A-4 Approach To Building The Management Plan

The SLRMA is a large area, with considerable variation in moose population density, human population density, habitat quality, and the presence of infrastructure elements (*i.e.* roads, railways, towns). The resulting diversity means that there is no way to create generalized guidelines which apply everywhere in the RMA. In order to allow management to be tailored to local conditions, the RMA was divided into seven moose management units.

A simple computer model was programmed for each unit to summarize the changes of the local moose population, keeping track of reproduction and mortality. The information available to manage the SLRMA is very basic, and often anecdotal. It may be that in the future, the accumulated body of data about this moose population will be large and precise enough that more complex models will become appropriate, but that day is many years away.

Each time a model was run, it simulated five years of moose mortality and reproduction. Levels of mortality were varied to show the response of each moose management unit's population to different intensities of harvest and predation, and an optimal annual harvest was derived for each management unit.

The 1994 moose management plan emphasized that the moose harvest by First Nations hunters must be reported and recorded. This plan endorses this approach, and provides a system to allow the moose harvest to be monitored, recorded, evaluated against the allowable harvest and adjusted for each management unit.

A-5 Moose Management Units

A-5.1 Creation of the Units

When the management units were created, several principles were applied to make the units appropriate from a number of different perspectives.

A-5.2 Meaningful Boundaries

First Nations hunters in the Split Lake area, when speaking about moose and moose hunting, refer frequently to certain key lakes and rivers. As much as possible, the management units were oriented to focus on these lakes and rivers, keeping each one completely within a single unit. Boundaries were laid out to avoid going through these areas, which tend to have high densities of moose. This principle ensured that, for example, if someone referred to moose along the Little Churchill River, it would not be necessary to get a more precise location. The entire Little Churchill River is in one management unit.

A-5.3 Meaningful Names

The same geographical reference points that were used to draw the boundaries were used, as much as possible, to name the units. Certain key lakes and rivers were used to identify the general area around them. It seemed that if the same geographical references were used to name the management units, there would be an intuitive meaning to the units. Essentially, a standardized vocabulary already existed, and we were only applying it. The seven names of the management units (

Table A-1) were submitted by Overview of Water and Land (OWL) staff and some additional First Nations individuals, and were then evaluated, modified, and accepted in a meeting of November 15, 2011, in Thompson.

Table A-1: The names and sizes of the Split Lake Resource Management Area moose management units

Number	Name (English)	Name (Cree)	Area (km^2)
1	Churchill River	Manteosippi	8,961
2	Little Churchill River	Oopawaha	5,152
3	Myre Lakes	Numaykoosani	5,919
4	Pelletier Lake	Kakwasanseesi	5,820
5	Limestone River	Wasekanoosees	4,270
6	Kettle Lakes	Askekosani	7,580
7	Nelson River	Kitchisippi	6,208

A-5.4 Appropriate Size

The choice of seven management units was made to create units that were similar to the Game Hunting Areas (GHAs) of Manitoba that are used to manage licensed big game hunting. These GHAs have been used for over 30 years. The mean size of the seven moose management units is 6,273 km^2, which is comparable to the major GHAs of southern Manitoba.

A-5.5 Minimize Movement Between Units

A key element of managing wildlife populations is to have current estimates of population size, therefore in future years, it will be necessary to fly aerial surveys of selected management units in the SLRMA. When the population of a management unit is estimated by one of these surveys, and compared with the 2010 estimate, it will be important to be confident that any changes were the result of mortality and reproduction within the unit, rather than the result of random movement of moose across the unit boundaries. By drawing boundaries through areas of low moose density (as described above), random movements between units should be minimized.

A-6 Characteristics of the Units

A-6.1 Ecological Overview of Moose Management Area

A variety of ecological conditions occurs throughout the SLRMA since it overlaps three Ecozones and four Ecoregions. Approximately 13% of the SLRMA is surface water, with this percentage ranging from 6% to 22% across the moose management units (Maps 1 and 2).

Surface materials in the SLRMA (Map A1) are dominated by lacustrine clays that were deposited by glacial Lake Agassiz. Fine and coarse textured marine deposits occur along the eastern margin of the RMA. Glaciofluvial ridges occur sporadically in the southwestern half of the area. Till blanket is most common in the northeastern and southern portions of SLRMA. Since the retreat of Lake Agassiz, organic deposits have developed over much of the area, with the main exceptions being on the glaciofluvial and coarse marine deposits.

Most of the northeastern half of the RMA falls within a subarctic climate while the southwestern half is in the subhumid high boreal ecoclimatic zone. Mean monthly temperatures decline along a line running from the southwest to the northeast portions of the rma. Corresponding with this temperature trend are an increasing amount of permafrost and a growing season length that declines by approximately 400 growing degree days (above 5° C).

Terrestrial vegetation in the SLRMA is primarily sparsely to moderately densely treed needleleaf woodlands. Tree canopy closure tends to decline moving northwards, and untreed vegetation types are most common in the northeast portion of the RMA. The southern quarter of the SLRMA differs from overall composition in several respects. Most of the moderately to densely treed needleleaf woodlands and dense needleleaf forest are located in this area, and broadleaf trees are more common. Shrublands are less abundant. This area also has a more even mixture of the various vegetation types found in the RMA. The north-central portion of the RMA is dominated by sparsely treed needleleaf woodlands.

Much of the SLRMA has been burned by large wildfires over the past twenty years. The southern quarter of the RMA has a lower proportion of its area in burns less than twenty years old. Approximately 45% of the land area was burned between five and twenty-years prior to the SLRMA moose population survey.

The following moose management units are described from an access, water and landscape perspective, and include a highlight of substantial differences as described above from the overall ecological conditions for the SLRMA.

A-6.2 Unit 1: Manteosippi (Churchill River)

The Manteosippi unit is the most remote unit in the RMA. From Split Lake to the north edge of this unit is 200 km. There are no direct water routes into this area from local communities. The railway to Churchill, which could provide limited snowmobile access, is 70 to 170 km away, on the east side of the RMA; otherwise, fly-in access is the only reasonable means of accessing this management unit. Barren-ground caribou can be abundant in this unit in the winter. During aerial surveys looking for moose tracks, flights over some parts of the unit had to be aborted because of disruption caused by the high density of caribou tracks.

The Churchill River flows through the Manteosippi unit from the southwest corner to the northeast corner, staying close to the southern and eastern boundaries. There are no other major watercourses. Major lakes include Hogg, Fidler, Solmundsson, Gersham, Numaykoos and Buckland. Numaykoos Provincial Wilderness Park overlaps with the Manteosippi unit on the north boundary of the unit.

This is one of the two coldest units in February and July. It has the highest proportion of medium density needleleaf woodland. This is one of the three units that has a very high proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.3 Unit 2: Oopawaha (Little Churchill River)

The Oopawaha unit is dominated by Waskaiowaka Lake and the Little Churchill River, both of which are completely contained by the unit. Recluse Lake, in the centre of the unit, is an S-shaped widening of the Little Churchill, and is frequently mentioned by First Nations hunters in accounts of moose hunting in this area. Embleton Lake is in the north half of the unit, between the Little Churchill and the Churchill Rivers.

A major snowmobile trail runs from Split Lake to Waskaiowaka Lake, and from there snowmobile trails extend north and north-east throughout the unit to all of the major lakes along the Little Churchill River. Direct water access from local communities is difficult, but after flying in to Waskaiowaka or Recluse Lakes or the confluence of the Churchill and Little Churchill Rivers, travel along the Little Churchill River is possible, especially when water levels are high. There are many cabins and hunting camps throughout this unit.

This unit has the second highest proportion of medium density needleleaf woodland and the highest proportion of sparsely treed needleleaf woodland. This unit has a relatively low proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.4 Unit 3: Numaykoosani (Myre Lakes)

Numaykoosani is also a remote unit, but in the winter is somewhat accessible by snowmobile along the railway right-of-way. The railway itself is used to get to some remote cabins in the area. A prominent feature is the string of lakes that run from southwest to northeast: Little Cygnet, Myre, Strobus and Weir. Other prominent lakes are Whitecap, Mistake and Bradshaw. The Owl River originates in the Numaykoosani unit, at Owl Lake.

Snowmobile access from Split Lake is along PR 280 to the north arm of Stephens Lake. From here, trails head north to Cygnet and Myre Lakes and connects Myre to Recluse Lake. Water access begins with flying in to Myre, Strobus, Weir and Whitecap Lakes. From Myre, 3 smaller lakes can be accessed by boat; from Whitecap, the Little Churchill River is accessible by boat.

The surface material composition of this unit deviates most greatly from the rest of the RMA. A considerably higher proportion of till blanket offsets less fine lacustrine material, and this is the only unit that includes coarse marine deposits. This is one of the two coldest units in February and July and is one of the three units that has had a very high proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.5 Unit 4: Kakwasanseesi (Pelletier Lake)

The Kakwasanseesi unit lies on the west side of the SLRMA. There are a number of sizable lakes: Pelletier, Campbell, White Stone and Pearson in the south half of the unit, and Settee, Christie, Holmes and Thomas further north, near the Churchill River.

Snowmobile access from Waskaiowaka Lake connects all major lakes, many of which have cabins. Water access is fly-in, and major destinations are Pelletier, Big Beaver Dam, Big Jack, Settee, Christie and Thomas lakes. Boat access to Christie is from Holmes Lake, and Pelletier may be accessed by boat from Waskaiowaka using the Rasp River.

Surface materials include a substantially higher proportion of glaciofluvial materials and a lower proportion of till. While February temperatures are similar to the RMA average, July temperatures are higher. This unit has the highest proportions of dense needleleaf forest and moderately dense needleleaf woodland and a relatively low proportion of very sparsely treed areas. This is one of the three units that has a very high proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.6 Unit 5: Wasekanoosees (Limestone River)

Limestone Lake and the Limestone River are completely contained within the Wasekanoosees unit. The unit is very accessible in some ways, being close to communities and PR 280, but in conversations with First Nations hunters, it was reported that some parts of the unit are very difficult to travel in. Cygnet Lake is the most prominent feature in the north half.

Snowmobile access from Split Lake is to Little Limestone Lake and on to Limestone Lake. There is a separate trail to Cygnet Lake. Water travel is limited, and most access is fly-in, with major destinations being Limestone, Cygnet and Little Limestone lakes.

Surface materials in this unit include substantially higher proportions of fine marine and glaciofluvial materials and lower proportions of fine lacustrine and till materials. This is one of two units to have a substantially lower proportion of surface water compared with the rest of the RMA. It has the second highest proportion of sparse needleleaf woodland. This unit has a relatively low proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.7 Unit 6: Askekosani (Kettle Lakes)

The Askekosani unit has some large patches of mixedwood forest. Access is good in the northern half of the unit, while the southern half is considered remote. Ilford is inside the unit, and is connected to Gillam, near the northeast border of the unit, by the railway line. Existing transmission lines, other trails, lakes and streams are also used in winter for travel, harvest and trapping purposes. Some prominent lakes are Atkinson, War, Butnau, Hawes, Kettle and Dafoe. As one travels into the unit from the north, the creeks and rivers, which flow primarily east-northeast, create important landmarks or obstacles: Kettle, Cyril, Dafoe, High Hill and Bigstone.

Split Lake is connected by snowmobile trails to Diana, Joy, and Dafoe lakes and Kettle Lake is similarly connected to both Split Lake and Gillam. Water access is fly-in and major destinations include Atkinson, War, Diana, Joy, Dafoe and Kettle Lakes.

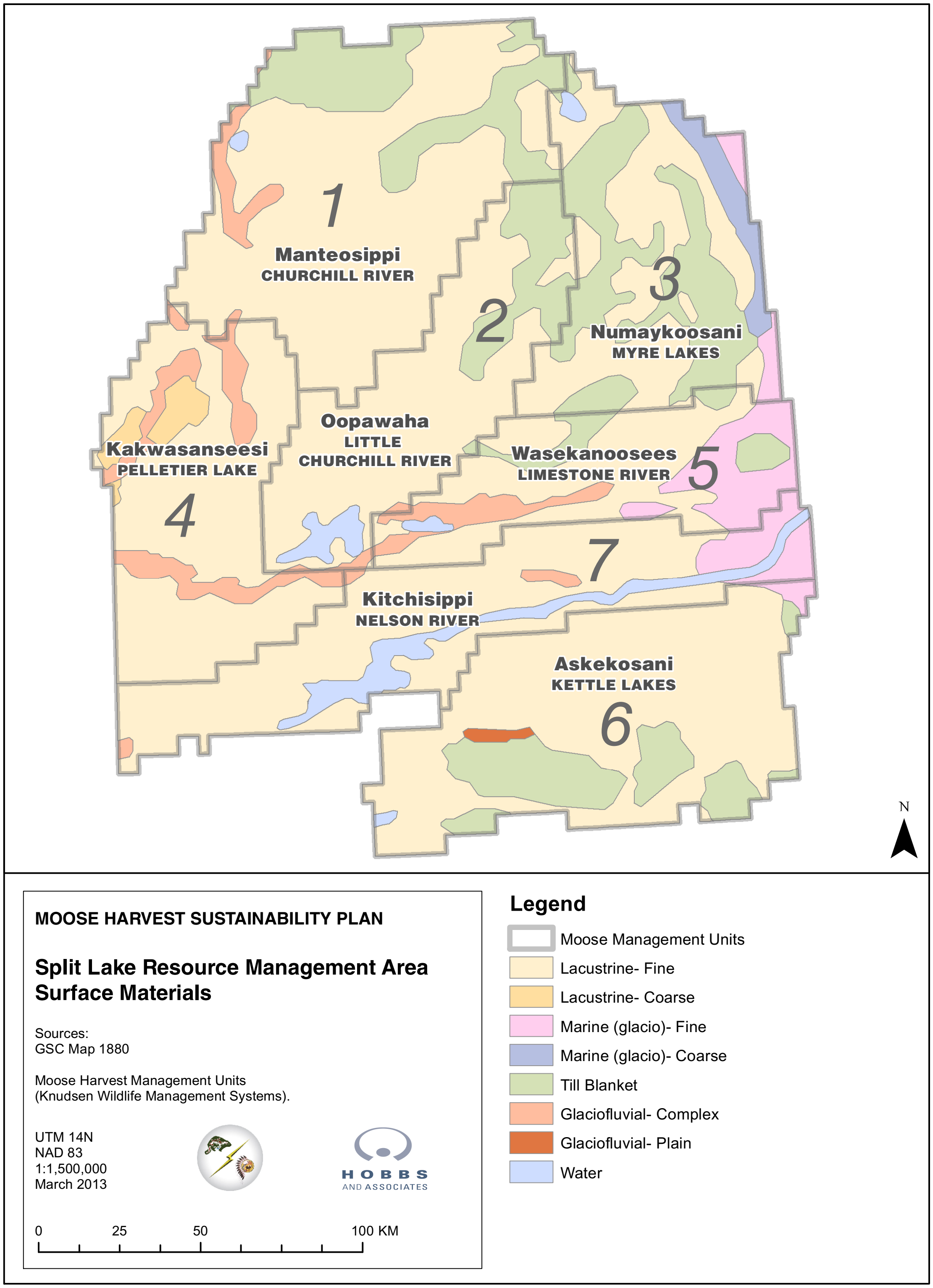
In the southeast corner, these rivers, except for the Kettle, drain into the Fox River, which in turn drains into the Hayes River. The Fox River area is important moose habitat, and receives regular fly-in hunting pressure.

Surface water accounts for a substantially lower proportion of the unit compared with the rest of the RMA. This is one of the two warmest units in February and July. This unit has the highest proportions of its land area in sparse needleleaf dominated mixedwoods and very sparsely treed areas and a relatively low proportion of sparse needleleaf woodland. This unit has a relatively low proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.

A-6.8 Unit 7: Kitchisippi (Nelson River)

Unit 7, Kitchisippi, is a corridor of development in the RMA, dominated by communities, roads, hydroelectric development and the Nelson River. Two lakes, expansions of the Nelson River, take up much of the unit's area: Stephens Lake in the east and Split Lake in the west. In the western portion of the unit, important water features are Assean Lake, Assean River, Hunting River, Orr Lake and the Odei River. Considerable human activity is associated with the infrastructure. Winter access trails are distributed throughout the unit, and other linear features including transmission lines and railways are present. The Kitchisippi management unit was created specifically to enclose most of the human activity in the SLRMA, and deal with existing and potential future impacts on moose.

Because this unit includes the Nelson River, it is the only unit to have a substantially higher proportion of surface water compared with the rest of the RMA. Surface materials in this unit include substantially higher proportions of fine lacustrine and fine marine and a lower proportion of and till materials. This is one of the two warmest units in February and July. This unit has the second highest proportions of sparse needleleaf dominated mixedwoods and very sparsely treed areas accompanied by a relatively low proportion of sparse needleleaf woodland. This unit has a relatively low proportion of its area burned between five and twenty-years prior to the SLRMA moose population survey.



