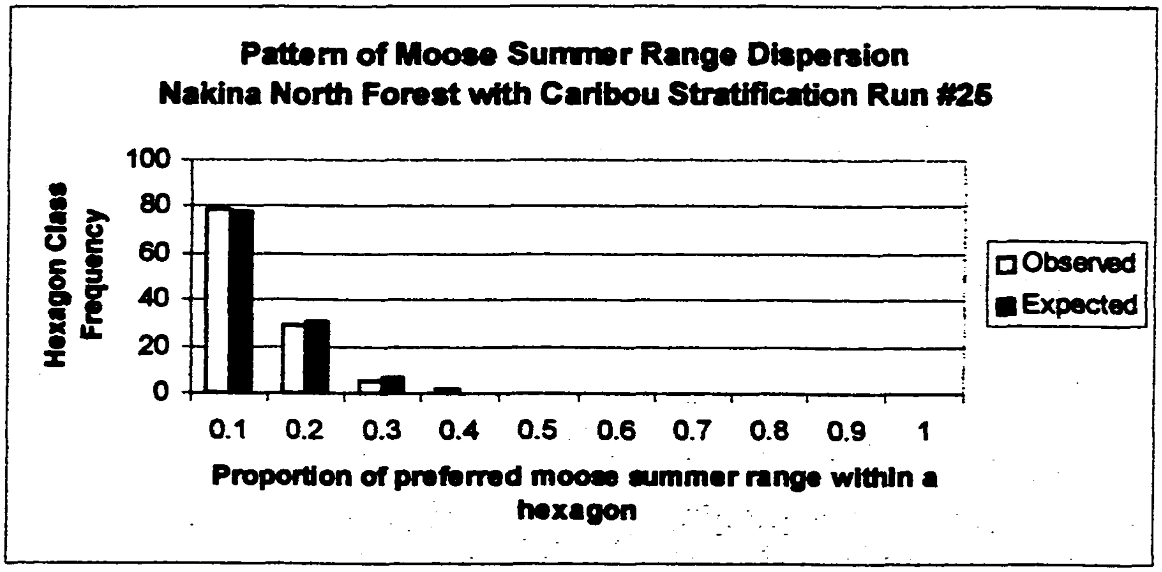

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #20
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
Observed
Expected

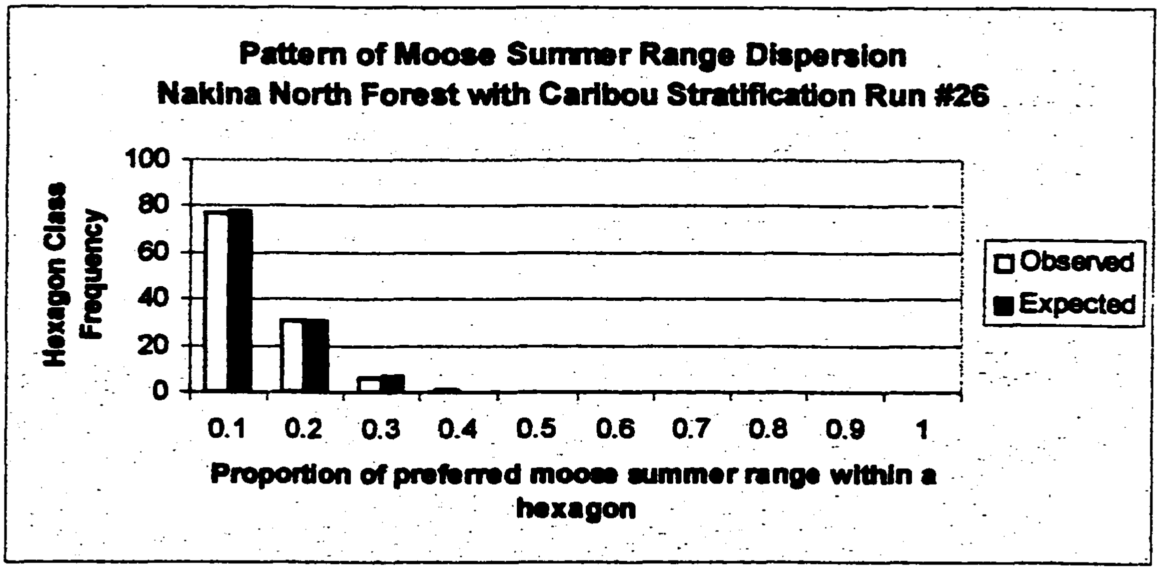

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #21
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

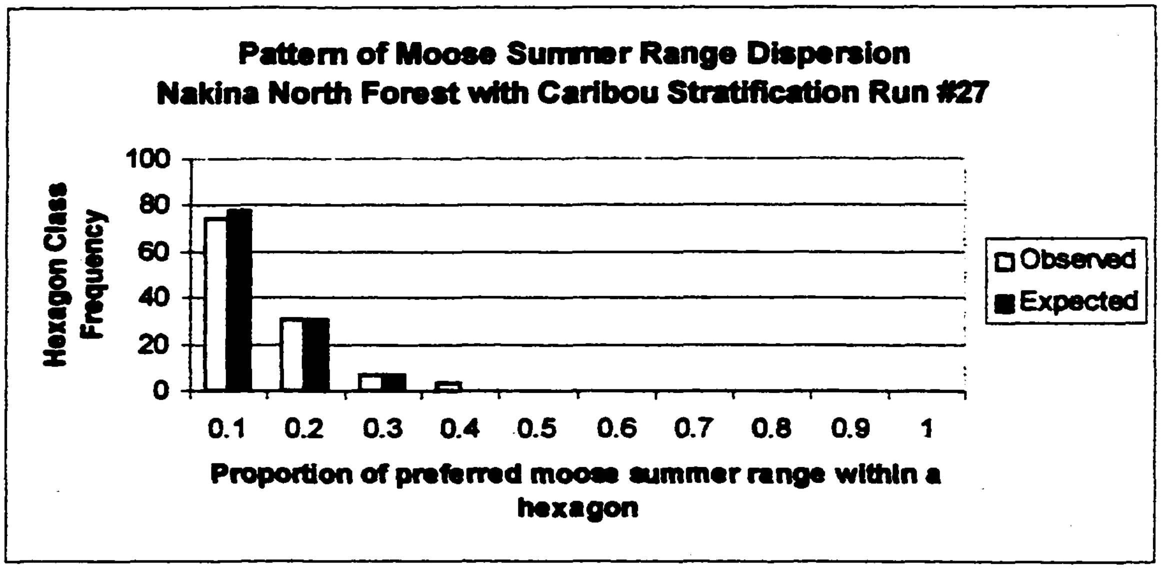

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #22
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

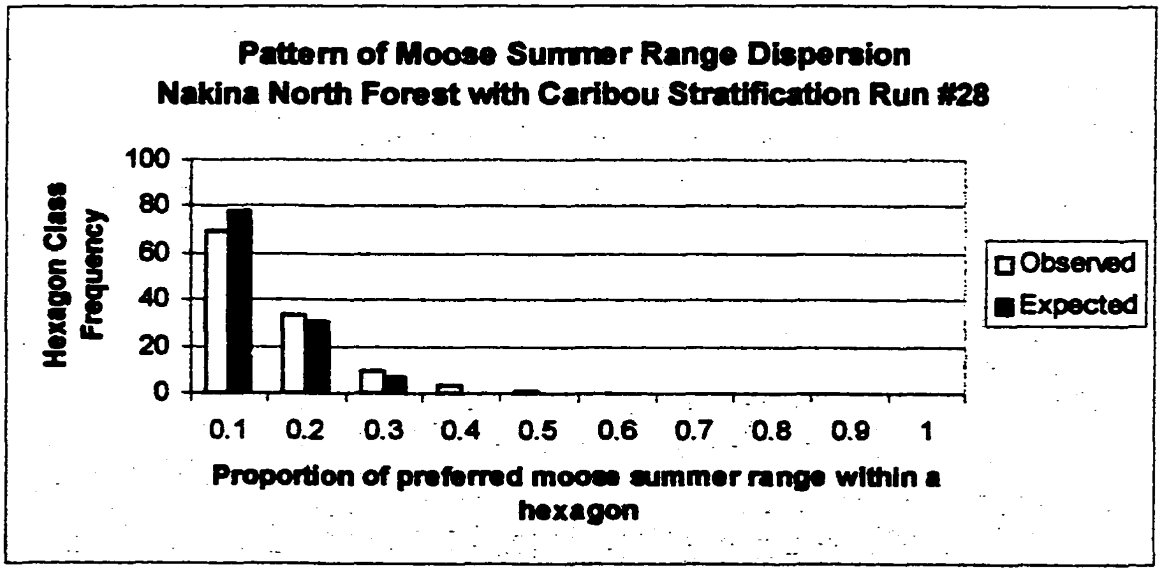

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #23
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

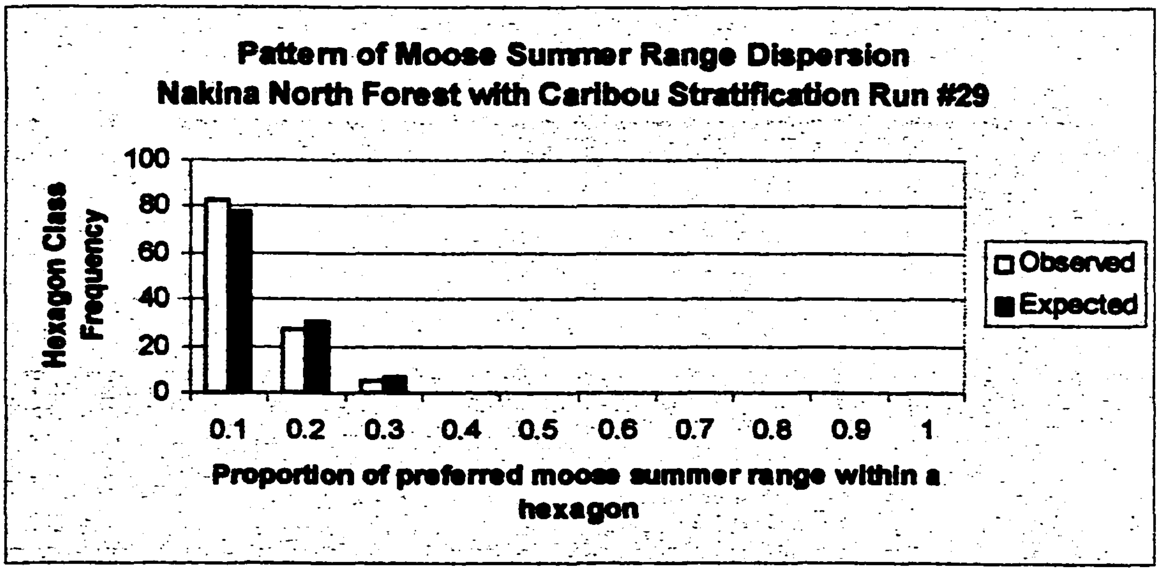

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #24
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

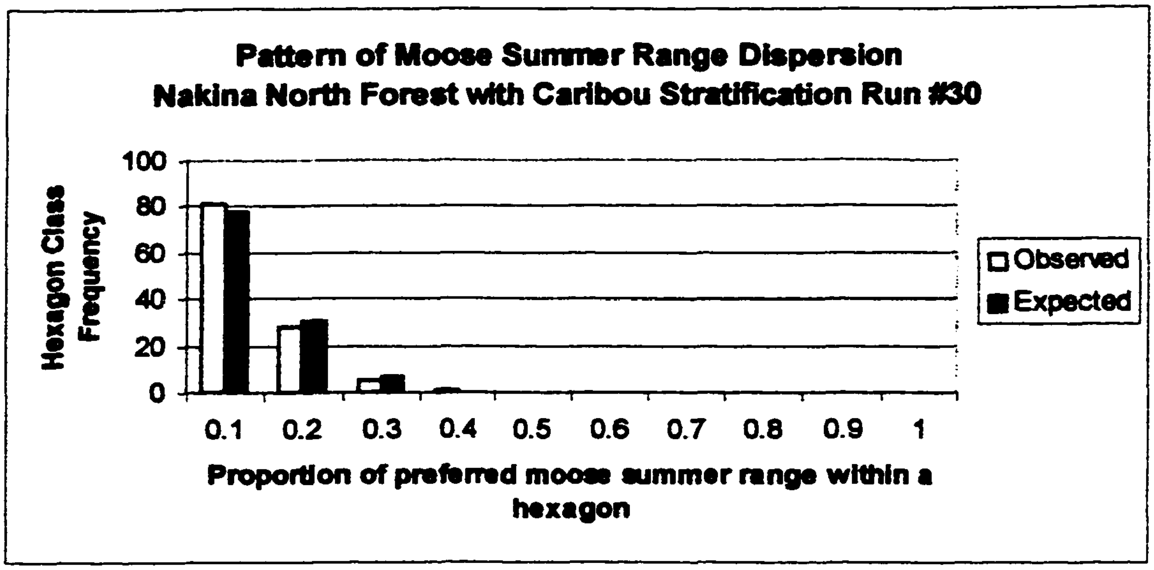

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #25
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

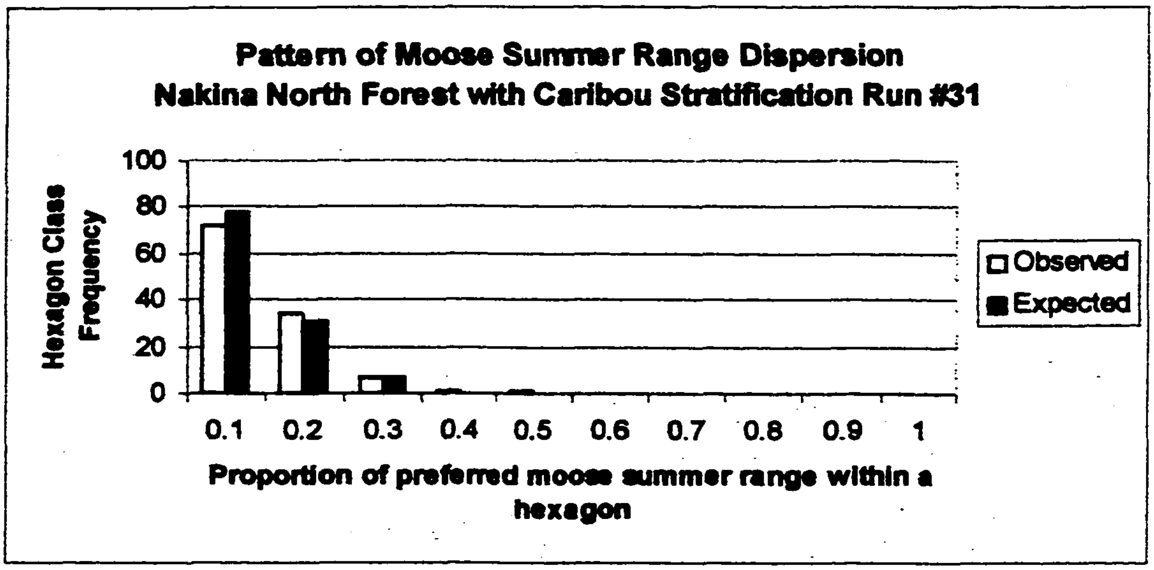

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #26
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

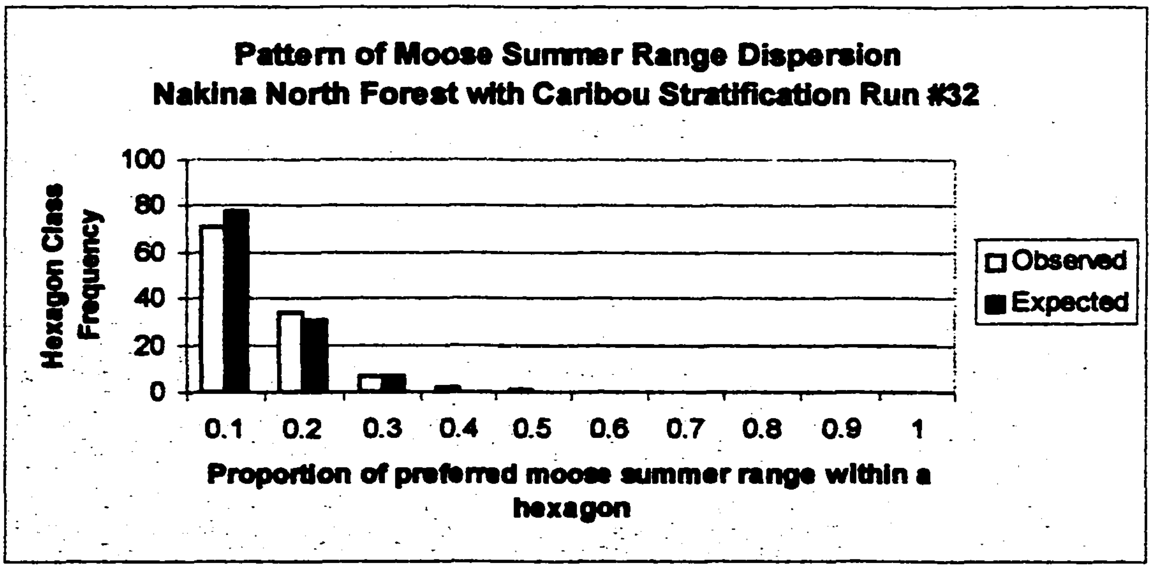

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #27
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

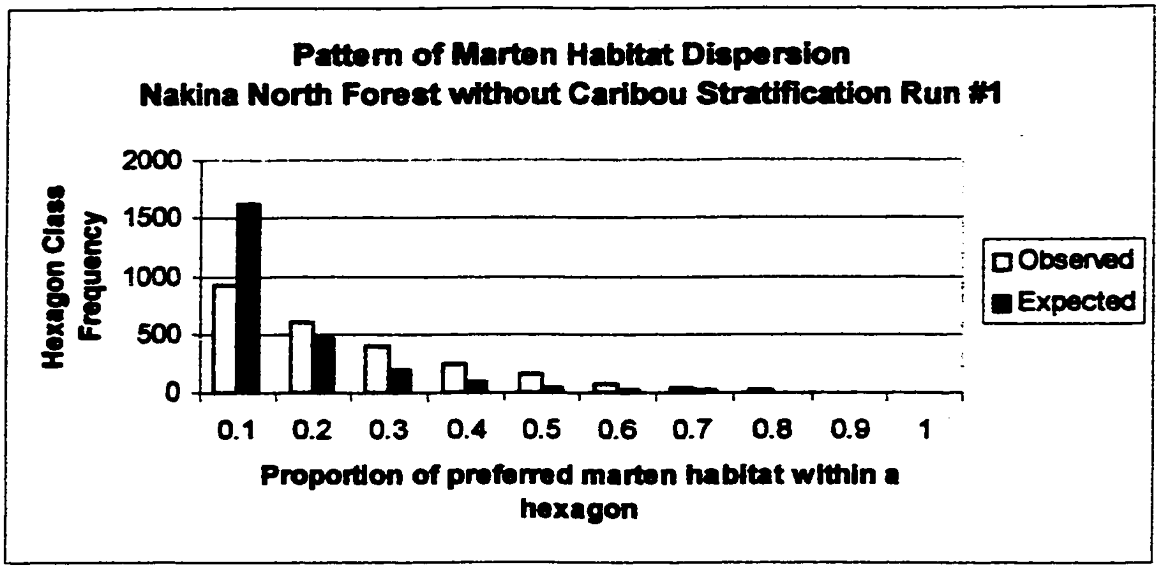

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #28
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

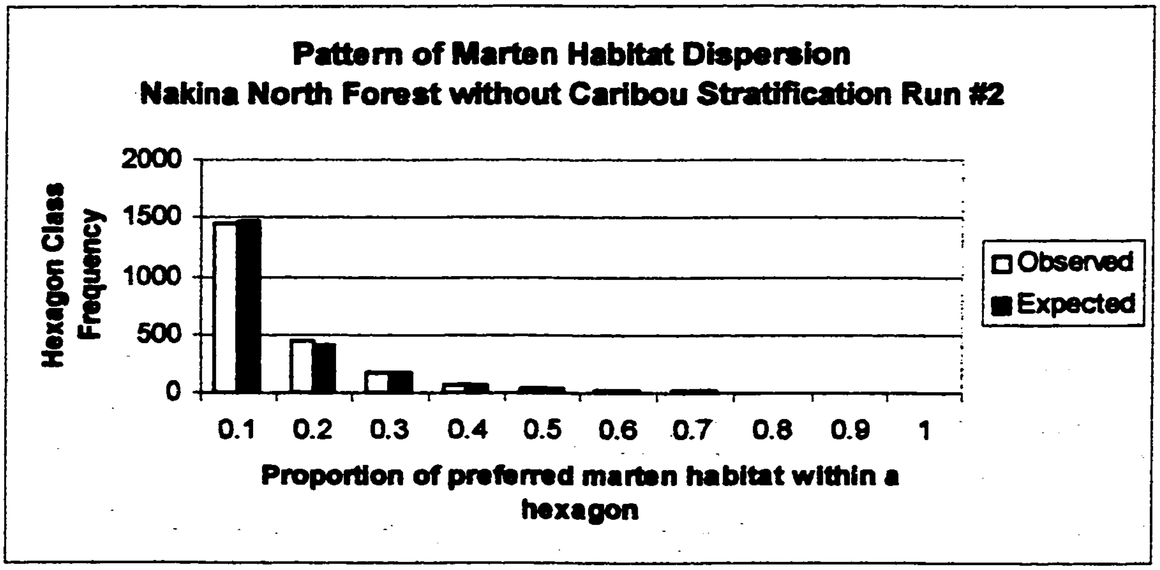

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #29
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
□ Observed
■ Expected

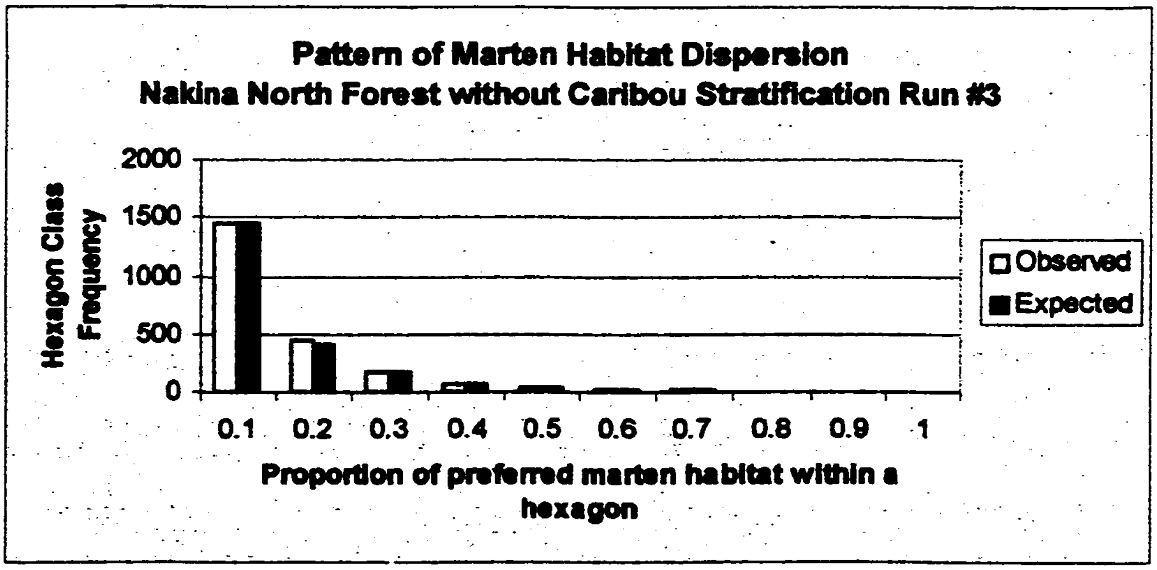

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #30
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

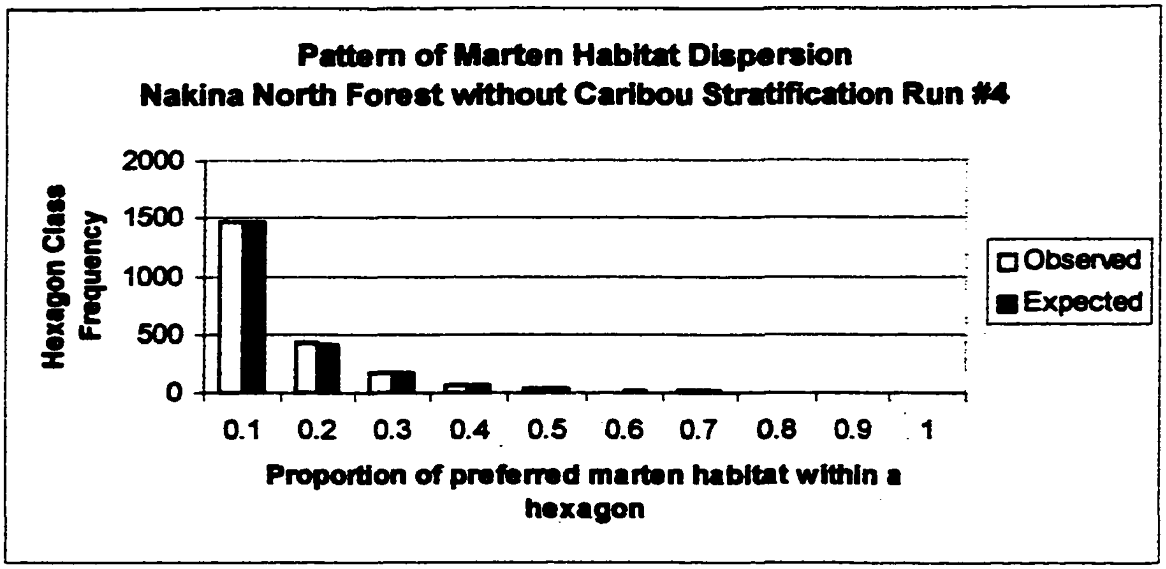

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #31
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

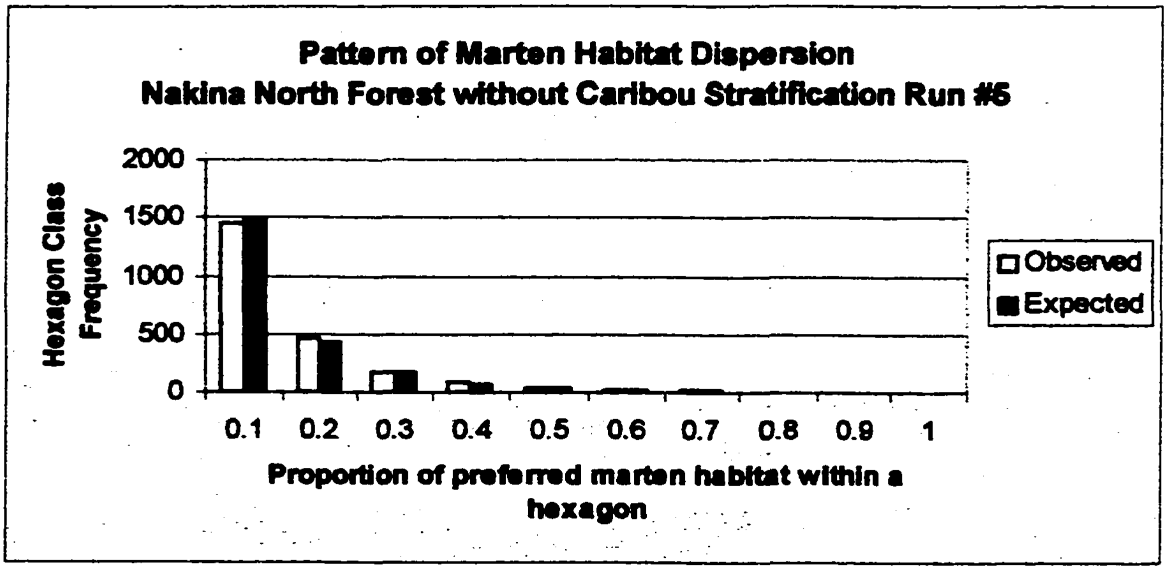

Pattern of Moose Summer Range Dispersion
Nakina North Forest with Caribou Stratification Run #32
Hexagon Class Frequency
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred moose summer range within a hexagon
☐ Observed
■ Expected

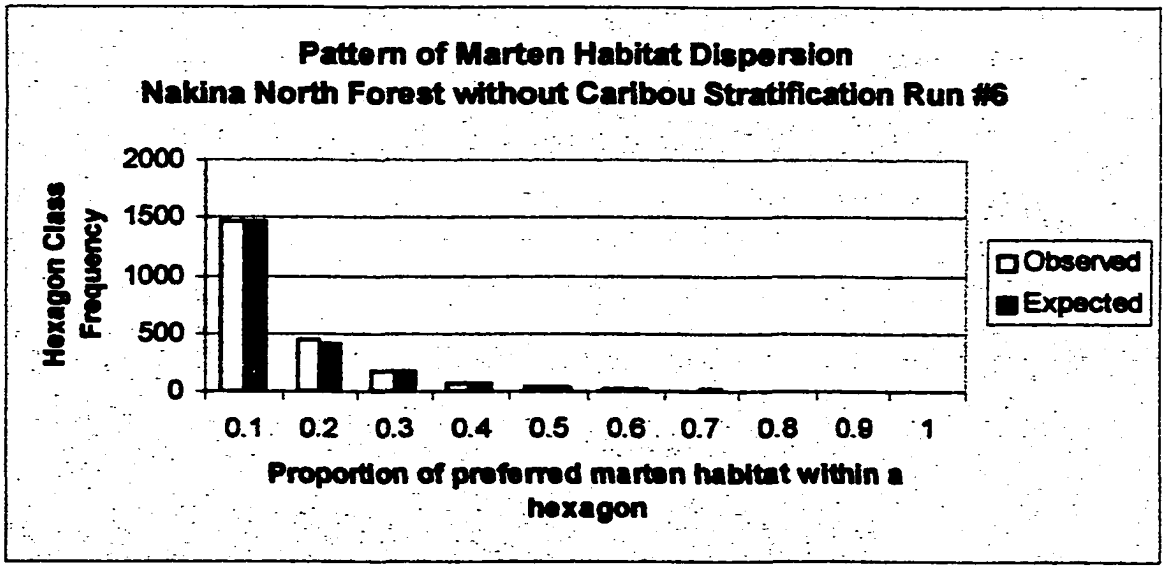

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #1
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

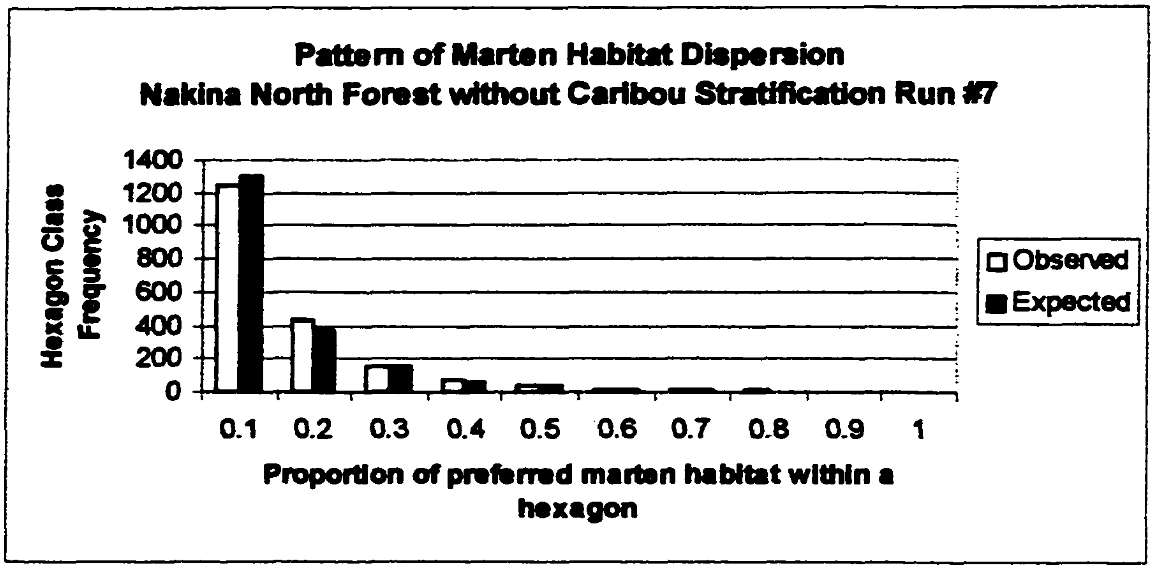

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #2
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

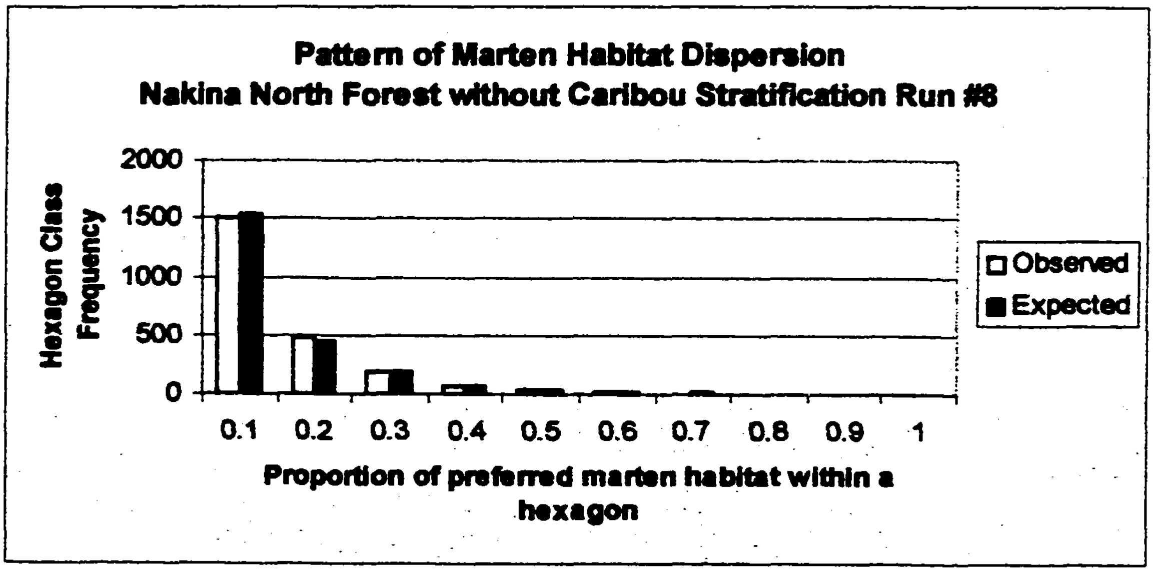

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #3
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

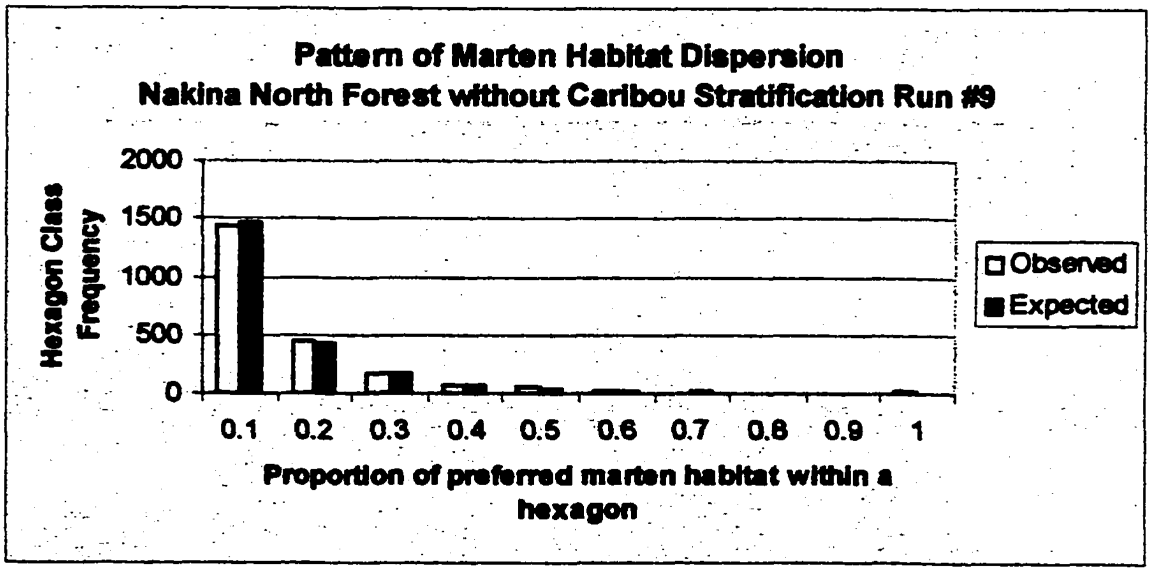

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #4
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