Map A1 – Surface materials in SLRMA

Appendix B
Population Simulations

B-1 Purpose of the Model

The purpose of the model is to gather all the factors that influence the moose population of a management unit, and create a five-year projection of the size and structure of the population. These projections generate an allowable harvest for each management unit, and provide a context for ongoing monitoring. The workings of the model and the derivation of input values are explained in the following sections, The Input Values section is necessarily quite detailed, because it involves estimating the distribution and abundance of wolves, which in turn requires estimating the distribution and abundance of caribou. Although this plan is described as managing moose, the moose are inseparable from wolves and their major alternate prey, caribou, as will be described below.

B-2 Structure of the Model

The model begins with the moose population of one management unit, starting in January 2010, and applies mortality factors, such as predation and hunting, to delete moose from the population in the same sequence that would happen in nature during the year. Moose are added to the population once each year, in the spring when calves are born. Each simulation runs for five years.

The first mortality factor is winter predation by wolves. The next is weather-related winter mortality. The complete list of annual events is shown in Table B-1.

Mortality factors are not applied the same way for all events. Some mortality is applied to age and sex groups (bulls, cows and calves) in proportion to their abundance in the population. Other mortality factors are applied using weights, which delete a specified percentage of the total mortality from each age/sex group. The weightings and the number of moose lost are made clear in the model, and can be scrutinized in the results.

Each simulation occurs on one page of a spreadsheet (see Appendix D). The inputs to the model are listed in two tables (see Appendix C). One shows the magnitude of mortality factors and the second shows the weighting of mortality factors (such as 40% bulls, 20% cows and 40% calves). The results are summarized in four ways:

- a table showing the January population for each year
- a graph of the January populations
- a table showing the percentage of bulls, cows and calves in the population each January
- a graph of the percentage of cows in the population

In addition to these summary tables, a complete table of each simulation's results was stored. These tables are presented in Appendix D.

Table B-1: Factors influencing the moose population during each simulated year

Month(s)	**Event**
January-February	Winter wolf predation
March	Winter weather mortality
May	Reproduction
June-August	Postnatal mortality of calves
September-October	Domestic First Nations harvest
September-October	Resident licensed harvest
September-October	Non-resident licensed harvest
October	Wounding mortality From hunting
November-December	Fall wolf predation
December	Black box mortality (*e.g.*, disease, accidents)

B-3 Input Values

Some input values were derived from formally acquired data, gathered according to a carefully designed sampling scheme. This is the case with the estimates of moose populations, gathered by the aerial surveys of 2009 and 2010. Other data are very approximate, such as estimates of mortality from accidents and disease. These factors are very difficult to measure. Between these two extremes, there are input values that can be derived from the extensive biological literature dealing with moose, wolves, caribou, and the relationships between them. CNP Members provided input data relating to moose densities, wolf densities and wolf pack locations.

The detailed derivations of all these values are presented below.

B-3.1 Starting Populations

The 2010 aerial survey of moose in the SLRMA divided the area into 2,580 sample units, with an average size of 17 km^2. Each sample unit was classified as having a moose density that was high (HI), medium (MED), low (LO), or extra-low (XLO). To calculate the moose population for each management unit as of January 2010, each unit was partitioned into the total area of each density level (Table B-2). Each area was multiplied by the stratum-specific densities of bulls, cows and calves (Table B-3) to assemble a population for the unit (Table B-4). These populations are shown graphically in Figure B-1.

Table B-2: Density levels in each moose management unit

Management Unit Number	Management Unit Name	Area (km²) XLO[1]	LO	MED	HI
1	Manteosippi	3,922	4,005	868	167
2	Oopawaha	1,932	2,424	780	17
3	Numaykoosani	4,187	1,228	488	17
4	Kakwasanseesi	495	2,833	2,048	444
5	Wasekanoosees	649	1,759	1,503	359
6	Askekosani	2,921	1,721	2,382	556
7	Kitchesippi	2,673	1,966	1,397	172

1. XLO (extra-low), LO (low), MED (medium) and HI (high) refer to moose density

Table B-3: Densities of bulls, cows, and calves in each density level

	Densities (animals/km²) Bulls	Cows	Calves
XLO[1]	0.0039	0.0078	0.0039
LO	0.0241	0.0134	0.0053
MED	0.0344	0.0292	0.0135
HI	0.1501	0.1474	0.0199

1. XLO = extra-low, LO = low, MED = medium, HI = high

Table B-4: Starting population used in simulations for each moose management unit

Management Unit	Bulls	Cows	Calves	Total
Manteosippi	194	156	60	410
Oopawaha	112	86	37	235
Numaykoosani	77	78	35	190
Kakwasanseesi	243	196	63	502
Wasekanoosees	176	147	46	369
Askekosani	254	229	74	557
Kitchesippi	154	133	50	337
Total	1,210	1,024	365	2,600

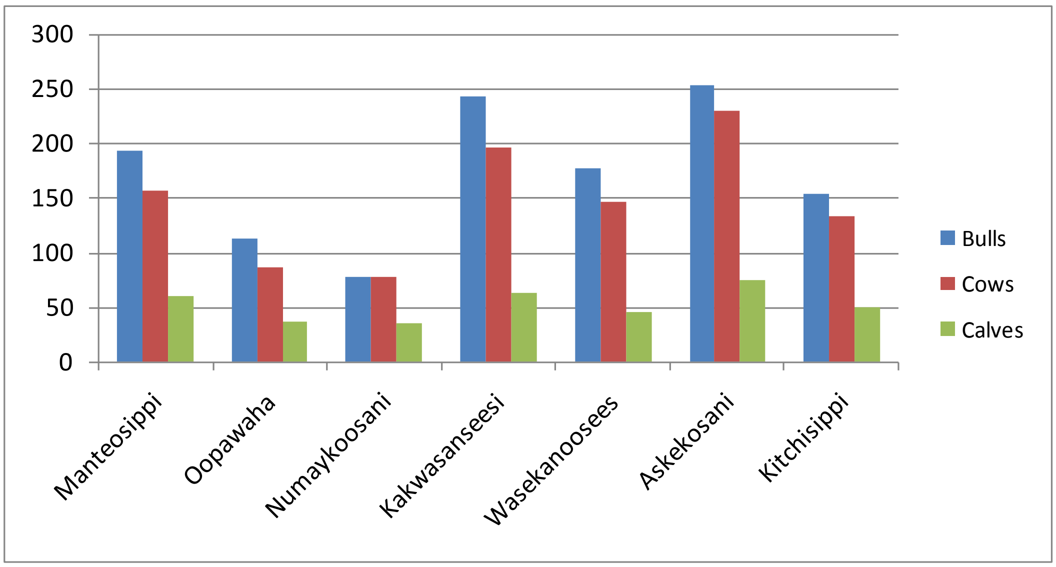


Figure B-1: The age/sex structure of the starting populations of all moose management units

B-3.2 Winter Wolf Predation

Wolf predation is a difficult, but not impossible, input factor to estimate in the absence of data from intensive field studies. The following material elaborates on how wolf populations can be estimated from ungulate biomass, which can be estimated by combining moose survey data with an approximate calculation of caribou density.

Wolf predation on moose can be broadly divided into two categories: predation on newborn calves and predation on all members of the moose herd in the fall and winter. For the purpose of this model, wolf predation on newborn calves is included in the category of Postnatal Mortality, along with predation by black bears and deaths from other factors. The category name "Total Wolf Predation" is really the predation that takes place during the 200 days from mid-fall to early spring. This period is convenient, because much of the literature expresses kill rates during this period as moose killed per wolf per 100 days. To allocate total mortality appropriately, it was divided into equal halves: one for winter and early spring and one for late fall. To reflect the higher vulnerability of calves and bulls stressed by the rut, the kill was weighted so that it was 40% bulls, 20% cows and 40% calves.

In order to estimate the total number of moose killed annually by wolves in each moose management unit, it was necessary to estimate the number of wolves. Aerial surveys, of the type used for moose, are not practicable for wolves because of the scarcity, mobility and smaller size of wolves. Individual wolves and packs can be detected and followed by small fixed-wing aircraft, but this method is prohibitively slow and expensive to be used to census large areas. Fortunately, a close relationship has been established between wolf numbers and the biomass of their ungulate prey. By estimating the total ungulate biomass of the SLRMA, one can generate the number of wolves that would be expected to be supported by that prey base. In the SLRMA, moose abundance has been known since 2010, but it is necessary to estimate the abundance of the only other ungulate, caribou.

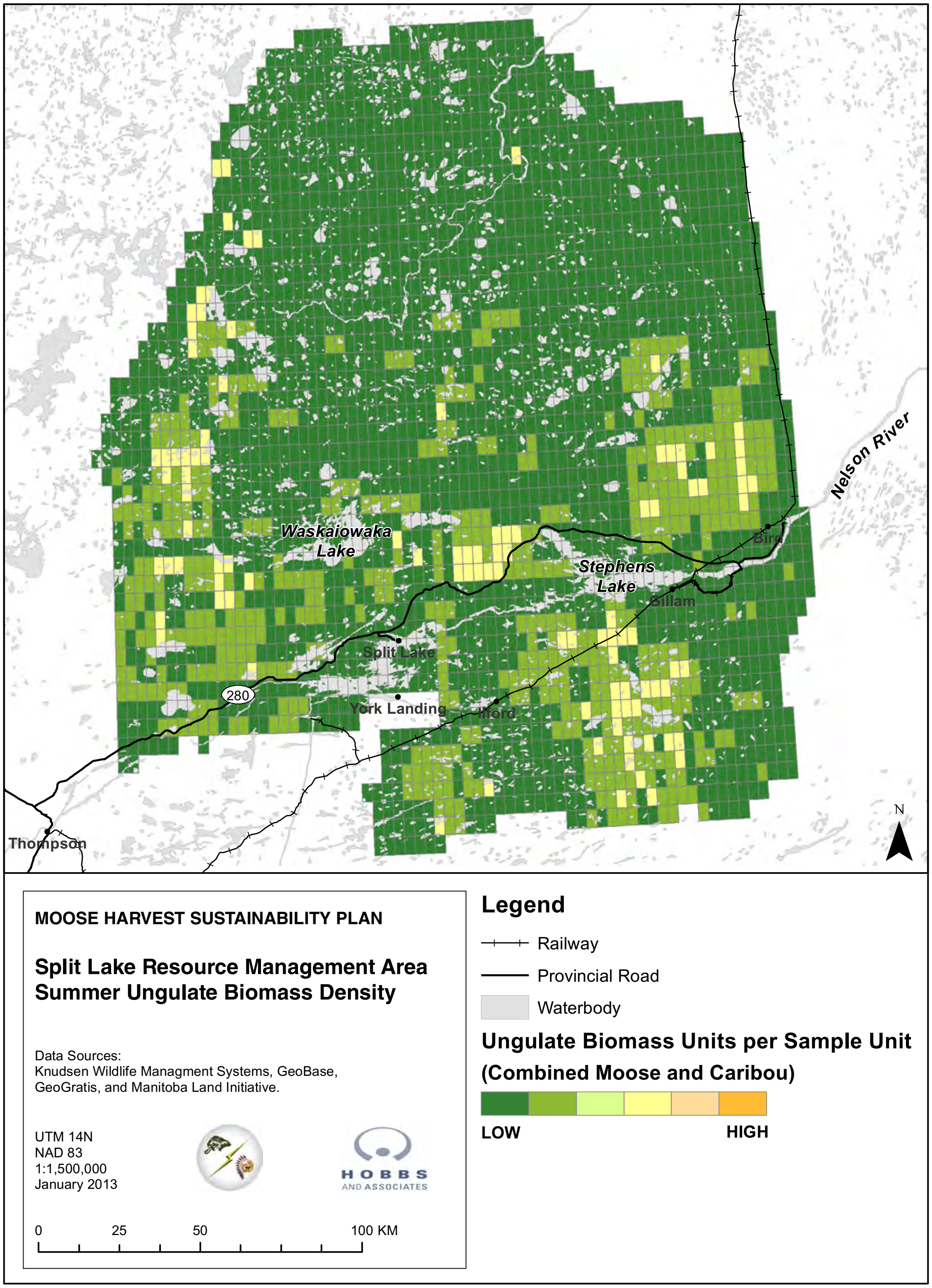
There are four different components to the caribou population. Some caribou are resident in the RMA and nearby regions, wandering, but not migratory. Three types of migratory caribou enter the RMA during the winter. Their arrival dates, departure dates, location and abundance are all irregular. Some animals from the Beverly-Qamanirjuaq barren-ground caribou herd move in from the north. Pen Islands caribou, from the Manitoba and Ontario coast of Hudson Bay come in from the east. Caribou from the Cape Churchill area arrive from the northeast.

Because of the migratory nature of some the caribou in the RMA, two estimates of ungulate biomass density need to be calculated: summer and winter. The summer ungulate biomass consists of moose and the summer resident caribou. The winter ungulate biomass incorporates the additional biomass of the migratory caribou.

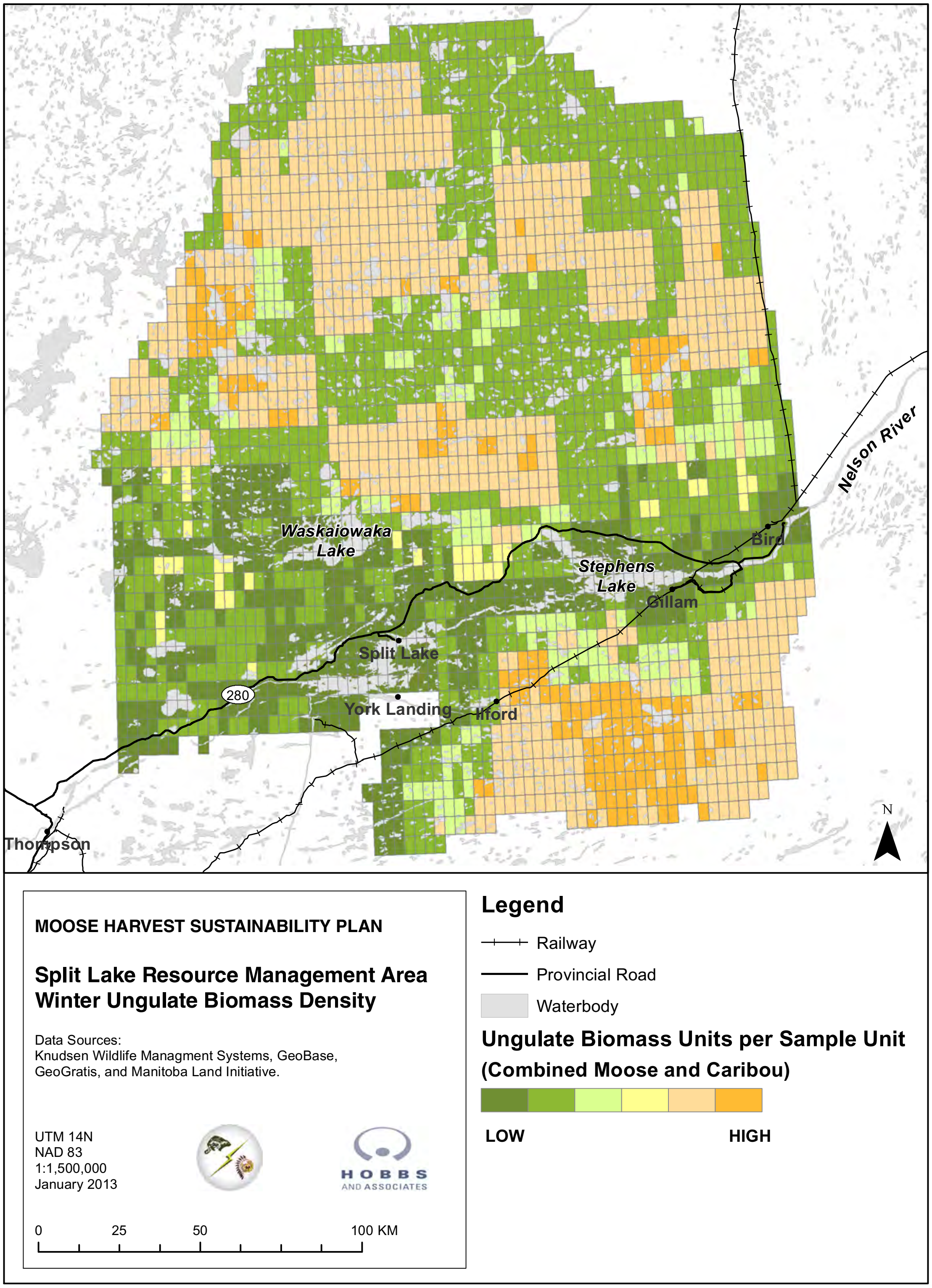
To estimate the winter distribution of caribou, the density of caribou tracks, which was recorded during the 2009 preliminary flights of the aerial moose survey, was used as a guide. The areas with a high density of caribou tracks were classified as high density. Areas with no tracks were classified as low density. Between these two areas, bands of medium density were classified, to reflect the irregular wandering of caribou, which blur the boundaries between density classifications. When the entire RMA was classified, each density class was assigned a density, expressed as number of caribou per 100 km^2. For the low density areas we used the general density for the Canadian boreal forest (3 caribou per 100 km^2) presented by Seip (1991) and Courtois and Oullet (2007). For the high density areas, we had to represent the dramatic immigration of migratory herds. Obviously, this high density changes rapidly as the animals are within the RMA, but some representative number was needed to express this. Ballard *et al*. (1997) reported a 40-fold increase in caribou density in Alaska when barren-ground caribou migrated into territory already occupied by resident moose and wolves. Because a multiplier of that magnitude had been documented, we used it here to generate a density of 120/100 km^2 for high density areas: 40 times the density of the low areas. Medium density areas were assigned a density of 40/100 km^2.

Every sample unit in the RMA now had an assigned density of caribou for summer and winter, which added up to an average summer population of 355 resident woodland caribou in the south-central part of the RMA, and an additional 25,145 migratory caribou, primarily in the northwest and north central portions. To evaluate the realism of these numbers, the size and movements of the Qamanirjuaq caribou herd was examined. The herd consists of approximately 350,000 animals (Campbell et al. 2010). On the wintering grounds, it is spread over approximately 600 km of forest, from Hudson Bay to northeastern Saskatchewan (Campbell 2005, 2007). Assuming an even distribution of the herd across the wintering grounds, approximately 25% of the herd, or 87,500 would be positioned north of the SLRMA. Movement into the boreal forest and taiga is variable, covering approximately 400 km from southern Nunavut to the Nelson River. Assuming an even north-south distribution, perhaps 25% of these would enter the RMA. In very round numbers, that would be approximately 22,000 caribou. Given the approximate nature of all the quantities used here (the population estimates, the calculation of the proportion of the herd in the RMA, and knowledge of distribution and movements,), this is an adequate fit to our density-based estimate of 15,733 migratory caribou coming from the Qamanirjuaq herd.

To combine moose and caribou into one expression of ungulate biomass, we followed Fuller *et al*. (2003), and converted abundance into ungulate biomass index (UBI) units. The UBI for a species represents its approximate mass, relative to white-tailed deer, which have a UBI of 1. The UBI for caribou is 2, and for moose, 6. For each of the 2,580 sample units in the RMA, the estimated number of caribou in the sample unit was multiplied by 2. The estimated number of moose was multiplied by 6. The two values were summed, to give total ungulate UBI for the sample unit. Migratory caribou were excluded for a summer UBI and included for a winter UBI. These values were then used to create maps of summer and winter ungulate biomass density, with darker shading indicating higher ungulate biomass (Map B-1 and Map B-2).



Map B-1 – Summer Ungulate Biomass



Map B-2 – Winter Ungulate Biomass

The maps of ungulate biomass density were used to generate estimates of wolf populations. This must be done in two steps, because just as there are resident and transient caribou in the RMA, there are resident and transient wolves. When wolves have a non-migratory ungulate prey base, such as moose or deer, they form packs which defend territories against other packs. Transient wolves, which are usually dispersing solitary young animals or older animals (Mech 1970), but which can also be habitually wandering tundra wolves in this case, are frequently killed if they wander into a pack's territory (Fuller *et al*. 2003, Mech and Boitani 2003). There are usually gaps between territories, which minimize aggressive encounters with other packs, and afford safer locations for lone wolves to occupy. When migratory ungulates, such as caribou, move into the territories of wolf packs for part of the year, the resident wolves usually hunt the temporarily available prey while they are available. When the migratory prey leave, however, the wolves usually do not follow. Ballard *et al*. (1997) found that when the caribou density increased 40-fold in an area occupied by moose and wolves in Alaska, the wolves shifted from a moose diet to one that was 92% caribou. When the caribou migrated out of the area, the wolves did not follow, but "preyed on the sparse moose population." In the SLRMA, we will assume that the resident wolves will also not follow the migratory caribou, but we will not assume that the resident wolves prey on migratory caribou on more than an opportunistic basis. The reason for this is apparent in the two maps of ungulate biomass. The area flooded by migratory caribou is not an area where resident wolves would have territories. Most of the area occupied by migratory caribou is classified XLO for moose, with a density of approximately 2/100 km^2. When moose are the only prey, wolves are absent from areas with moose densities below 3/100 km^2 (Messier 1994). Therefore there are no wolves waiting to benefit from the arrival of the Qamanirjuaq caribou, and we assume that the resident wolves, organized into packs, prey primarily on the resident moose population, and defend territories in the areas of highest moose density.

Fuller *et al*. (2003) examined 32 studies in which the biomass of prey and the number of wolves could be estimated. They found that the mean UBI per wolf was 271. The 2,600 moose in the SLRMA, taken by themselves, generate a UBI value of 15,600. If this is divided by 271, it gives the number of wolves that could be supported solely by the moose population, which is 58. To estimate mean pack size for resident wolves, we used tabulated mean sizes of early winter and midwinter wolf packs from a number of studies (Fuller *et al*. 2003). Solitary wolves were not included in the means. Twenty of the mean values, based on over 900 packs, were for packs preying on populations of nonmigratory ungulates (either moose or a combination of deer and moose). The median and mean (both unweighted) of these 20 sizes were 5.9 and 6.1, respectively. In 2010, the mean size of 17 packs adjacent to the SLRMA, extending to the west and southwest, was 4.7 (Manitoba Hydro 2011). The latter sample had a disproportionate number of packs of 2 (n=8), suggesting that it incorporated a number of transient wolves, therefore we were guided primarily by the larger sample size of the Fuller *et al*. data, and used a mean pack size of 6 for resident wolves in the SLRMA. Four observations of wolf packs were made during caribou surveys in December 2011 and January 2011 (R. Berger, pers. comm.), in the area between Split Lake, Stephens Lake and Waskaiowaka Lake. The pack sizes were 4 and 8 in December 2011, and 6 and 9 in January 2012.

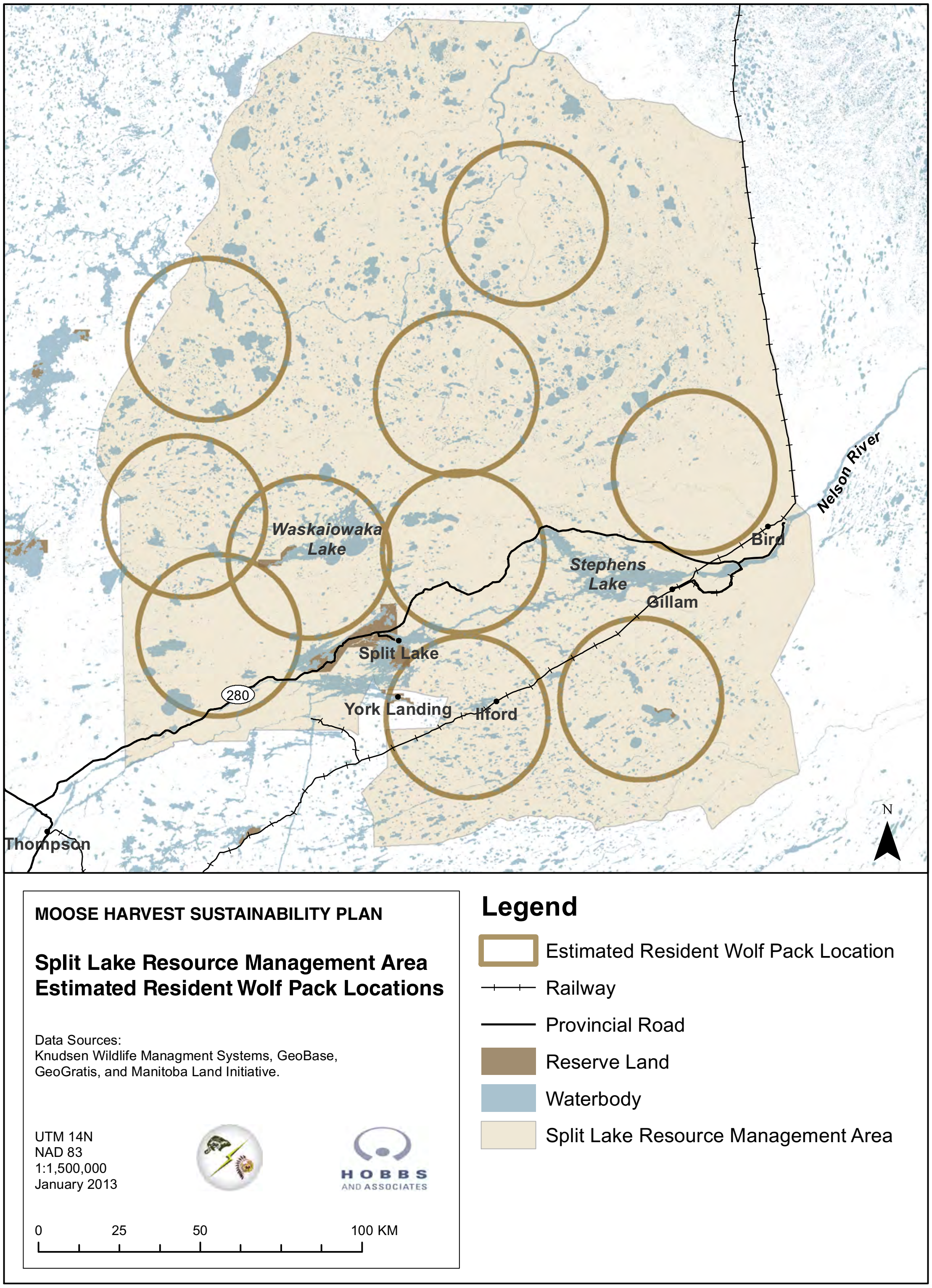
We rounded the resident wolf population estimate of 58 up to an even multiple of 6, and estimated that there were 10 packs of 6 wolves in the RMA. To estimate the locations of the centres of the 10 pack territories, two sources of data were used. The first source of data was First Nations residents of the area, who were asked to indicate areas that they considered to be regions of high wolf densities. These areas were overlain on the ungulate biomass maps, and points were placed by eye on the underlying pattern. To indicate the approximate area that would be defended by each pack to secure the necessary ungulate biomass (approximately 1600 UBI units for the pack, or approximately 45 moose per wolf), a 25 km buffer was applied to each centroid. shows the high correspondence between the pack areas reported by First Nations residents and generated by ungulate biomass density. The easternmost circular range is in an area that First Nations hunters reported as being very difficult to travel, so the lack of information about wolves in this area may be a result of less hunting effort being applied there.

Throughout the range of migratory caribou, some wolves follow the herds. In a personal communication (Peterson and Ciucci 2003), D. Thomas reported seeing 50 wolves following a herd across a frozen lake. More commonly, tundra wolves (as they are often called, to distinguish them from wolves staying in the forest, referred to as timber wolves) are in small groups. They follow the migrating herds out on to the barrens in the spring, stopping in appropriate denning locations to have their pups, and then pick up the herds on their way back to the wintering grounds. On the wintering grounds in northern Manitoba, wolf groups tend to be small. Parker (1973) observed approximately 50,000 caribou through the winter in 1968. The number of wolves with the herd varied from 258 to as low as 60, in packs with an average size of 3. During the winter, the mean number of caribou per wolf in this dynamic predator/prey system was approximately 500, or 1000 UBI units. The migratory caribou coming into the SLRMA from the east, the Pen Islands herd, will also have wolves associated with them. Kolenosky and Stanfield (1975), in a discussion of the wolves of Ontario, identify a distinct type of wolf, the "northern Hudson Bay wolf" of the Hudson Bay and James Bay coastal areas that would be the equivalent of the tundra wolf for the caribou migrating from the coastal barrens of Manitoba and Ontario into the boreal forest in the southeastern SLRMA. Using Parker's data, the 25,145 migratory caribou from the Beverly-Qamanirjuaq, Cape Churchill, and Pen Islands herds (constituting 50,290 UBI units) wintering in the SLRMA, should have approximately 50 transient wolves associated with them. To express this transient wolf population in our map of ungulate biomass and wolves, 16 packs of 3 were overlain on the map of winter ungulate biomass density. The locations of these packs will be determined by two factors:

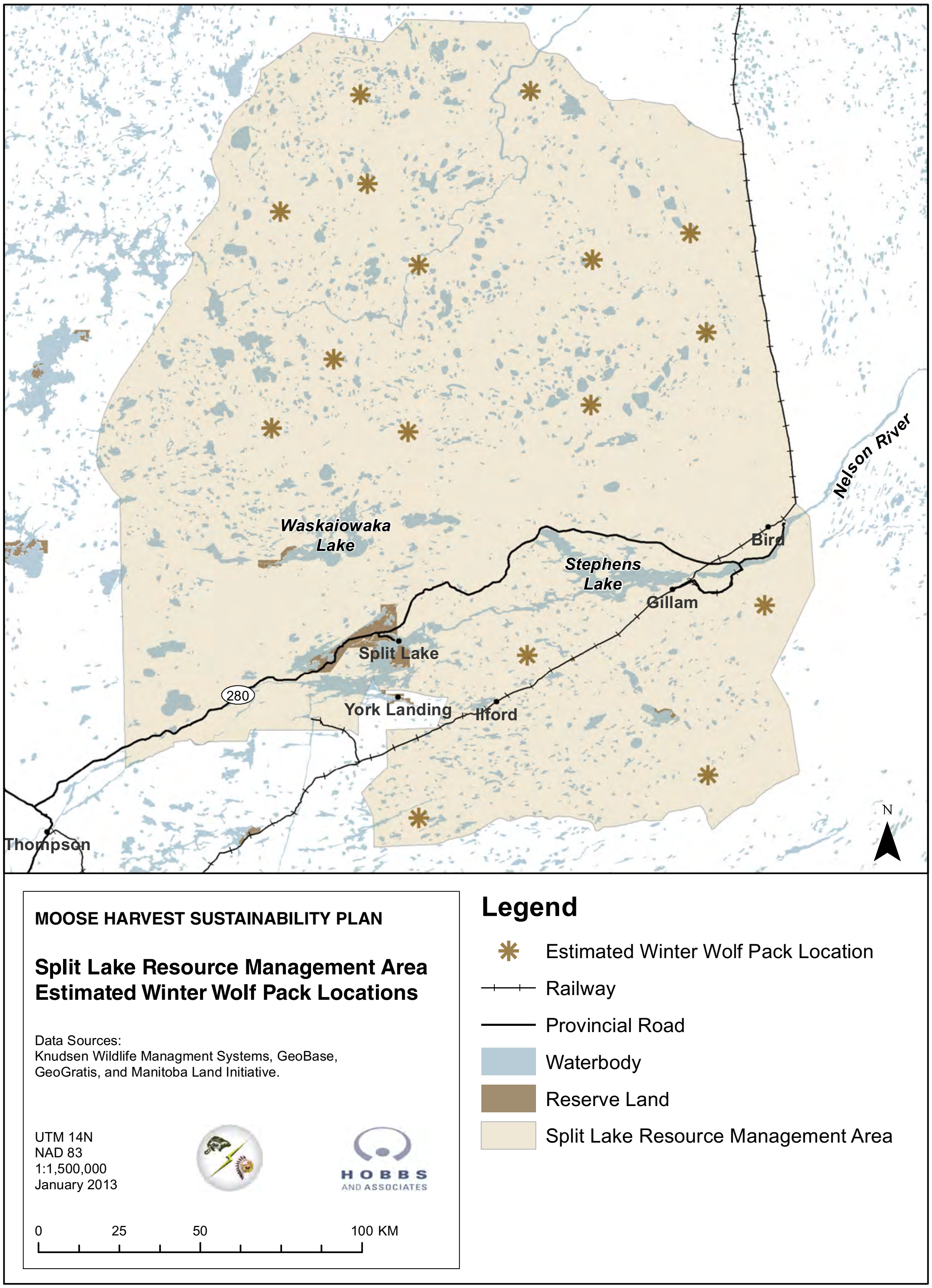
1. the winter ungulate biomass density, primarily migratory caribou
2. the locations of resident wolf packs.

The locations of the packs were placed by eye, shown as red triangles in Map B-4. These locations, and the locations of the migratory caribou, will move continually throughout each winter. The areas marked by the triangles represent areas where the probability of encountering migratory caribou or transient wolves would be highest.