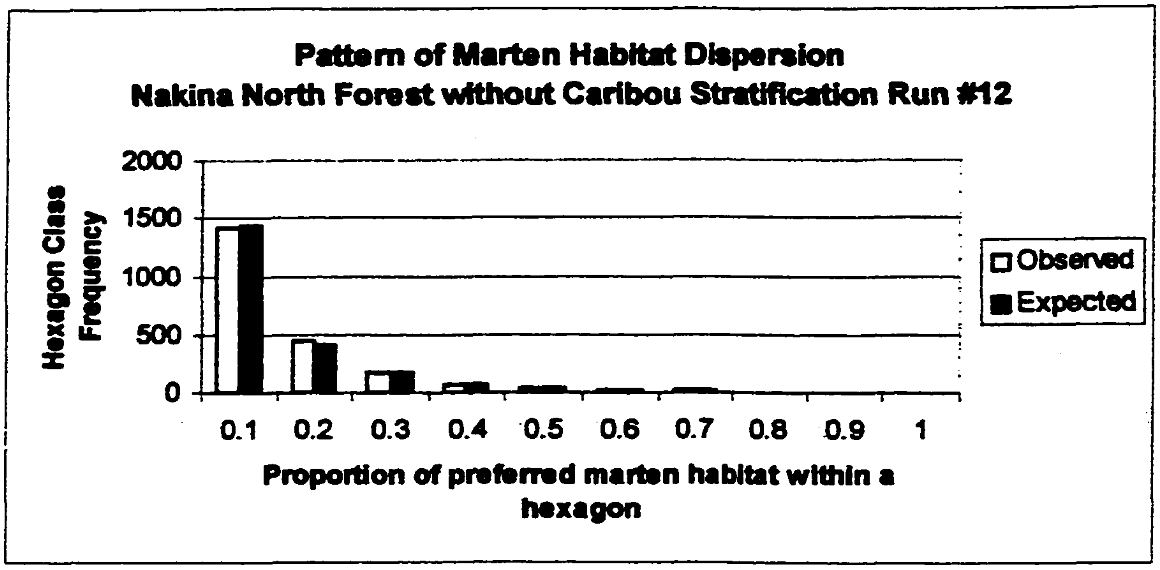

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #5
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

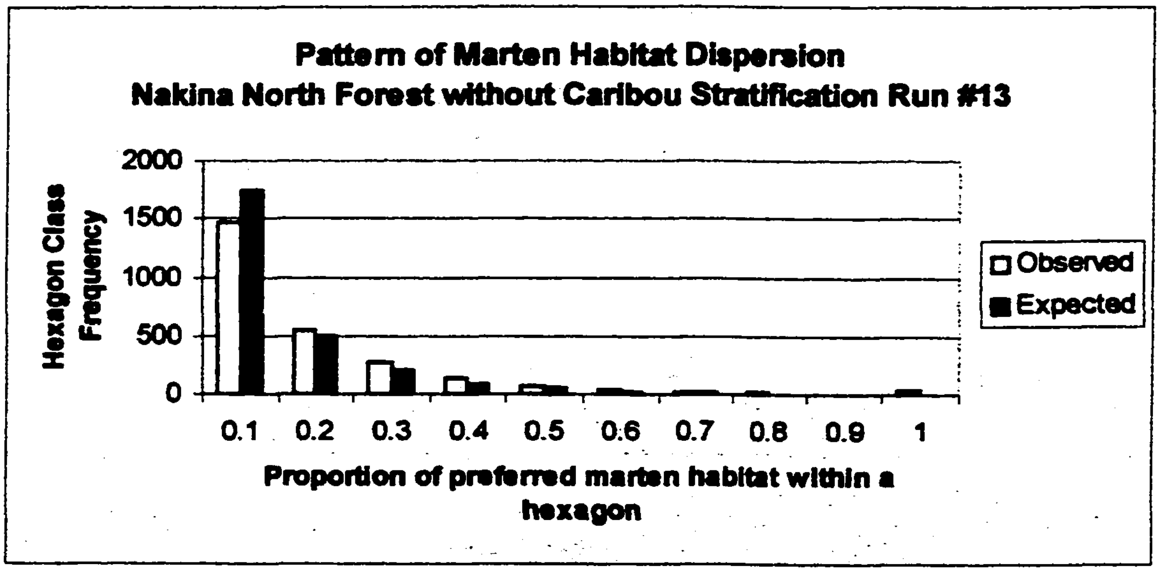

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #6
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

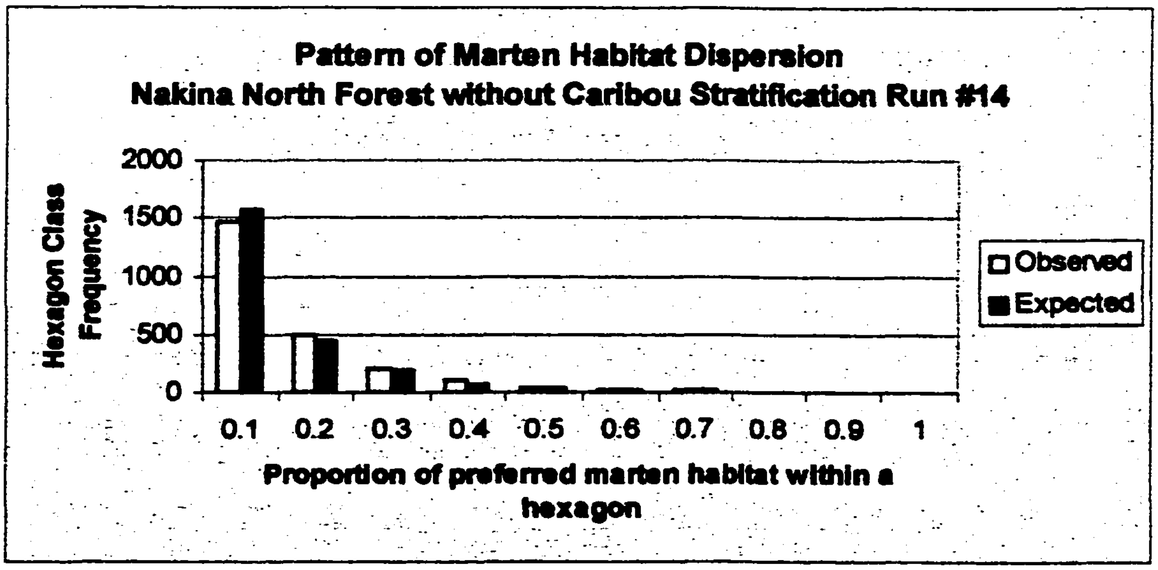

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #7
Hexagon Class Frequency
1400
1200
1000
800
600
400
200
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

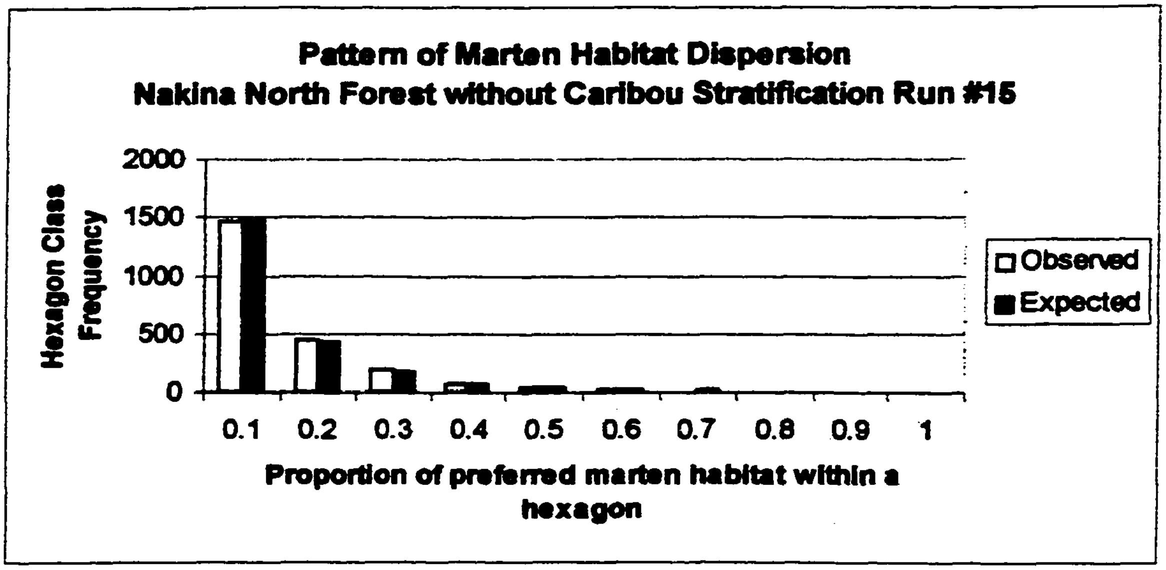

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #8
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

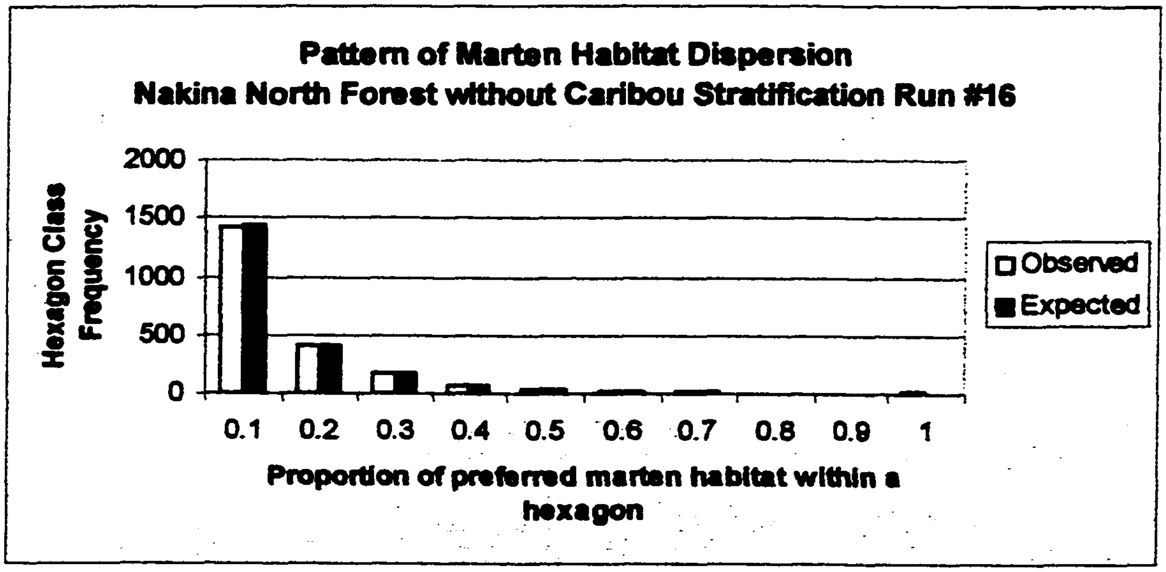

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #9
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

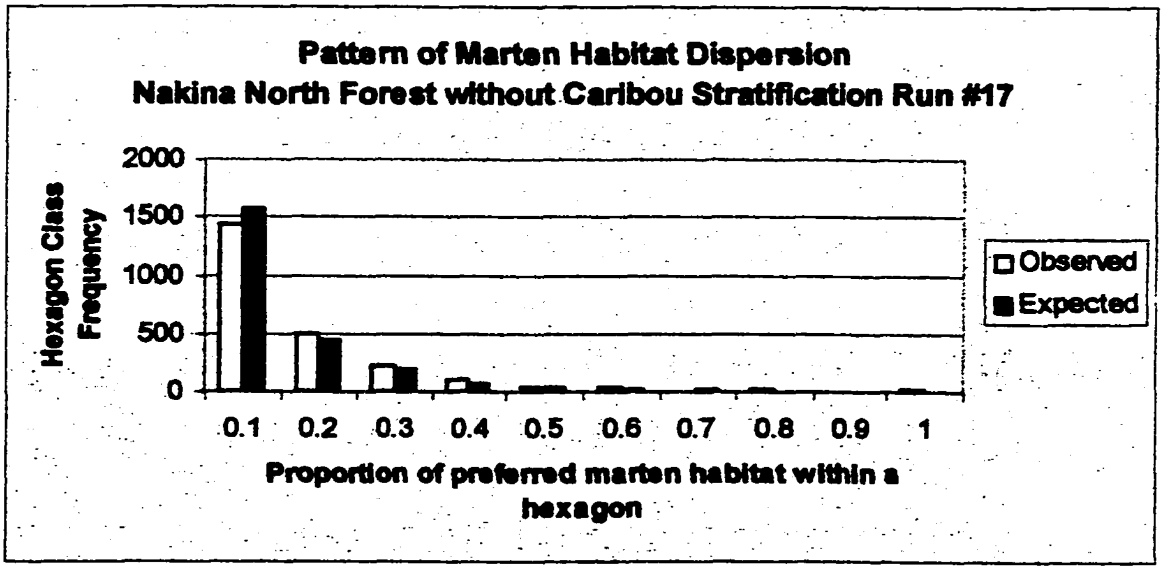

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #12
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
☐ Observed
■ Expected

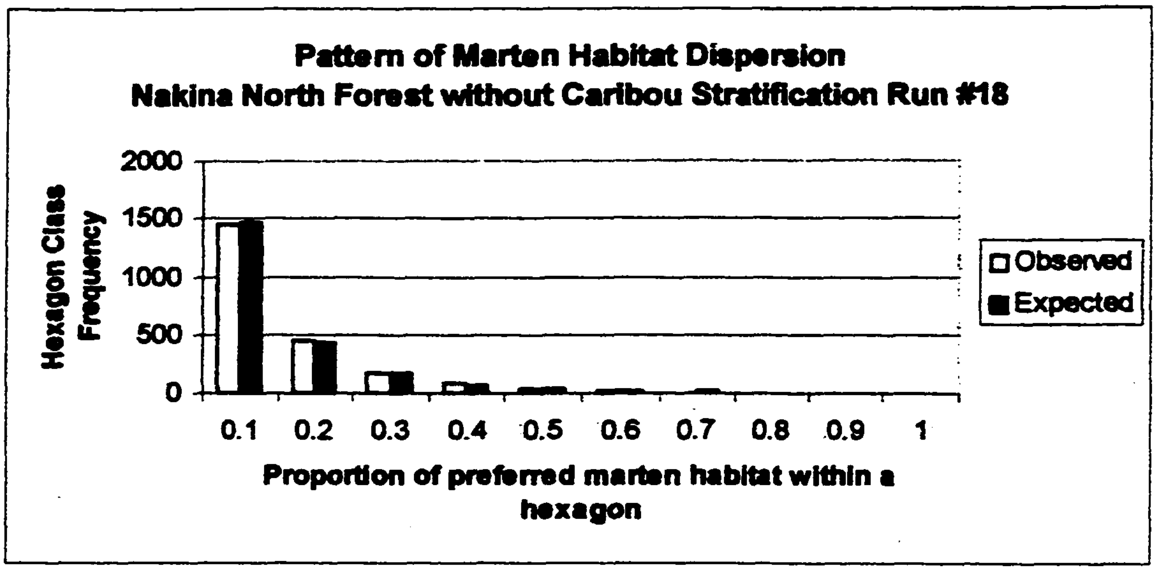

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #13
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
☐ Observed
■ Expected

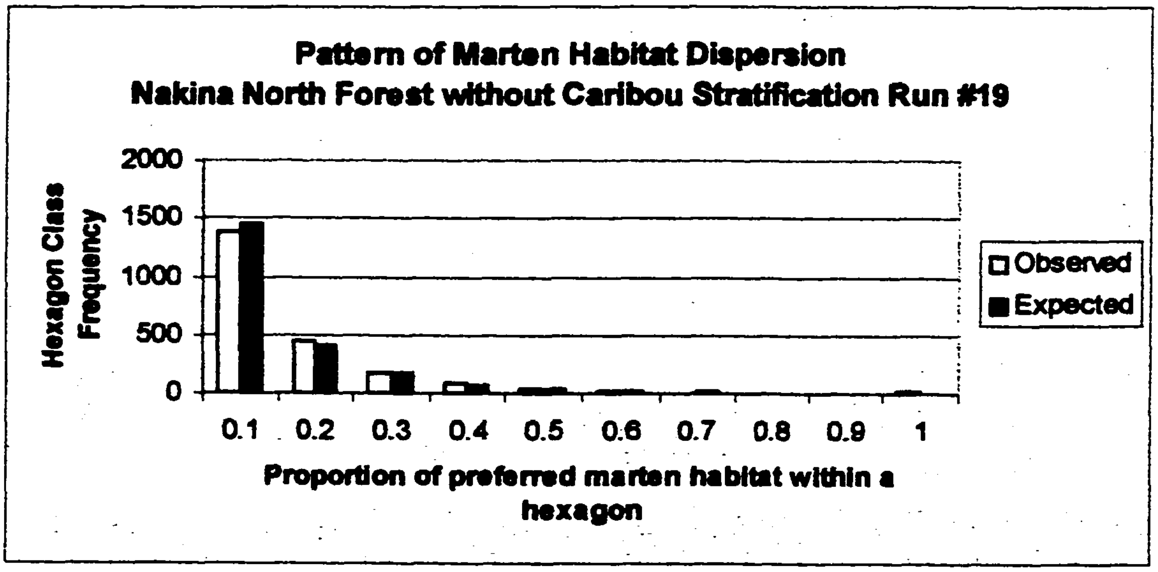

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #14
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
☐ Observed
■ Expected

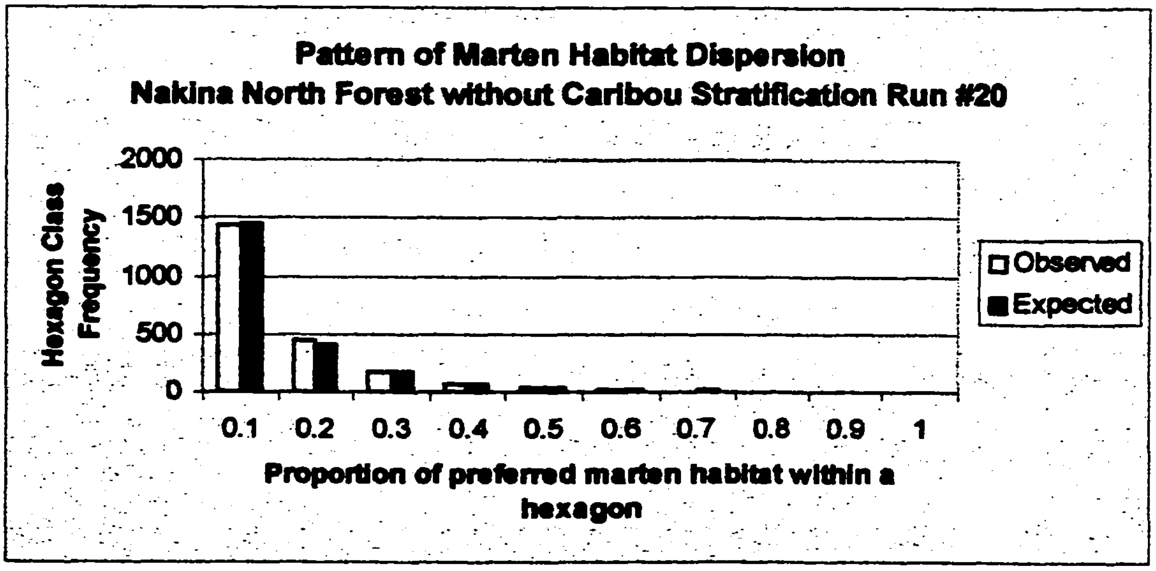

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #15
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

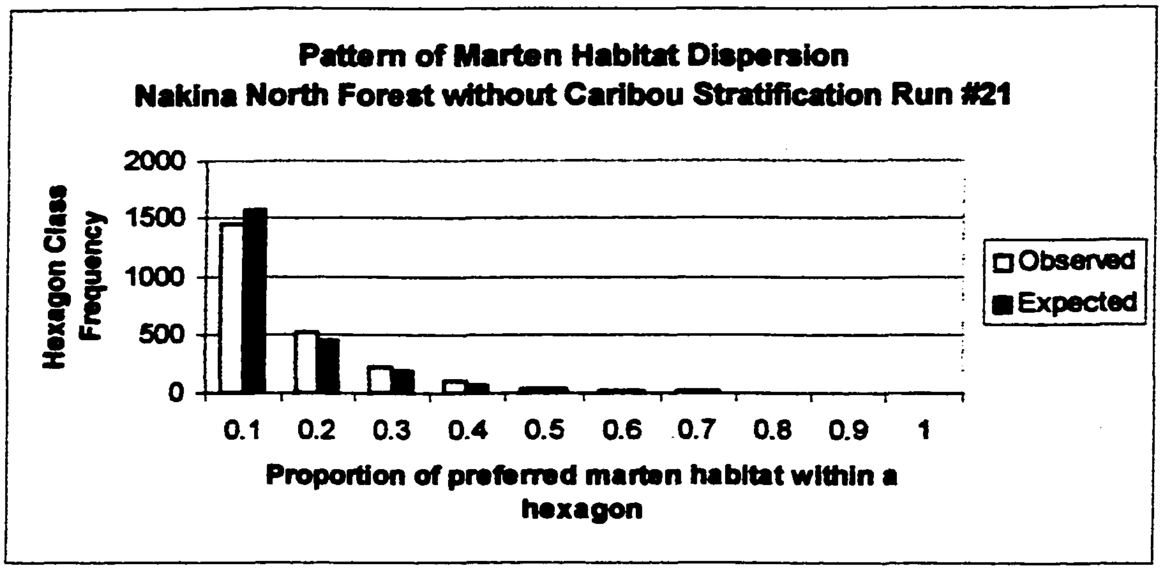

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #16
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

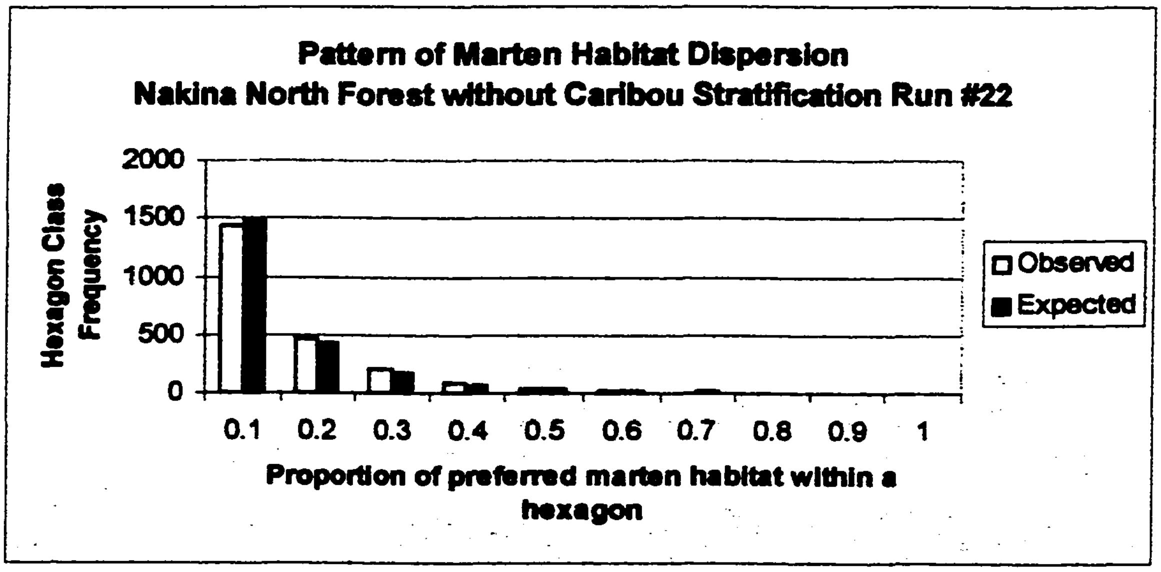

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #17
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

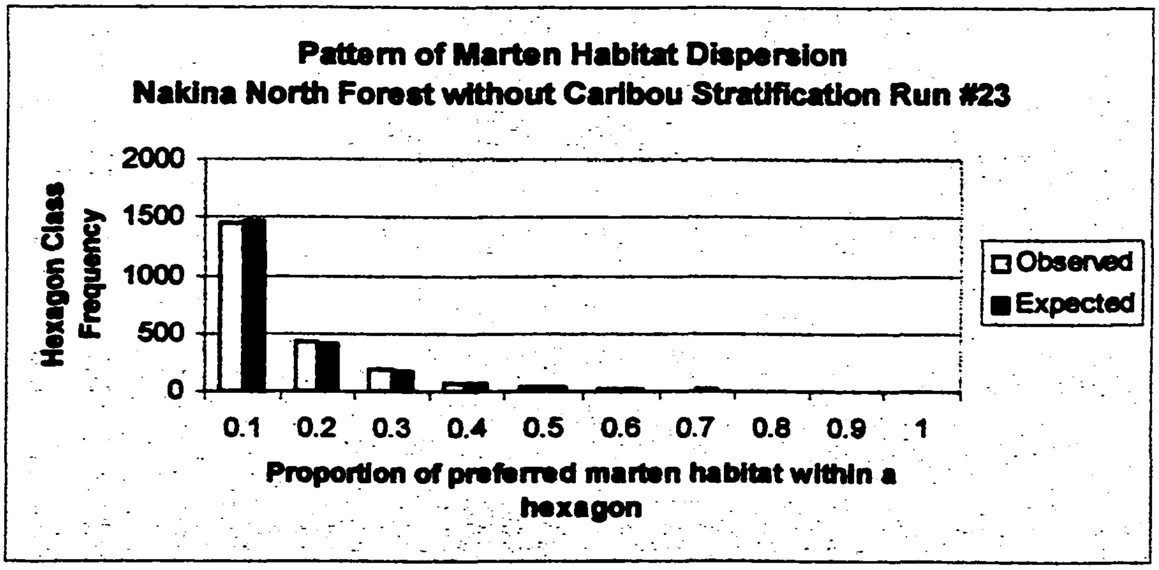

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #18
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

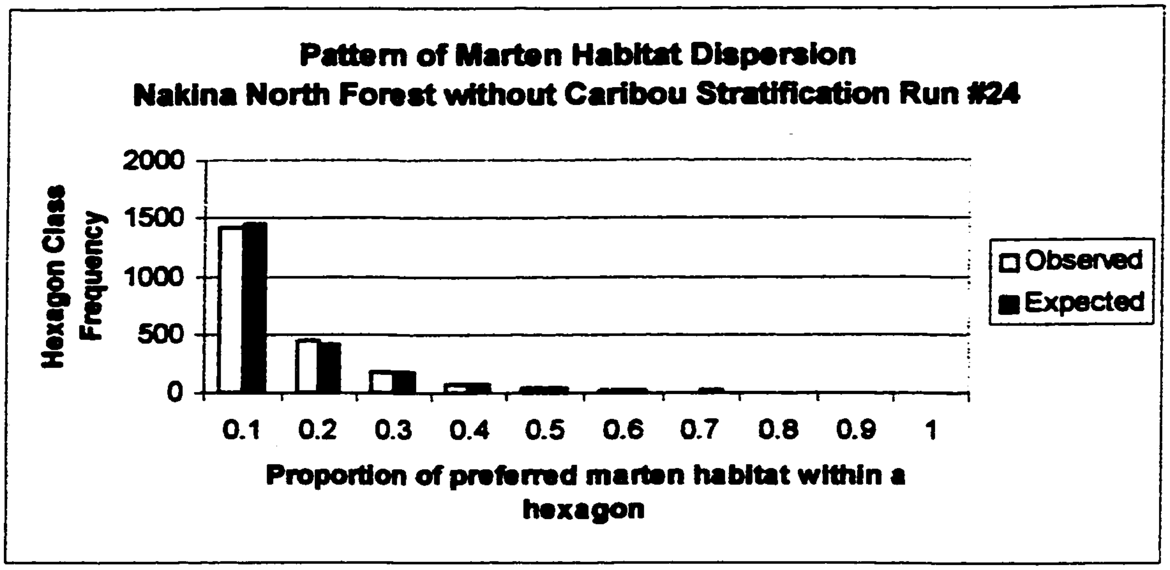

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #19
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #20
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

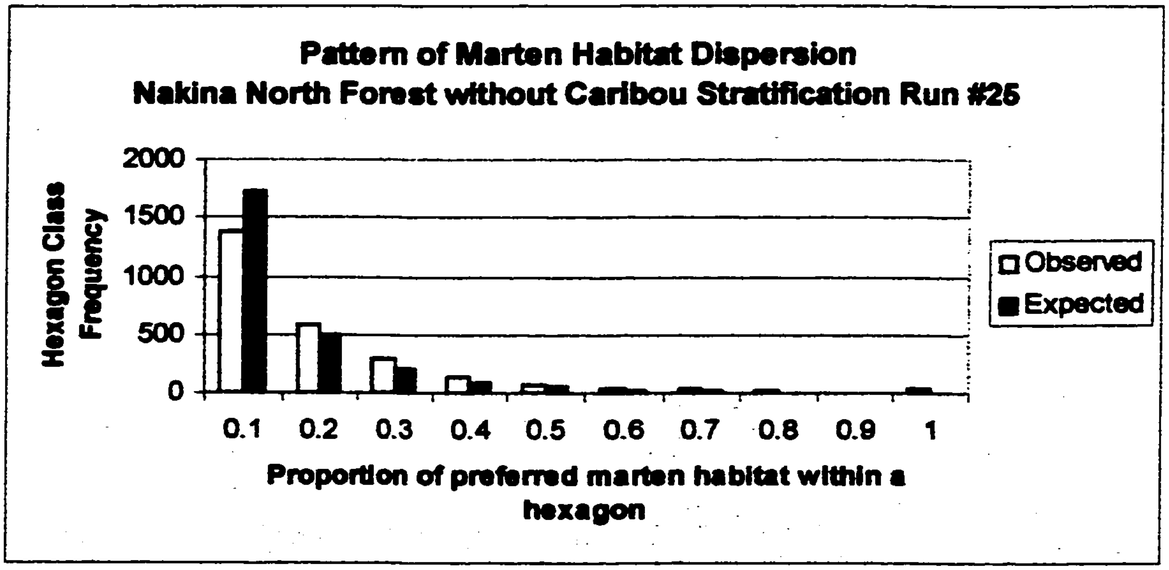

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #21
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #22
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

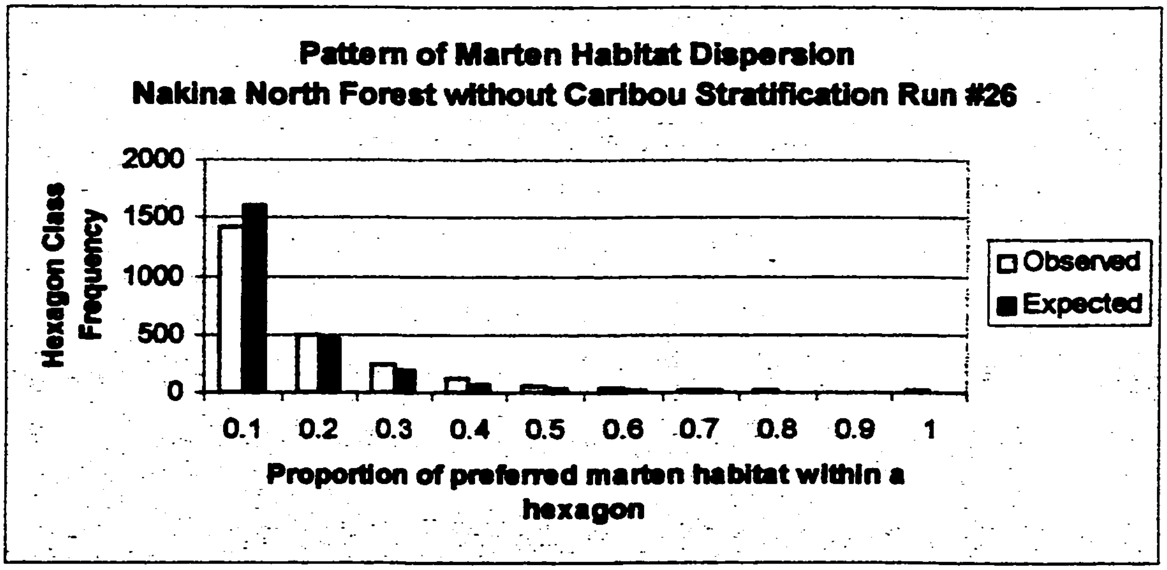

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #23
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected



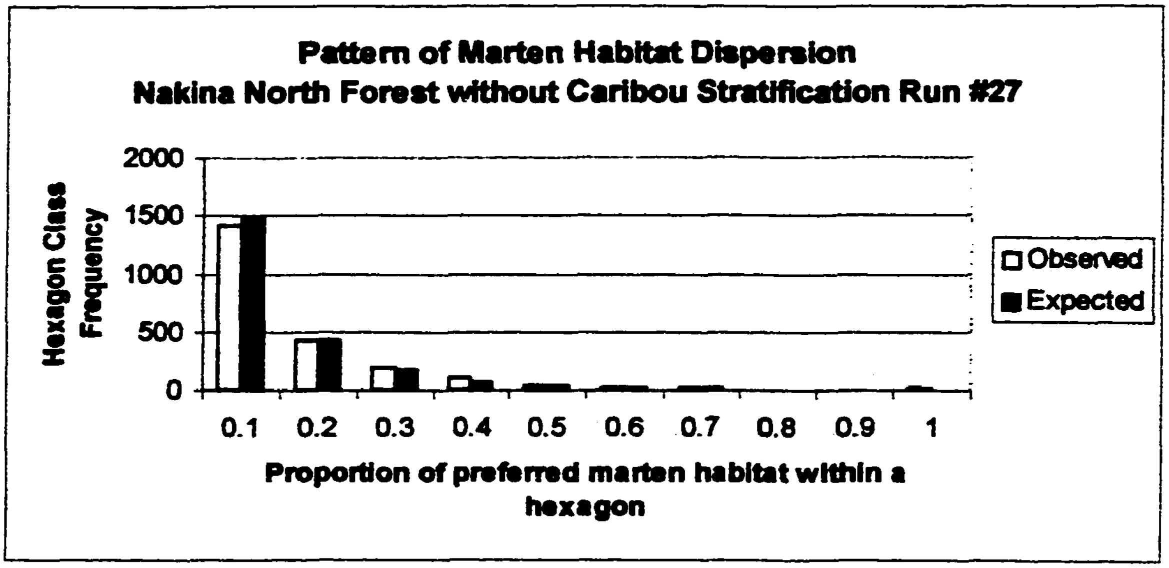
Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #24