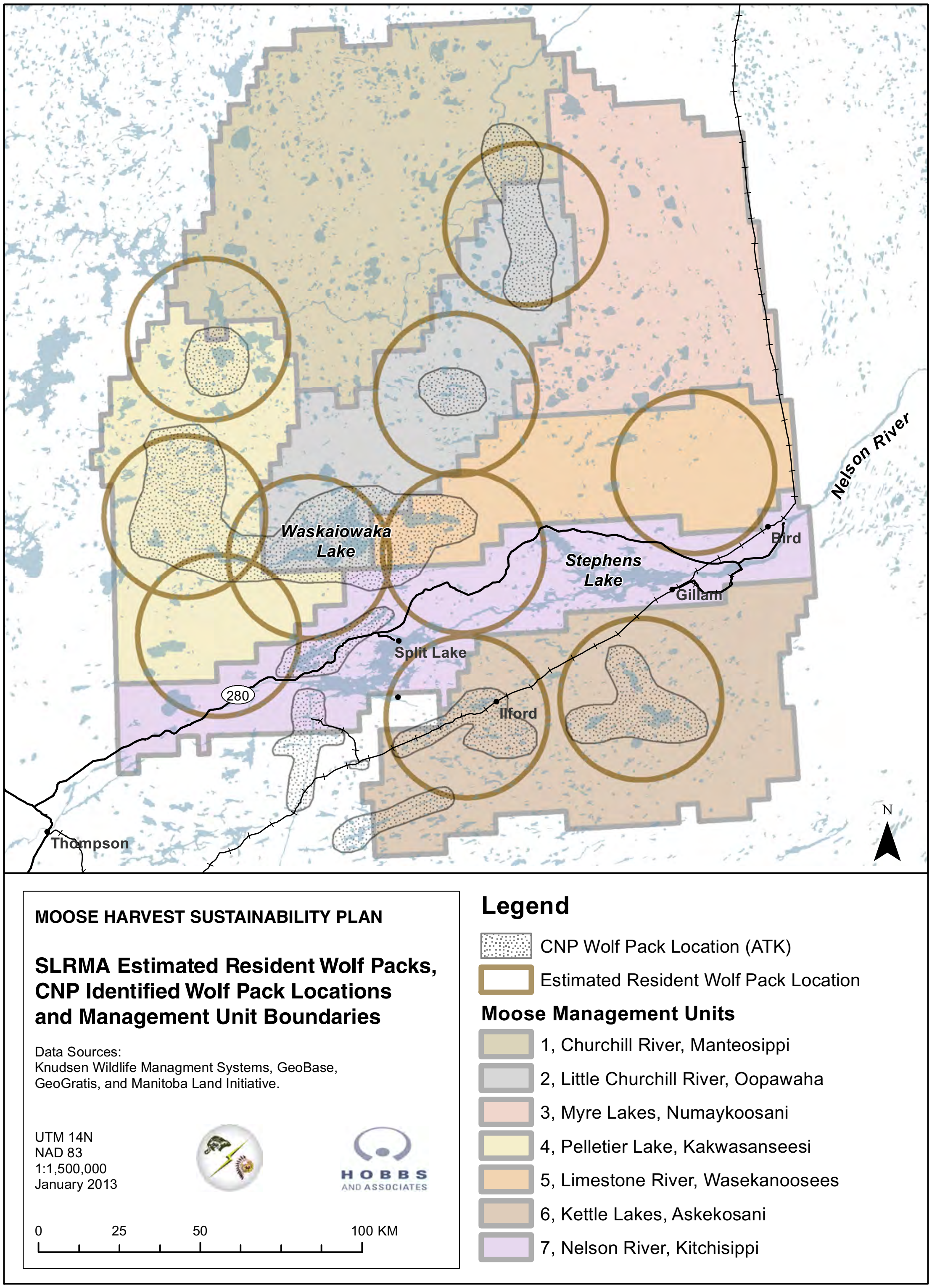
The locations of resident and transient wolf packs can be used to allocate summer and winter wolf predation levels to each moose management unit. If a resident pack's territory fell on a boundary between management units (MapB-5), the pack was assigned partly to one unit and partly to the other (Table B-5).



Map B-3 – Resident Wolf Pack Locations



Map B-4 – Winter Wolf Pack Locations



Map B-5 – Wolf Packs and Management Unit Boundaries

Table B-5: Distribution of wolf packs among management units

Management Unit Number	Management Unit Name	Resident Packs	Transient Packs
1	Manteosippi	0.7	6.0
2	Oopawaha	2.0	1.0
3	Numaykoosani	0.2	4.0
4	Kakwasanseesi	2.7	1.0
5	Wasekanoosees	1.4	0.0
6	Askekosani	1.8	4.0
7	Kitchesippi	1.2	0.0
Total		10.0	16.0

Messier (1994) tabulated the kill rates of wolves on moose from 14 studies. He found that for most of the range of moose densities, the kill rate could be predicted by moose density. Below a moose density of 30/100 km^2, however, the kill rate was extremely variable. Moose densities in the SLRMA are below that density for 95% of the area. Three kill rates were taken from studies whose moose densities were approximately the same as the areas occupied by resident wolf packs. Their average value was approximately 3 moose per winter per wolf, or 18 moose per winter per pack, taking a winter as being 200 days long. This kill rate was applied to the resident wolves in each moose management unit, and was adjusted for the estimated percentage of the ungulate biomass that wolves would acquire from moose in the winter in each unit. By multiplying the number of wolves by the kill rate and by the percentage of biomass acquired from moose, the estimated winter kill from resident wolves was calculated. The same procedure was followed for transient wolves, and the two values were summed to derive the total winter kill of moose by wolves in each management unit (Table B-6).

Table B-6: Moose mortality due to wolf predation in moose management units

Management Unit	Kill By Resident Wolves Per Winter	Kill By Transient Wolves Per Winter	Total Winter Moose Kill By Wolves
Manteosippi	11	22	33
Oopawaha	29	2	31
Numaykoosani	2	14	17
Kakwasanseesi	46	5	51
Wasekanoosees	24	0	24
Askekosani	28	14	42
Kitchisippi	19	0	19
Total	159	57	216

B-3.3 Winter Weather Mortality

Winter weather in this model is mortality specifically caused by severe cold weather and/or deep snow. It does not include additional mortality from wolves as a result of deep or crusted snow. Because moose have behavioural, physiological and anatomical adaptations to living in the boreal forest in the winter, winter weather is not usually a major mortality factor for moose, but because the SLRMA is on the fringe of moose range, a small annual mortality is accounted for in the model. All the moose management units have a 2% annual winter weather mortality. Peterson (1977) identified calves as vulnerable to winter weather if they are already stressed at the beginning of winter. Coady (1982) reviewed the susceptibility of age and sex groups to winter weather, and found that in addition to calves, older adults and males stressed by the rut were vulnerable. Because of the identified vulnerability of bulls, cows and calves in certain circumstances, winter mortality is not weighted toward any group or groups.

B-3.4 Reproduction

In the model's annual cycle, reproduction is expressed as the number of calves born per 100 cows. In the Split Lake RMA, very few moose cows exceed the age of 5 years, so in the following calculations, females in the population will be assumed to be 5 years old and younger. Female calves do not become pregnant. The pregnancy rate for yearling cows is 35%, and none of these yearling pregnancies produce twins (Crichton 1992). The pregnancy rate for cows from 2 to 5 years old is 88%, and 21% of these pregnancies produce twins (Crichton 1992). (Twinning rates can vary locally depending on the quality of forage available to pregnant cows.) If the maximum expected age of a moose cow is 5, the number of yearlings in a stable age distribution of cows will be approximately 30% of the total number of cows. From these figures, it follows that for every 100 cows, 30 will be yearlings, who will produce 10 calves. Of the remaining 70 cows, 88% (62) will become pregnant each year. Of these 62 pregnancies, 21% (13) will produce twins (26 calves) and the remaining 49 cows will produce 49 calves, making a total of 85 calves born for every 100 cows. This figure was used for all moose management units in the RMA.

B-3.5 Postnatal Mortality

The weeks immediately after birth are time of high mortality for calves. In some areas, mortality is extreme because of high densities of predators. In Alaska, the combination of wolves and grizzly bears can increase calf mortality in the first 8 weeks of life to 83% (e.g. Osborne *et al*. 1991, Gasaway *et al*. 1992). More common mortality rates when bear and wolf predation is high are 50%. In Manitoba, survival rates for calves are expected to be higher, particularly in areas where neither wolves nor black bears are particularly abundant, as in the SLRMA. In this model, the mortality rate of calves from birth to late summer is assumed to be 30%, and is applied at this level to all management units.

B-3.6 First Nations Harvest

First Nations residents of the SLRMA area provided estimates of the moose taken for domestic harvest, both through the Access Program and other hunting, along with the locations where moose were taken. These data were used to allocate the harvest among the moose management units (Table B-7, Figure B-2). These figures are useful to allocate the domestic harvest, but not all data were gathered according to a formal reporting scheme. There might also be a bias in the allocation of the harvest if hunters from one unit were more likely to report their harvest than hunters from other units. This may be the case with the Oopawaha unit.

These data are used here as a starting point, but as the management of the SLRMA moose herd proceeds, it will be essential to have a formal reporting scheme to monitor the domestic harvest, as well as other harvests.

Table B-7: Quantity of domestic harvest and moose abundance in each management unit

Management Unit	Total Population	Percent Of Herd	Domestic Harvest	Percent Of Domestic Harvest
Manteosippi	410	16	5	6
Oopawaha	235	9	24	30
Numaykoosani	190	7	1	1
Kakwasanseesi	502	19	10	12
Wasekanoosees	369	14	4	5
Askekosani	557	21	13	16
Kitchesippi	337	13	24	30
Total	2,600		81	

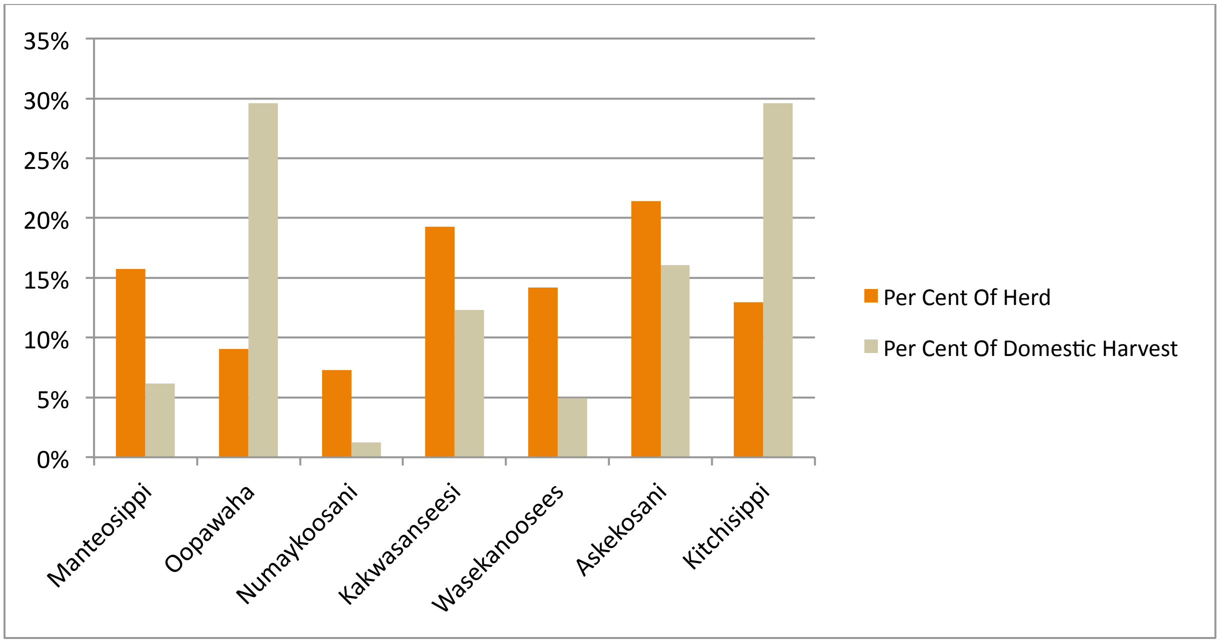


Figure B-2: The distribution of domestic harvest among moose management units, along with the equivalent distribution of moose

B-3.7 Resident and Non-resident Licensed Harvest and Wounding Loss

Data from Manitoba Conservation and Water Stewardship big game hunter questionnaires and outfitter reports were used to estimate the harvest by licensed hunters in the RMA. These data were combined with the First Nations domestic harvest, and used to calculate an overall wounding loss from hunting, which was estimated to be 15% of the number of retrieved moose (Table B-8).

The licensed harvest data would also be improved by having a formal reporting scheme that conforms to the newly proposed moose management units in the SLRMA. Manitoba Conservation and Water Stewardship does not gather data more precisely than by Game Hunting Area (GHA). The licensed resident harvest in the SLRMA was estimated by Knudsen *et al.* (2011) to be 35, based on the mean harvest by GHA from 1993 to 2007, the overlap of GHAs with the SLRMA, and a subjective evaluation of the degree of access in the RMA. The same logic was applied to dividing that harvest among moose management units (Table B-8). Even without a formal reporting scheme, these estimates of licensed resident harvest in each management unit could benefit from comments by resident First Nations individuals.

The licensed non-resident harvest was based on the allocation of licences for the area and the mean success rate in recent years (approximately 70%). This harvest can be specified in more detail, because the Outfitter Declaration Forms, required by Manitoba Conservation, link each non-resident hunter to an allocation area, and report each hunter's success.

The numbers presented here for non-residents have been discussed with CNP, particularly for the Oopawaha management unit. It was felt that the non-resident licensed harvest data should be scrutinized and refined. Regardless of the precision of these data, future management will require the acquisition and tabulation of non-resident hunting data.

Table B-8: Current estimates of hunting mortality of moose in the Split Lake Resource Management Area

Management Unit	Domestic Harvest	Licensed Resident Harvest	Licensed Non-resident Harvest	Total Retrieved Kill	Wounding Losses	Total Hunting Mortality
Manteosippi	5	2	5	12	2	14
Oopawaha	24	4	10	38	6	44
Numaykoosani	1	2	5	8	1	9
Kakwasanseesi	10	9	5	24	4	28
Wasekanoosees	4	3	5	12	2	14
Askekosani	13	6	10	29	4	33
Kitchesippi	24	9	0	33	5	38
Total	81	35	40	156	23	179

B-3.8 Fall Wolf Predation

As stated earlier, wolf predation, aside from summer predation on newborn calves, was divided equally between winter and fall. This is the fall half.

B-3.9 Black Box Mortality

Every moose population suffers mortality from a range of minor sources. These include parasites, collisions with vehicles, falling through ice and becoming mired in mud. Even in the most favourable circumstances it is extremely difficult to quantify mortality from these sources, but some data are available to assist in generating estimates. Child (1998) examined the magnitude of incidental mortality. He found that in North America known collisions with vehicles and trains was usually less than 10% of the allowable harvest from a herd. In Ontario, it was 3.5%. (The magnitude of the unknown collisions is obviously unknown.) If the allowable harvest from the SLRMA is considered approximately 200 (using very round numbers), an annual loss to collisions of 10% of the harvest would be approximately 20, or slightly less than 1% of the January population. However, the railway line passing through the RMA is not equivalent to main line railways in the more developed parts of North America. In the SLRMA, trains are infrequent and therefore moose mortality is expected to be much lower.

Lankester and Samuel (1998) did not attempt to quantify mortality to parasites and disease. They commented that many animals suffering from these factors would not actually die from them, but would be taken by predators when they began to be weakened. Much of this mortality is therefore accounted for as wolf predation.

To account for these miscellaneous sources of mortality, the model applies a 3% annual black box mortality to all management units except Kitchisippi. Kitchisippi, which contains PR 280, has a black box mortality rate of 6%.

B-4 Combined Hunting and Wolf Mortality

Hunting and predation have such a large impact on moose populations that it is useful to be aware of the combined effect of both. Table B-9 and Figure B-3 show these estimates.

Table B-9: Moose mortality due to hunting and wolf predation

Management Unit	Total Hunting Mortality	Losses To Wolves	Hunting + Wolves
Manteosippi	14	33	47
Oopawaha	44	31	75
Numaykoosani	9	17	26
Kakwasanseesi	28	51	79
Wasekanoosees	14	24	38
Askekosani	33	42	75
Kitchesippi	38	19	57
Total	180	217	397

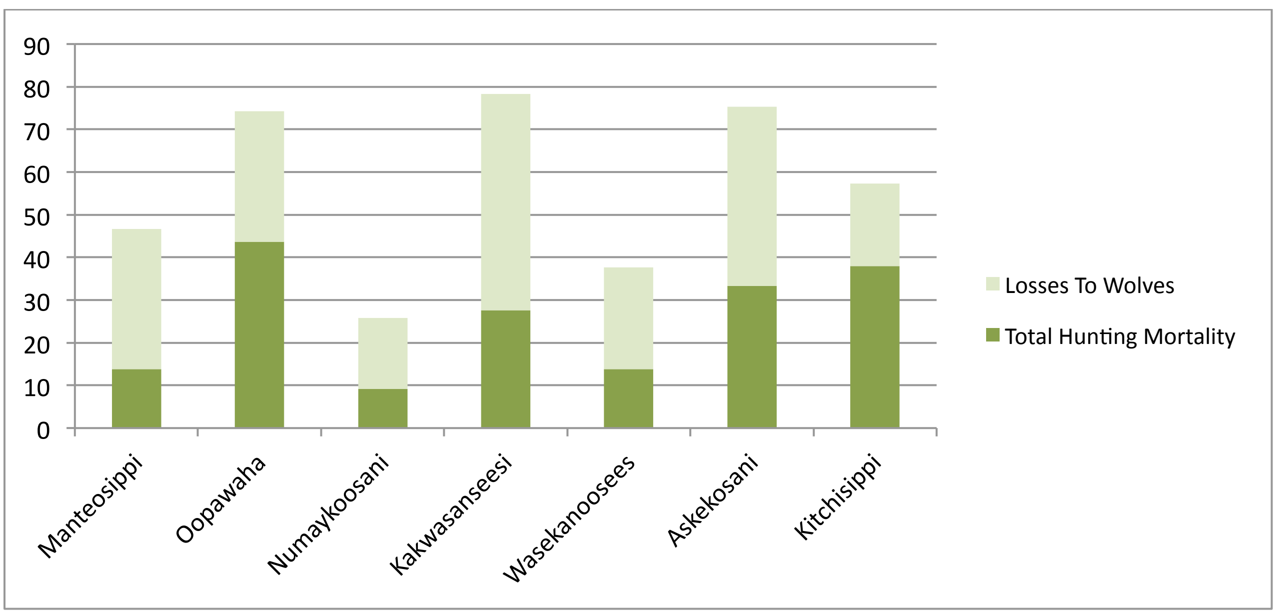


Figure B-3: Losses to wolves and hunting

Appendix C
Management Unit Projections

The following sections show how all the input data for each moose management unit are combined to create specific projections for the unit. Two projections are presented for each unit. One projection shows the track of the population if current conditions continue unchanged, starting in 2010. The second shows the track of the population if the harvest by hunters is changed to maintain a stable population, approximately at the levels of the 2010 population estimates. When a population shows a potential for increased harvest, that increase is always shown as an increase to the First Nations domestic harvest.