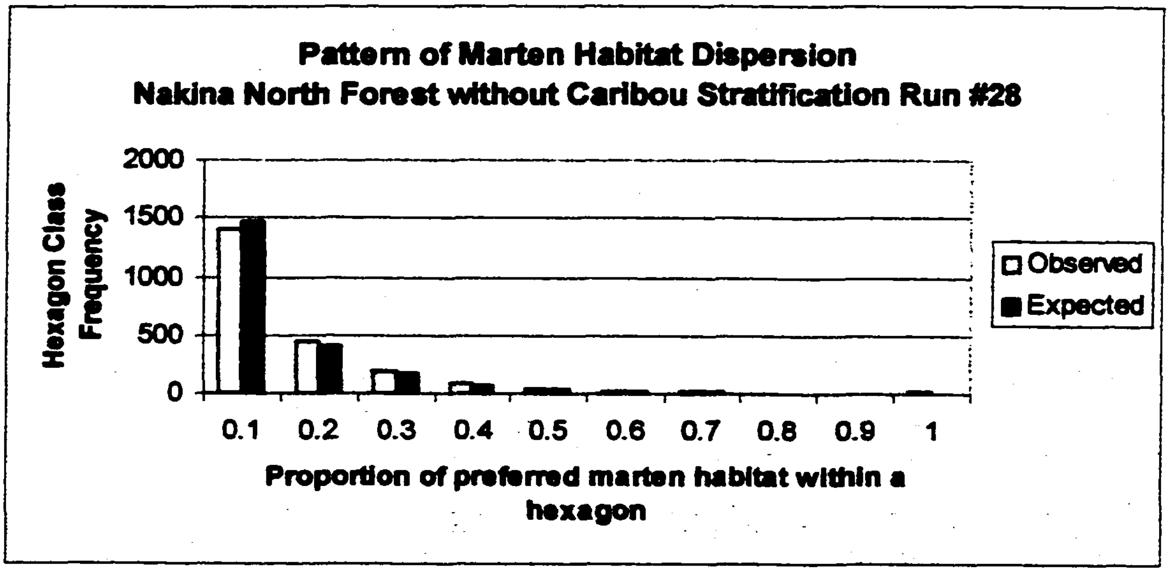


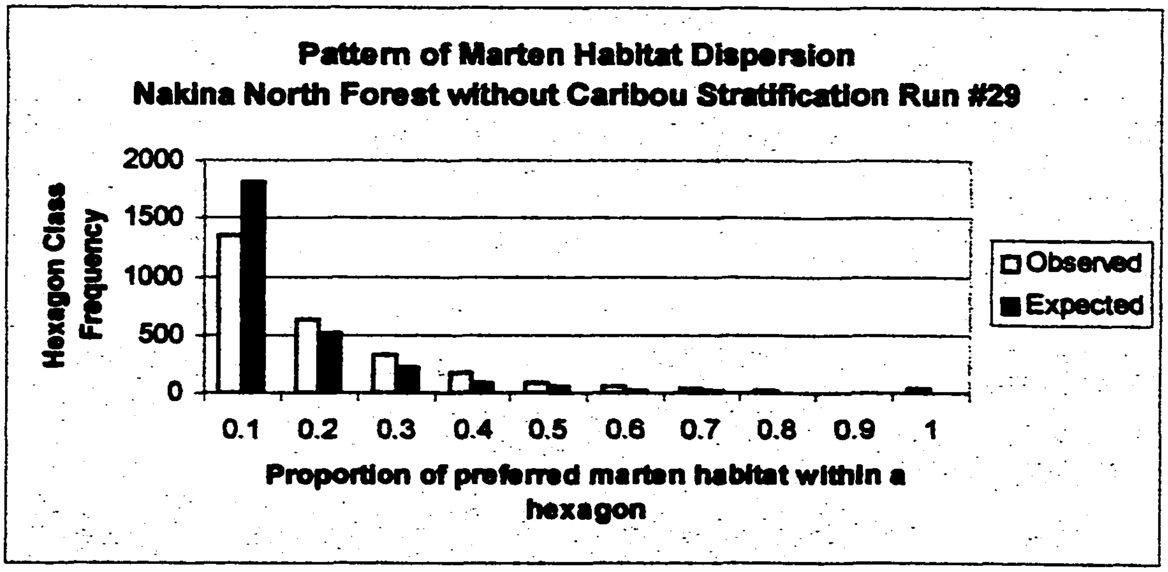
Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #25

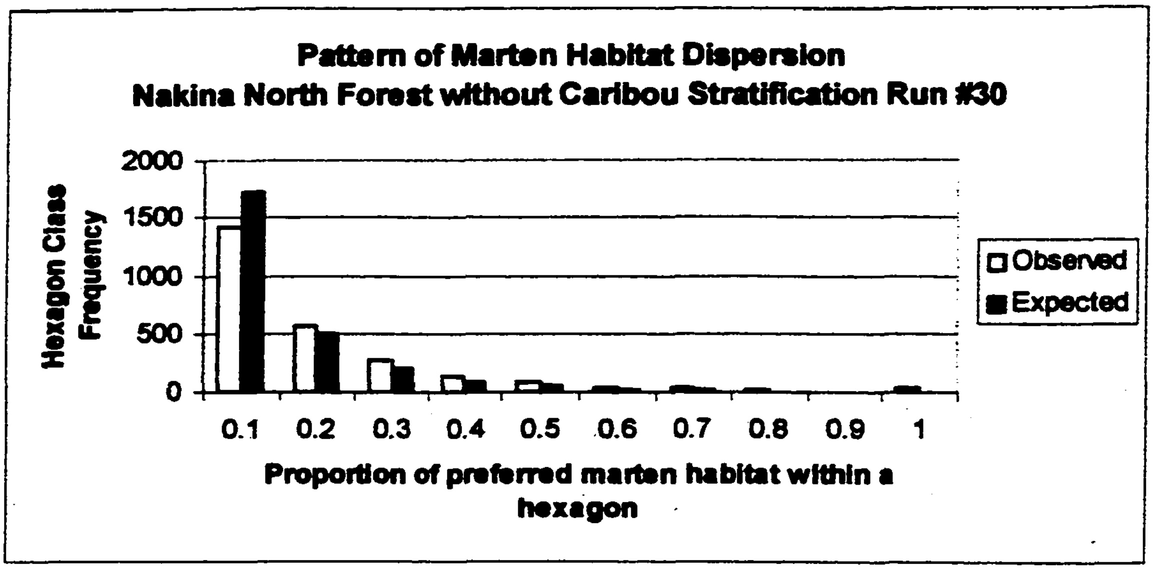


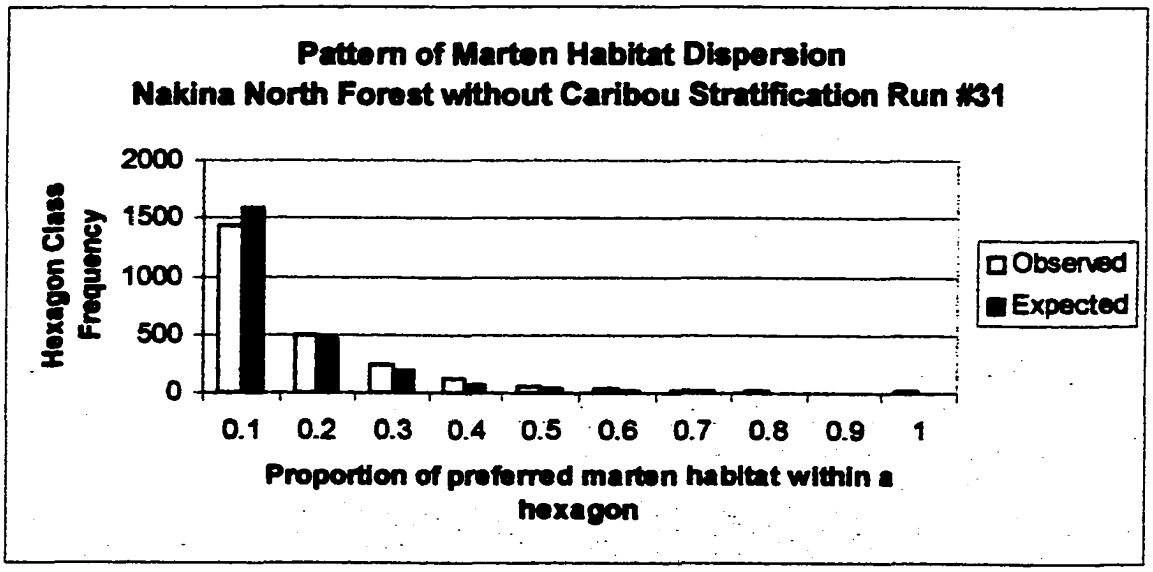
Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #26

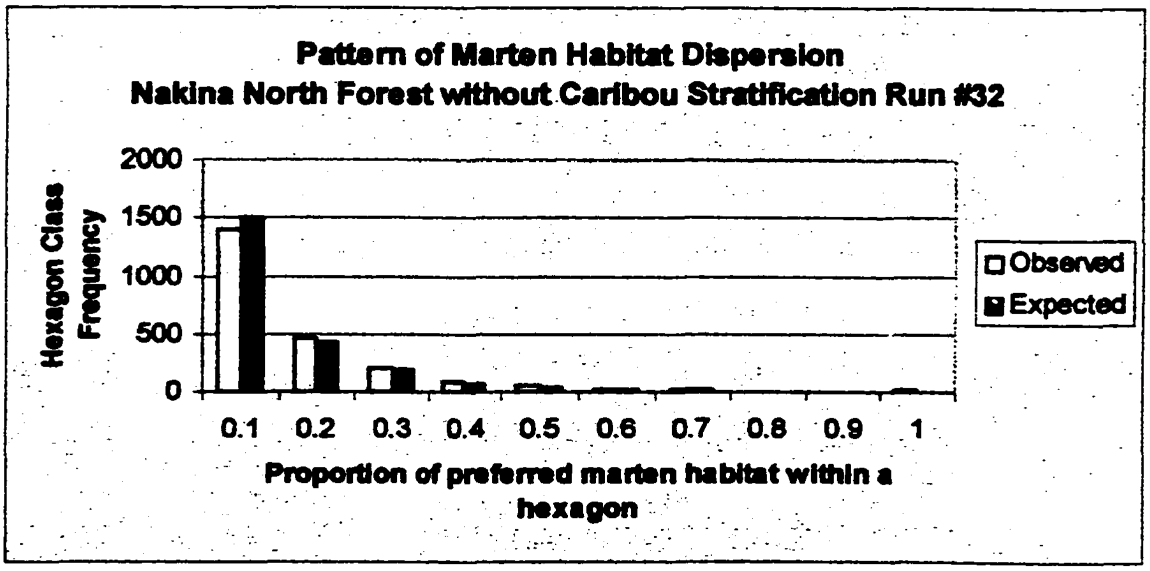

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #27
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

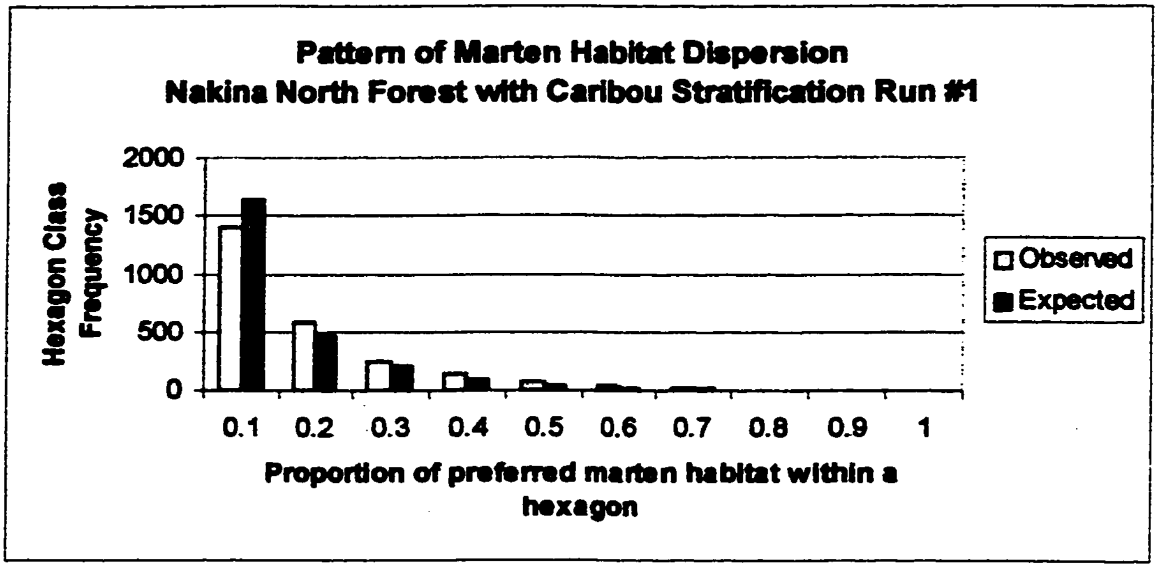

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #28
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #29
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

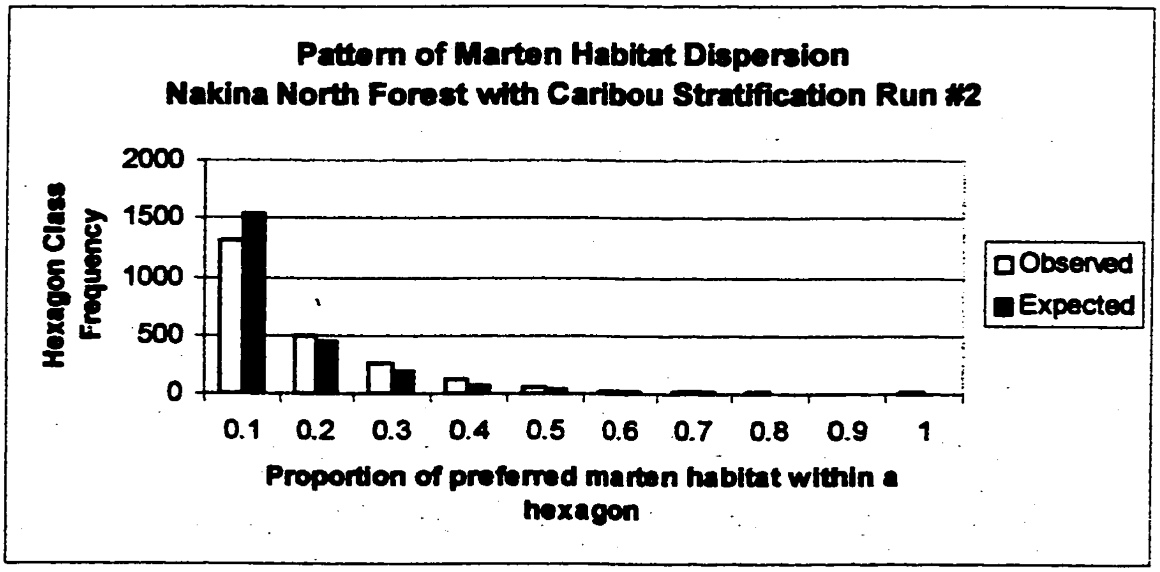

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #30
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #31
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

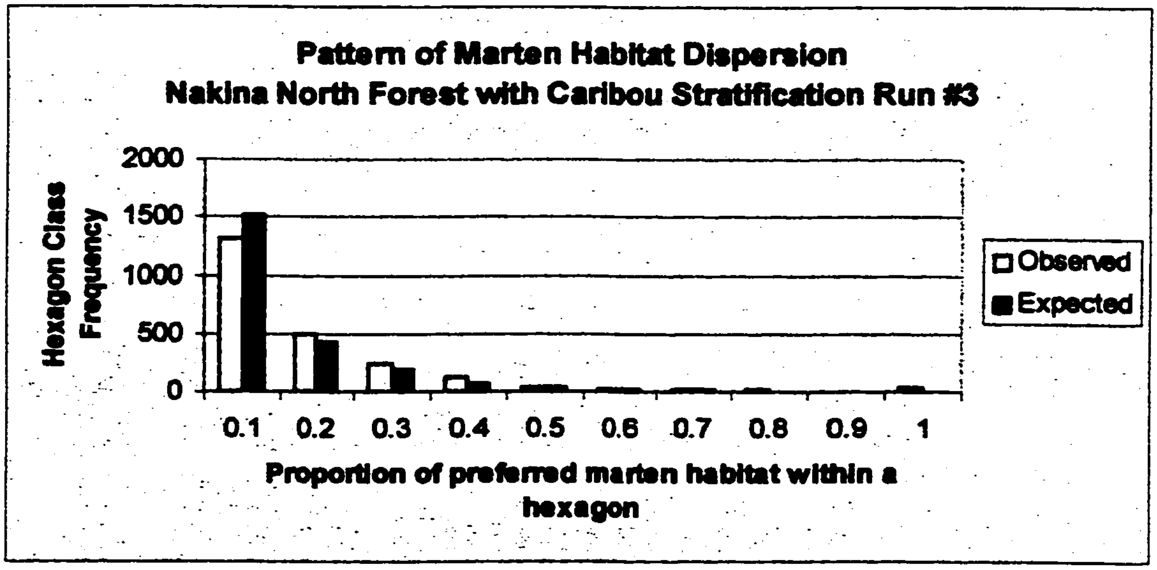

Pattern of Marten Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #32
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected



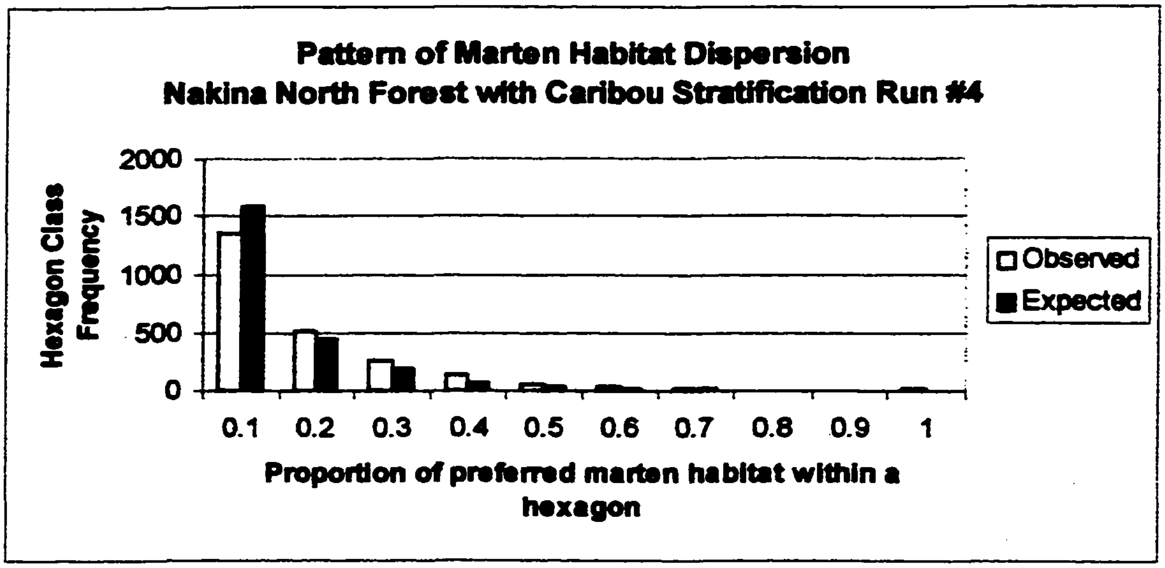
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #1
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

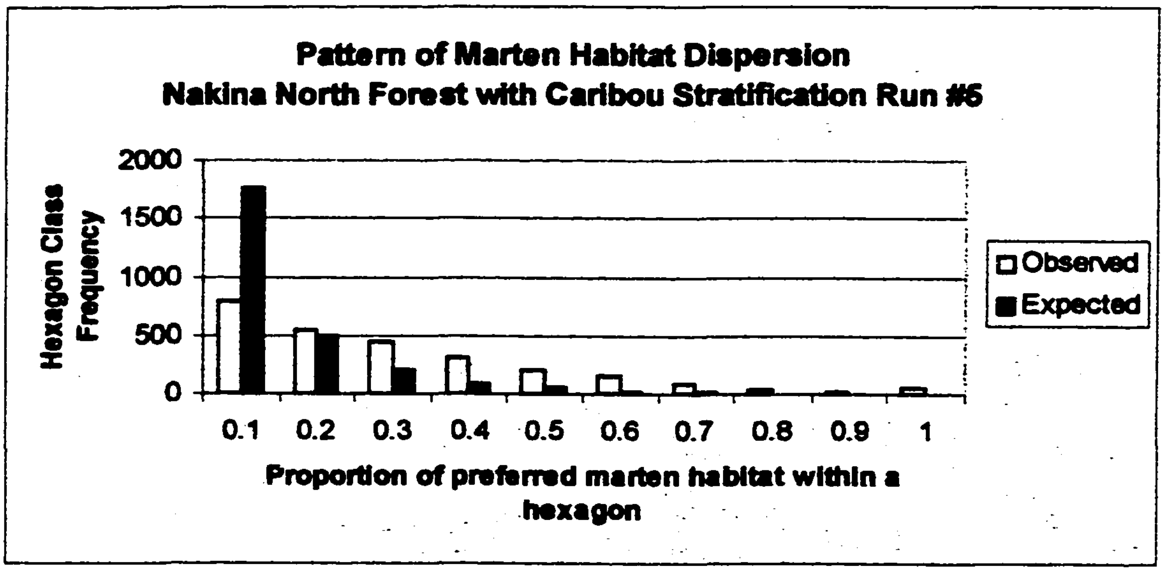


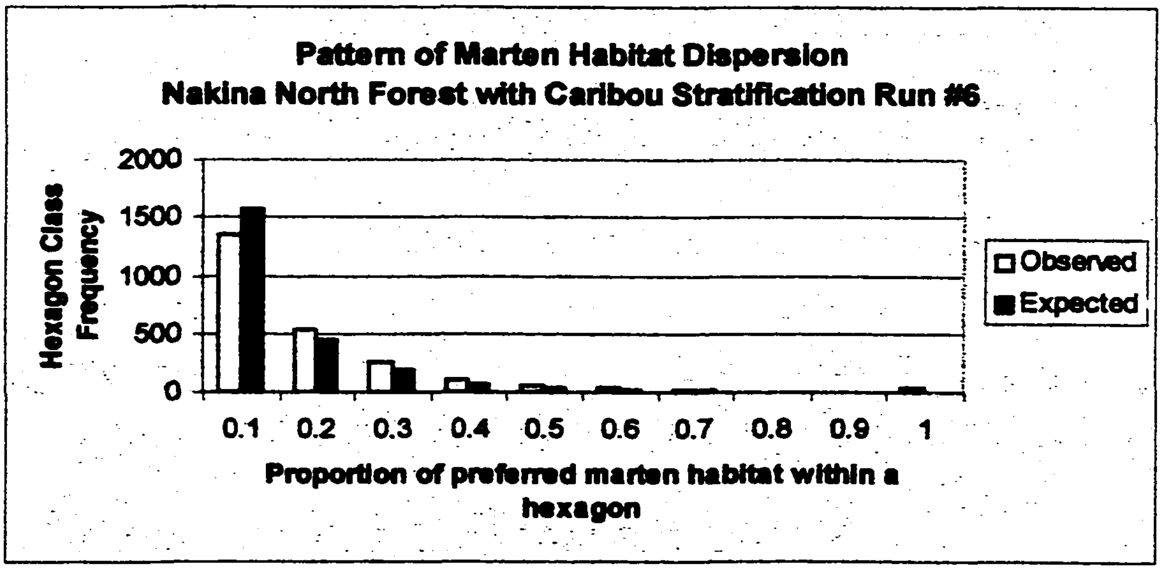
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #2
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

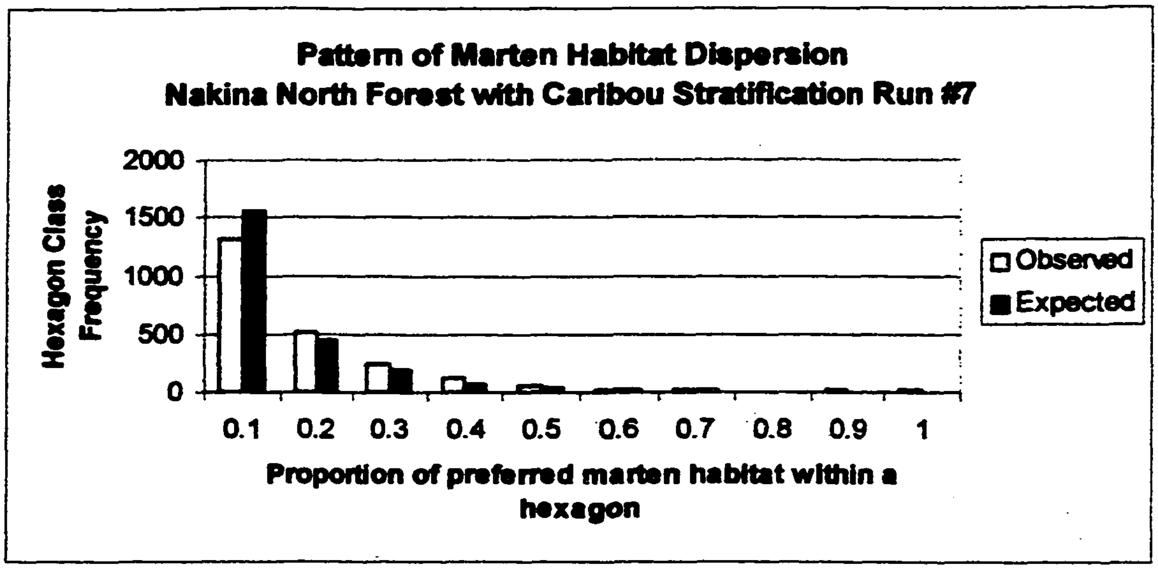


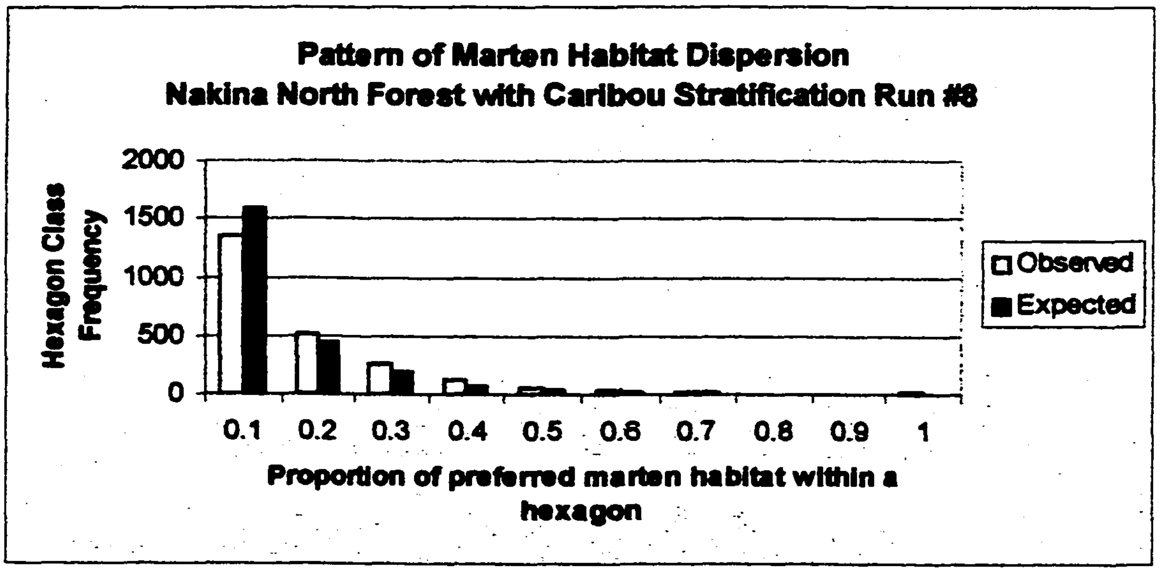
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #3
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

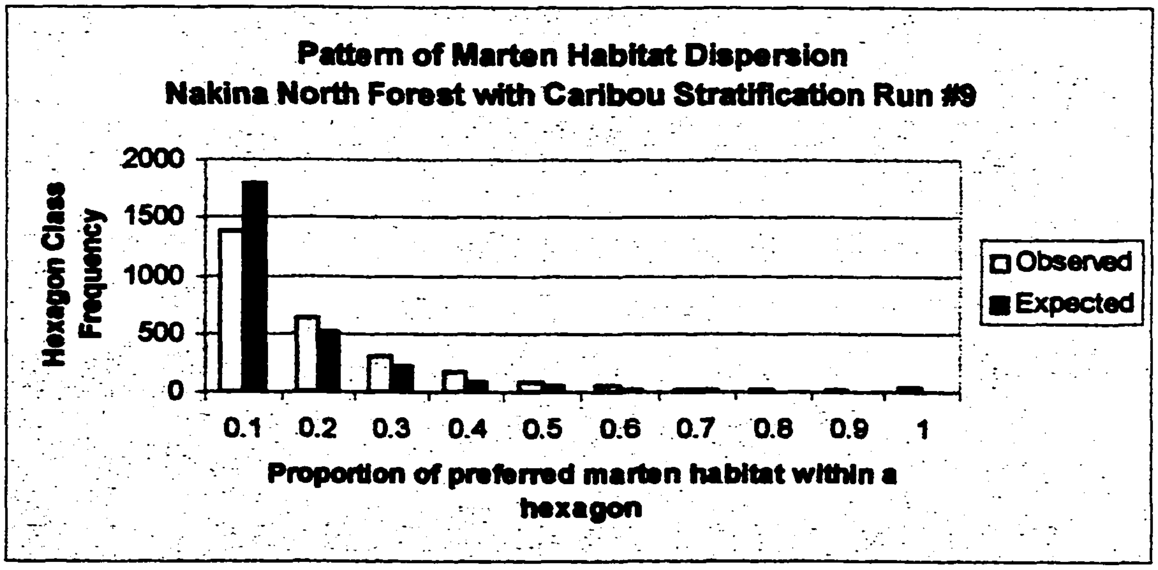

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #4
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

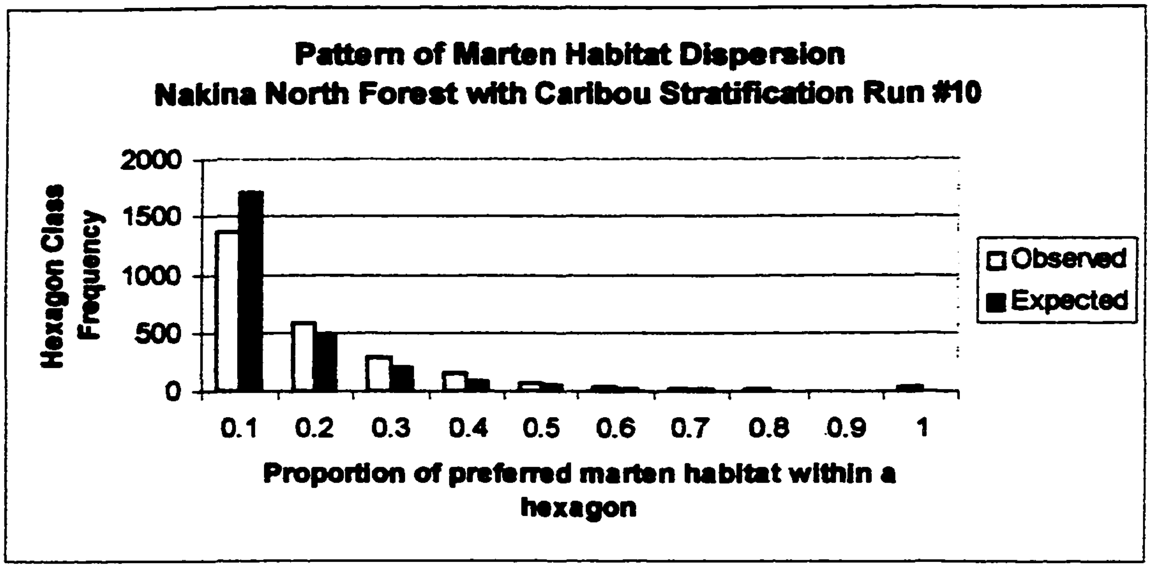

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #5
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #6
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

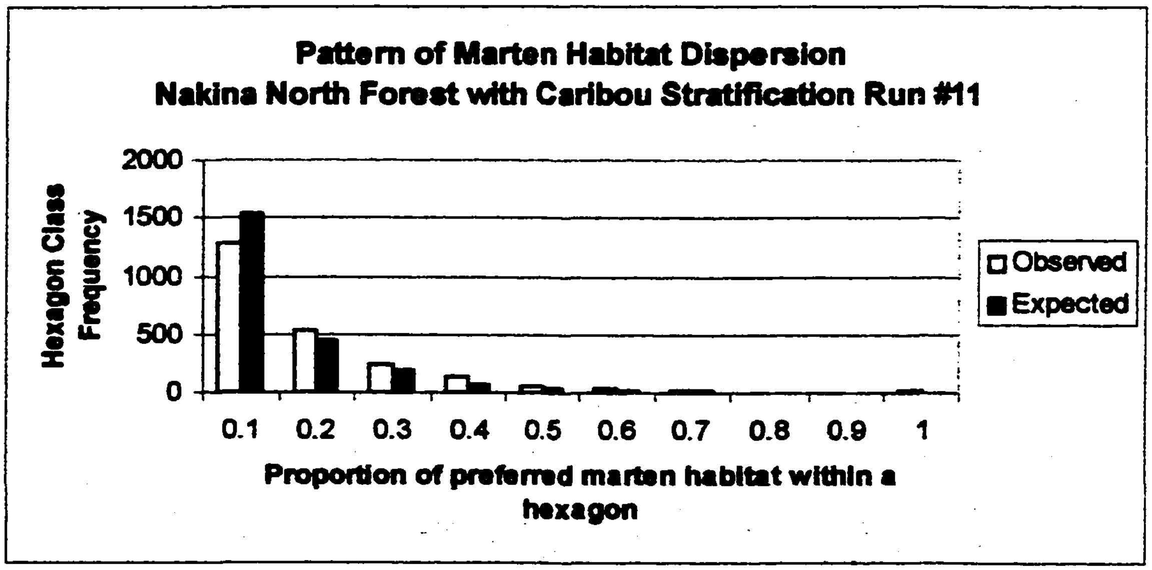

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #7
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #8
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

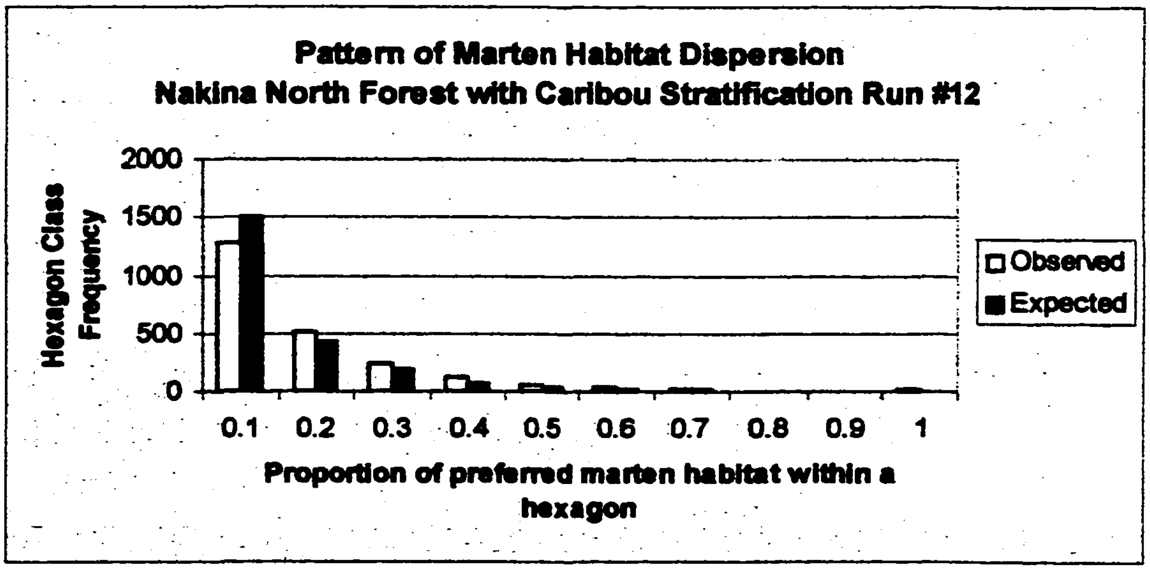

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #9
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected



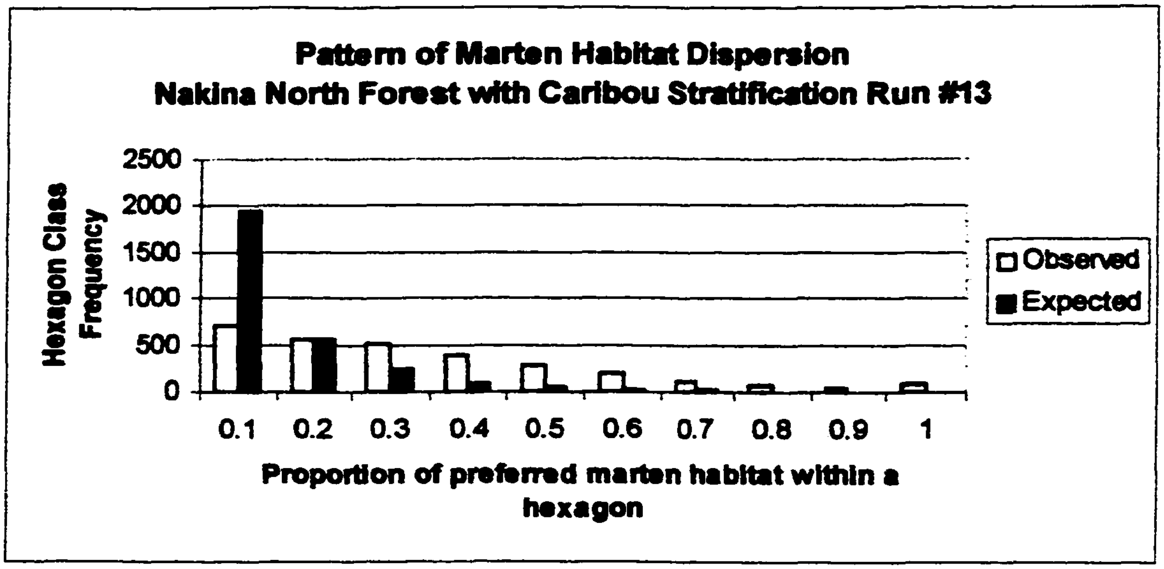
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #10



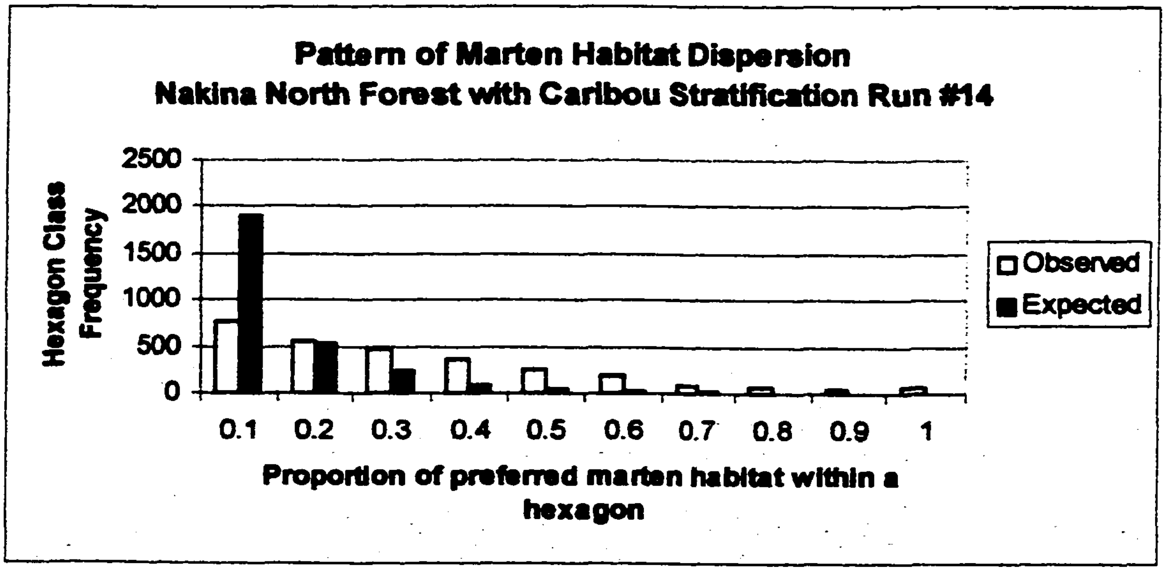
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #11



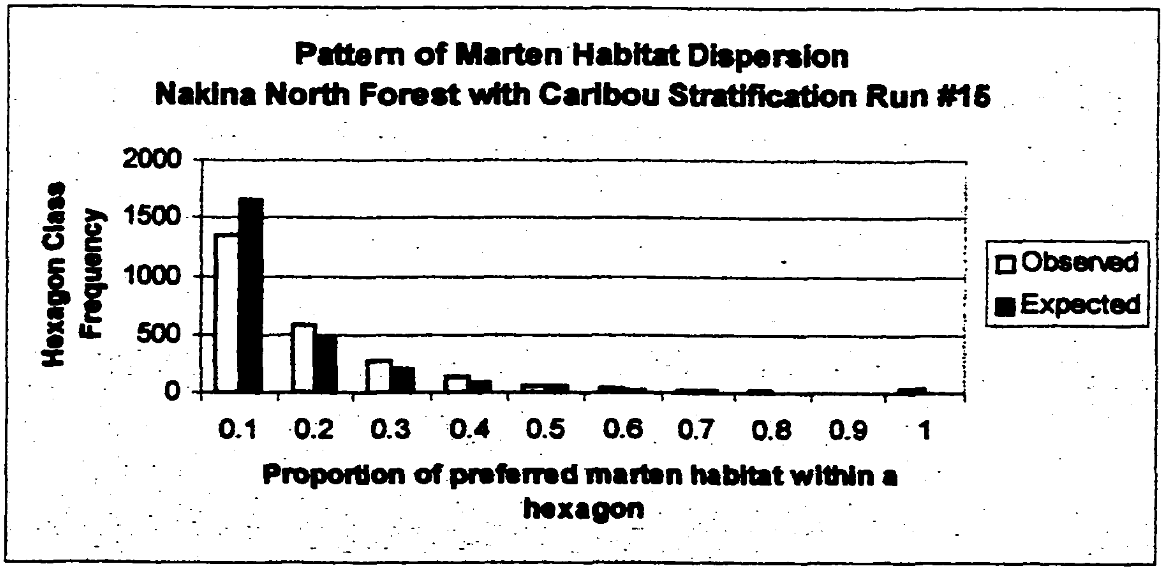
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #12



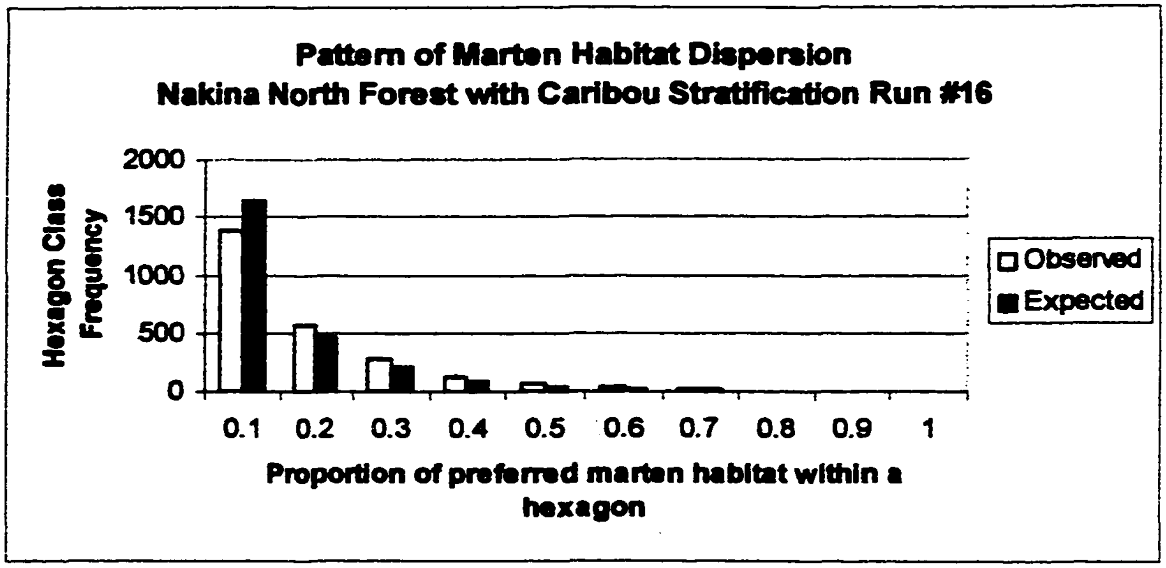
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #13

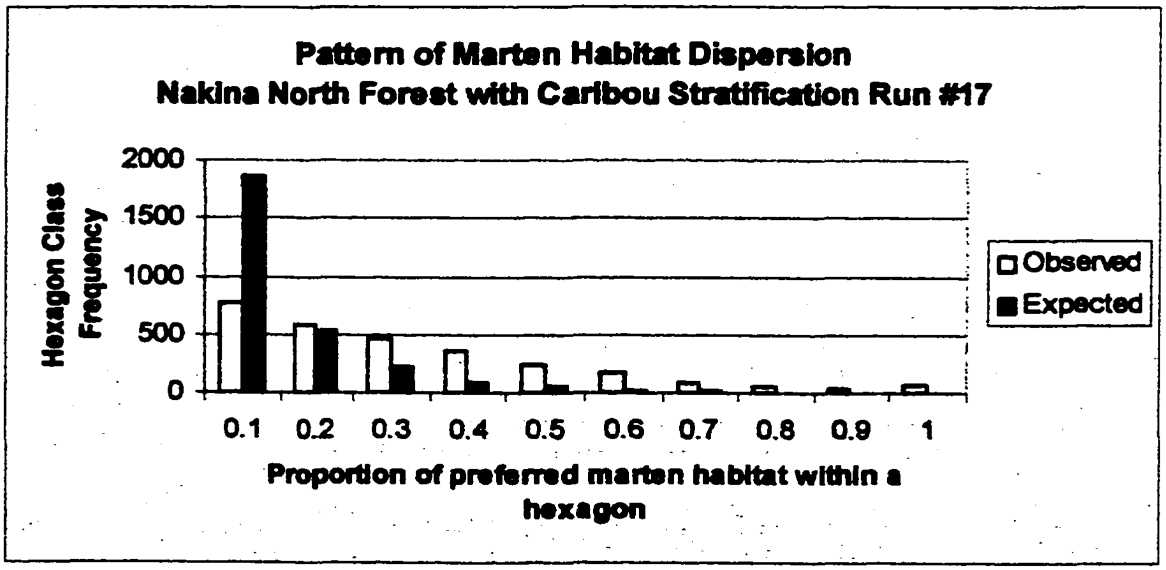


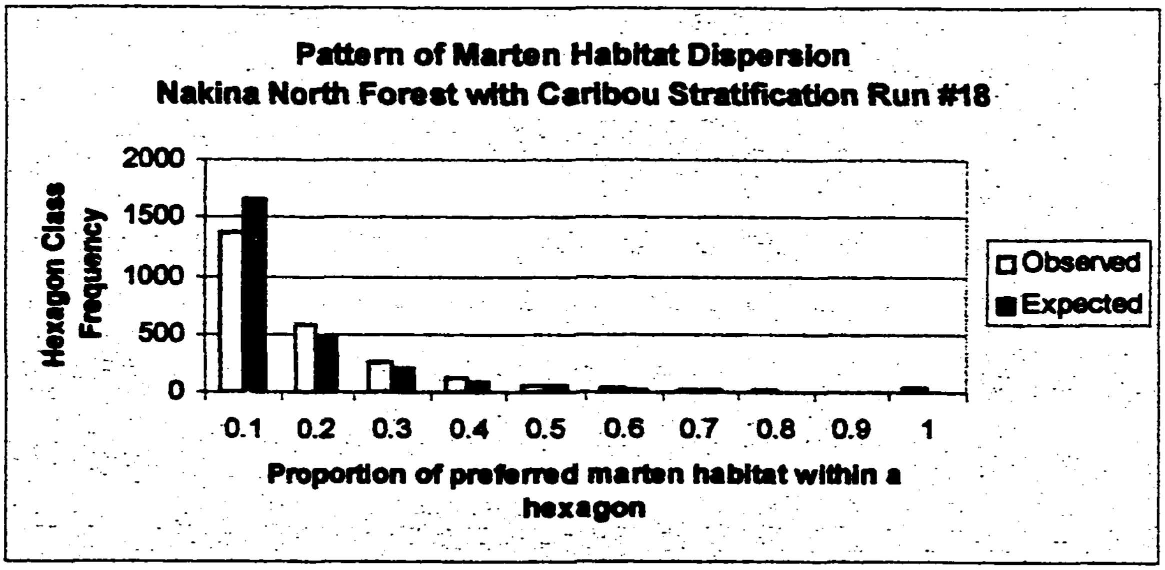
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #14

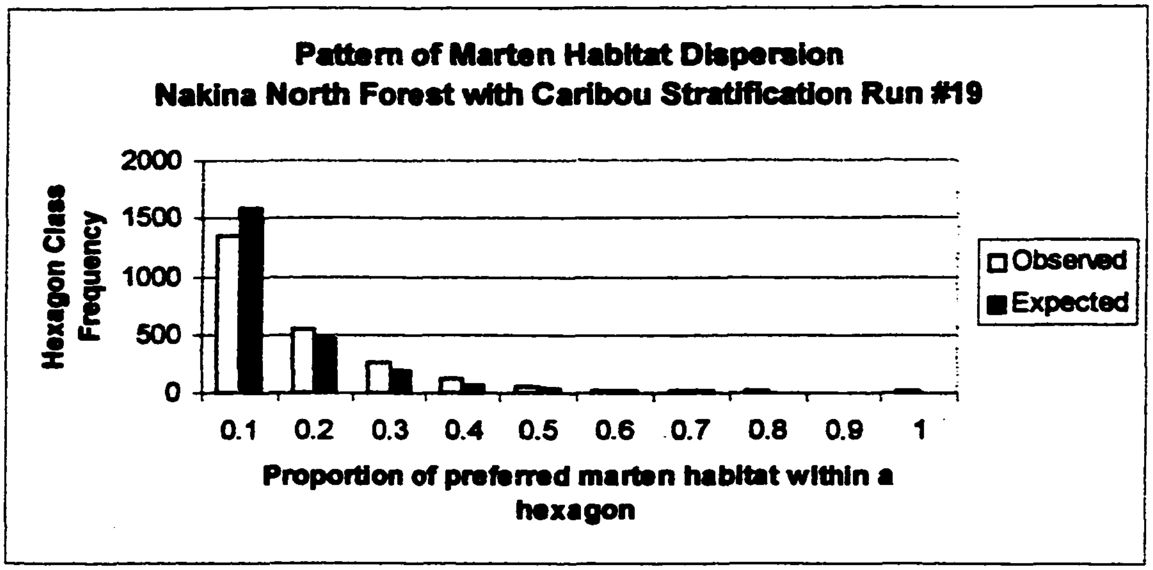


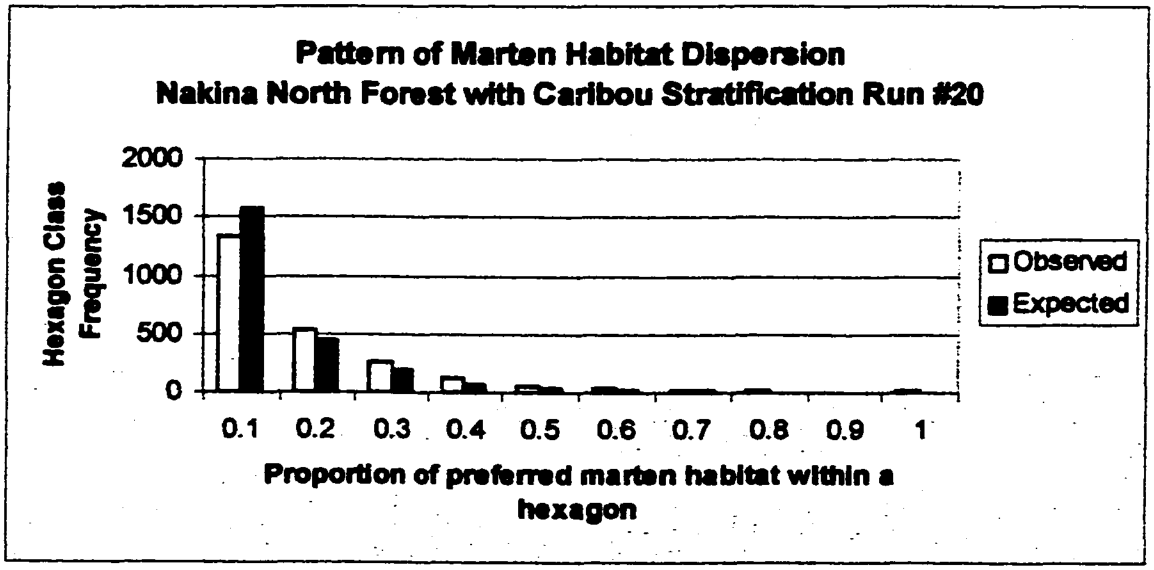
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #15

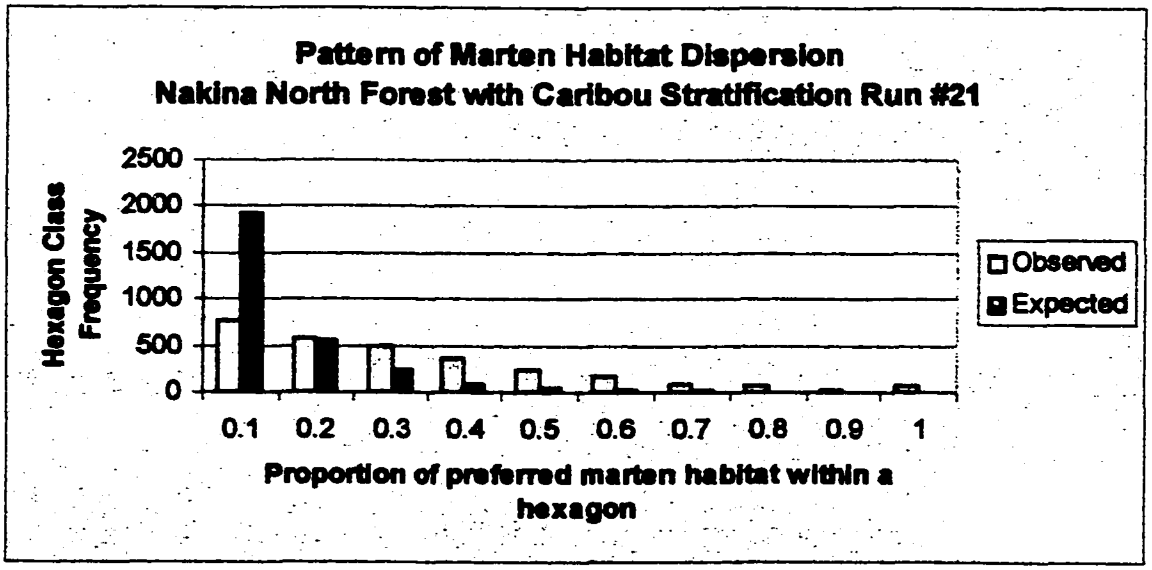

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #16
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

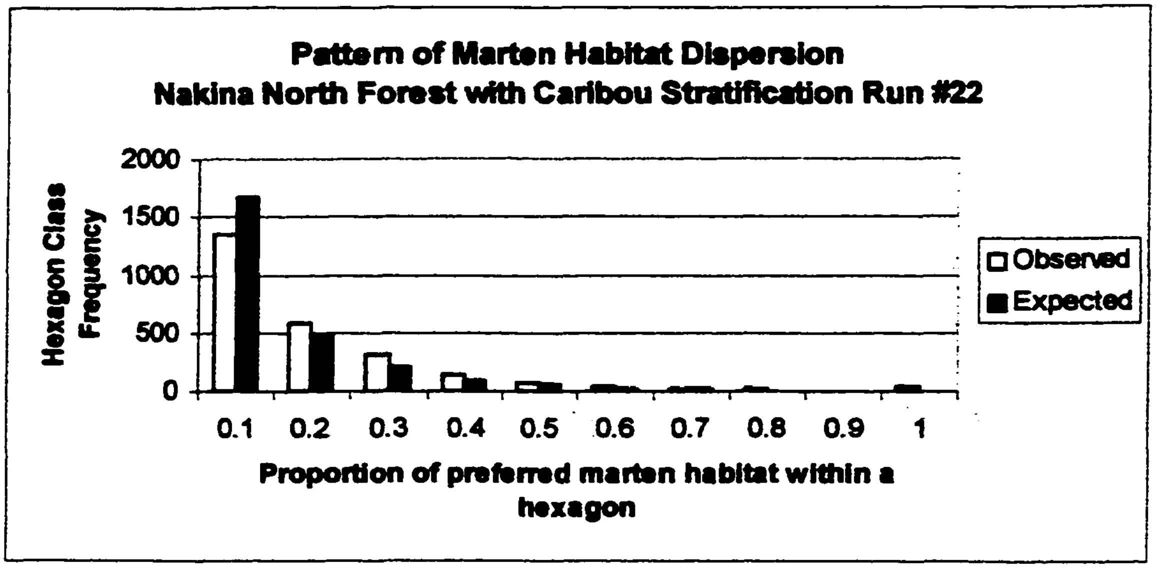

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #17
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #18
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

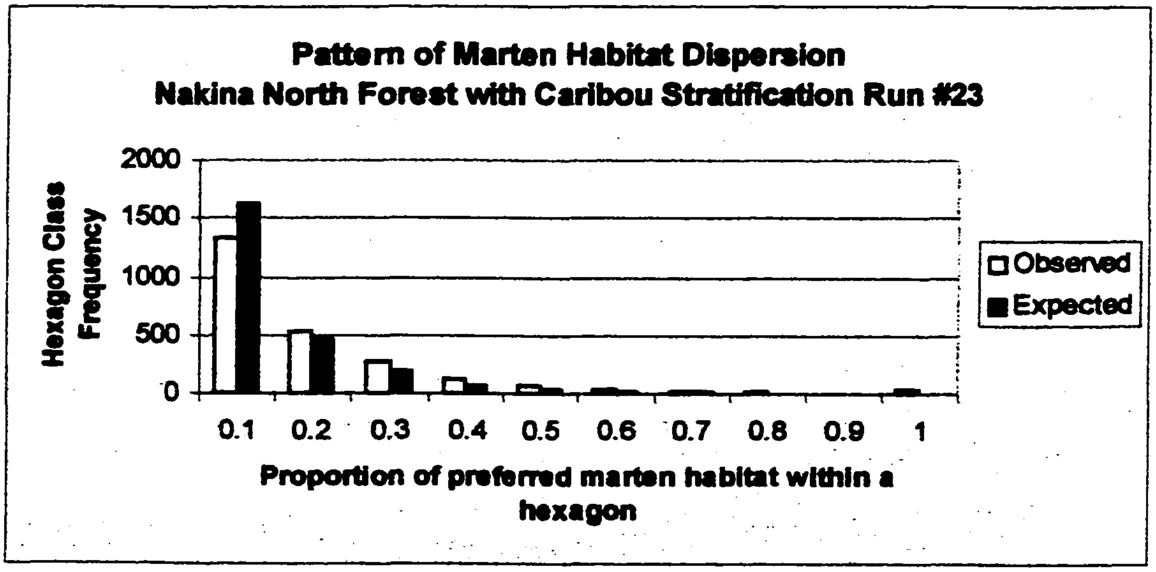

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #19


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #20

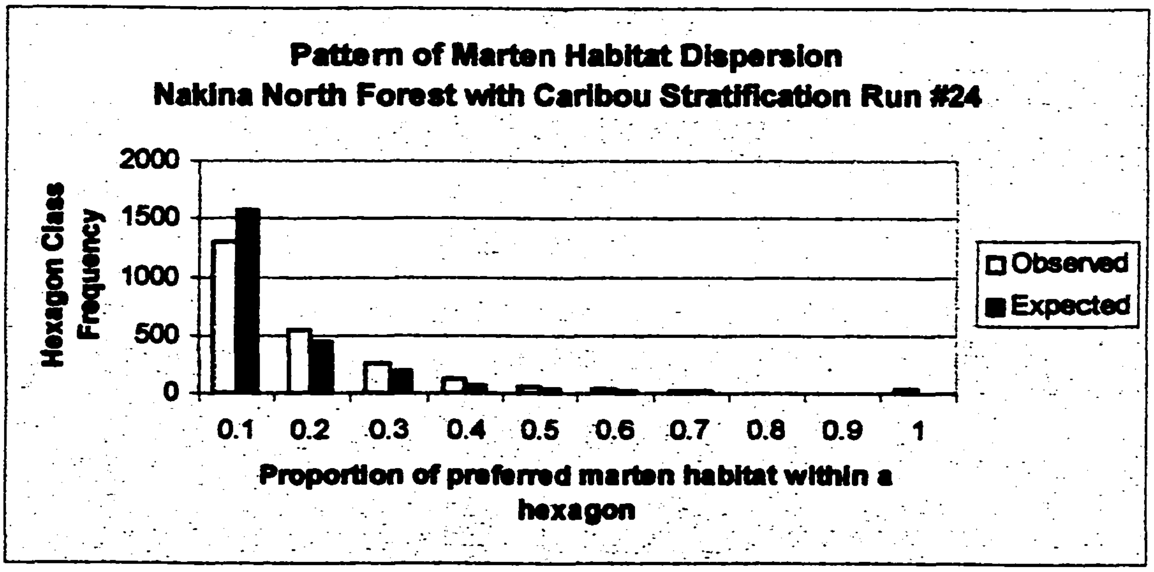

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #21



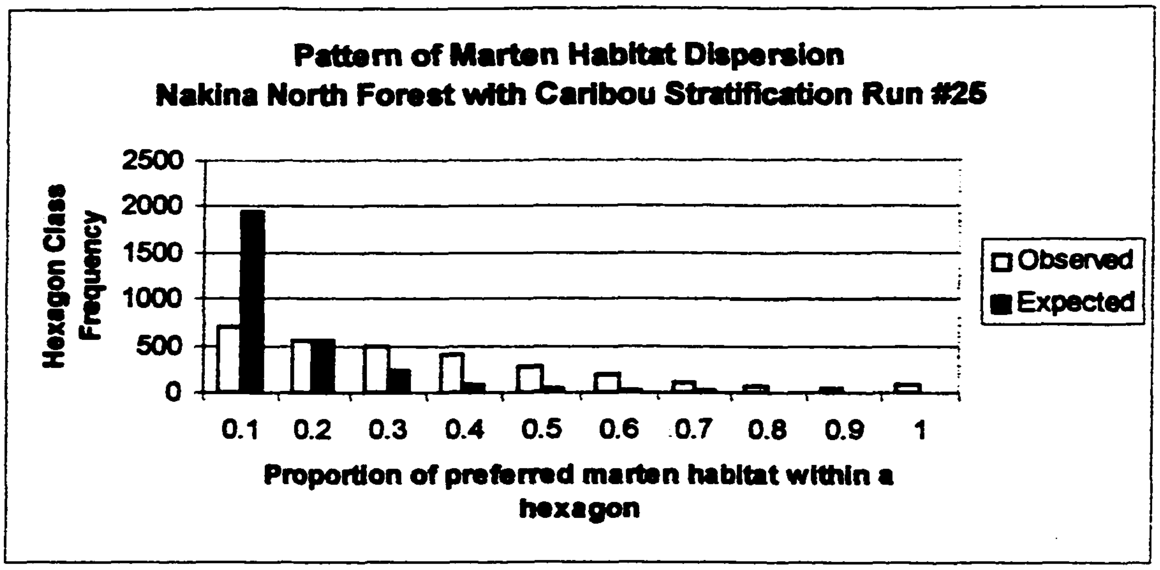
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #22

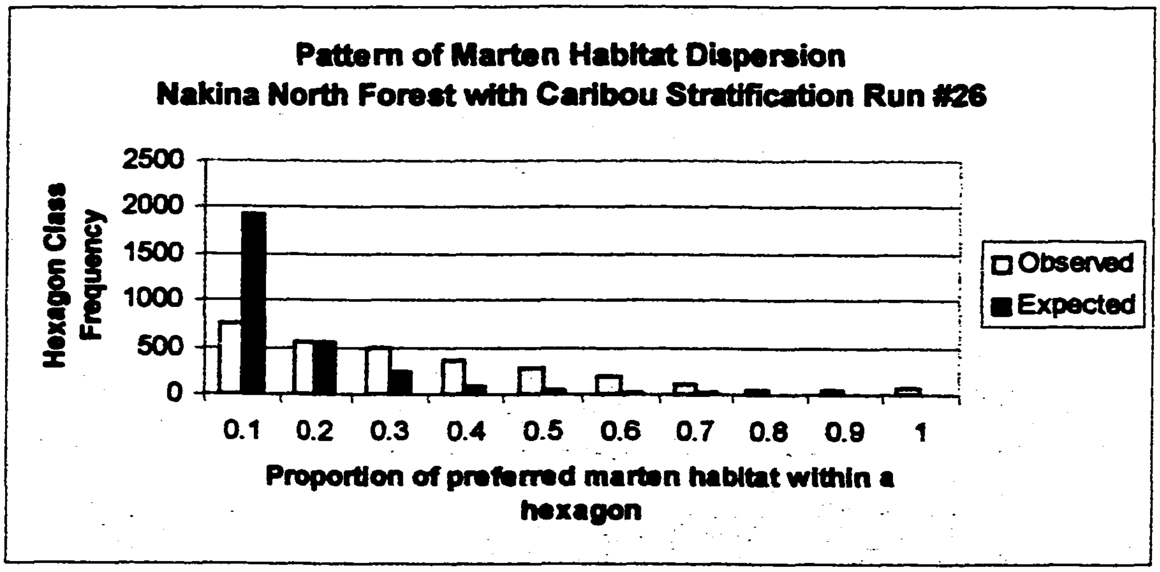


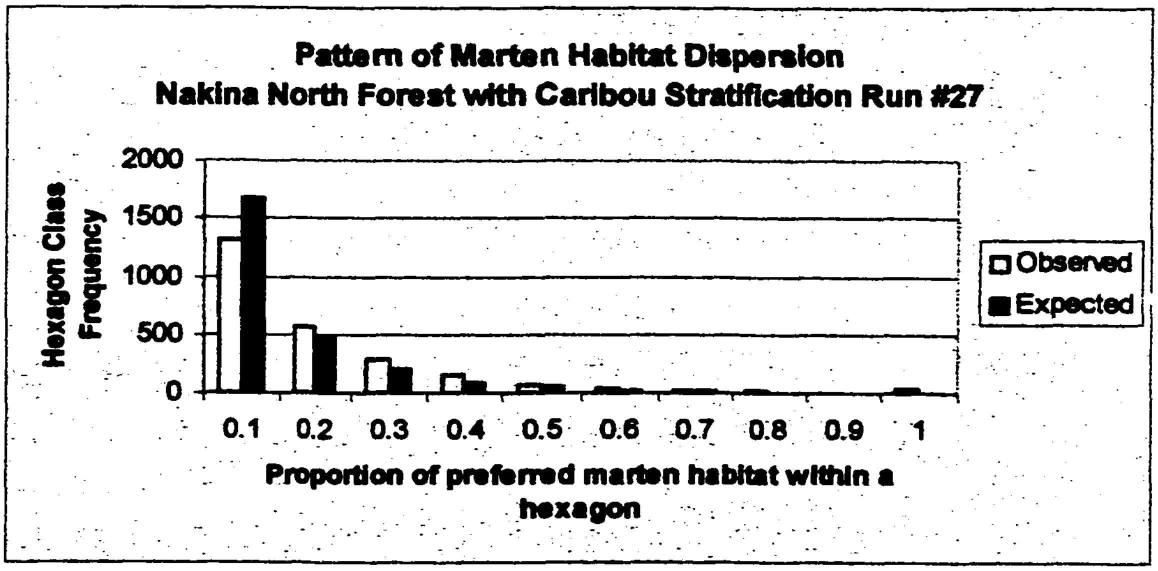
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #23

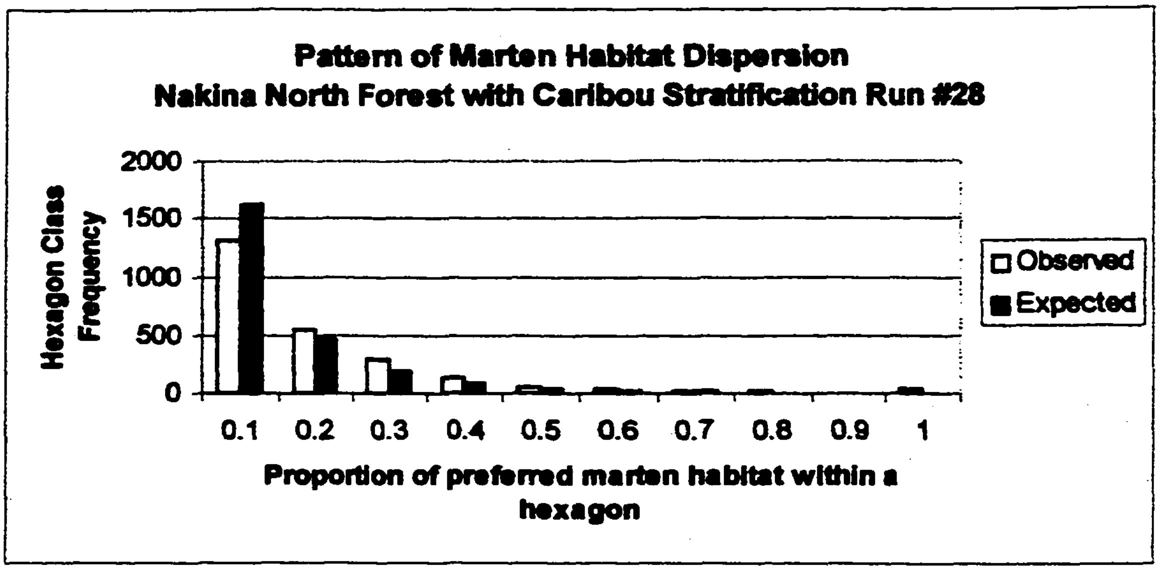


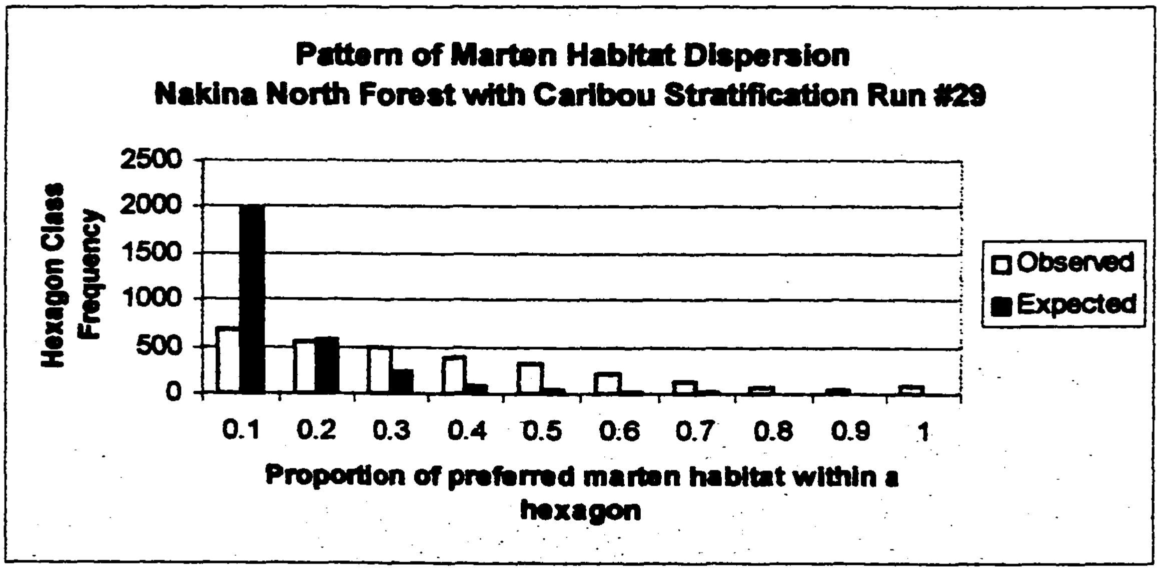
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #24