In examining these projections, it is important to remember that the input data were derived from a wide range of sources, many of which were the best available approximations. The projections are definitely not presented as a statement of fact, or the final word on each population. Just the reverse: the projections are a framework for our knowledge of the moose population, prompting people to examine specific details, with an eye to correcting data when possible, and identifying the need for further data acquisition when good data are not at hand. Comments need not be highly quantitative. If a trapper reports that he has indeed seen many small packs of wolves on his trapline in February, that might provide valuable confirmation of the assumption of transient wolves in that area. If he says that he never sees wolves there, that would suggest that the assumption of transient wolves is incorrect. The key point is to move from general statements to specific ones, and then use those specific pieces of information, gradually building a more detailed and accurate picture of the overall system.

With respect to the allowable harvest by all hunters, the projected total sustainable harvest is probably a good management guideline, but it can only be implemented if there is a formal recording of all moose taken by all hunters, licensed and First Nations.

For each projection, the inputs and results are presented as they are generated in the spreadsheet model. The weightings of mortality factors are shown only once, for the first Manteosippi projection, because these inputs did not change for any of the projections.

All projections rely heavily on the 70% weighting of the hunting harvest toward bulls. Every simulation shows that if bulls are selectively harvested the proportion of cows in the population increases, generating an ever-growing sustainable harvest of bulls. This is an essential part of the plan, and provides a quantitative demonstration of a key element of the 1994 Moose Conservation Plan: the harvest must be bulls.

C-1 Unit 1: Manteosippi

C-1.1 Current Status

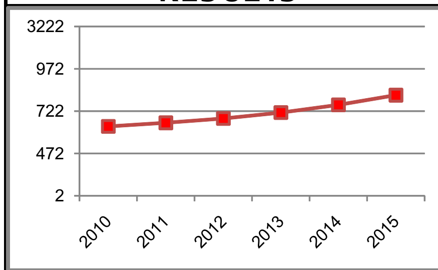
The Manteosippi unit appears to be slightly underutilized by hunters due to the difficulty of access and distance from local communities. The current domestic harvest of 5 could be increased to 30 if bulls constitute 70% of the harvest. The question of access is very important for this unit, given its remote nature. Realizing a larger harvest could present considerable logistic difficulties.

This unit is the only one in which a portion of moose surveys had to be abandoned because of the high density of caribou tracks. If those caribou bring more wolves with them than we currently estimate, and if those wolves are adaptable enough to take moose at will, the Manteosippi herd could be subject to considerably more wolf predation than is used as an input here. It would be wise to acquire more detailed First Nations local knowledge for the Manteosippi unit, if possible.

INPUT

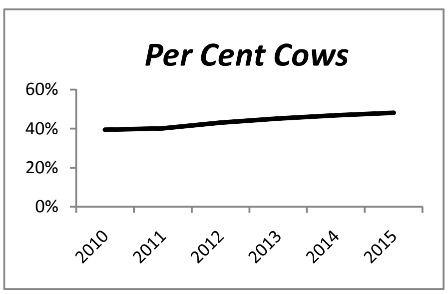
Start Year	2010	
Bulls (Start)	194	
Cows (Start)	156	
Calves (Start)	60	
Total (Start)		410
Total Wolf Predation	33 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	5 moose	
Resident Licensed Kill	2 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	410
2011	431
2012	457
2013	492
2014	537
2015	595

Figure C-1: Manteosippi: current status and growth under a harvest regime emphasizing bulls



Year	% Bulls	% Cows	% Calves
2010	47%	38%	15%
2011	43%	39%	18%
2012	41%	41%	19%
2013	39%	42%	19%
2014	37%	43%	20%
2015	36%	44%	20%

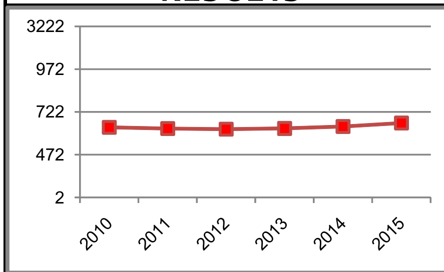
	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

Figure C-2: Manteosippi: herd structure changes and weighting of mortality for simulations in all management units

C-1.2 Sustainable Harvest

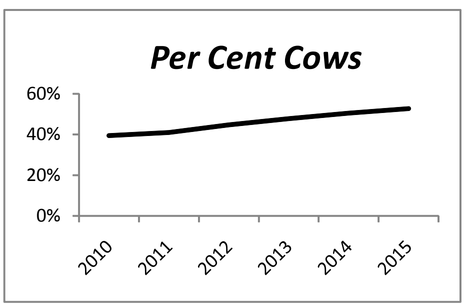
INPUT	
Start Year	2010
Bulls (Start)	194
Cows (Start)	156
Calves (Start)	60
Total (Start)	410
Total Wolf Predation	33 moose
Winter Kill	2 %
Calves Born/100 Cows	85
Postnatal Mortality	30 %
First Nations Harvest	30 moose
Resident Licensed Kill	2 moose
Nonresident Licensed Kill	5 moose
Wounding Mortality	15 %
Black Box Mortality	3 %

RESULTS



January Population	
Year	Moose
2010	410
2011	403
2012	400
2013	404
2014	415
2015	435

Figure C-3: Manteosippi: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	47%	38%	15%
2011	41%	40%	19%
2012	36%	44%	20%
2013	32%	47%	22%
2014	28%	49%	23%
2015	25%	51%	24%

Figure C-4: Manteosippi: population structure under sustainable harvest

C-2 Unit 2: Oopawaha

C-2.1 Current Status

The Oopawaha unit requires considerable scrutiny and comment. The simulation suggests that if current harvest levels are maintained, a serious decline would occur. The results after 3 years become meaningless, because the bull component of the herd has gone to zero.

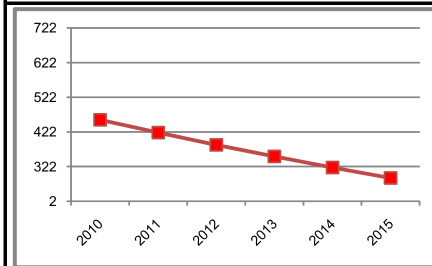
In preliminary discussions, the non-resident licensed harvest of 10 was questioned, but that kill, being 100% bulls, would have little impact on the trajectory of the population.

This might be a unit that has net immigration. If moose move into Oopawaha from Manteosippi or Kakwasanseesi, perhaps in response to the higher density of wolf packs on the west side of the SLRMA, the sustainable harvest in Oopawaha could be larger than is indicated here.

INPUT

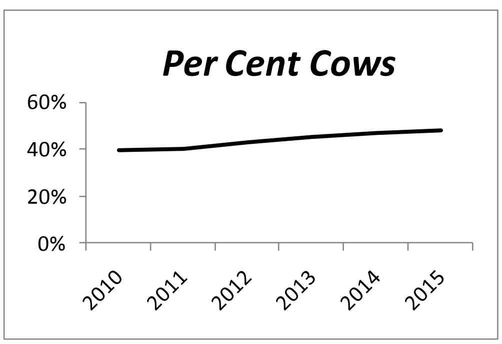
Start Year	2010	
Bulls (Start)	112	
Cows (Start)	86	
Calves (Start)	37	
Total (Start)		235
Total Wolf Predation	31 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	24 moose	
Resident Licensed Kill	4 moose	
Nonresident Licensed Kill	10 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	235
2011	198
2012	163
2013	129
2014	97
2015	67

Figure C-5: Oopawaha: current status and growth under a harvest regime emphasizing bulls



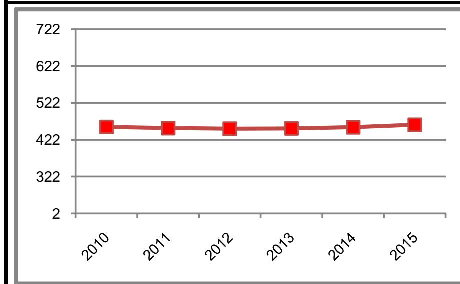
Year	% Bulls	% Cows	% Calves
2010	48%	37%	16%
2011	38%	43%	19%
2012	24%	53%	23%
2013	4%	66%	29%

Figure C-6: Oopawaha: herd structure changes and weighting of mortality for simulations in all management units

C-2.2 Sustainable Harvest

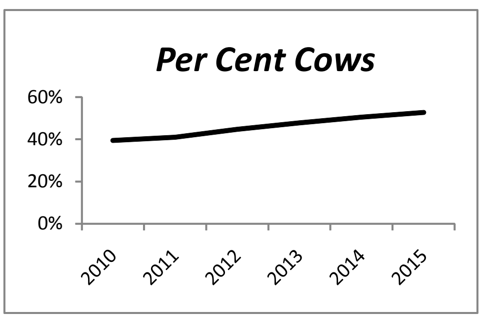
INPUT	
Start Year	2010
Bulls (Start)	112
Cows (Start)	86
Calves (Start)	37
Total (Start)	235
Total Wolf Predation	31 moose
Winter Kill	2 %
Calves Born/100 Cows	85
Postnatal Mortality	30 %
First Nations Harvest	8 moose
Resident Licensed Kill	0 moose
Nonresident Licensed Kill	0 moose
Wounding Mortality	15 %
Black Box Mortality	3 %

RESULTS



January Population	
Year	Moose
2010	235
2011	232
2012	230
2013	231
2014	234
2015	240

Figure C-7: Oopawaha: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	48%	37%	16%
2011	44%	38%	17%
2012	41%	40%	18%
2013	39%	42%	19%
2014	36%	44%	20%
2015	34%	46%	21%

Figure C-8: Oopawaha: population structure under sustainable harvest

C-3 Unit 3: Numaykoosani

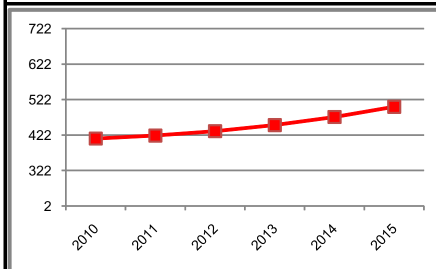
Numaykoosani is another unit that seems to be underutilized by First Nations domestic harvest. The current reported harvest estimate is only 1. The population shows a capability of 12 moose for domestic harvest.

C-3.1 Current Status

INPUT

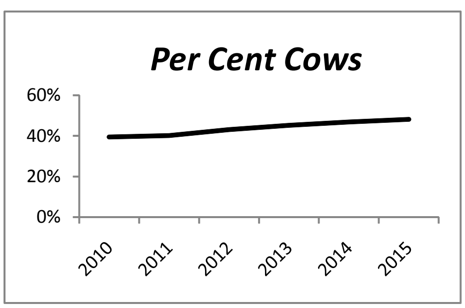
Start Year	2010
Bulls (Start)	77
Cows (Start)	78
Calves (Start)	35
Total (Start)	190
Total Wolf Predation	17 moose
Winter Kill	2 %
Calves Born/100 Cows	85
Postnatal Mortality	30 %
First Nations Harvest	1 moose
Resident Licensed Kill	2 moose
Nonresident Licensed Kill	5 moose
Wounding Mortality	15 %
Black Box Mortality	3 %

RESULTS



January Population	
Year	Moose
2010	190
2011	199
2012	211
2013	228
2014	251
2015	280

Figure C-9: Numaykoosani: current status and growth under a harvest regime emphasizing bulls



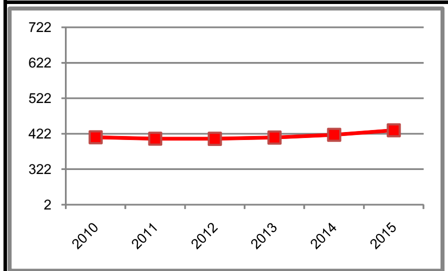
Year	% Bulls	% Cows	% Calves
2010	41%	41%	18%
2011	37%	43%	20%
2012	34%	45%	21%
2013	32%	47%	22%
2014	30%	48%	22%
2015	29%	48%	23%

Figure C-10: Numaykoosani: herd structure changes and weighting of mortality for simulations in all management units

C-3.2 Sustainable Harvest

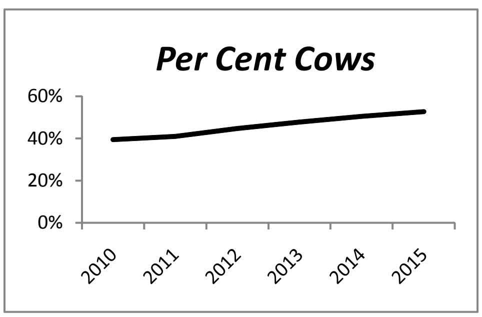
INPUT		
Start Year	2010	
Bulls (Start)	77	
Cows (Start)	78	
Calves (Start)	35	
Total (Start)		190
Total Wolf Predation	17 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	12 moose	
Resident Licensed Kill	2 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	**Moose**
2010	190
2011	186
2012	186
2013	189
2014	197
2015	210

Figure C-11: Numaykoosani: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	41%	41%	18%
2011	35%	45%	21%
2012	29%	49%	22%
2013	24%	52%	24%
2014	20%	55%	25%
2015	17%	57%	26%

Figure C-12: Numaykoosani: population structure under sustainable harvest

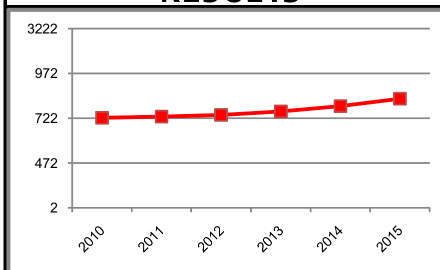
C-4 Unit 4: Kakwasanseesi

The Kakwasanseesi unit should be able to maintain a domestic harvest of 25 moose. The current report of domestic harvest is only 10. This evaluation has to be qualified by two points. The density of wolf packs in Kakwasanseei is high. If there is a shortage of refuge areas for moose, such as large gaps between territories, the kill rate per wolf could be higher in this unit. In addition, as discussed regarding Oopawaha, if there is heavy predation pressure, there could be a net emigration out of Kakwasanseesi into Oopawaha.

C-4.1 Current Status

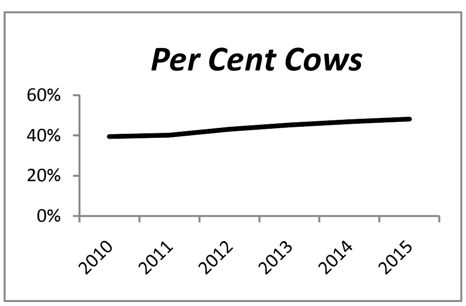
INPUT	
Start Year	2010
Bulls (Start)	243
Cows (Start)	196
Calves (Start)	63
Total (Start)	502
Total Wolf Predation	51 moose
Winter Kill	2 %
Calves Born/100 Cows	85
Postnatal Mortality	30 %
First Nations Harvest	10 moose
Resident Licensed Kill	9 moose
Nonresident Licensed Kill	5 moose
Wounding Mortality	15 %
Black Box Mortality	3 %

RESULTS



January Population	
Year	Moose
2010	502
2011	509
2012	518
2013	538
2014	568
2015	609

Figure C-13: Kakwasaneesi: current status and growth under a harvest regime emphasizing bulls



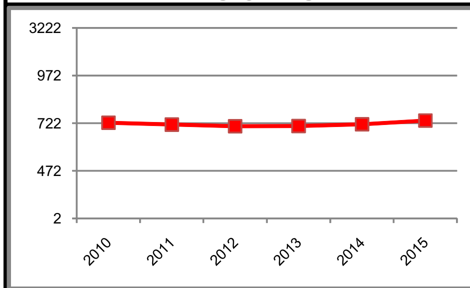
Year	% Bulls	% Cows	% Calves
2010	48%	39%	13%
2011	42%	39%	19%
2012	39%	42%	19%
2013	35%	44%	20%
2014	33%	46%	21%
2015	30%	48%	22%

Figure C-14: Kakwasaneesi: herd structure changes and weighting of mortality for simulations in all management units

C-4.2 Sustainable Harvest

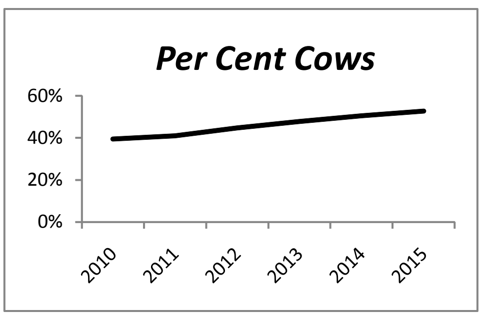
INPUT		
Start Year	2010	
Bulls (Start)	243	
Cows (Start)	196	
Calves (Start)	63	
Total (Start)		502
Total Wolf Predation	51 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	25 moose	
Resident Licensed Kill	9 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	502
2011	493
2012	484
2013	485
2014	494
2015	514

Figure C-15: Kakwasaneesi: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	48%	39%	13%
2011	41%	40%	19%
2012	36%	44%	20%
2013	32%	47%	22%
2014	27%	50%	23%
2015	24%	52%	24%

Figure C-16: Kakwasaneesi: population structure under sustainable harvest

C-5 Unit 5: Wasekanoosees

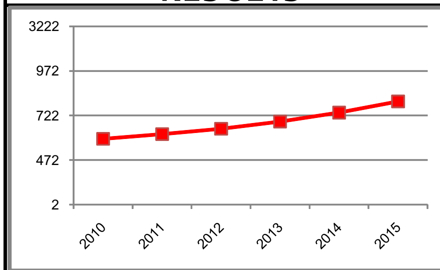
The Wasekanoosees unit is another unit that suggests a larger domestic harvest could be taken: 30 instead of 4. However, the current estimate of 4 moose could be a serious underestimate, if hunters from other First Nations communities are taking a substantial number of moose from Wasekanoosees. Gathering those data could be a challenge, but without them, it will be difficult to manage the harvest by First Nations hunters who are resident in the SLRMA.

C-5.1 Current Status

INPUT

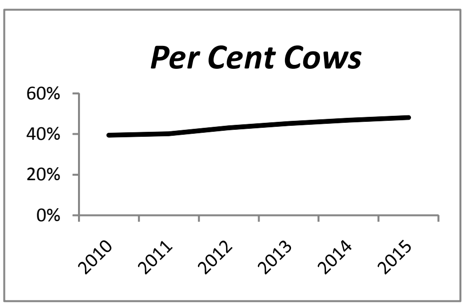
Start Year	2010
Bulls (Start)	176
Cows (Start)	147
Calves (Start)	46
Total (Start)	369
Total Wolf Predation	24 moose
Winter Kill	2 %
Calves Born/100 Cows	85
Postnatal Mortality	30 %
First Nations Harvest	4 moose
Resident Licensed Kill	3 moose
Nonresident Licensed Kill	5 moose
Wounding Mortality	15 %
Black Box Mortality	3 %

RESULTS



January Population	
Year	Moose
2010	369
2011	396
2012	426
2013	466
2014	516
2015	579

Figure C-17: Wasekanoosees: current status and growth under a harvest regime emphasizing bulls



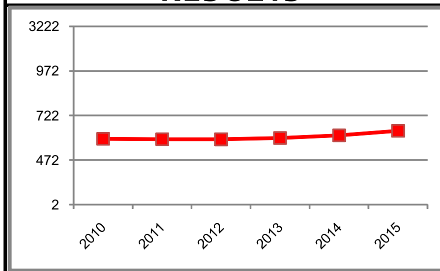
Year	% Bulls	% Cows	% Calves
2010	48%	40%	12%
2011	42%	39%	19%
2012	40%	41%	19%
2013	38%	42%	20%
2014	36%	43%	20%
2015	35%	44%	21%

Figure C-18: Wasekanoosees: herd structure changes and weighting of mortality for simulations in all management units

C-5.2 Sustainable Harvest

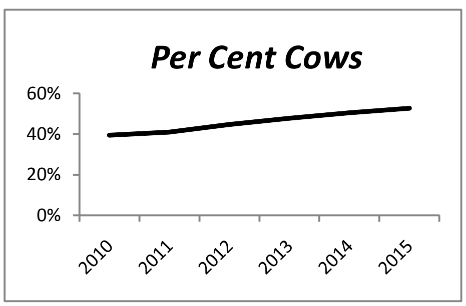
INPUT		
Start Year	2010	
Bulls (Start)	176	
Cows (Start)	147	
Calves (Start)	46	
Total (Start)		369
Total Wolf Predation	24 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	30 moose	
Resident Licensed Kill	3 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	369
2011	367
2012	366
2013	374
2014	389
2015	414

Figure C-19: Wasekanoosees: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	48%	40%	12%
2011	39%	40%	20%
2012	35%	45%	20%
2013	30%	48%	22%
2014	26%	50%	23%
2015	23%	52%	25%

Figure C-20: Wasekanoosees: population structure under sustainable harvest

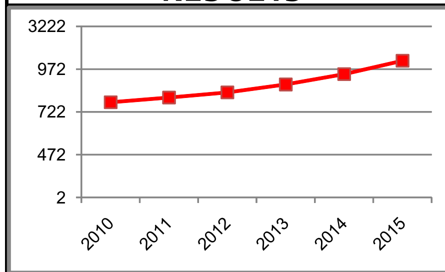
C-6 Unit 6: Askekosani

The Askekosani unit is another unit in which the actual annual harvest by all hunters must be monitored and recorded. Currently, the estimated annual harvests are 13 for First Nations hunters and 6 for resident licensed hunters. The proximity of this unit to Gillam, and the relatively large number of moose suggests that these harvest figures should be scrutinized.

C-6.1 Current Status

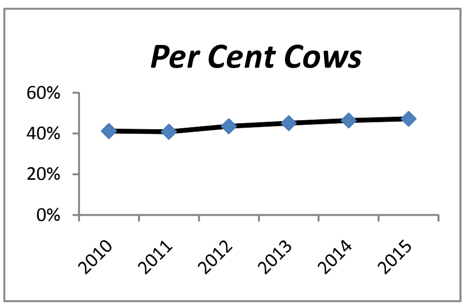
INPUT		
Start Year	2010	
Bulls (Start)	254	
Cows (Start)	229	
Calves (Start)	74	
Total (Start)		557
Total Wolf Predation	42 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	13 moose	
Resident Licensed Kill	6 moose	
Nonresident Licensed Kill	10 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	557
2011	584
2012	615
2013	661
2014	721
2015	800

Figure C-21: Askekosani: current status and growth under a harvest regime emphasizing bulls



Year	% Bulls	% Cows	% Calves
2010	46%	41%	13%
2011	39%	41%	20%
2012	37%	43%	20%
2013	34%	45%	21%
2014	32%	46%	22%
2015	31%	47%	22%

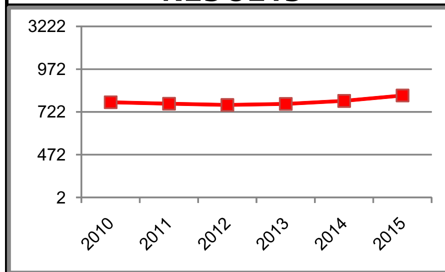
Figure C-22: Askekosani: herd structure changes and weighting of mortality for simulations in all management units

C-6.2 Sustainable Harvest

INPUT

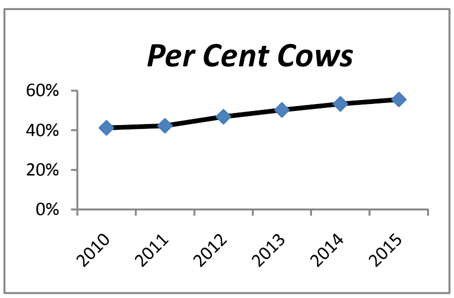
Start Year	2010	
Bulls (Start)	254	
Cows (Start)	229	
Calves (Start)	74	
Total (Start)		557
Total Wolf Predation	42 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	45 moose	
Resident Licensed Kill	6 moose	
Nonresident Licensed Kill	10 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	557
2011	548
2012	541
2013	547
2014	565
2015	596

Figure C-23: Askekosani: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	46%	41%	13%
2011	37%	42%	21%
2012	32%	47%	21%
2013	26%	50%	23%
2014	22%	53%	25%
2015	19%	56%	26%

Figure C-24: Askekosani: herd structure changes and weighting of mortality for simulations in all management units

C-7 Unit 7: Kitchisippi

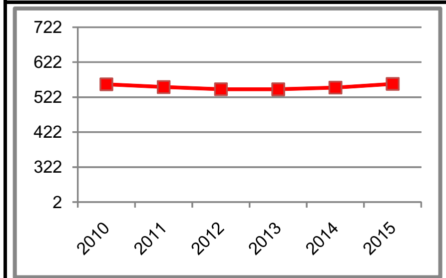
The Kitchisippi unit appears to be harvested at its maximum sustainable level now. This is predicated, however, on the harvest consisting primarily of bulls. If the proportion of cows in the population were to stay as it was in 2010 (41%), which generates a bull:cow ratio of 112:100, the population would be expected to decline if current harvest rates continue.

C-7.1 Current Status

INPUT

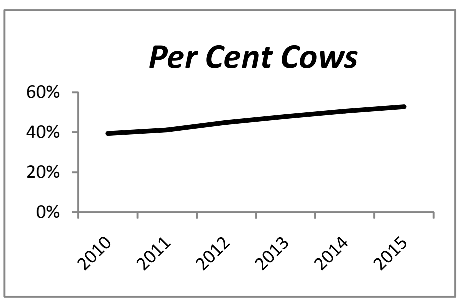
Start Year	2010	
Bulls (Start)	154	
Cows (Start)	133	
Calves (Start)	50	
Total (Start)		337
Total Wolf Predation	19 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	24 moose	
Resident Licensed Kill	9 moose	
Nonresident Licensed Kill	0 moose	
Wounding Mortality	15 %	
Black Box Mortality	6 %	

RESULTS



January Population	
Year	Moose
2010	337
2011	329
2012	323
2013	323
2014	328
2015	338

Figure C-25: **Kitchisippi: current status and growth under a harvest regime emphasizing bulls**



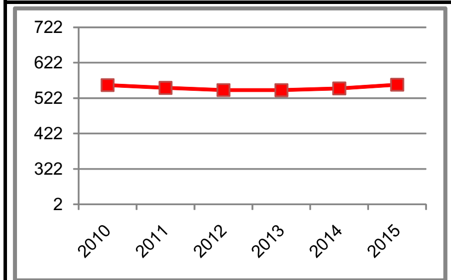
Year	% Bulls	% Cows	% Calves
2010	46%	39%	15%
2011	39%	41%	20%
2012	34%	45%	21%
2013	30%	48%	22%
2014	26%	51%	24%
2015	22%	53%	25%

Figure C-26: **Kitchisippi: herd structure changes and weighting of mortality for simulations in all management units**

C-7.2 Sustainable Harvest

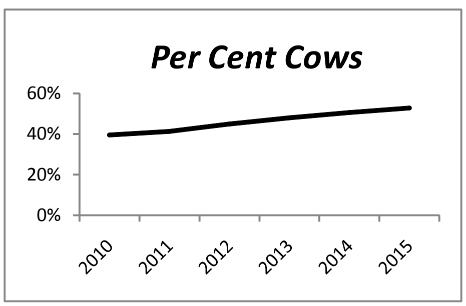
INPUT		
Start Year	2010	
Bulls (Start)	154	
Cows (Start)	133	
Calves (Start)	50	
Total (Start)		337
Total Wolf Predation	19 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	24 moose	
Resident Licensed Kill	9 moose	
Nonresident Licensed Kill	0 moose	
Wounding Mortality	15 %	
Black Box Mortality	6 %	

RESULTS



January Population	
Year	Moose
2010	337
2011	329
2012	323
2013	323
2014	328
2015	338

Figure C-27: Kitchisippi: sustainable harvest



Year	% Bulls	% Cows	% Calves
2010	46%	39%	15%
2011	39%	41%	20%
2012	34%	45%	21%
2013	30%	48%	22%
2014	26%	51%	24%
2015	22%	53%	25%

Figure C-28: Kitchisippi: herd structure changes and weighting of mortality for simulations in all management units

Appendix D
Model Printouts: Sustainable Harvest

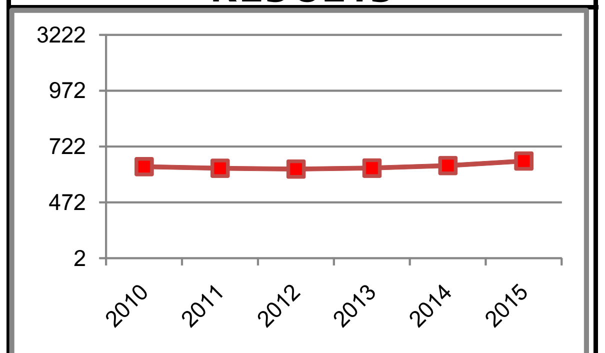
The following pages show the detailed results of simulations. The status of the population can be checked at any stage in the year.

D-1 Unit 1: Manteosipi

INPUT

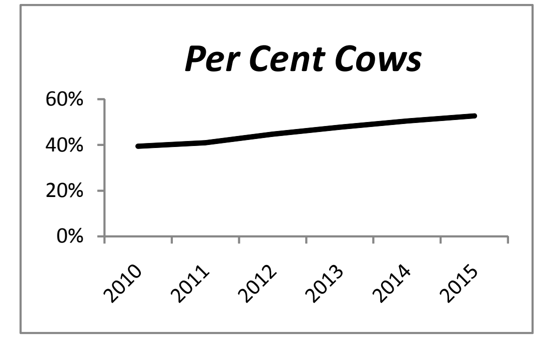
Start Year	2010	
Bulls (Start)	194	
Cows (Start)	156	
Calves (Start)	60	
Total (Start)		410
Total Wolf Predation	33 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	30 moose	
Resident Licensed Kill	2 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population

Year	Moose
2010	410
2011	403
2012	400
2013	404
2014	415
2015	435



Year	% Bulls	% Cows	% Calves
2010	47%	38%	15%
2011	41%	40%	19%
2012	36%	44%	20%
2013	32%	47%	22%
2014	28%	49%	23%
2015	25%	51%	24%