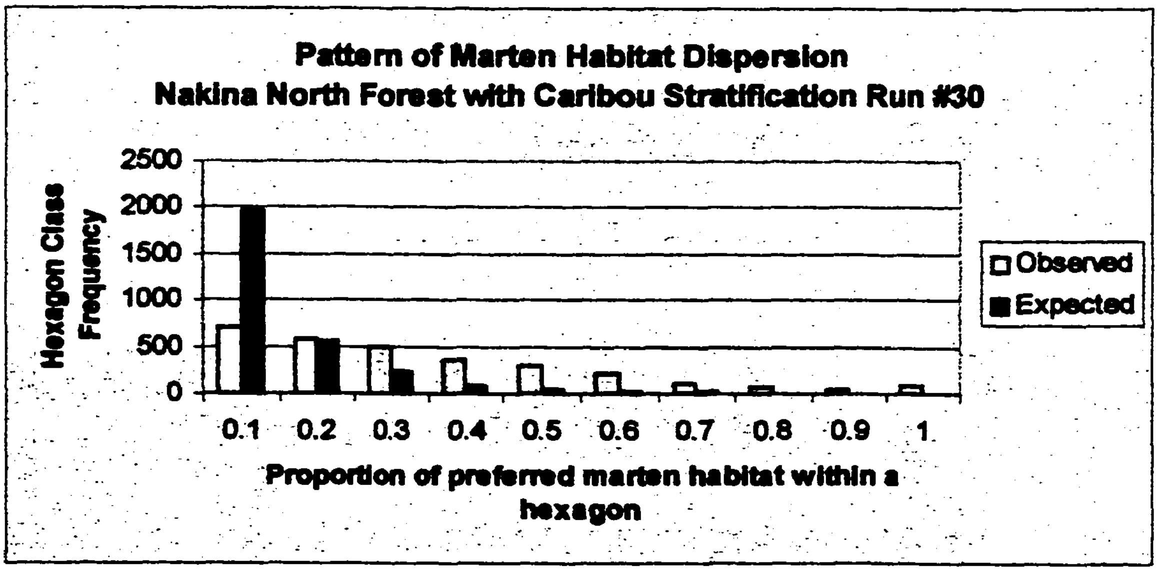

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #25
Hexagon Class Frequency
2500
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
Observed
Expected

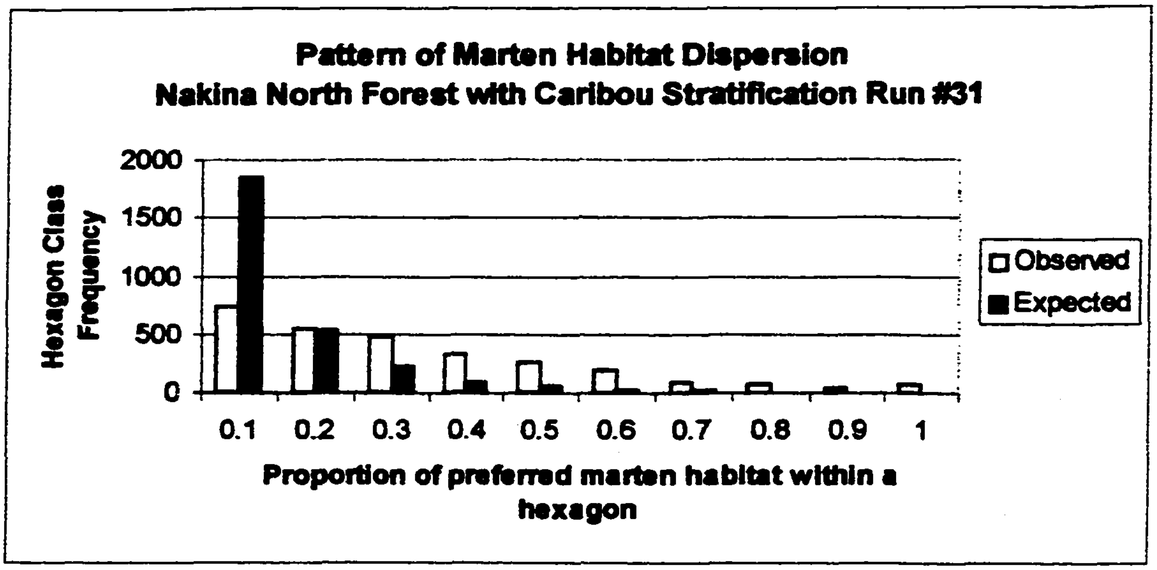

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #26
Hexagon Class Frequency
2500
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
Observed
Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #27
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
Observed
Expected

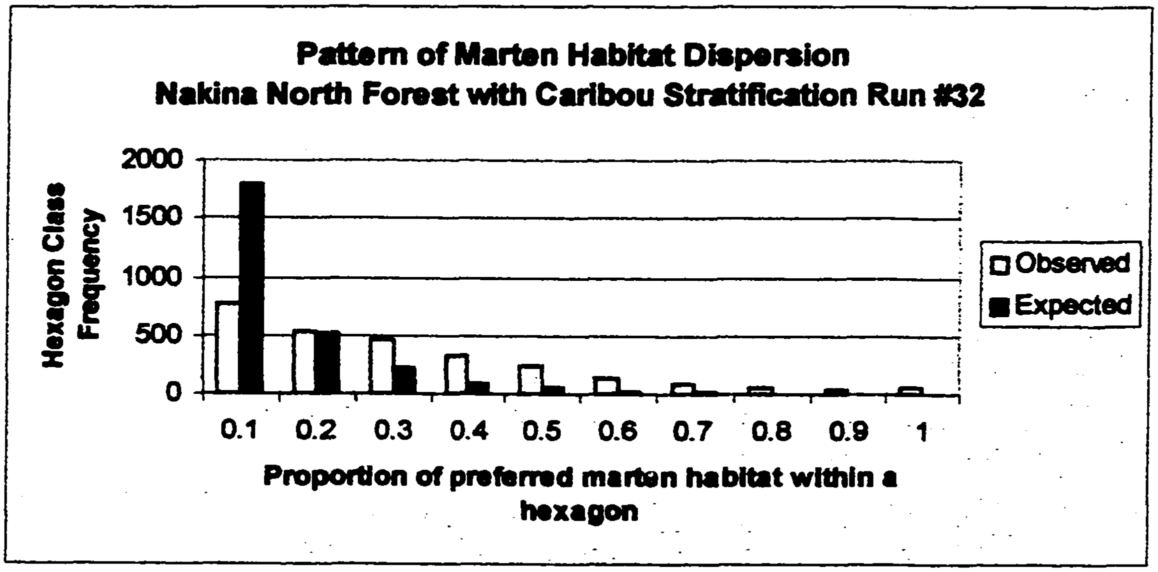

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #28
Hexagon Class Frequency
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected


Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #29
Hexagon Class Frequency
2500
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected

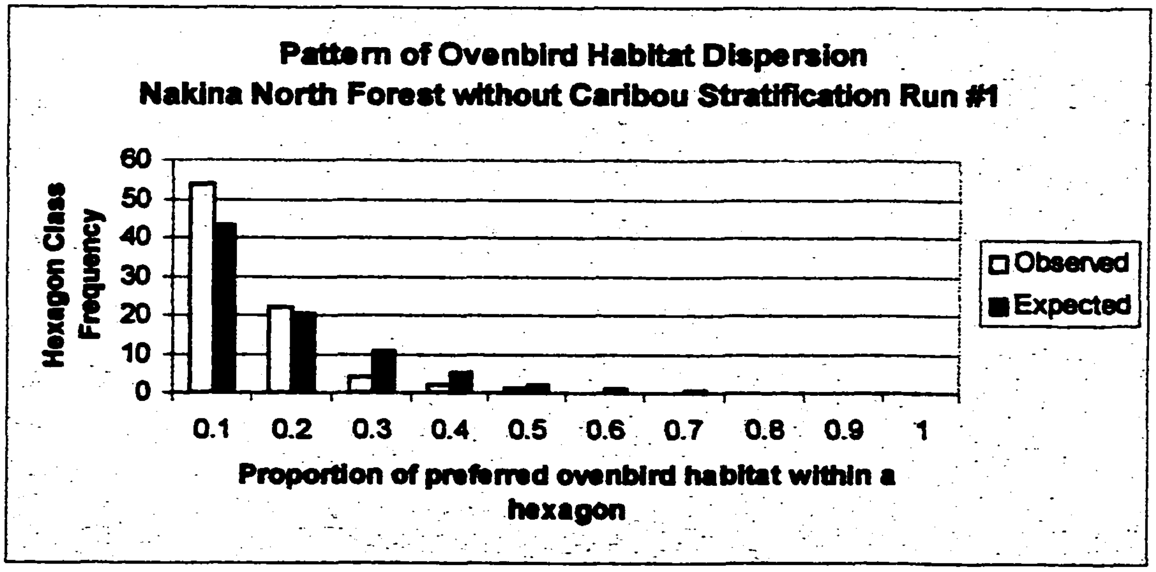

Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #30
Hexagon Class Frequency
2500
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred marten habitat within a hexagon
□ Observed
■ Expected



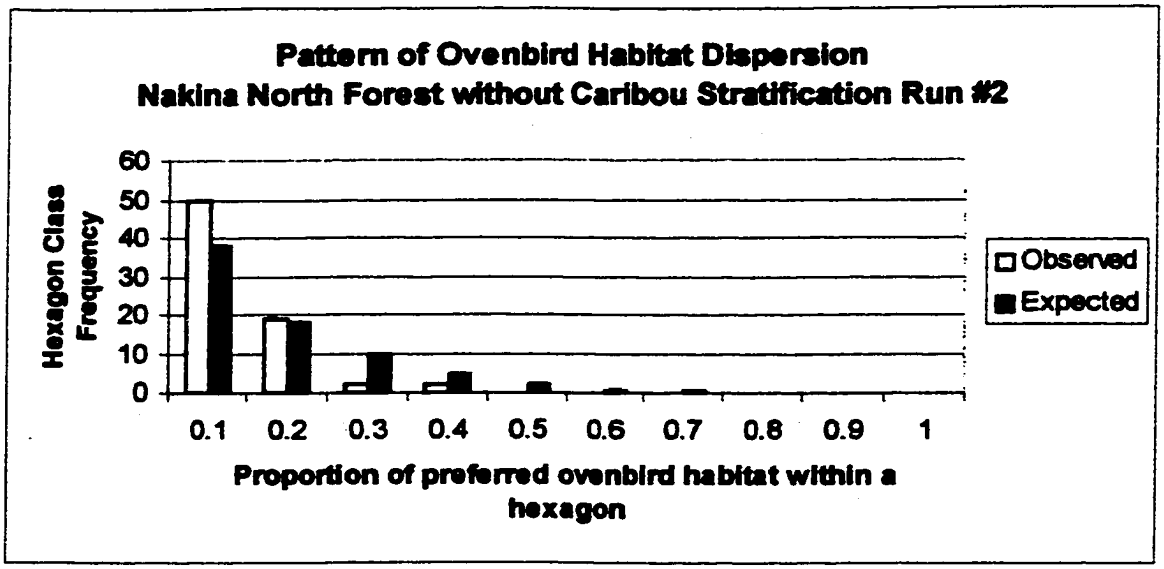
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #31

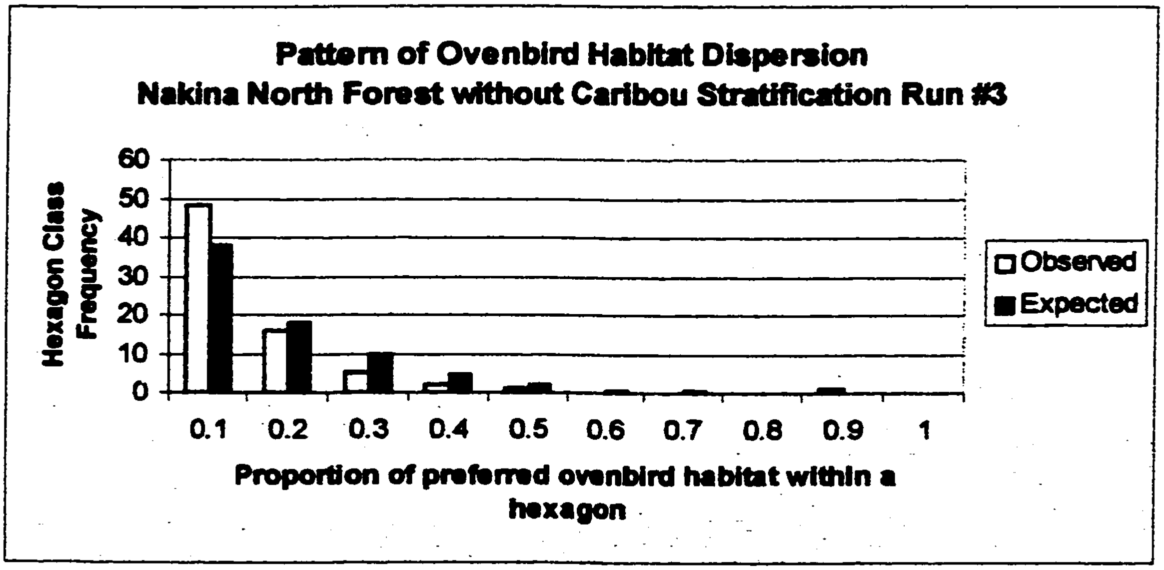


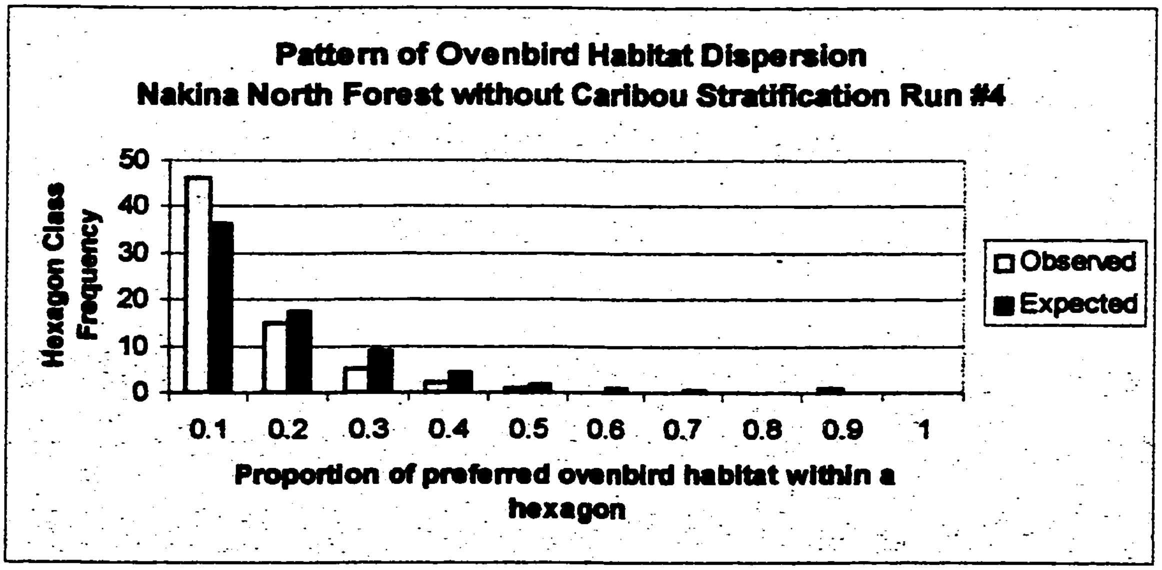
Pattern of Marten Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #32

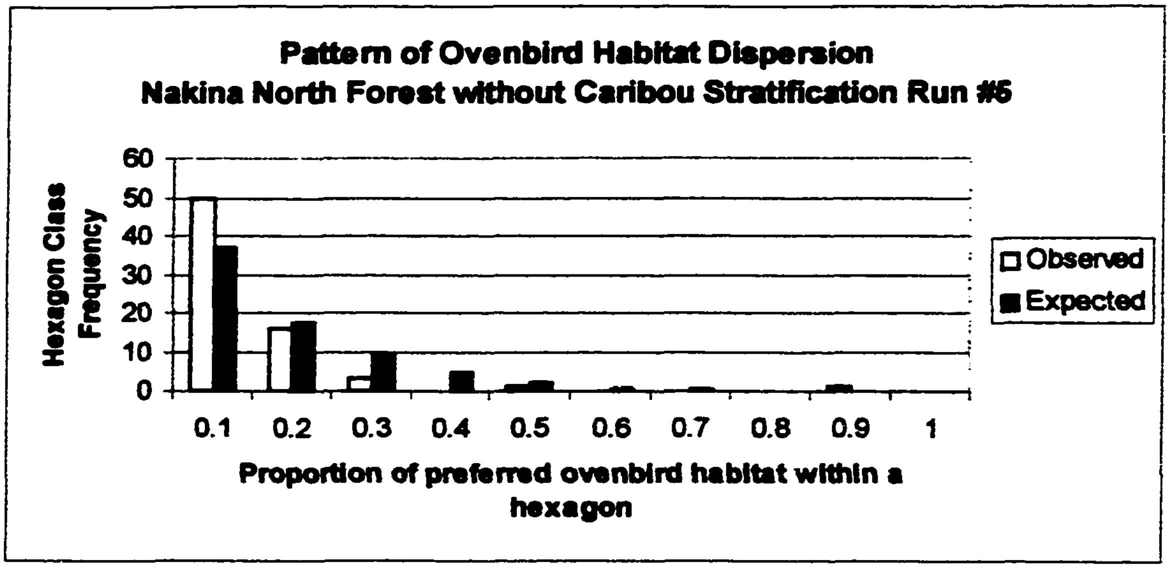


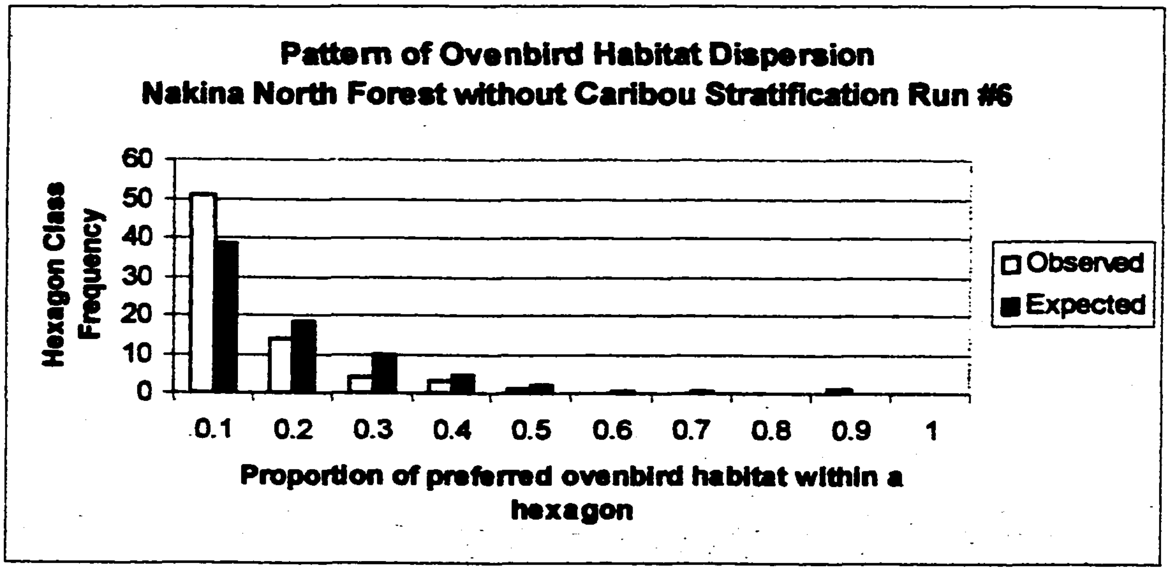
Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #1

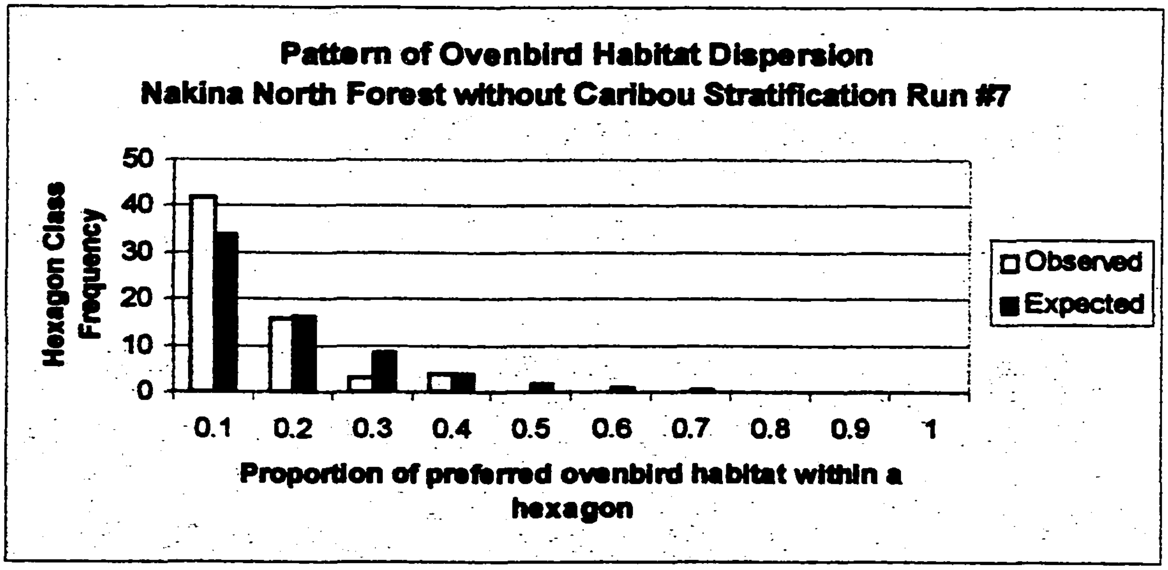

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #2

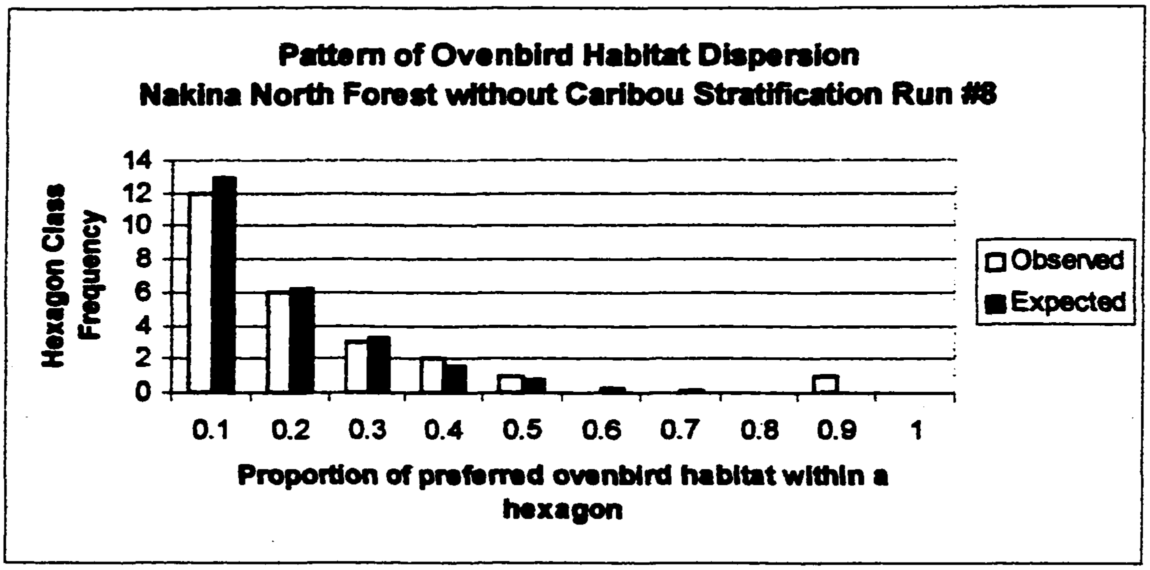

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #3

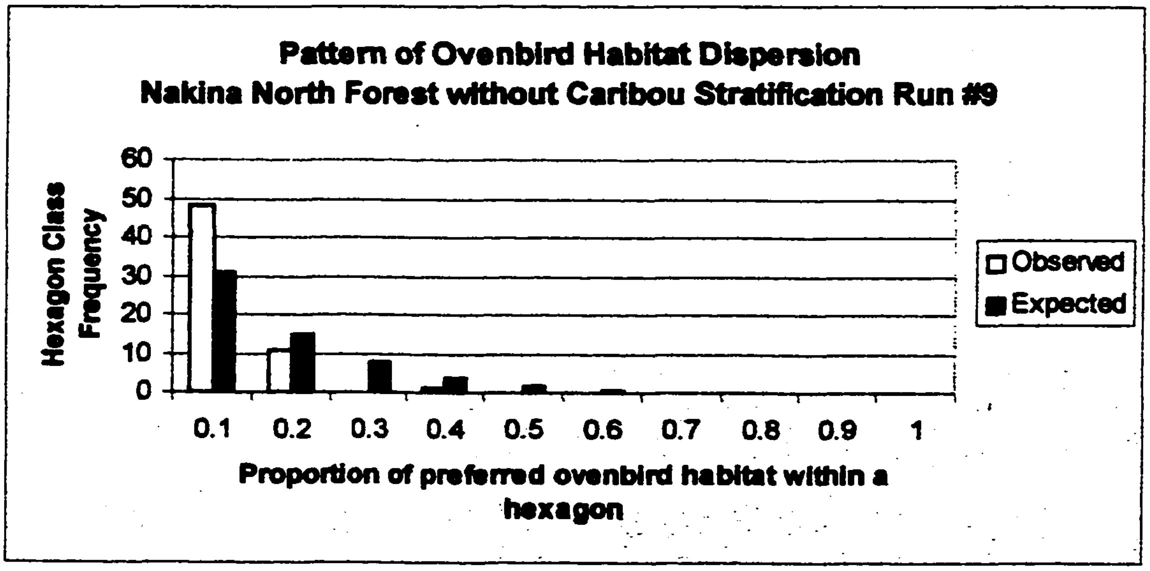

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #4

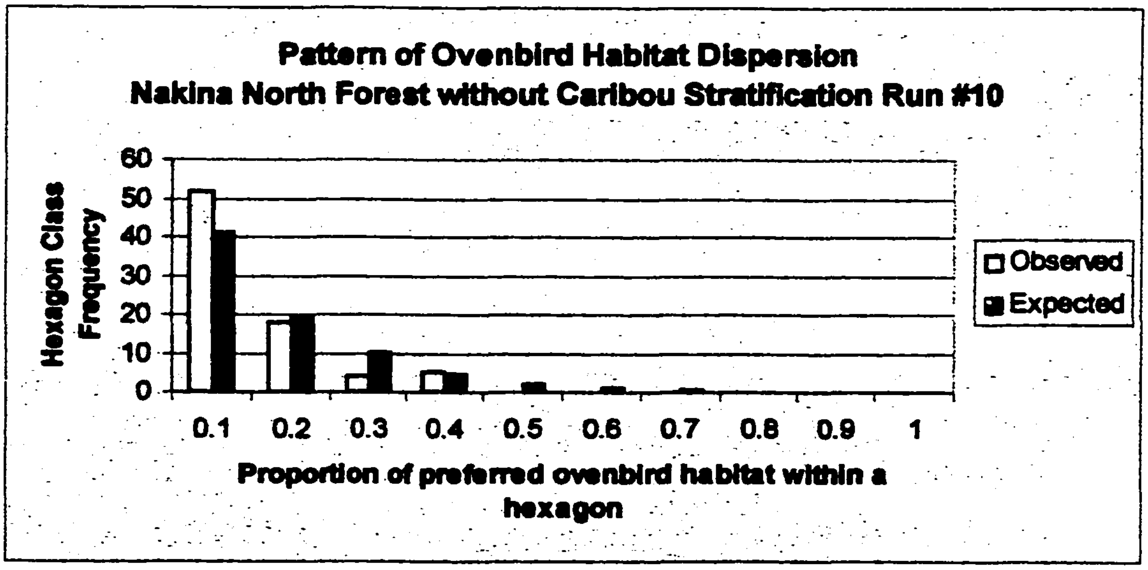

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #6

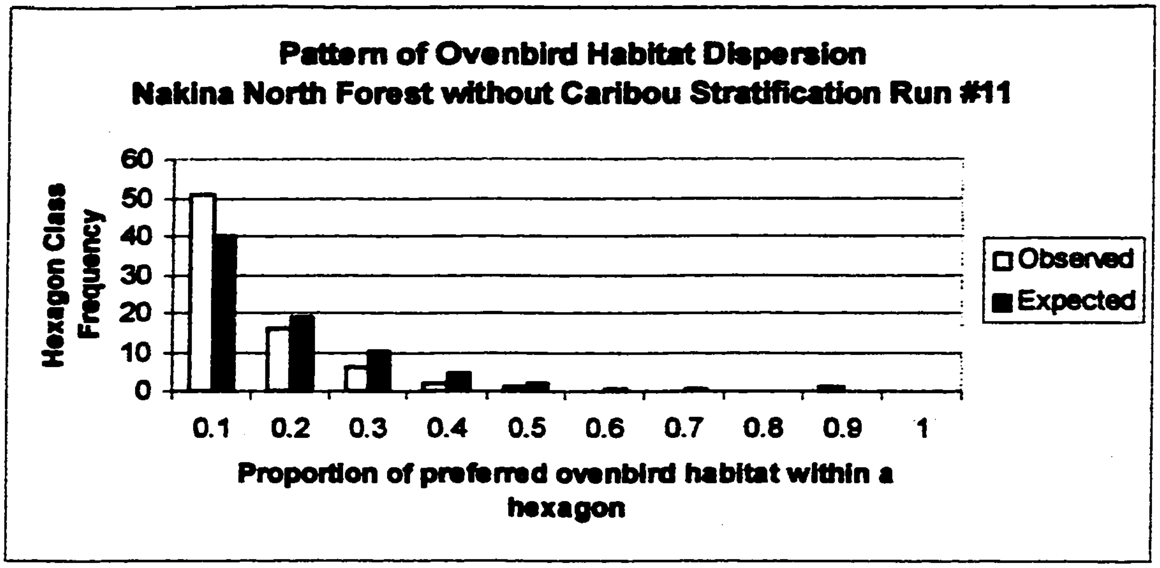

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #6

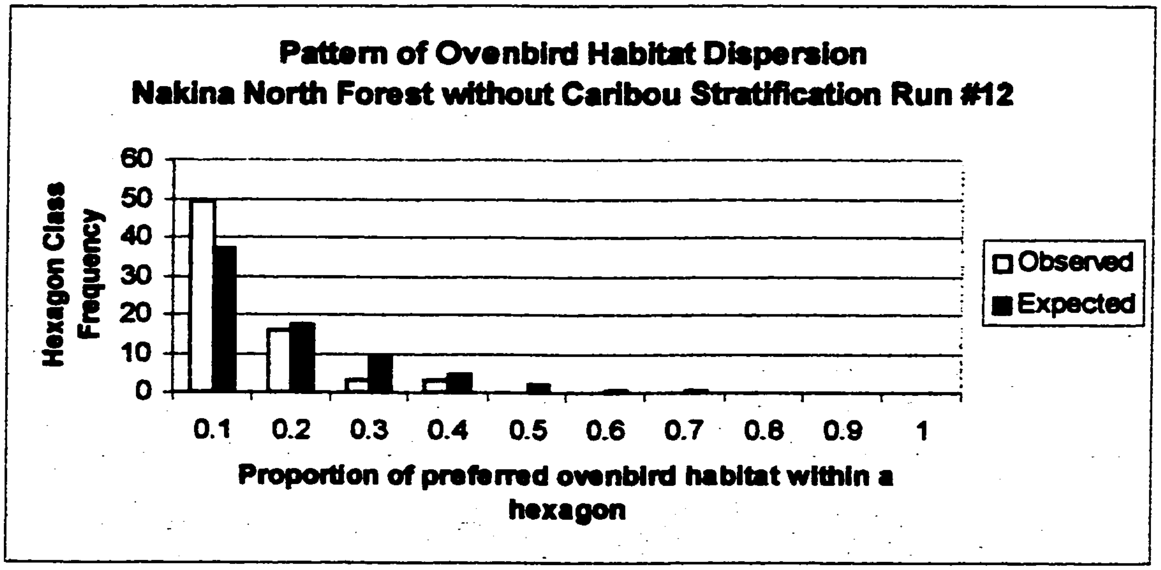

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #7

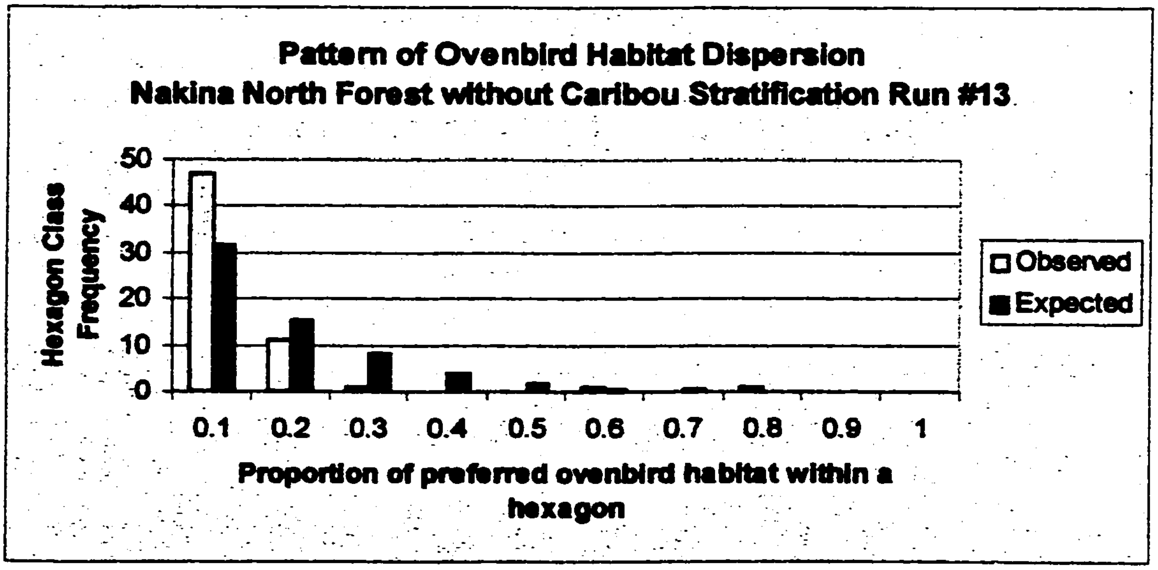

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #8
Hexagon Class Frequency
14
12
10
8
6
4
2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

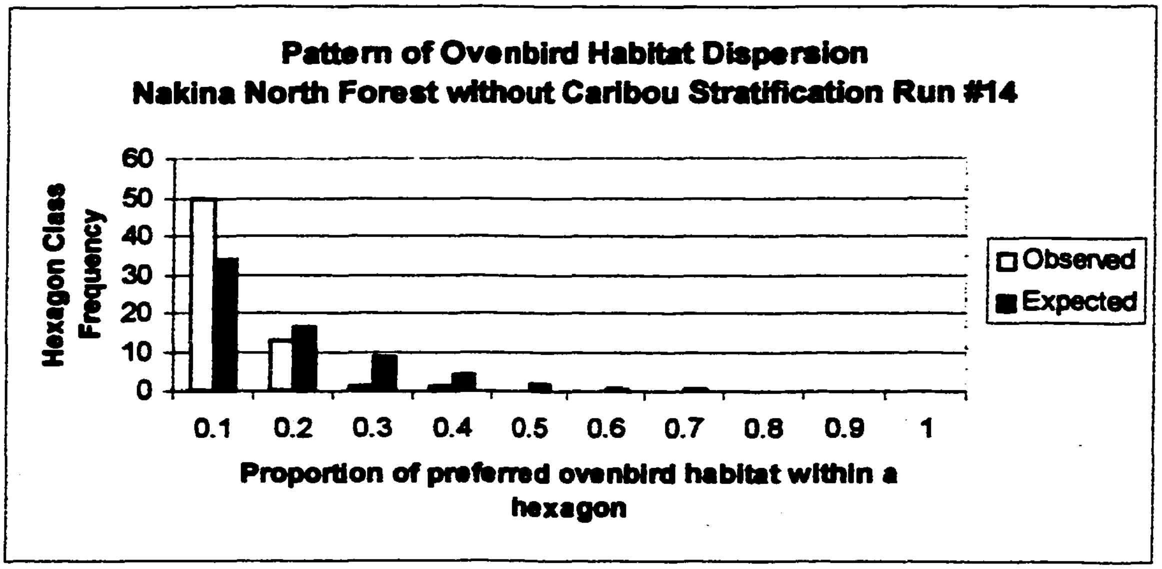

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #9
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

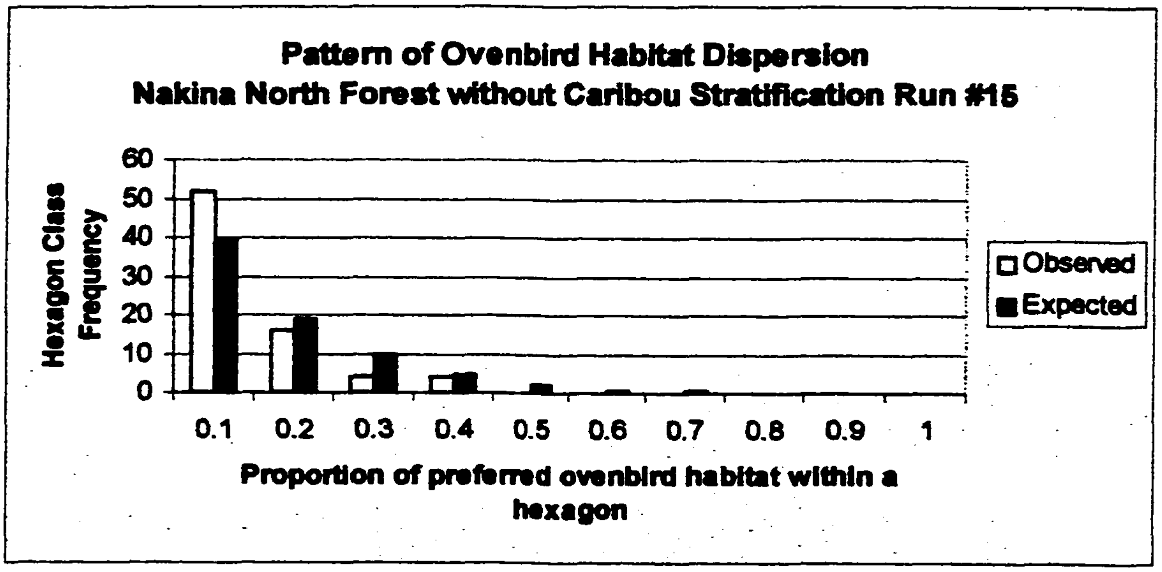

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #10
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

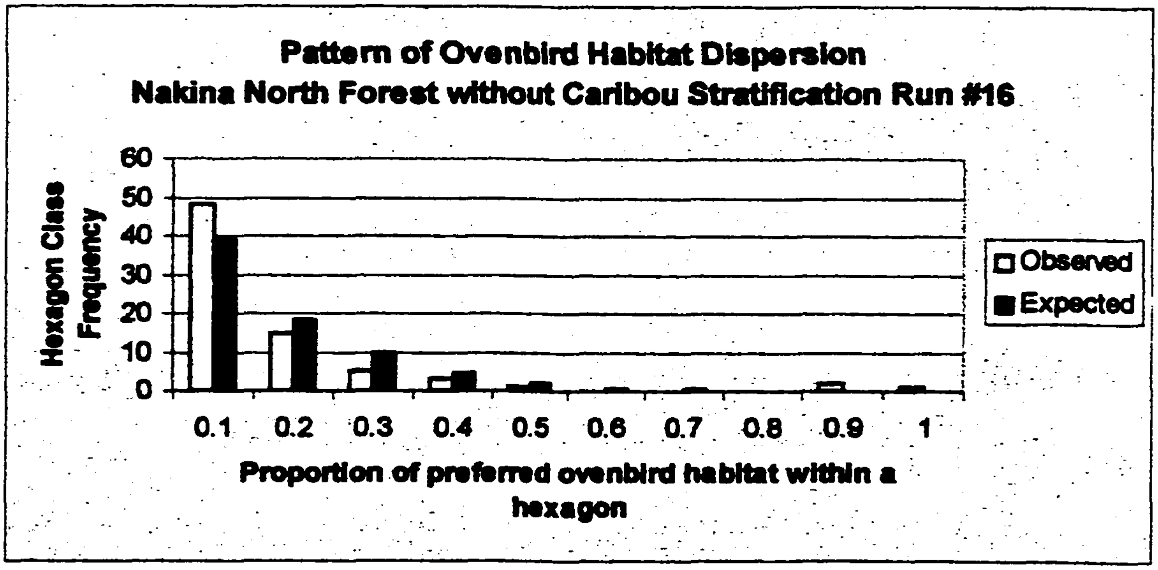

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #11
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

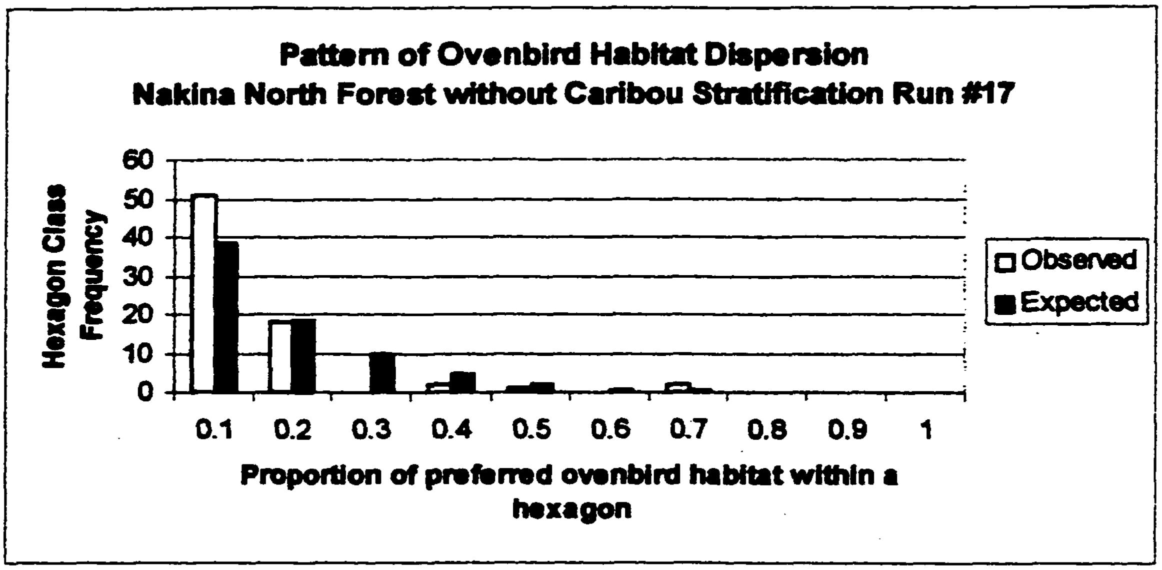

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #12
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

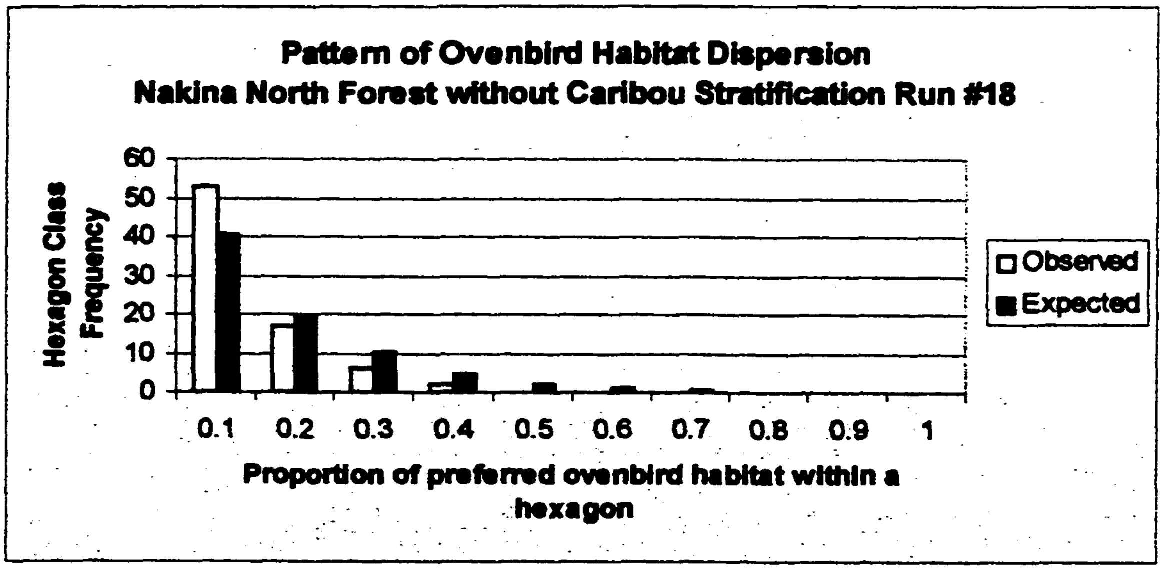

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #13
Hexagon Class Frequency
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

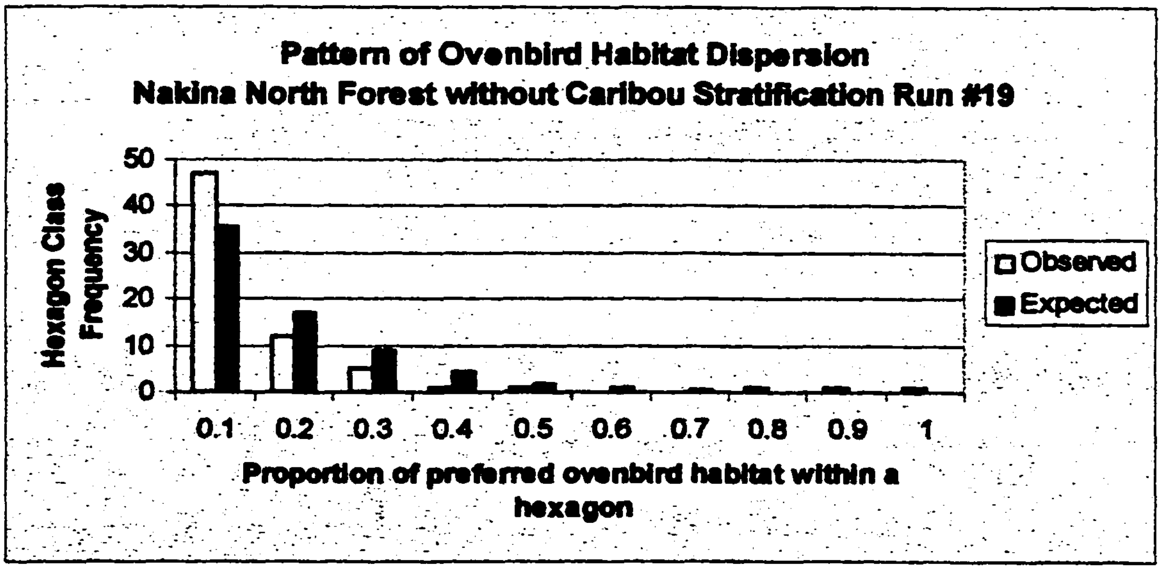

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #14

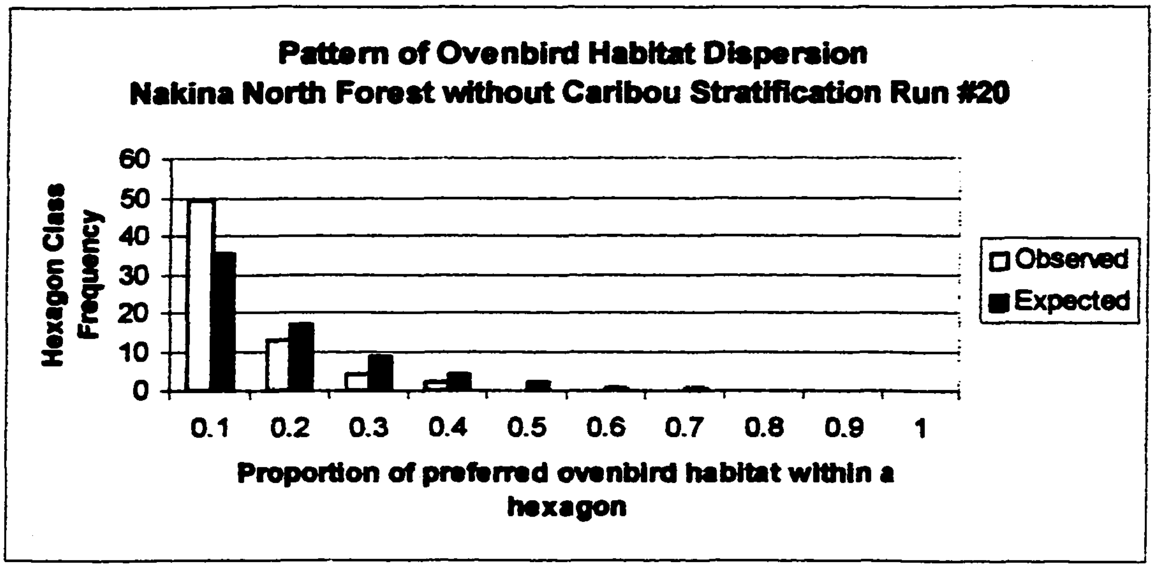

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #15

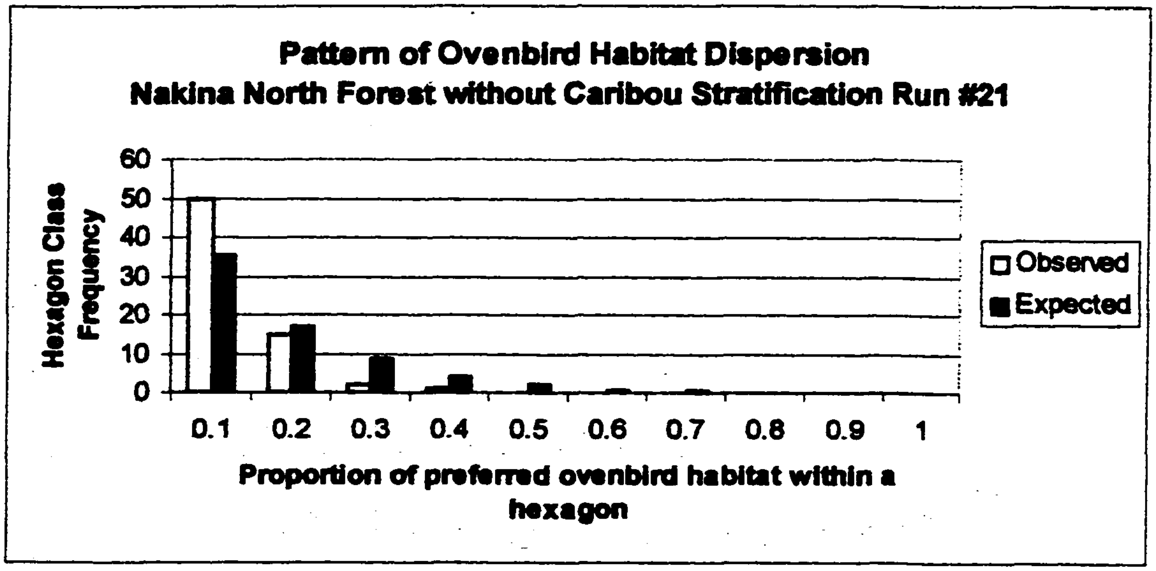

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #16

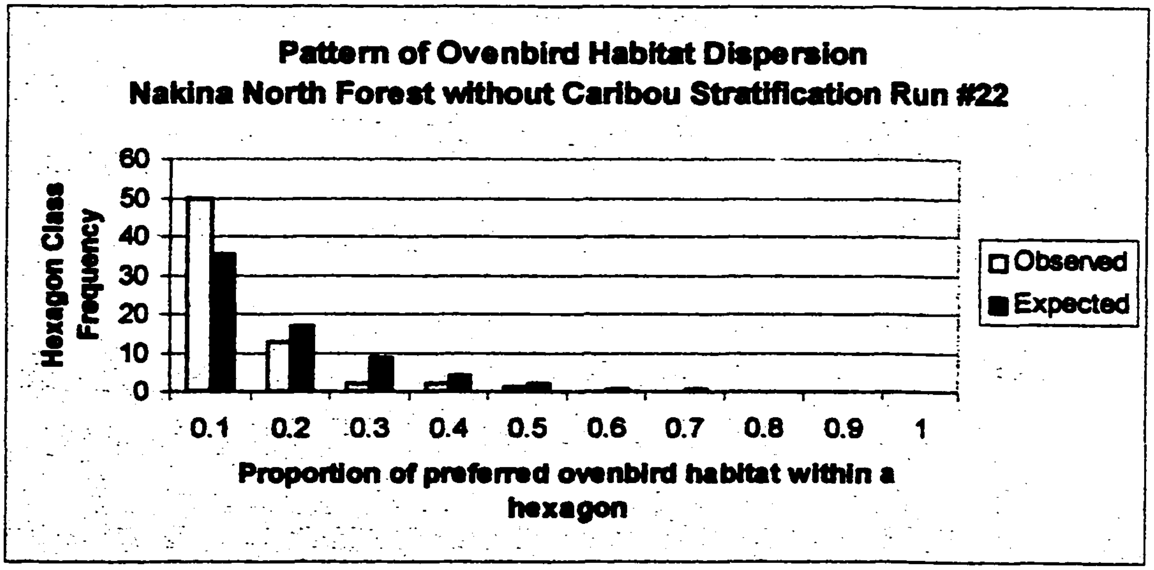

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #17

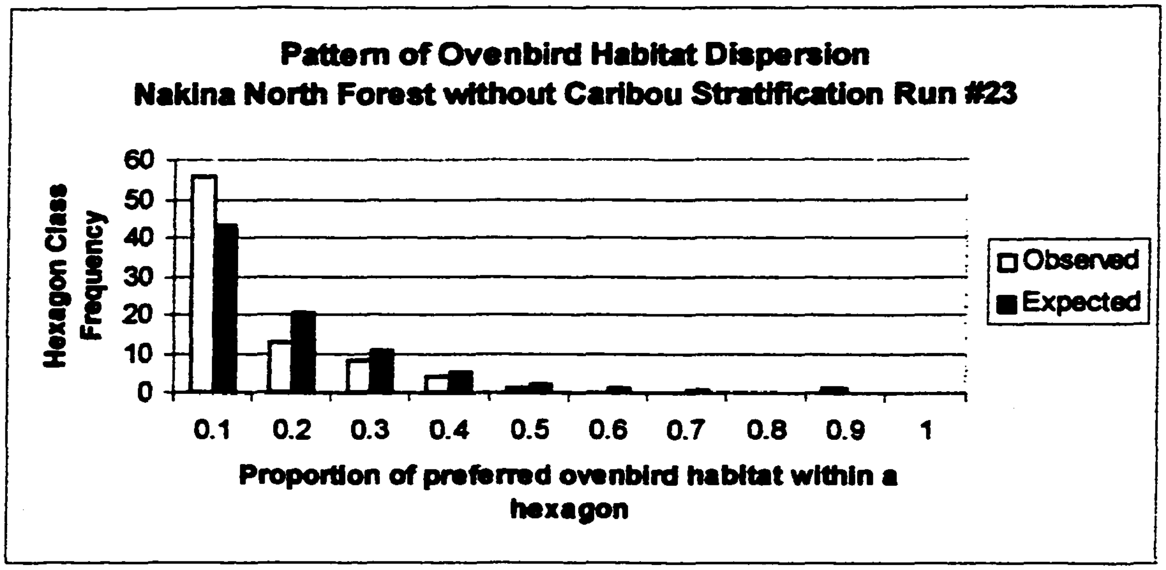

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #18

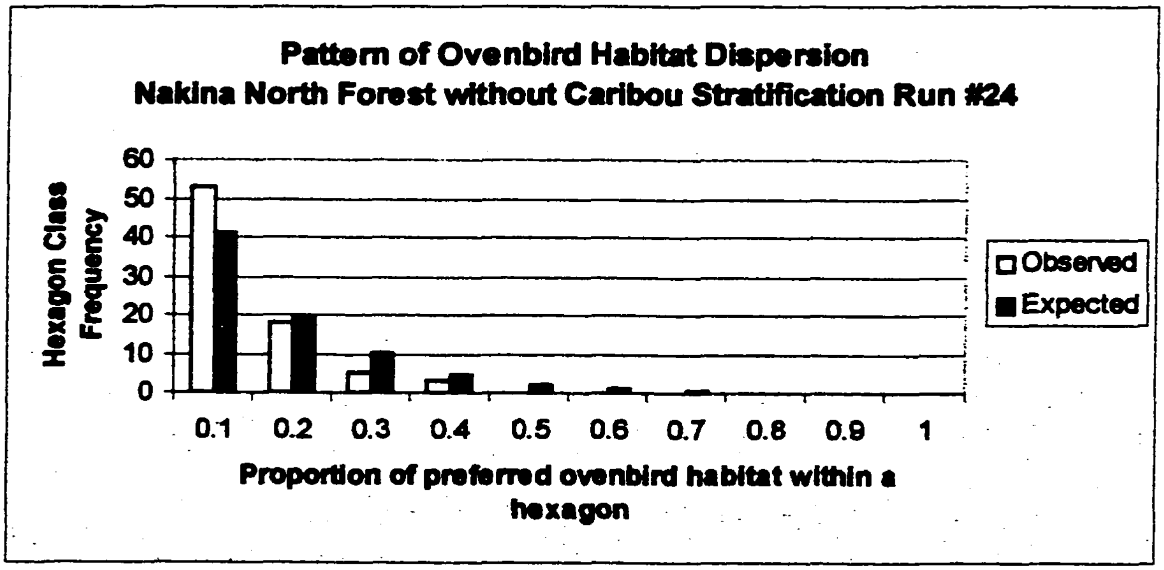

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #19

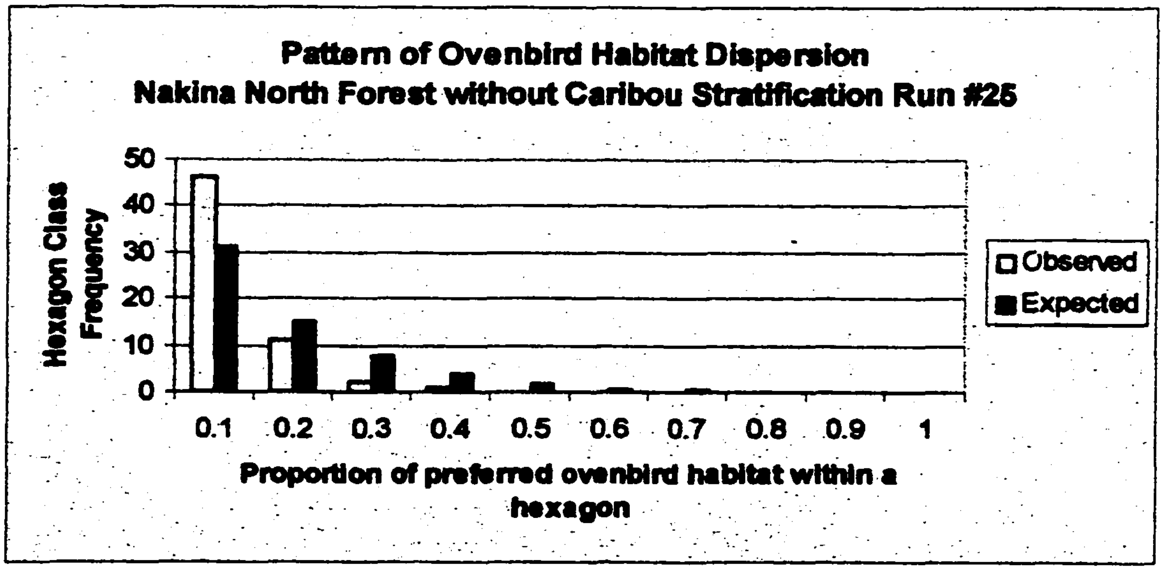

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #20
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

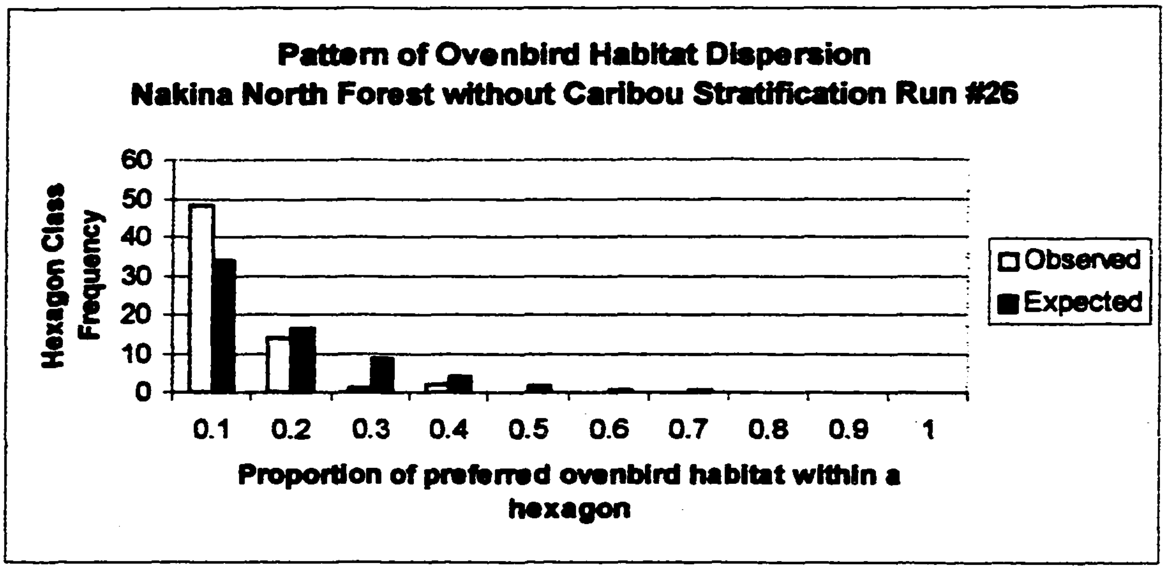

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #21
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

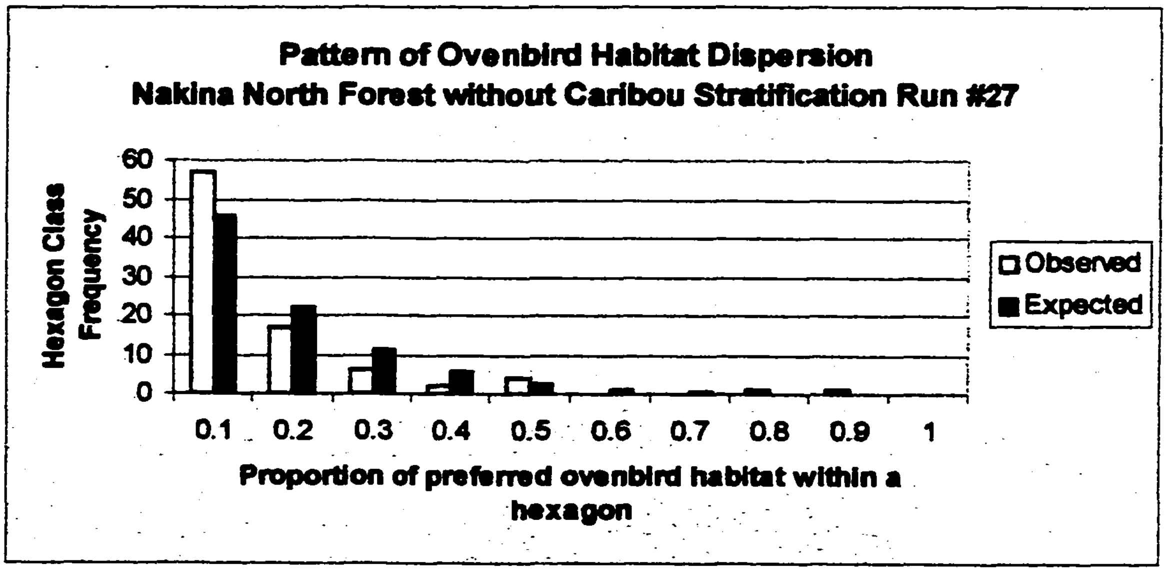

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #22
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

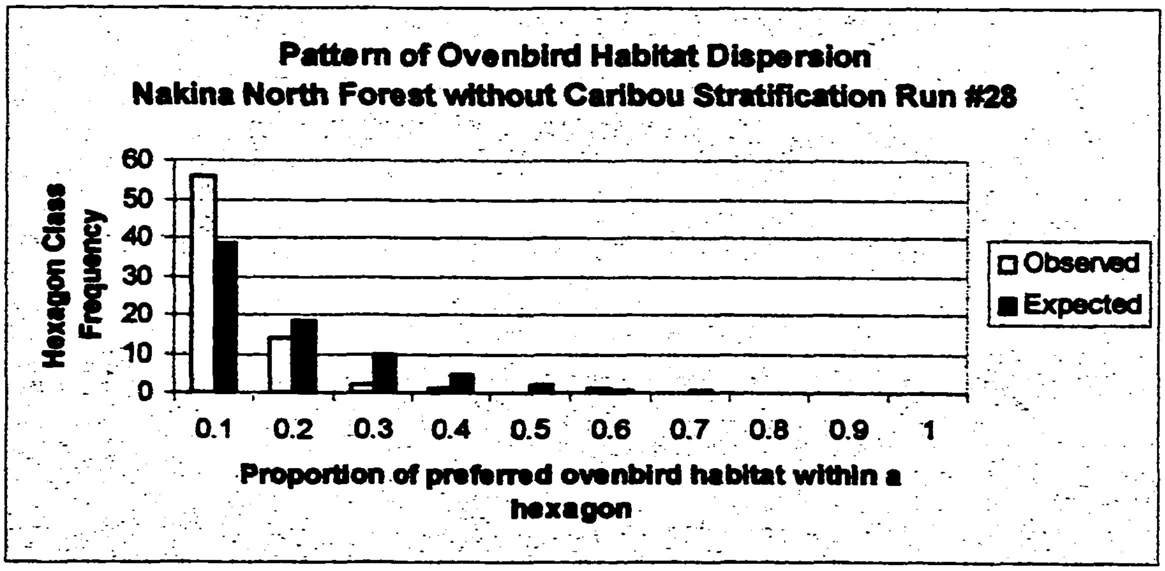

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #23

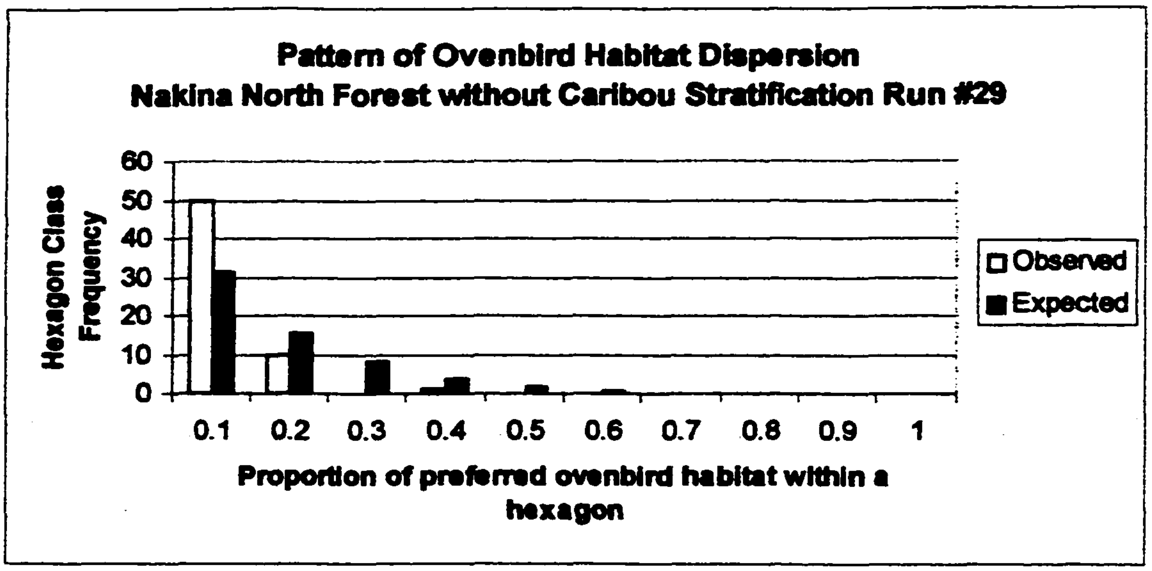

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #24

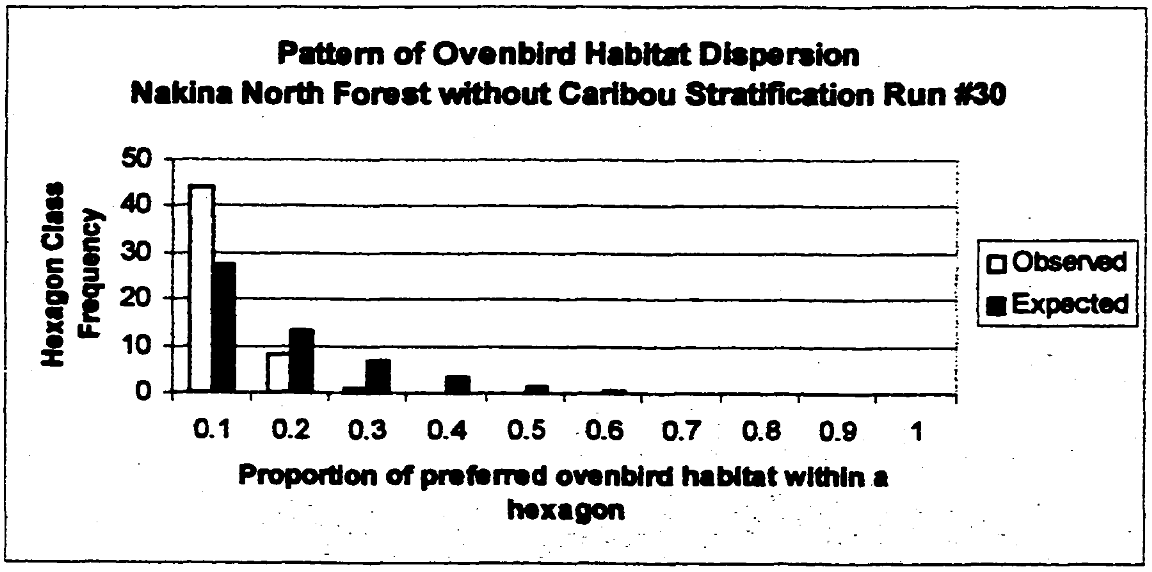

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #25

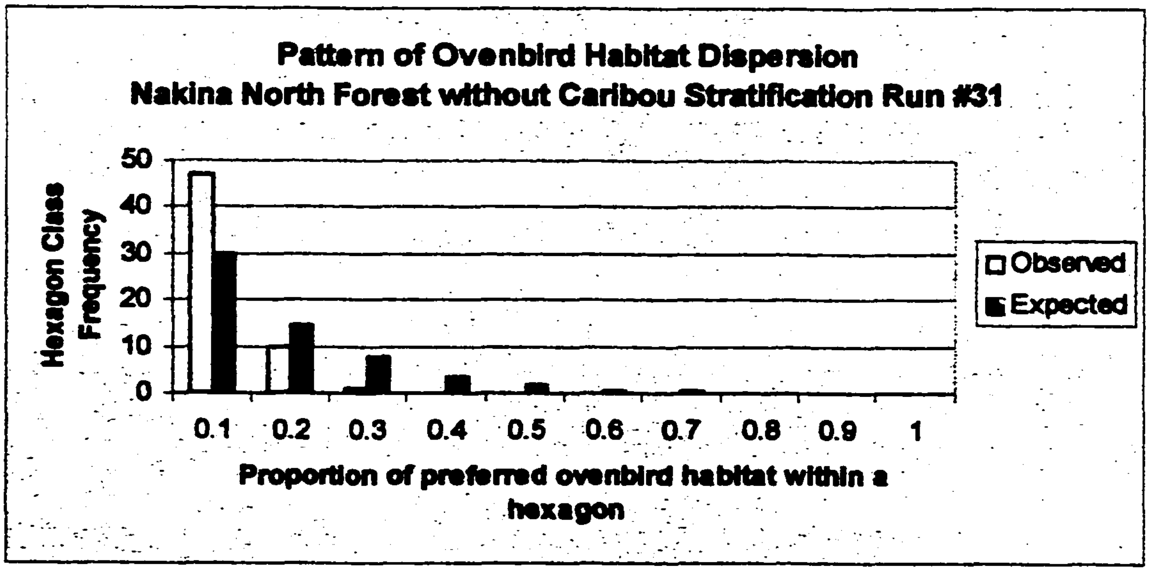

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #26
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
Observed
Expected