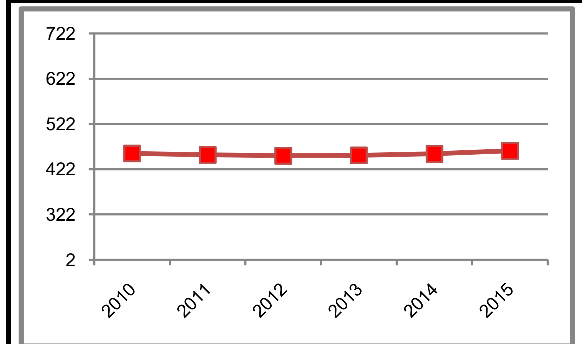
	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			194	156	60	410											47%	38%	15%
2010	Jan-Mar	Wolf Predation (Winter)	16.5	moose	194	156	60	410	yes	40	20	40		187	153	53	394	-17			
2010	Mar	Winter Kill	2	per cent	187	153	53	394	no				8	184	150	52	386	-8			
2010	Jun	Reproduction			184	150	52	386						210	176	127	513	127			
2010	Jul-Aug	Postnatal Mortality	30	per cent	210	176	127	513	yes	0	0	100	38	210	176	89	475	-38			
2010	Sep	First Nations Harvest	30	moose	210	176	89	475	yes	70	20	10		189	170	86	445	-30			
2010	Sep	Resident Licensed Hunting	2	moose	189	170	86	445	yes	100	0	0		187	170	86	443	-2			
2010	Sep	Nonresident Licensed Hunting	5	moose	187	170	86	443	yes	100	0	0		182	170	86	438	-5			
2010	Sep	Wounding Mortality	15	per cent	182	170	86	438	yes	90	5	5	6	177	170	86	432	-6			
2010	Oct-Dec	Wolf Predation (Fall)	16.5	moose	177	170	86	432	yes	40	20	40		170	166	79	416	-16			
2010	All Year	Black Box Mortality	3	per cent	170	166	79	416	no				12	165	161	77	403	-12			
2011	Jan	Population At Year Start			165	161	77	403											41%	40%	19%
2011	Jan-Mar	Wolf Predation (Winter)	16.5	moose	165	161	77	403	yes	40	20	40		159	158	70	387	-17			
2011	Mar	Winter Kill	2	per cent	159	158	70	387	no				8	155	155	69	379	-8			
2011	Jun	Reproduction			155	155	69	379						190	189	132	510	132			
2011	Jul-Aug	Postnatal Mortality	30	per cent	190	189	132	510	yes	0	0	100	39	190	189	92	471	-39			
2011	Sep	First Nations Harvest	30	moose	190	189	92	471	yes	70	20	10		169	183	89	441	-30			
2011	Sep	Resident Licensed Hunting	2	moose	169	183	89	441	yes	100	0	0		167	183	89	439	-2			
2011	Sep	Nonresident Licensed Hunting	5	moose	167	183	89	439	yes	100	0	0		162	183	89	434	-5			
2011	Sep	Wounding Mortality	15	per cent	162	183	89	434	yes	90	5	5	6	157	183	89	428	-6			
2011	Oct-Dec	Wolf Predation (Fall)	16.5	moose	157	183	89	428	yes	40	20	40		150	180	82	412	-17			
2011	All Year	Black Box Mortality	3	per cent	150	180	82	412	no				12	146	174	80	400	-12			
2012	Jan	Population At Year Start			146	174	80	400											36%	44%	20%
2012	Jan-Mar	Wolf Predation (Winter)	16.5	moose	146	174	80	400	yes	40	20	40		139	171	73	383	-16			
2012	Mar	Winter Kill	2	per cent	139	171	73	383	no				8	136	167	72	375	-8			
2012	Jun	Reproduction			136	167	72	375						172	203	142	518	142			
2012	Jul-Aug	Postnatal Mortality	30	per cent	172	203	142	518	yes	0	0	100	43	172	203	100	475	-43			
2012	Sep	First Nations Harvest	30	moose	172	203	100	475	yes	70	20	10		151	197	97	445	-30			
2012	Sep	Resident Licensed Hunting	2	moose	151	197	97	445	yes	100	0	0		149	197	97	443	-2			
2012	Sep	Nonresident Licensed Hunting	5	moose	149	197	97	443	yes	100	0	0		144	197	97	438	-5			
2012	Sep	Wounding Mortality	15	per cent	144	197	97	438	yes	90	5	5	6	139	197	96	433	-6			
2012	Oct-Dec	Wolf Predation (Fall)	16.5	moose	139	197	96	433	yes	40	20	40		133	194	90	416	-16			
2012	All Year	Black Box Mortality	3	per cent	133	194	90	416	no				12	129	188	87	404	-12			
2013	Jan	Population At Year Start			129	188	87	404											32%	47%	22%
2013	Jan-Mar	Wolf Predation (Winter)	16.5	moose	129	188	87	404	yes	40	20	40		122	185	80	387	-17			
2013	Mar	Winter Kill	2	per cent	122	185	80	387	no				8	119	181	79	379	-8			
2013	Jun	Reproduction			119	181	79	379						159	220	154	533	154			
2013	Jul-Aug	Postnatal Mortality	30	per cent	159	220	154	533	yes	0	0	100		159	220	108	487	-46			
2013	Sep	First Nations Harvest	30	moose	159	220	108	487	yes	70	20	10		138	214	105	457	-30			
2013	Sep	Resident Licensed Hunting	2	moose	138	214	105	457	yes	100	0	0		136	214	105	455	-2			
2013	Sep	Nonresident Licensed Hunting	5	moose	136	214	105	455	yes	100	0	0		131	214	105	450	-5			
2013	Sep	Wounding Mortality	15	per cent	131	214	105	450	yes	90	5	5	6	126	214	104	444	-6			
2013	Oct-Dec	Wolf Predation (Fall)	16.5	moose	126	214	104	444	yes	40	20	40		119	211	98	428	-17			
2013	All Year	Black Box Mortality	3	per cent	119	211	98	428	no				13	116	204	95	415	-13			
2014	Jan	Population At Year Start			116	204	95	415											28%	49%	23%
2014	Jan-Mar	Wolf Predation (Winter)	16.5	moose	116	204	95	415	yes	40	20	40		109	201	88	399	-17			
2014	Mar	Winter Kill	2	per cent	109	201	88	399	no				8	107	197	86	391	-8			
2014	Jun	Reproduction			107	197	86	391						150	240	168	558	168			
2014	Jul-Aug	Postnatal Mortality	30	per cent	150	240	168	558	yes	0	0	100	50	150	240	117	508	-50			
2014	Sep	First Nations Harvest	30	moose	150	240	117	508	yes	70	20	10		129	234	114	478	-30			
2014	Sep	Resident Licensed Hunting	2	moose	129	234	114	478	yes	100	0	0		127	234	114	476	-2			
2014	Sep	Nonresident Licensed Hunting	5	moose	127	234	114	476	yes	100	0	0		122	234	114	471	-5			
2014	Sep	Wounding Mortality	15	per cent	122	234	114	471	yes	90	5	5	6	117	234	114	465	-6			
2014	Oct-Dec	Wolf Predation (Fall)	16.5	moose	117	234	114	465	yes	40	20	40		111	231	107	449	-17			
2014	All Year	Black Box Mortality	3	per cent	111	231	107	449	no				13	107	224	104	435	-13			
2015	Jan	Population At Simulation Finish			107	224	104	435											25%	51%	24%

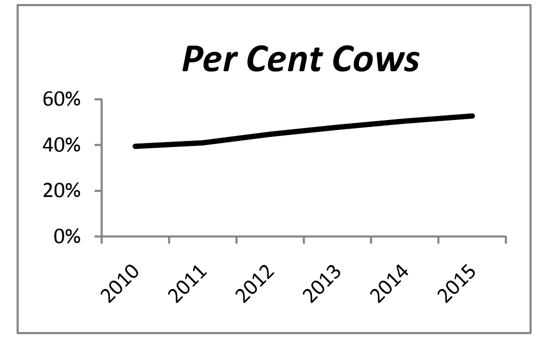
D-2 Unit 2: Oopawaha

INPUT		
Start Year	2010	
Bulls (Start)	112	
Cows (Start)	86	
Calves (Start)	37	
Total (Start)		235
Total Wolf Predation	31 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	8 moose	
Resident Licensed Kill	0 moose	
Nonresident Licensed Kill	0 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	235
2011	232
2012	230
2013	231
2014	234
2015	240



Year	% Bulls	% Cows	% Calves
2010	48%	37%	16%
2011	44%	38%	17%
2012	41%	40%	18%
2013	39%	42%	19%
2014	36%	44%	20%
2015	34%	46%	21%

	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

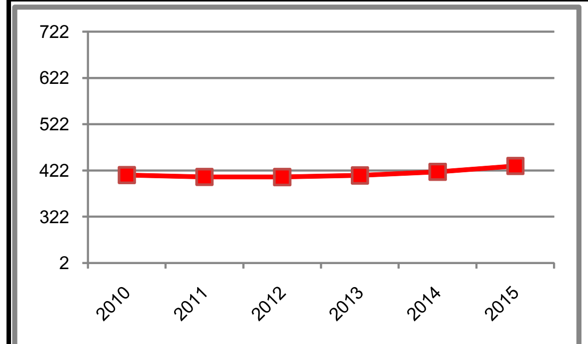
YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			112	86	37	235											48%	37%	16%
2010	Jan-Mar	Wolf Predation (Winter)	15.5	moose	112	86	37	235	yes	40	20	40		106	83	31	220	-16			
2010	Mar	Winter Kill	2	per cent	106	83	31	220	no				4	104	81	30	215	-4			
2010	Jun	Reproduction			104	81	30	215						119	96	69	284	69			
2010	Jul-Aug	Postnatal Mortality	30	per cent	119	96	69	284	yes	0	0	100	21	119	96	48	263	-21			
2010	Sep	First Nations Harvest	8	moose	119	96	48	263	yes	70	20	10		113	95	48	255	-8			
2010	Sep	Resident Licensed Hunting	0	moose	113	95	48	255	yes	100	0	0		113	95	48	255	0			
2010	Sep	Nonresident Licensed Hunting	0	moose	113	95	48	255	yes	100	0	0		113	95	48	255	0			
2010	Sep	Wounding Mortality	15	per cent	113	95	48	255	yes	90	5	5	1	112	95	47	254	-1			
2010	Oct-Dec	Wolf Predation (Fall)	15.5	moose	112	95	47	254	yes	40	20	40		106	92	41	239	-16			
2010	All Year	Black Box Mortality	3	per cent	106	92	41	239	no				7	103	89	40	232	-7			
2011	Jan	Population At Year Start			103	89	40	232											44%	38%	17%
2011	Jan-Mar	Wolf Predation (Winter)	15.5	moose	103	89	40	232	yes	40	20	40		97	86	34	216	-16			
2011	Mar	Winter Kill	2	per cent	97	86	34	216	no				4	95	84	33	212	-4			
2011	Jun	Reproduction			95	84	33	212						111	101	71	283	71			
2011	Jul-Aug	Postnatal Mortality	30	per cent	111	101	71	283	yes	0	0	100	21	111	101	50	262	-21			
2011	Sep	First Nations Harvest	8	moose	111	101	50	262	yes	70	20	10		106	99	49	254	-8			
2011	Sep	Resident Licensed Hunting	0	moose	106	99	49	254	yes	100	0	0		106	99	49	254	0			
2011	Sep	Nonresident Licensed Hunting	0	moose	106	99	49	254	yes	100	0	0		106	99	49	254	0			
2011	Sep	Wounding Mortality	15	per cent	106	99	49	254	yes	90	5	5	1	104	99	49	253	-1			
2011	Oct-Dec	Wolf Predation (Fall)	15.5	moose	104	99	49	253	yes	40	20	40		98	96	43	237	-16			
2011	All Year	Black Box Mortality	3	per cent	98	96	43	237	no				7	95	93	42	230	-7			
2012	Jan	Population At Year Start			95	93	42	230											41%	40%	18%
2012	Jan-Mar	Wolf Predation (Winter)	15.5	moose	95	93	42	230	yes	40	20	40		89	90	35	214	-16			
2012	Mar	Winter Kill	2	per cent	89	90	35	214	no				4	87	88	35	210	-4			
2012	Jun	Reproduction			87	88	35	210						105	105	75	285	75			
2012	Jul-Aug	Postnatal Mortality	30	per cent	105	105	75	285	yes	0	0	100	22	105	105	52	263	-22			
2012	Sep	First Nations Harvest	8	moose	105	105	52	263	yes	70	20	10		99	104	52	255	-8			
2012	Sep	Resident Licensed Hunting	0	moose	99	104	52	255	yes	100	0	0		99	104	52	255	0			
2012	Sep	Nonresident Licensed Hunting	0	moose	99	104	52	255	yes	100	0	0		99	104	52	255	0			
2012	Sep	Wounding Mortality	15	per cent	99	104	52	255	yes	90	5	5	1	98	104	52	253	-1			
2012	Oct-Dec	Wolf Predation (Fall)	15.5	moose	98	104	52	253	yes	40	20	40		92	101	45	238	-16			
2012	All Year	Black Box Mortality	3	per cent	92	101	45	238	no				7	89	98	44	231	-7			
2013	Jan	Population At Year Start			89	98	44	231											39%	42%	19%
2013	Jan-Mar	Wolf Predation (Winter)	15.5	moose	89	98	44	231	yes	40	20	40		83	95	38	215	-16			
2013	Mar	Winter Kill	2	per cent	83	95	38	215	no				4	81	93	37	211	-4			
2013	Jun	Reproduction			81	93	37	211						100	111	79	290	79			
2013	Jul-Aug	Postnatal Mortality	30	per cent	100	111	79	290	yes	0	0	100		100	111	55	266	-24			
2013	Sep	First Nations Harvest	8	moose	100	111	55	266	yes	70	20	10		94	110	54	258	-8			
2013	Sep	Resident Licensed Hunting	0	moose	94	110	54	258	yes	100	0	0		94	110	54	258	0			
2013	Sep	Nonresident Licensed Hunting	0	moose	94	110	54	258	yes	100	0	0		94	110	54	258	0			
2013	Sep	Wounding Mortality	15	per cent	94	110	54	258	yes	90	5	5	1	93	110	54	257	-1			
2013	Oct-Dec	Wolf Predation (Fall)	15.5	moose	93	110	54	257	yes	40	20	40		87	106	48	241	-16			
2013	All Year	Black Box Mortality	3	per cent	87	106	48	241	no				7	84	103	47	234	-7			
2014	Jan	Population At Year Start			84	103	47	234											36%	44%	20%
2014	Jan-Mar	Wolf Predation (Winter)	15.5	moose	84	103	47	234	yes	40	20	40		78	100	40	219	-16			
2014	Mar	Winter Kill	2	per cent	78	100	40	219	no				4	76	98	40	214	-4			
2014	Jun	Reproduction			76	98	40	214						96	118	83	298	83			
2014	Jul-Aug	Postnatal Mortality	30	per cent	96	118	83	298	yes	0	0	100	25	96	118	58	273	-25			
2014	Sep	First Nations Harvest	8	moose	96	118	58	273	yes	70	20	10		91	116	58	265	-8			
2014	Sep	Resident Licensed Hunting	0	moose	91	116	58	265	yes	100	0	0		91	116	58	265	0			
2014	Sep	Nonresident Licensed Hunting	0	moose	91	116	58	265	yes	100	0	0		91	116	58	265	0			
2014	Sep	Wounding Mortality	15	per cent	91	116	58	265	yes	90	5	5	1	90	116	58	263	-1			
2014	Oct-Dec	Wolf Predation (Fall)	15.5	moose	90	116	58	263	yes	40	20	40		83	113	51	248	-15			
2014	All Year	Black Box Mortality	3	per cent	83	113	51	248	no				7	81	110	50	240	-7			
2015	Jan	Population At Simulation Finish			81	110	50	240											34%	46%	21%

D-3 Unit 3: Numaykoosani

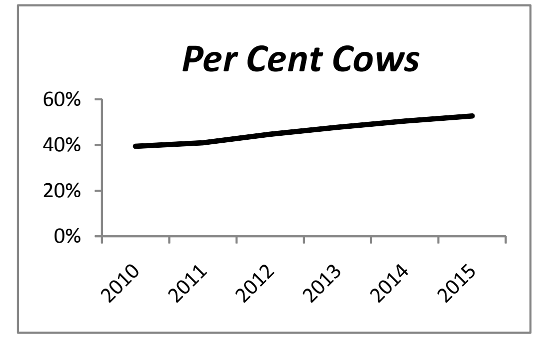
INPUT

Start Year	2010	
Bulls (Start)	77	
Cows (Start)	78	
Calves (Start)	35	
Total (Start)		190
Total Wolf Predation	17 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	12 moose	
Resident Licensed Kill	2 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	190
2011	186
2012	186
2013	189
2014	197
2015	210



Year	% Bulls	% Cows	% Calves
2010	41%	41%	18%
2011	35%	45%	21%
2012	29%	49%	22%
2013	24%	52%	24%
2014	20%	55%	25%
2015	17%	57%	26%