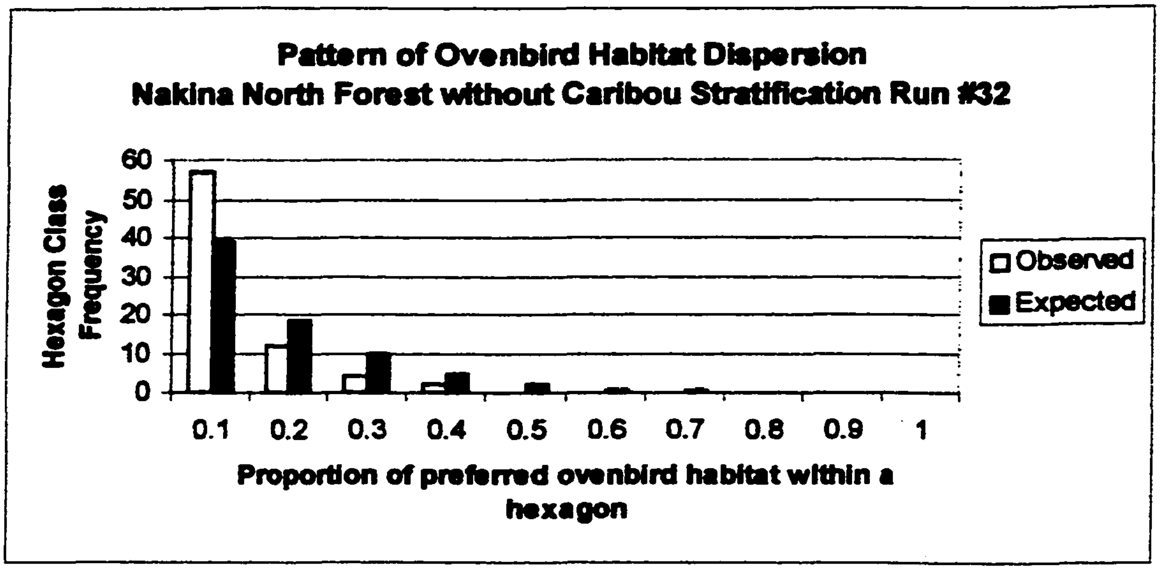

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #27
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
Observed
Expected

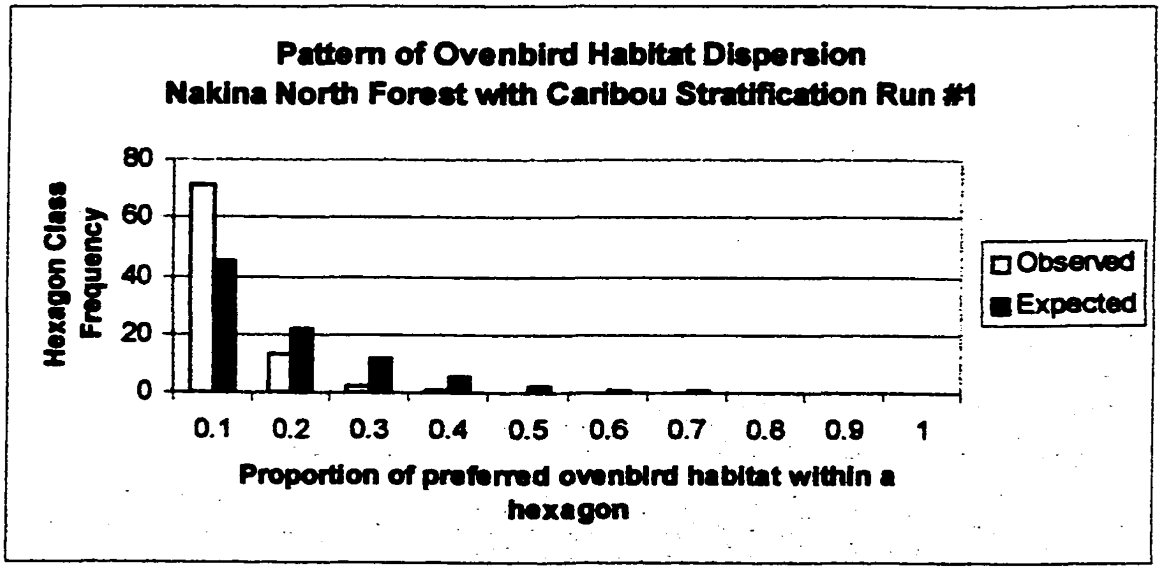

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #28
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
Observed
Expected

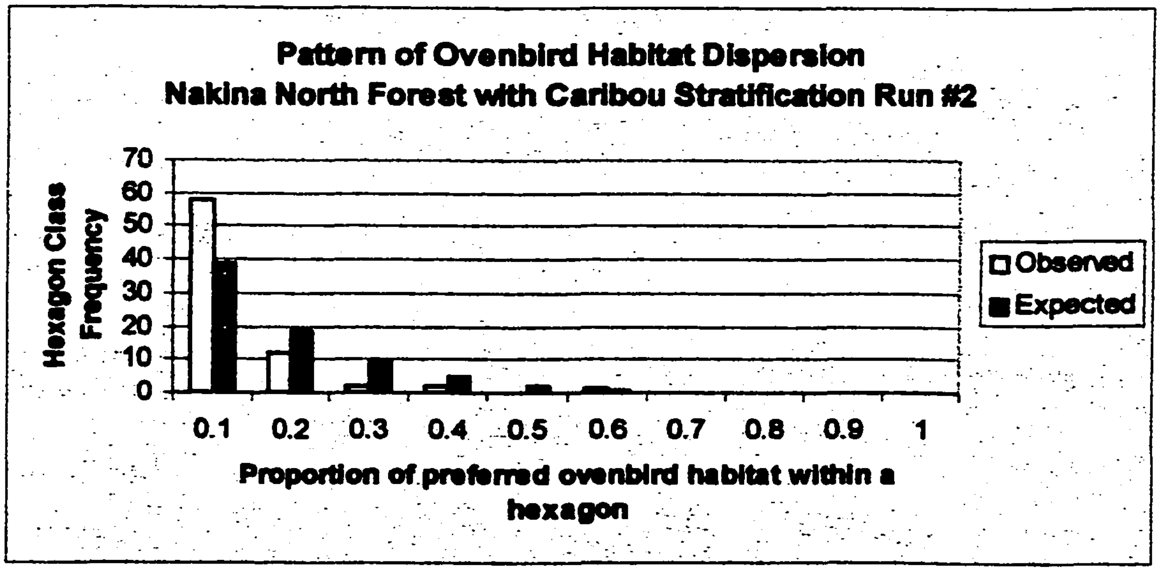

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #29
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

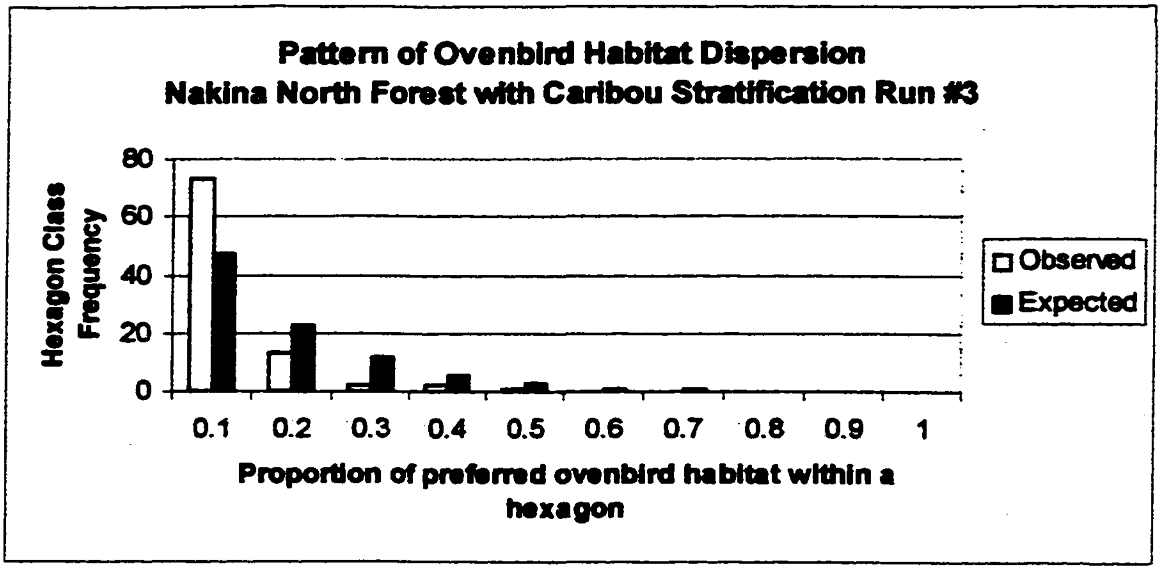

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #30
Hexagon Class Frequency
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

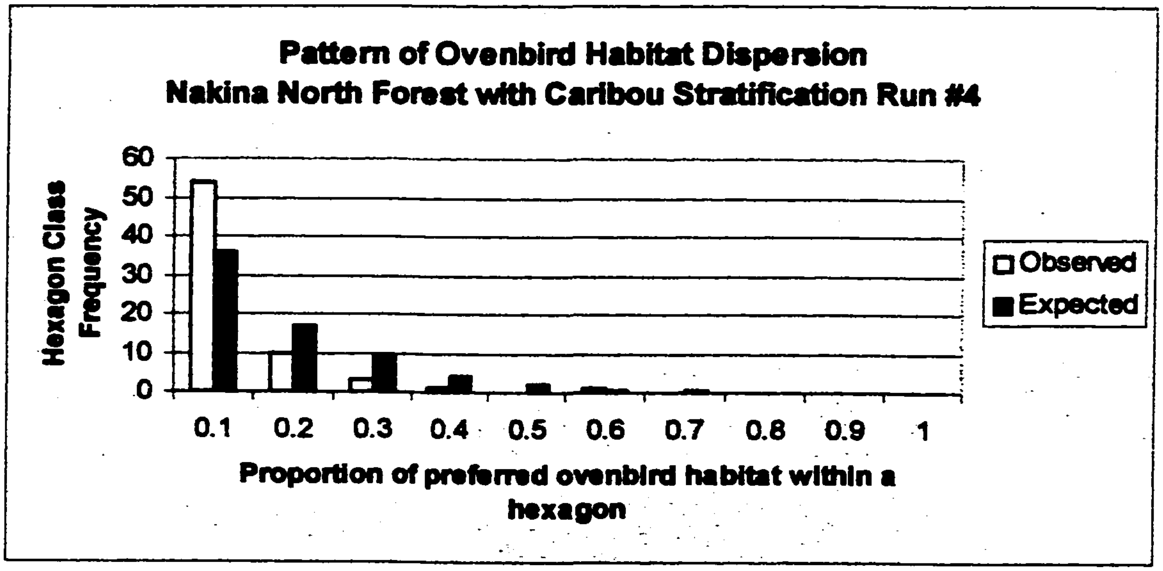

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #31
Hexagon Class Frequency
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

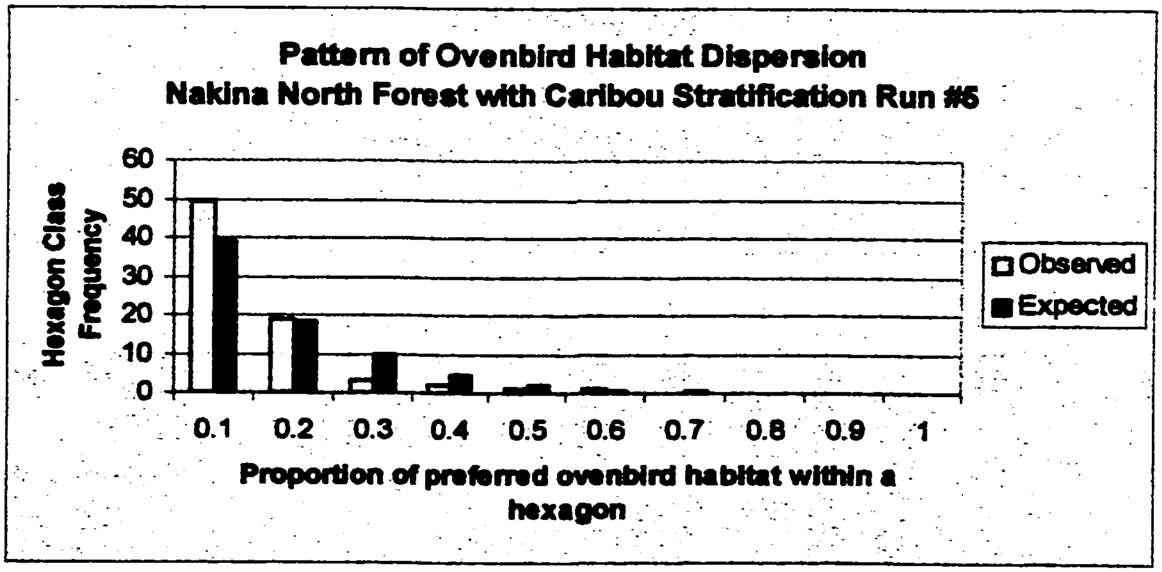

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest without Caribou Stratification Run #32
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

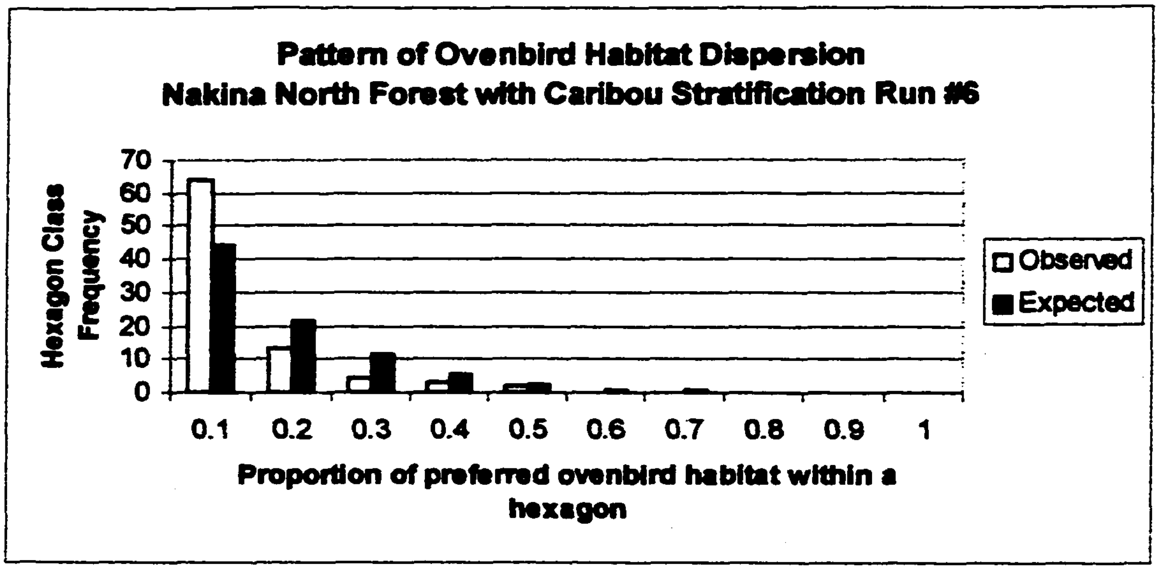

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #1
Hexagon Class Frequency
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

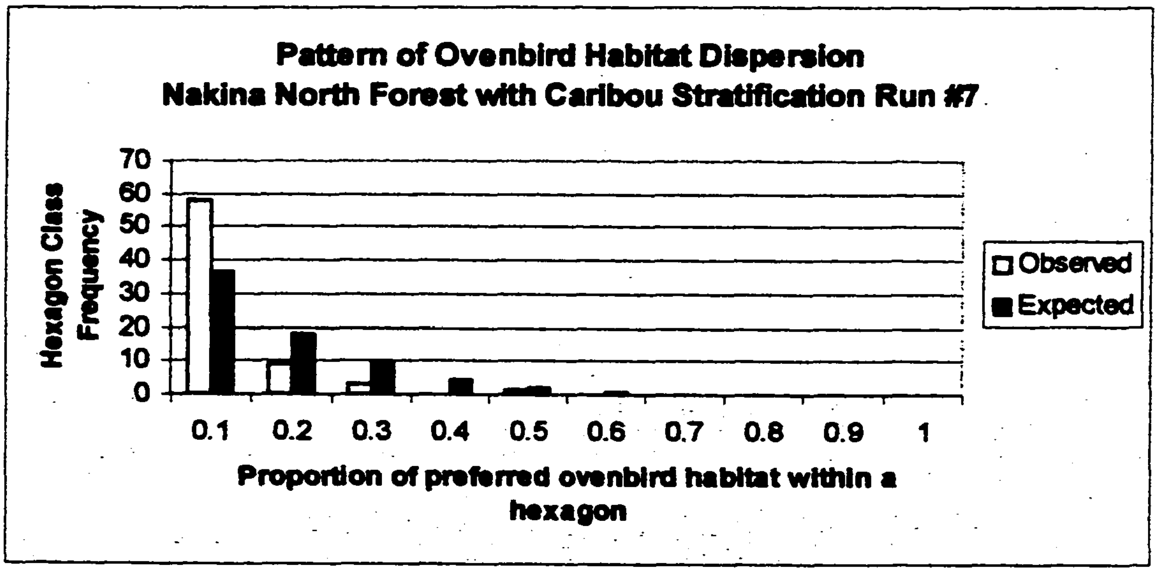

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #2
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

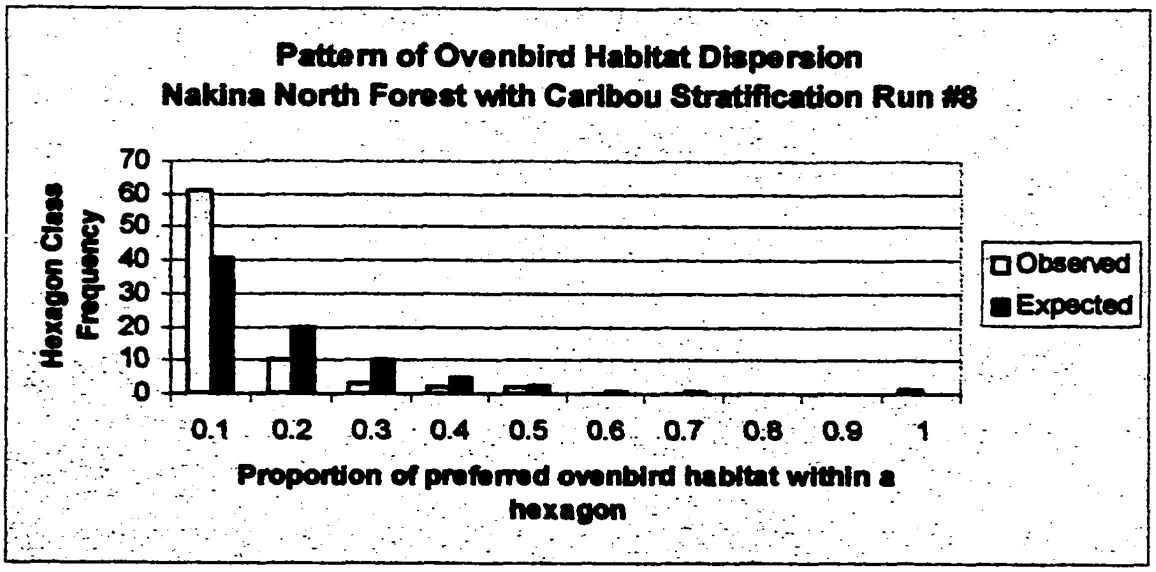

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #3
Hexagon Class Frequency
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

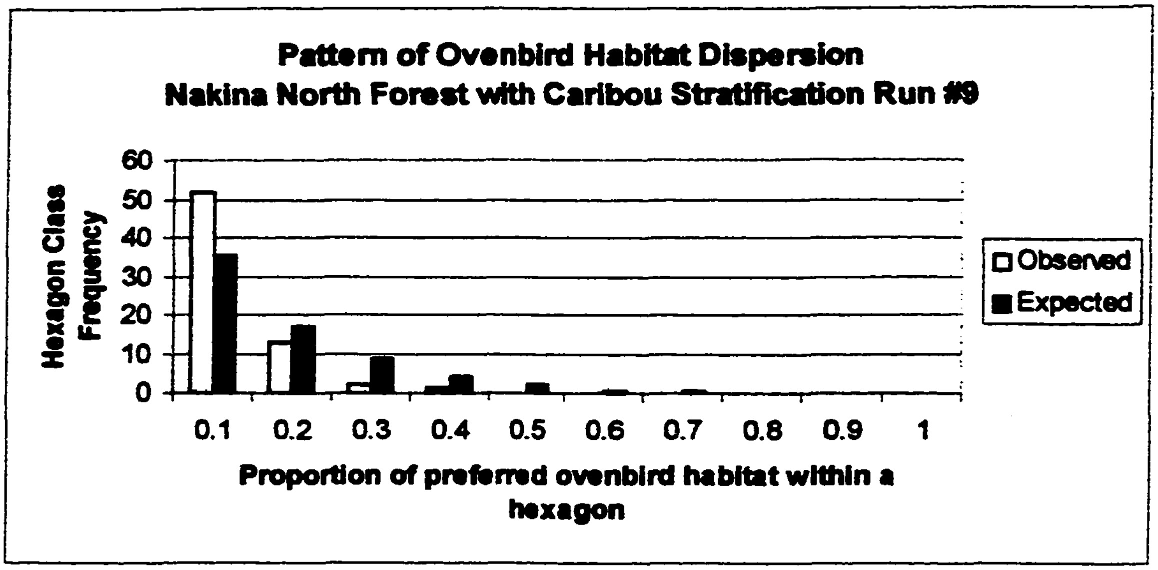

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #4
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

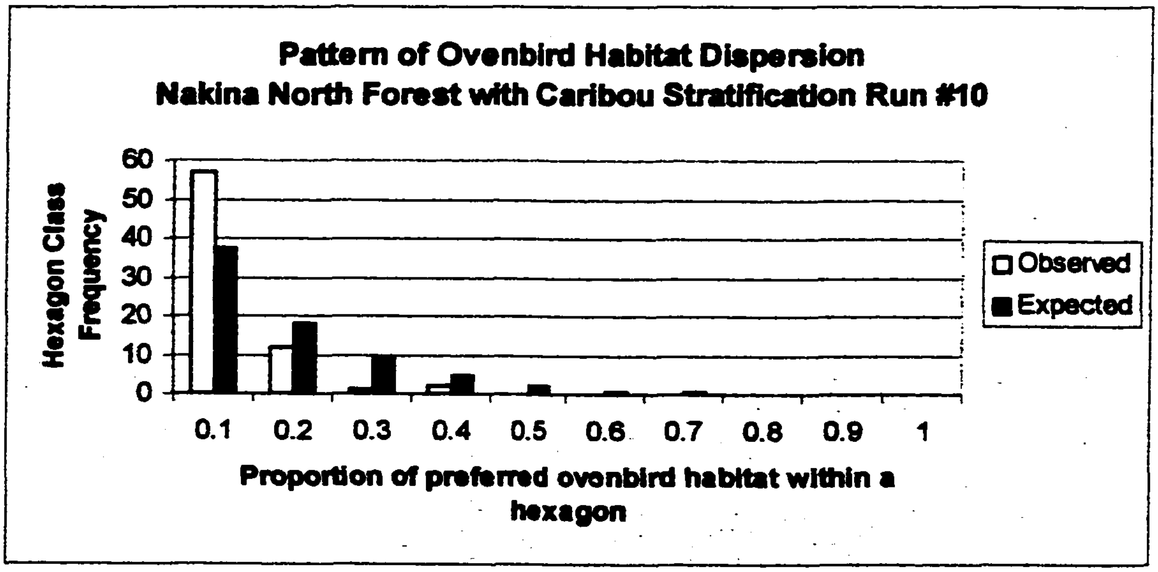

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #5
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

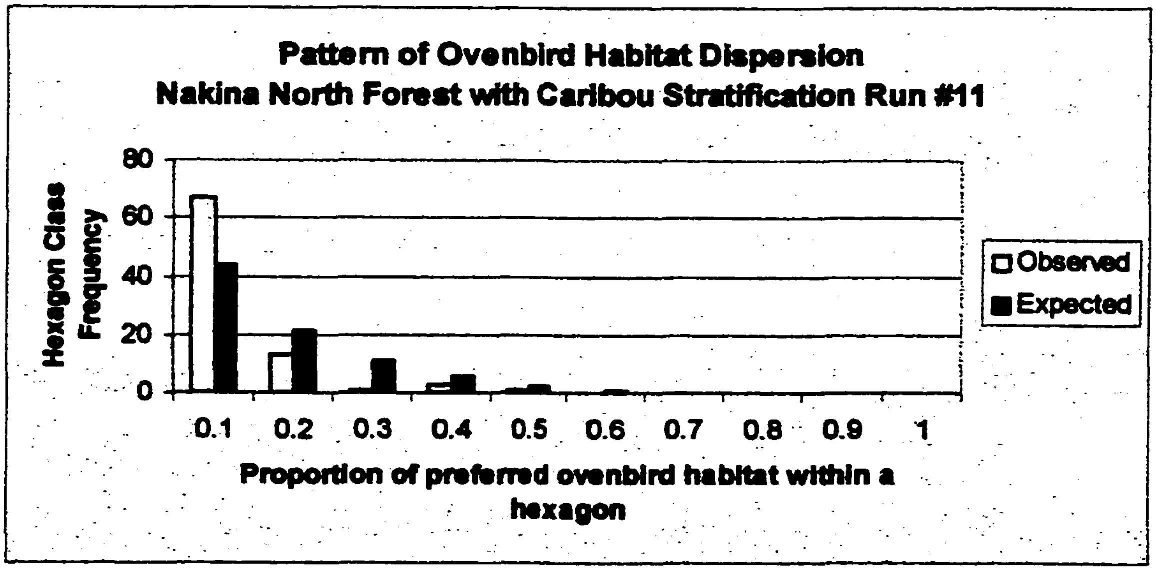

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #6
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

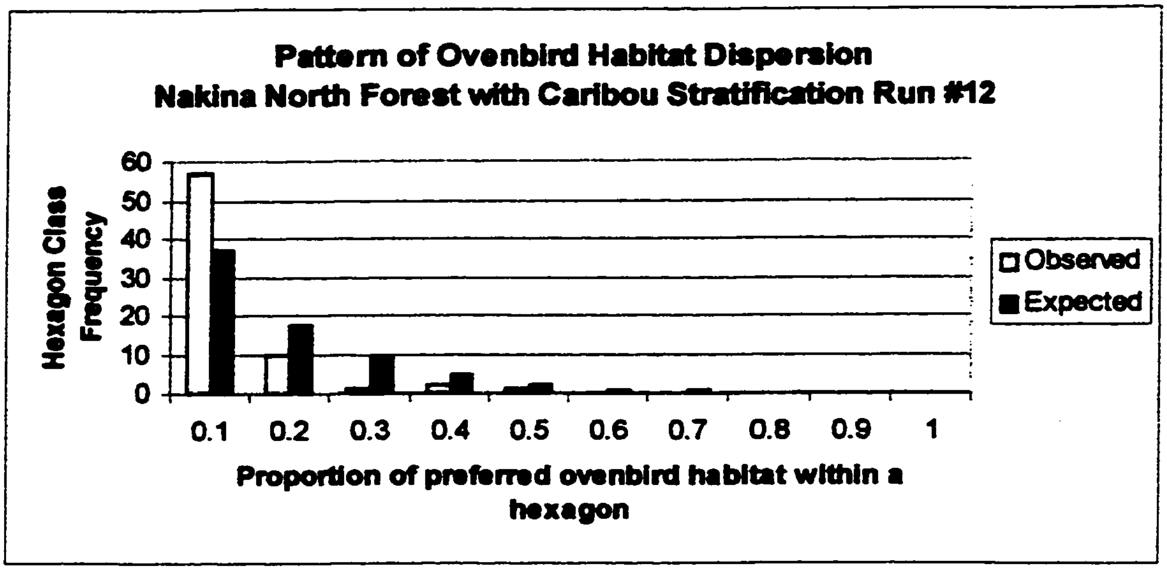

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #7
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

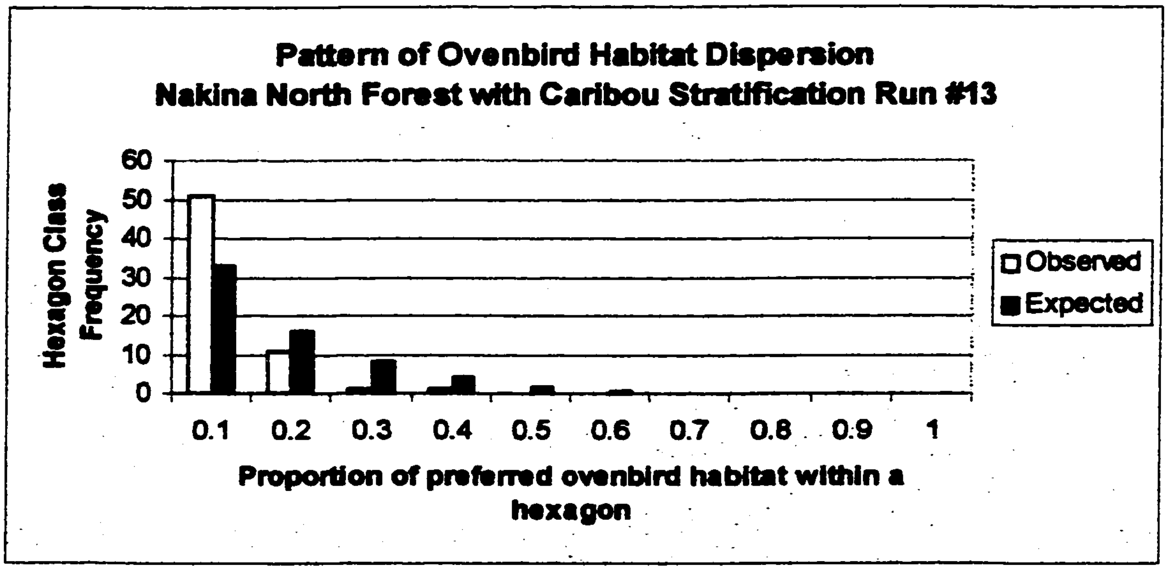

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #8
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

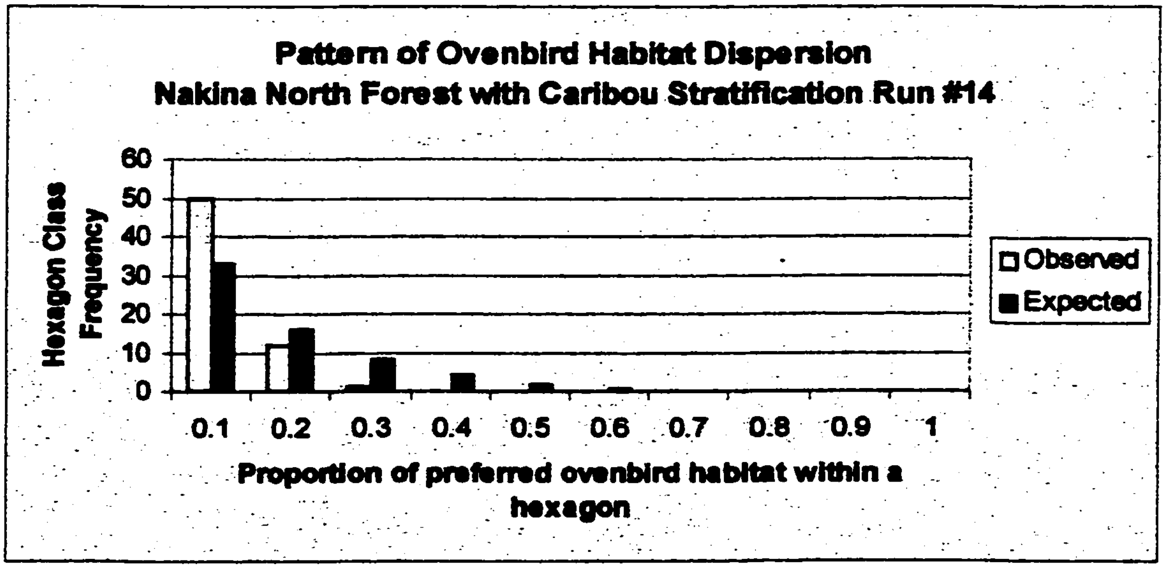

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #9

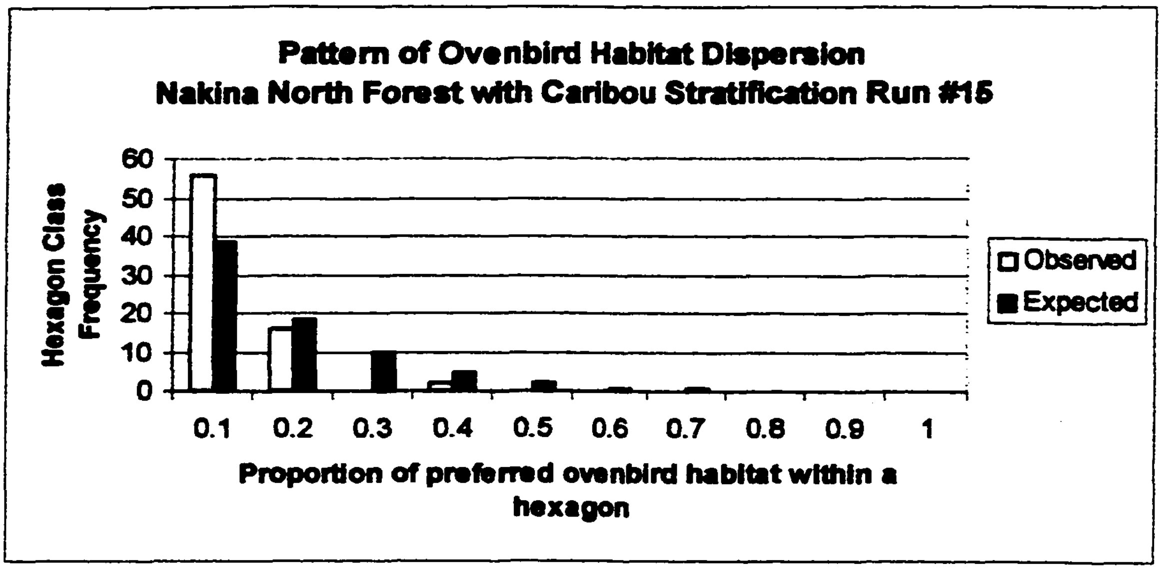

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #10

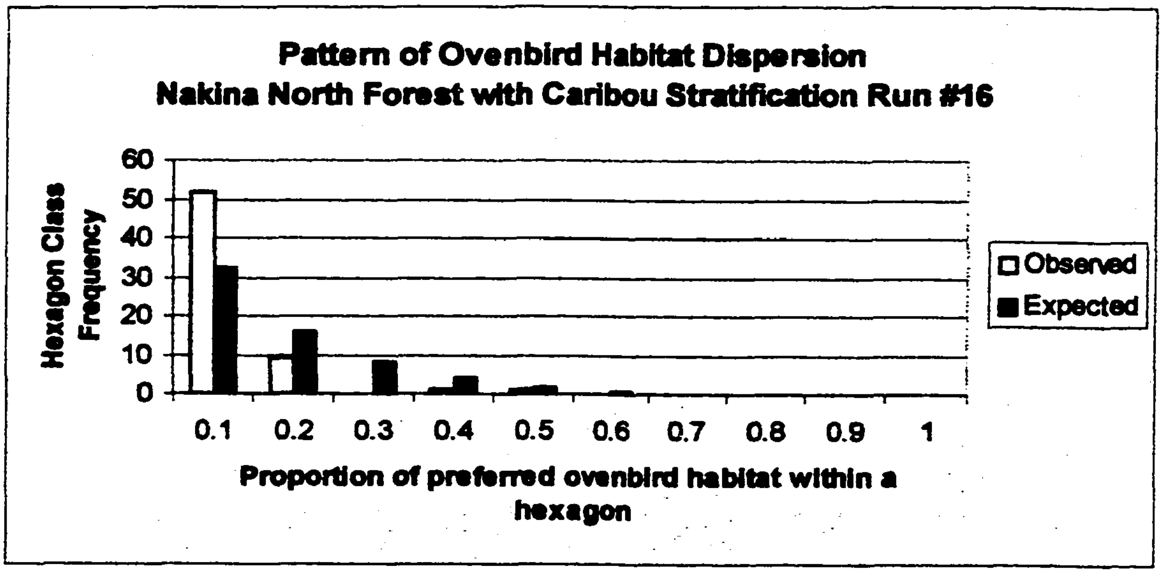

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #11

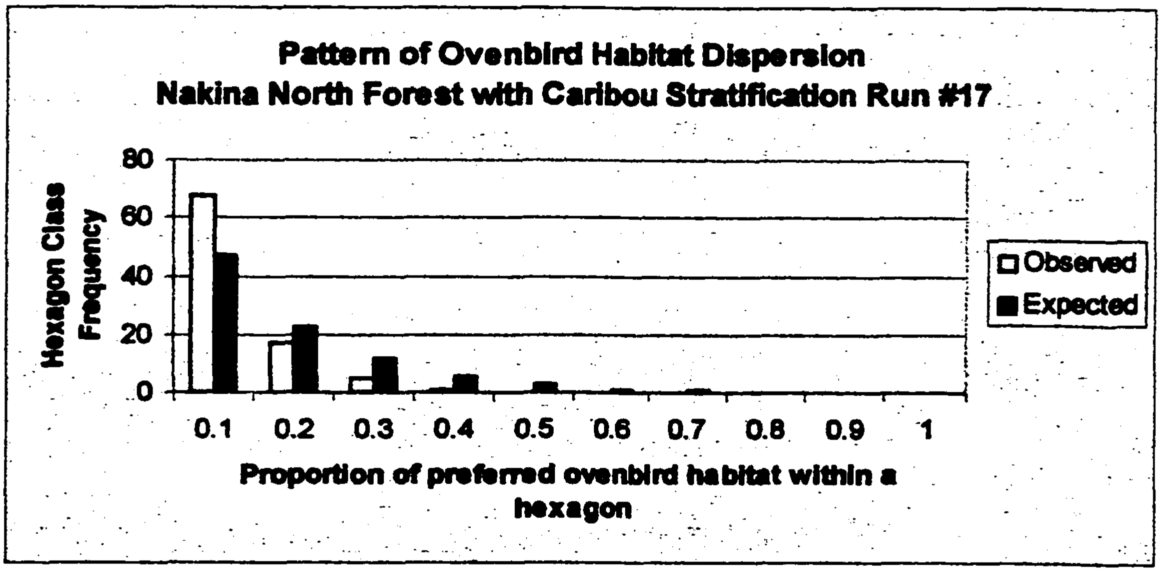

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #12
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

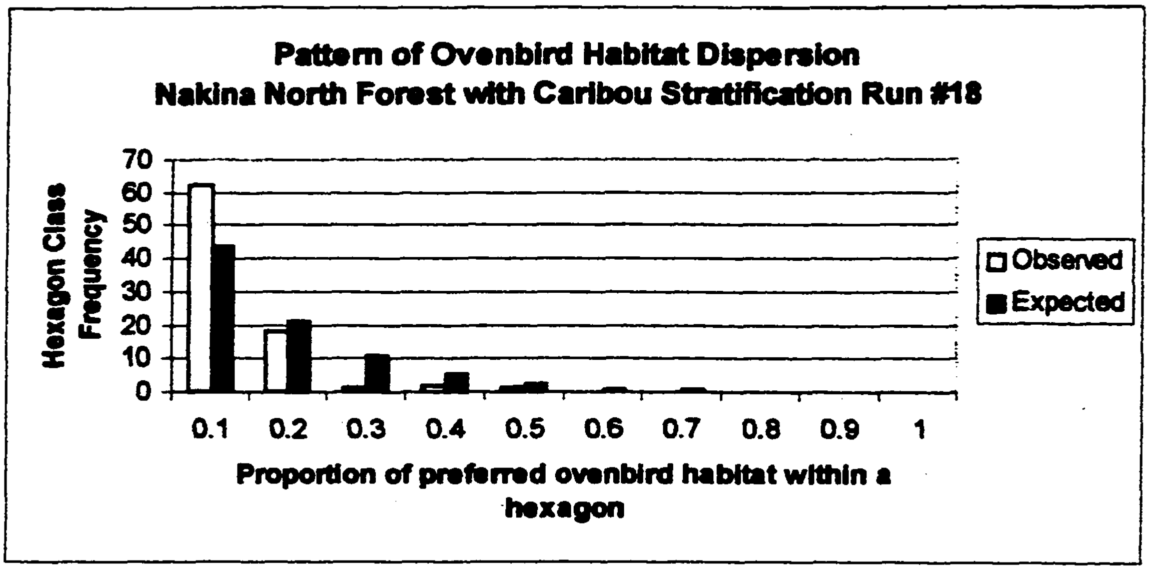

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #13
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

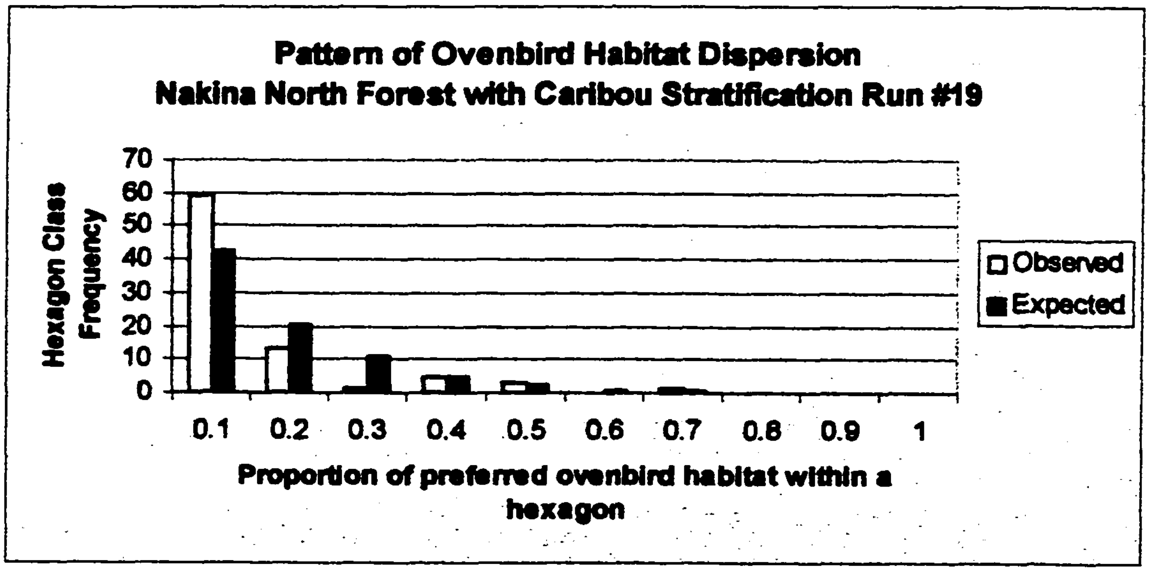

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #14
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

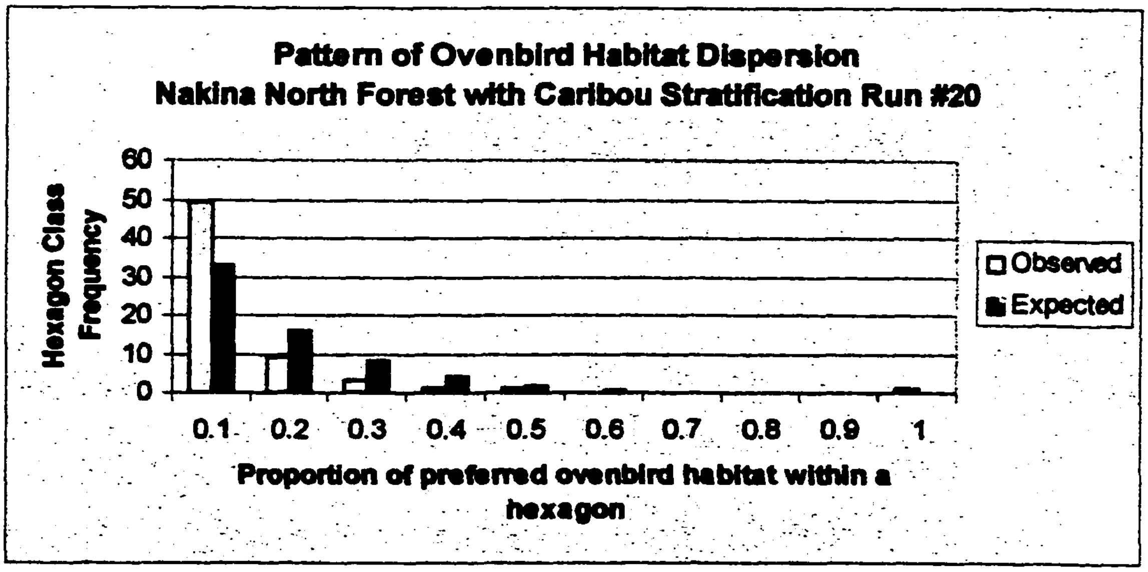

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #15
Hexagon Class Frequency
0
10
20
30
40
50
60
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
☐ Observed
■ Expected

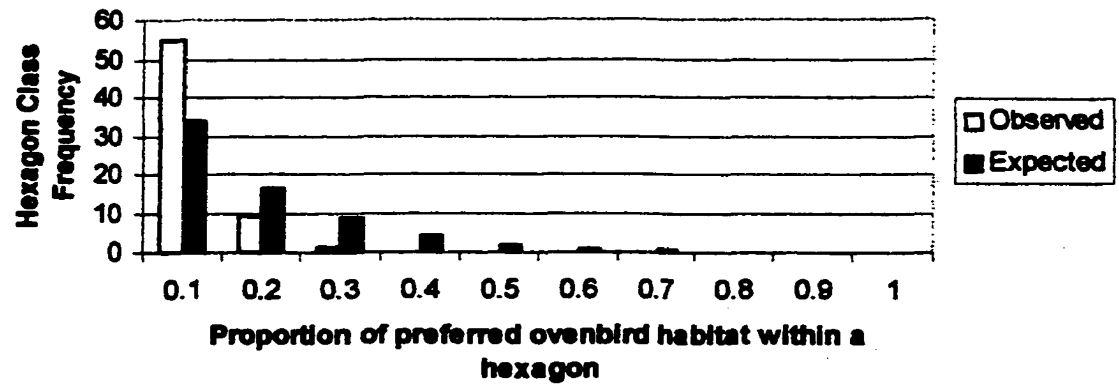

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #16
Hexagon Class Frequency
0
10
20
30
40
50
60
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
☐ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #17
Hexagon Class Frequency
0
20
40
60
80
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
☐ Observed
■ Expected

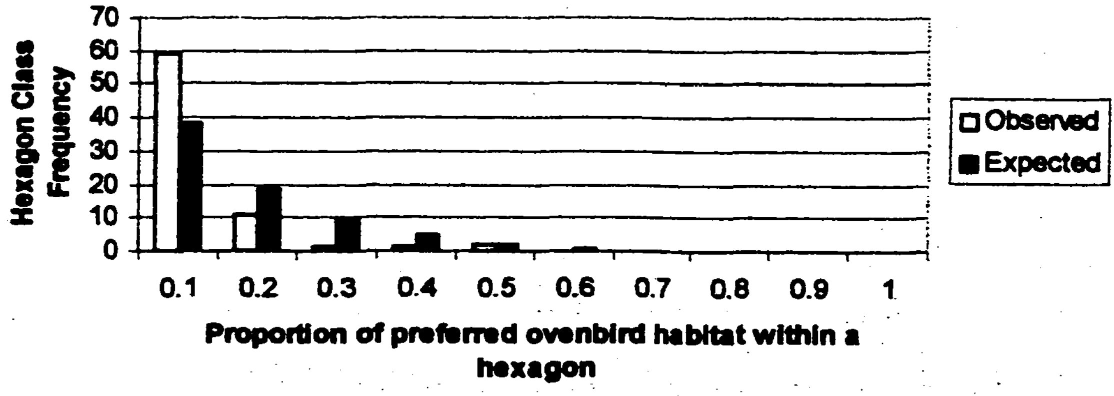

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #18
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #19
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

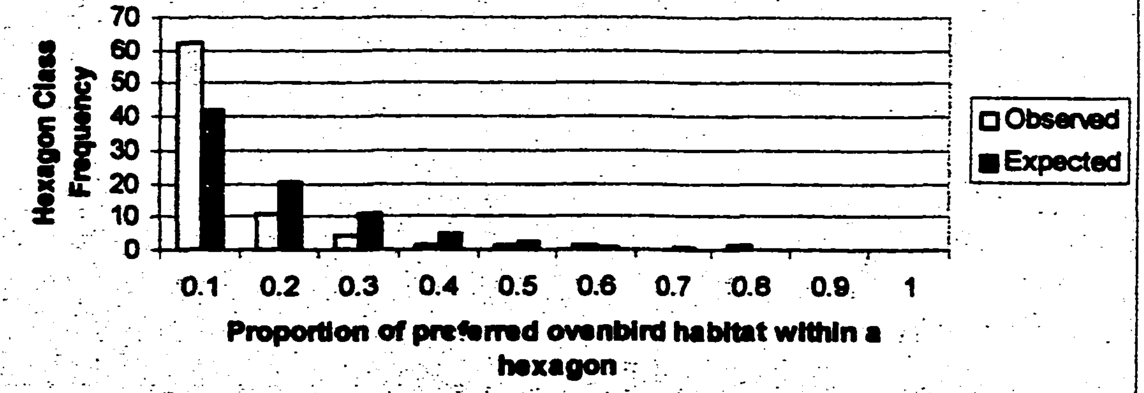

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #20
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected



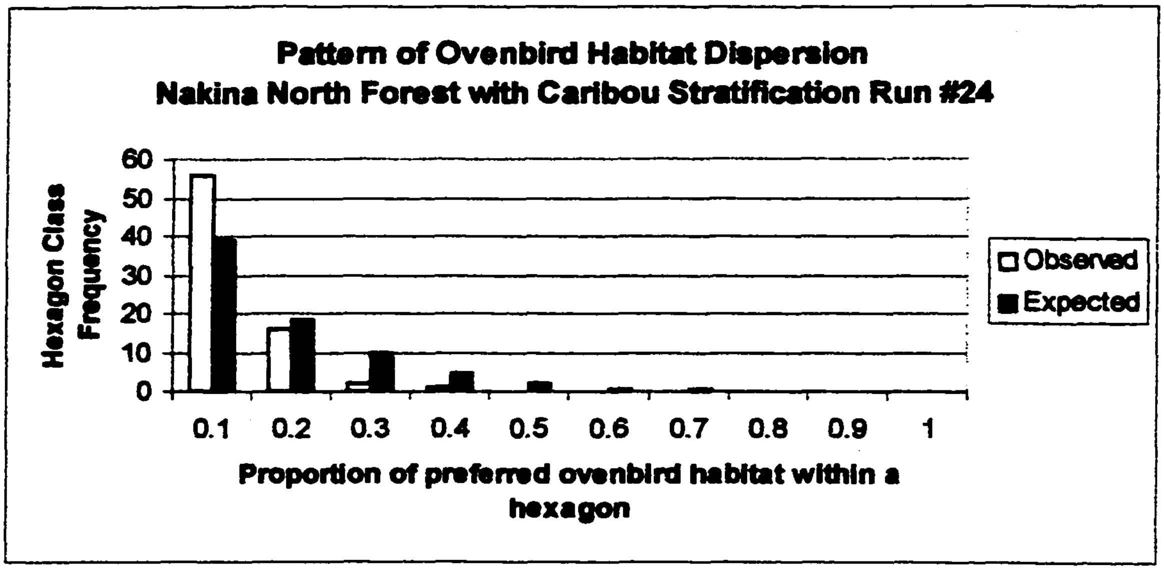
Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #21

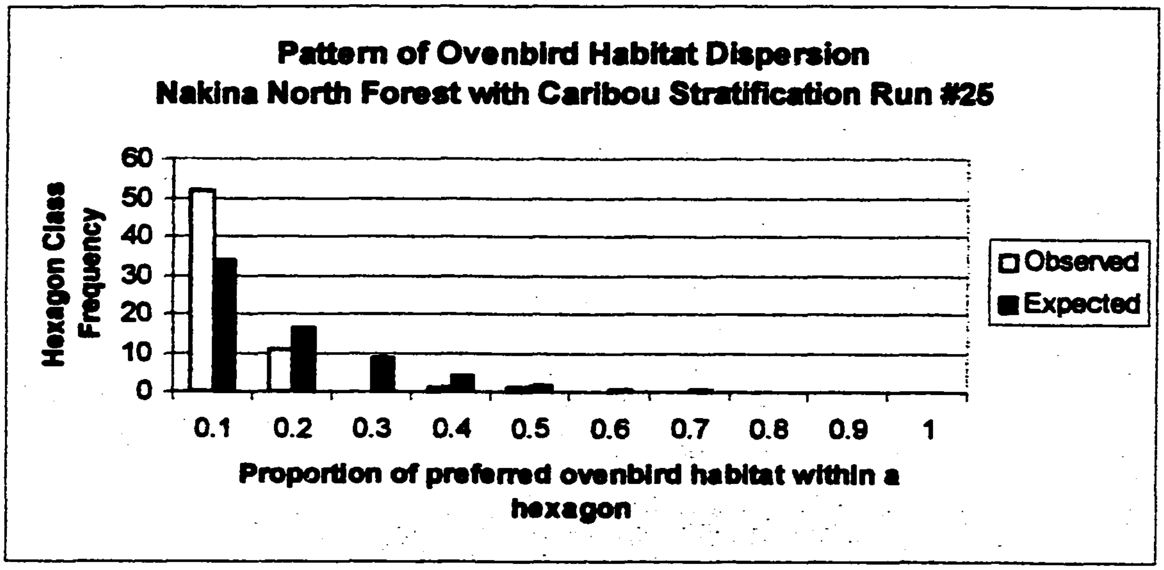


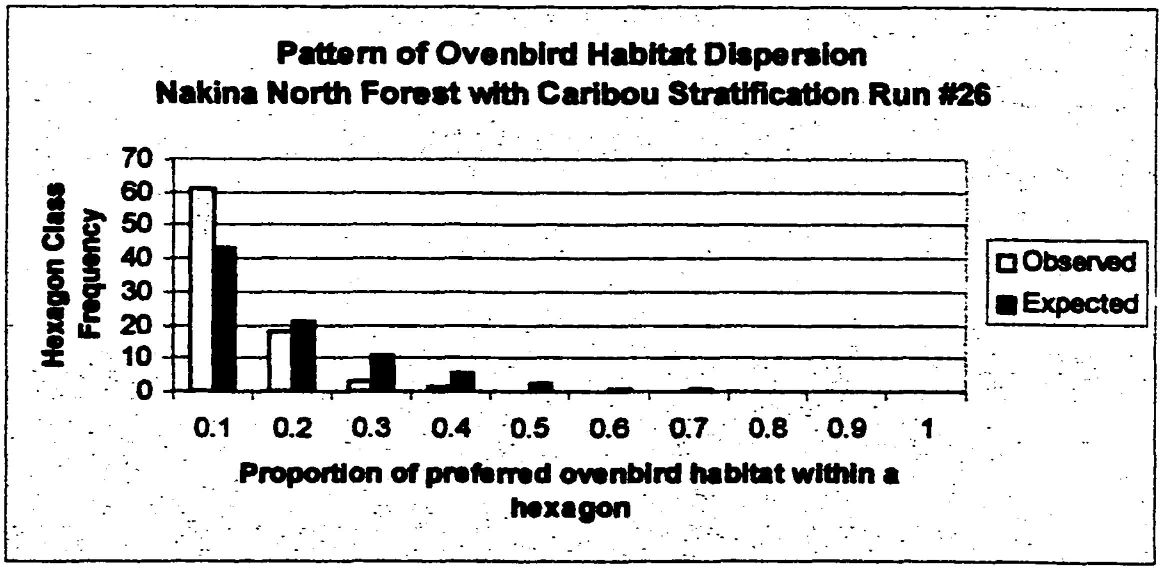
Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #22

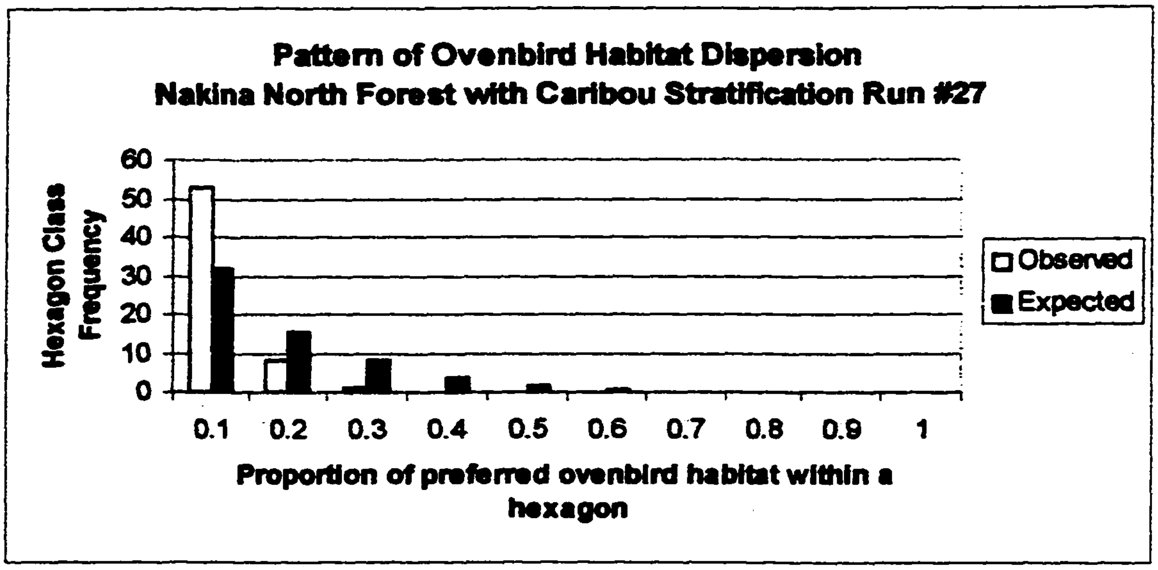


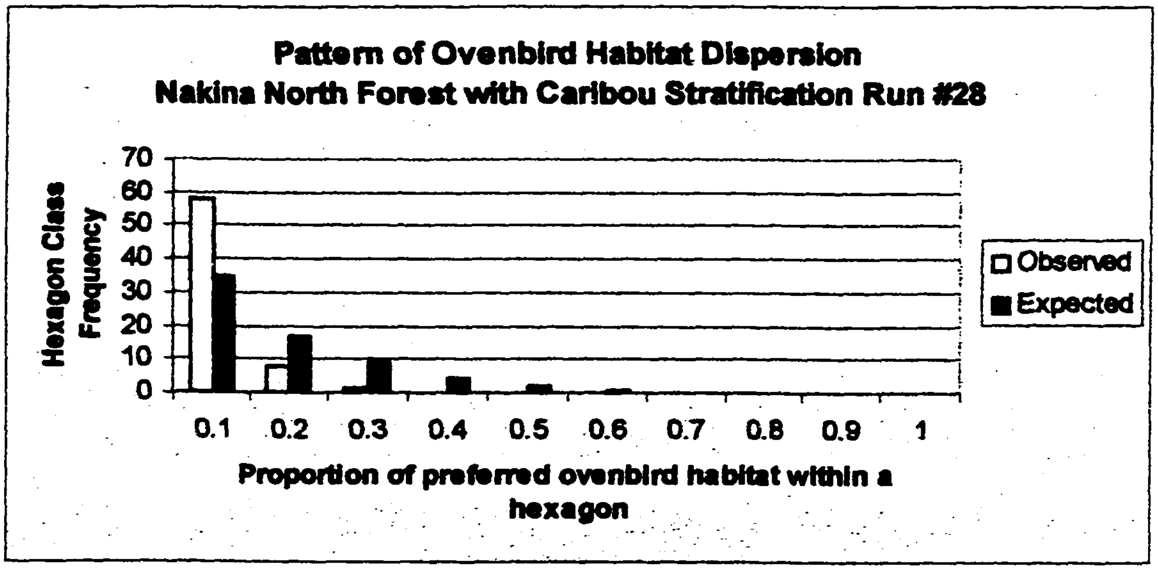
Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #23

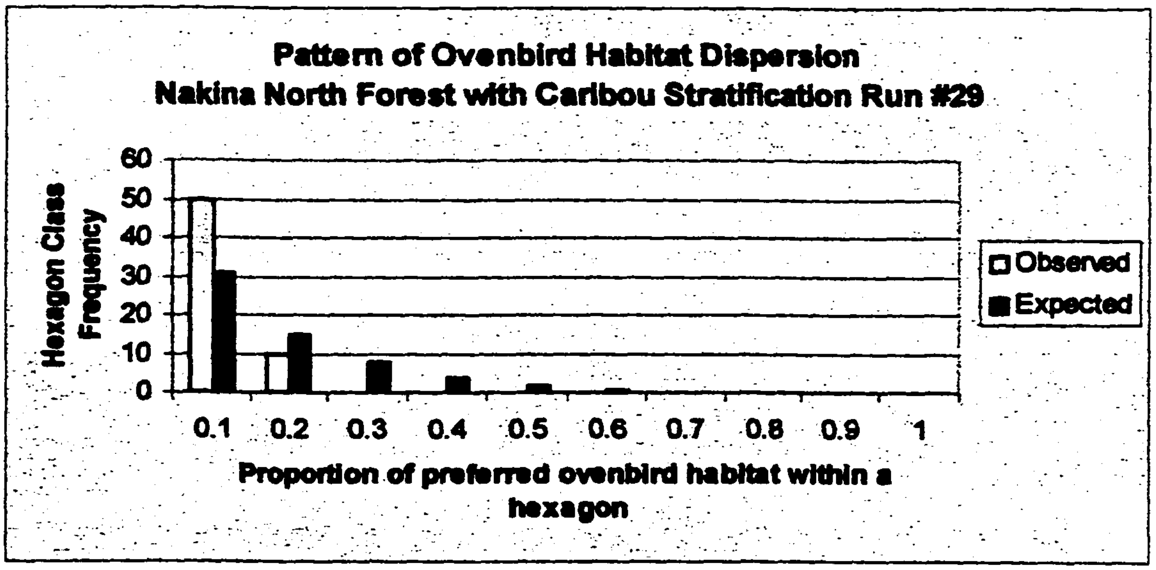

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #24
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

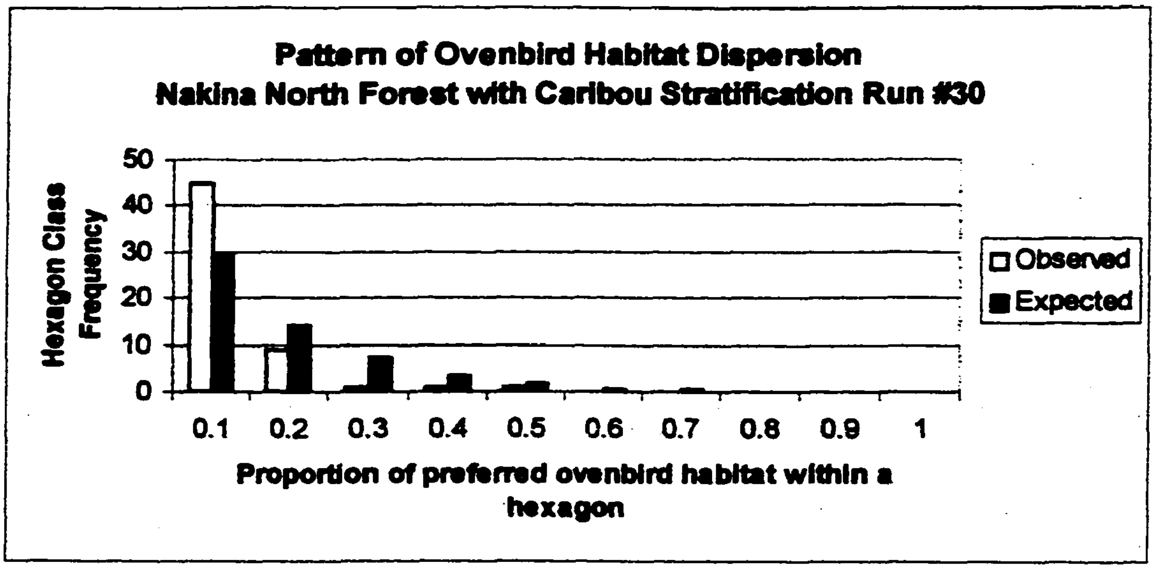

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #25
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

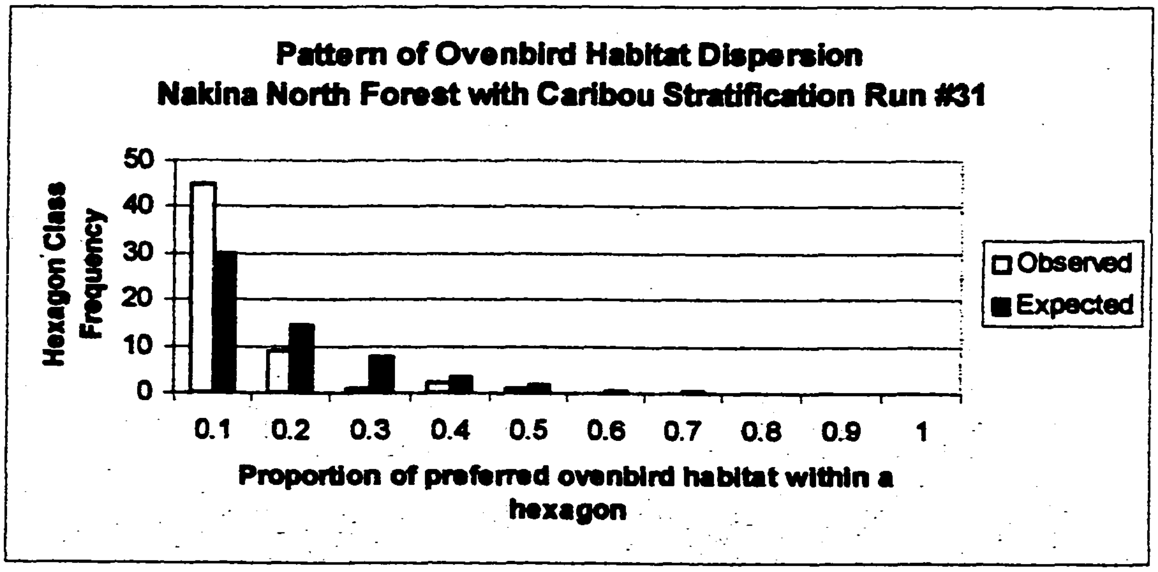

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #26
Hexagon Class Frequency
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected

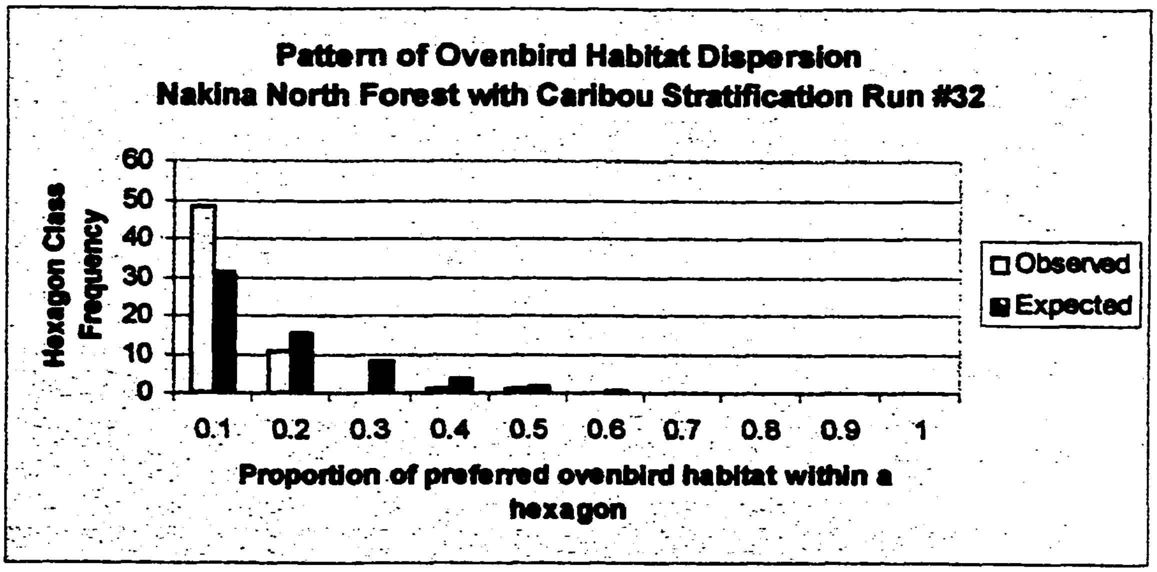

Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #27
Hexagon Class Frequency
0
10
20
30
40
50
60
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #28
Hexagon Class Frequency
0
10
20
30
40
50
60
70
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #29
Hexagon Class Frequency
0
10
20
30
40
50
60
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #30
Hexagon Class Frequency
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #31
Hexagon Class Frequency
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected


Pattern of Ovenbird Habitat Dispersion
Nakina North Forest with Caribou Stratification Run #32
Hexagon Class Frequency
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Proportion of preferred ovenbird habitat within a hexagon
□ Observed
■ Expected