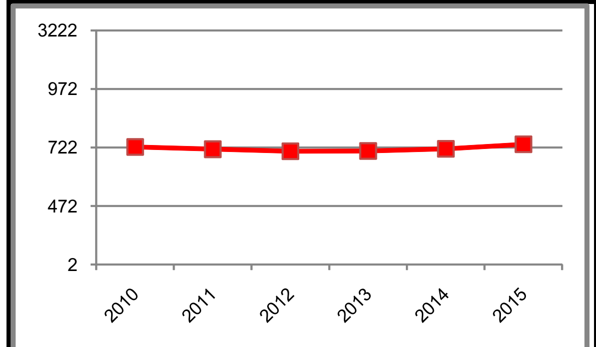
	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			77	78	35	190											41%	41%	18%
2010	Jan-Mar	Wolf Predation (Winter)	8.5	moose	77	78	35	190	yes	40	20	40		74	76	32	182	-9			
2010	Mar	Winter Kill	2	per cent	74	76	32	182	no				4	72	75	31	178	-4			
2010	Jun	Reproduction			72	75	31	178						88	90	64	241	64			
2010	Jul-Aug	Postnatal Mortality	30	per cent	88	90	64	241	yes	0	0	100	19	88	90	44	222	-19			
2010	Sep	First Nations Harvest	12	moose	88	90	44	222	yes	70	20	10		79	88	43	210	-12			
2010	Sep	Resident Licensed Hunting	2	moose	79	88	43	210	yes	100	0	0		77	88	43	208	-2			
2010	Sep	Nonresident Licensed Hunting	5	moose	77	88	43	208	yes	100	0	0		72	88	43	203	-5			
2010	Sep	Wounding Mortality	15	per cent	72	88	43	203	yes	90	5	5	3	70	88	43	201	-3			
2010	Oct-Dec	Wolf Predation (Fall)	8.5	moose	70	88	43	201	yes	40	20	40		66	86	40	192	-9			
2010	All Year	Black Box Mortality	3	per cent	66	86	40	192	no				6	64	83	39	186	-6			
2011	Jan	Population At Year Start			64	83	39	186											35%	45%	21%
2011	Jan-Mar	Wolf Predation (Winter)	8.5	moose	64	83	39	186	yes	40	20	40		61	82	35	178	-8			
2011	Mar	Winter Kill	2	per cent	61	82	35	178	no				4	60	80	34	174	-4			
2011	Jun	Reproduction			60	80	34	174						77	97	68	242	68			
2011	Jul-Aug	Postnatal Mortality	30	per cent	77	97	68	242	yes	0	0	100	20	77	97	48	222	-20			
2011	Sep	First Nations Harvest	12	moose	77	97	48	222	yes	70	20	10		68	95	46	210	-12			
2011	Sep	Resident Licensed Hunting	2	moose	68	95	46	210	yes	100	0	0		66	95	46	208	-2			
2011	Sep	Nonresident Licensed Hunting	5	moose	66	95	46	208	yes	100	0	0		61	95	46	203	-5			
2011	Sep	Wounding Mortality	15	per cent	61	95	46	203	yes	90	5	5	3	59	95	46	200	-3			
2011	Oct-Dec	Wolf Predation (Fall)	8.5	moose	59	95	46	200	yes	40	20	40		56	93	43	192	-9			
2011	All Year	Black Box Mortality	3	per cent	56	93	43	192	no				6	54	90	42	186	-6			
2012	Jan	Population At Year Start			54	90	42	186											29%	49%	22%
2012	Jan-Mar	Wolf Predation (Winter)	8.5	moose	54	90	42	186	yes	40	20	40		50	89	38	177	-9			
2012	Mar	Winter Kill	2	per cent	50	89	38	177	no				4	49	87	37	174	-4			
2012	Jun	Reproduction			49	87	37	174						68	106	74	248	74			
2012	Jul-Aug	Postnatal Mortality	30	per cent	68	106	74	248	yes	0	0	100	22	68	106	52	225	-22			
2012	Sep	First Nations Harvest	12	moose	68	106	52	225	yes	70	20	10		60	103	50	213	-12			
2012	Sep	Resident Licensed Hunting	2	moose	60	103	50	213	yes	100	0	0		58	103	50	211	-2			
2012	Sep	Nonresident Licensed Hunting	5	moose	58	103	50	211	yes	100	0	0		53	103	50	206	-5			
2012	Sep	Wounding Mortality	15	per cent	53	103	50	206	yes	90	5	5	3	50	103	50	204	-3			
2012	Oct-Dec	Wolf Predation (Fall)	8.5	moose	50	103	50	204	yes	40	20	40		47	101	47	195	-9			
2012	All Year	Black Box Mortality	3	per cent	47	101	47	195	no				6	45	98	46	189	-6			
2013	Jan	Population At Year Start			45	98	46	189											24%	52%	24%
2013	Jan-Mar	Wolf Predation (Winter)	8.5	moose	45	98	46	189	yes	40	20	40		42	97	42	181	-8			
2013	Mar	Winter Kill	2	per cent	42	97	42	181	no				4	41	95	41	177	-4			
2013	Jun	Reproduction			41	95	41	177						62	115	80	258	80			
2013	Jul-Aug	Postnatal Mortality	30	per cent	62	115	80	258	yes	0	0	100		62	115	56	233	-24			
2013	Sep	First Nations Harvest	12	moose	62	115	56	233	yes	70	20	10		53	113	55	221	-12			
2013	Sep	Resident Licensed Hunting	2	moose	53	113	55	221	yes	100	0	0		51	113	55	219	-2			
2013	Sep	Nonresident Licensed Hunting	5	moose	51	113	55	219	yes	100	0	0		46	113	55	214	-5			
2013	Sep	Wounding Mortality	15	per cent	46	113	55	214	yes	90	5	5	3	44	113	55	212	-3			
2013	Oct-Dec	Wolf Predation (Fall)	8.5	moose	44	113	55	212	yes	40	20	40		40	111	52	203	-9			
2013	All Year	Black Box Mortality	3	per cent	40	111	52	203	no				6	39	108	50	197	-6			
2014	Jan	Population At Year Start			39	108	50	197											20%	55%	25%
2014	Jan-Mar	Wolf Predation (Winter)	8.5	moose	39	108	50	197	yes	40	20	40		36	106	47	188	-9			
2014	Mar	Winter Kill	2	per cent	36	106	47	188	no				4	35	104	46	185	-4			
2014	Jun	Reproduction			35	104	46	185						58	127	88	273	88			
2014	Jul-Aug	Postnatal Mortality	30	per cent	58	127	88	273	yes	0	0	100	26	58	127	62	246	-26			
2014	Sep	First Nations Harvest	12	moose	58	127	62	246	yes	70	20	10		50	124	61	234	-12			
2014	Sep	Resident Licensed Hunting	2	moose	50	124	61	234	yes	100	0	0		48	124	61	232	-2			
2014	Sep	Nonresident Licensed Hunting	5	moose	48	124	61	232	yes	100	0	0		43	124	61	227	-5			
2014	Sep	Wounding Mortality	15	per cent	43	124	61	227	yes	90	5	5	3	40	124	60	225	-3			
2014	Oct-Dec	Wolf Predation (Fall)	8.5	moose	40	124	60	225	yes	40	20	40		37	122	57	216	-9			
2014	All Year	Black Box Mortality	3	per cent	37	122	57	216	no				6	35	119	55	210	-6			
2015	Jan	Population At Simulation Finish			35	119	55	210											17%	57%	26%

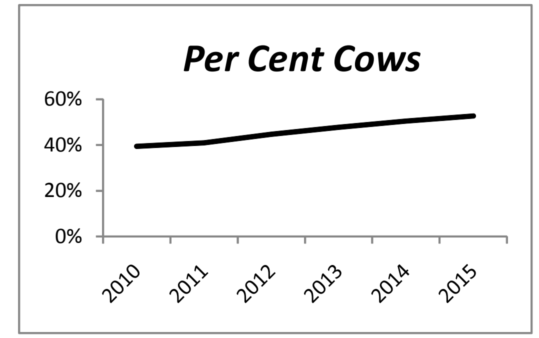
D-4 Unit 4: Kakwasanseesi

INPUT		
Start Year	2010	
Bulls (Start)	243	
Cows (Start)	196	
Calves (Start)	63	
Total (Start)		502
Total Wolf Predation	51 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	25 moose	
Resident Licensed Kill	9 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	502
2011	493
2012	484
2013	485
2014	494
2015	514



Year	% Bulls	% Cows	% Calves
2010	48%	39%	13%
2011	41%	40%	19%
2012	36%	44%	20%
2013	32%	47%	22%
2014	27%	50%	23%
2015	24%	52%	24%

	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

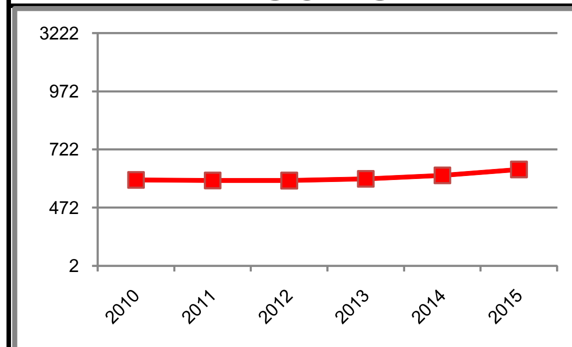
YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			243	196	63	502											48%	39%	13%
2010	Jan-Mar	Wolf Predation (Winter)	25.5	moose	243	196	63	502	yes	40	20	40		233	191	53	477	-25			
2010	Mar	Winter Kill	2	per cent	233	191	53	477	no				10	228	187	52	467	-10			
2010	Jun	Reproduction			228	187	52	467						254	213	159	626	159			
2010	Jul-Aug	Postnatal Mortality	30	per cent	254	213	159	626	yes	0	0	100	48	254	213	111	578	-48			
2010	Sep	First Nations Harvest	25	moose	254	213	111	578	yes	70	20	10		237	208	109	553	-25			
2010	Sep	Resident Licensed Hunting	9	moose	237	208	109	553	yes	100	0	0		228	208	109	544	-9			
2010	Sep	Nonresident Licensed Hunting	5	moose	228	208	109	544	yes	100	0	0		223	208	109	539	-5			
2010	Sep	Wounding Mortality	15	per cent	223	208	109	539	yes	90	5	5	6	217	208	109	533	-6			
2010	Oct-Dec	Wolf Predation (Fall)	25.5	moose	217	208	109	533	yes	40	20	40		207	203	98	508	-26			
2010	All Year	Black Box Mortality	3	per cent	207	203	98	508	no				15	201	196	95	493	-15			
2011	Jan	Population At Year Start			201	196	95	493											41%	40%	19%
2011	Jan-Mar	Wolf Predation (Winter)	25.5	moose	201	196	95	493	yes	40	20	40		191	191	85	467	-26			
2011	Mar	Winter Kill	2	per cent	191	191	85	467	no				9	187	188	83	458	-9			
2011	Jun	Reproduction			187	188	83	458						229	229	159	617	159			
2011	Jul-Aug	Postnatal Mortality	30	per cent	229	229	159	617	yes	0	0	100	48	229	229	112	569	-48			
2011	Sep	First Nations Harvest	25	moose	229	229	112	569	yes	70	20	10		211	224	109	544	-25			
2011	Sep	Resident Licensed Hunting	9	moose	211	224	109	544	yes	100	0	0		202	224	109	535	-9			
2011	Sep	Nonresident Licensed Hunting	5	moose	202	224	109	535	yes	100	0	0		197	224	109	530	-5			
2011	Sep	Wounding Mortality	15	per cent	197	224	109	530	yes	90	5	5	6	192	224	109	525	-6			
2011	Oct-Dec	Wolf Predation (Fall)	25.5	moose	192	224	109	525	yes	40	20	40		182	219	99	499	-26			
2011	All Year	Black Box Mortality	3	per cent	182	219	99	499	no				15	176	212	96	484	-15			
2012	Jan	Population At Year Start			176	212	96	484											36%	44%	20%
2012	Jan-Mar	Wolf Predation (Winter)	25.5	moose	176	212	96	484	yes	40	20	40		166	207	85	459	-25			
2012	Mar	Winter Kill	2	per cent	166	207	85	459	no				9	163	203	84	449	-9			
2012	Jun	Reproduction			163	203	84	449						204	245	173	622	173			
2012	Jul-Aug	Postnatal Mortality	30	per cent	204	245	173	622	yes	0	0	100	52	204	245	121	570	-52			
2012	Sep	First Nations Harvest	25	moose	204	245	121	570	yes	70	20	10		187	240	118	545	-25			
2012	Sep	Resident Licensed Hunting	9	moose	187	240	118	545	yes	100	0	0		178	240	118	536	-9			
2012	Sep	Nonresident Licensed Hunting	5	moose	178	240	118	536	yes	100	0	0		173	240	118	531	-5			
2012	Sep	Wounding Mortality	15	per cent	173	240	118	531	yes	90	5	5	6	168	240	118	525	-6			
2012	Oct-Dec	Wolf Predation (Fall)	25.5	moose	168	240	118	525	yes	40	20	40		158	235	108	500	-26			
2012	All Year	Black Box Mortality	3	per cent	158	235	108	500	no				15	153	228	105	485	-15			
2013	Jan	Population At Year Start			153	228	105	485											32%	47%	22%
2013	Jan-Mar	Wolf Predation (Winter)	25.5	moose	153	228	105	485	yes	40	20	40		143	222	94	459	-26			
2013	Mar	Winter Kill	2	per cent	143	222	94	459	no				9	140	218	93	450	-9			
2013	Jun	Reproduction			140	218	93	450						186	264	185	636	185			
2013	Jul-Aug	Postnatal Mortality	30	per cent	186	264	185	636	yes	0	0	100		186	264	130	580	-56			
2013	Sep	First Nations Harvest	25	moose	186	264	130	580	yes	70	20	10		169	259	127	555	-25			
2013	Sep	Resident Licensed Hunting	9	moose	169	259	127	555	yes	100	0	0		160	259	127	546	-9			
2013	Sep	Nonresident Licensed Hunting	5	moose	160	259	127	546	yes	100	0	0		155	259	127	541	-5			
2013	Sep	Wounding Mortality	15	per cent	155	259	127	541	yes	90	5	5	6	149	259	127	535	-6			
2013	Oct-Dec	Wolf Predation (Fall)	25.5	moose	149	259	127	535	yes	40	20	40		139	254	117	510	-26			
2013	All Year	Black Box Mortality	3	per cent	139	254	117	510	no				15	135	246	113	494	-15			
2014	Jan	Population At Year Start			135	246	113	494											27%	50%	23%
2014	Jan-Mar	Wolf Predation (Winter)	25.5	moose	135	246	113	494	yes	40	20	40		125	241	103	469	-25			
2014	Mar	Winter Kill	2	per cent	125	241	103	469	no				9	122	236	101	459	-9			
2014	Jun	Reproduction			122	236	101	459						173	287	201	660	201			
2014	Jul-Aug	Postnatal Mortality	30	per cent	173	287	201	660	yes	0	0	100	60	173	287	141	600	-60			
2014	Sep	First Nations Harvest	25	moose	173	287	141	600	yes	70	20	10		155	282	138	575	-25			
2014	Sep	Resident Licensed Hunting	9	moose	155	282	138	575	yes	100	0	0		146	282	138	566	-9			
2014	Sep	Nonresident Licensed Hunting	5	moose	146	282	138	566	yes	100	0	0		141	282	138	561	-5			
2014	Sep	Wounding Mortality	15	per cent	141	282	138	561	yes	90	5	5	6	136	281	138	555	-6			
2014	Oct-Dec	Wolf Predation (Fall)	25.5	moose	136	281	138	555	yes	40	20	40		126	276	128	530	-26			
2014	All Year	Black Box Mortality	3	per cent	126	276	128	530	no				16	122	268	124	514	-16			
2015	Jan	Population At Simulation Finish			122	268	124	514											24%	52%	24%

D-5 Unit 5: Wasekanoosees

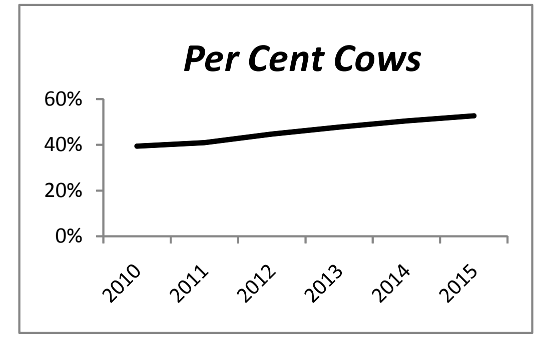
INPUT

Start Year	2010	
Bulls (Start)	176	
Cows (Start)	147	
Calves (Start)	46	
Total (Start)		369
Total Wolf Predation	24 moose	
Winter Kill	2 %	
Calves Born/100 Cows	85	
Postnatal Mortality	30 %	
First Nations Harvest	30 moose	
Resident Licensed Kill	3 moose	
Nonresident Licensed Kill	5 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	Moose
2010	369
2011	367
2012	366
2013	374
2014	389
2015	414



Year	% Bulls	% Cows	% Calves
2010	48%	40%	12%
2011	39%	40%	20%
2012	35%	45%	20%
2013	30%	48%	22%
2014	26%	50%	23%
2015	23%	52%	25%

	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

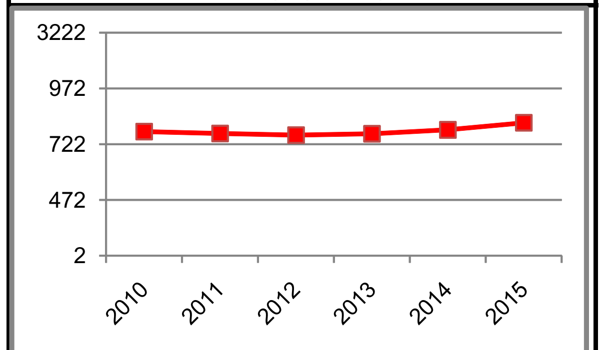
YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			176	147	46	369											48%	40%	12%
2010	Jan-Mar	Wolf Predation (Winter)	12	moose	176	147	46	369	yes	40	20	40		171	145	41	357	-12			
2010	Mar	Winter Kill	2	per cent	171	145	41	357	no				7	168	142	40	350	-7			
2010	Jun	Reproduction			168	142	40	350						188	162	120	470	120			
2010	Jul-Aug	Postnatal Mortality	30	per cent	188	162	120	470	yes	0	0	100	36	188	162	84	434	-36			
2010	Sep	First Nations Harvest	30	moose	188	162	84	434	yes	70	20	10		167	156	81	404	-30			
2010	Sep	Resident Licensed Hunting	3	moose	167	156	81	404	yes	100	0	0		164	156	81	401	-3			
2010	Sep	Nonresident Licensed Hunting	5	moose	164	156	81	401	yes	100	0	0		159	156	81	396	-5			
2010	Sep	Wounding Mortality	15	per cent	159	156	81	396	yes	90	5	5	6	154	156	81	390	-6			
2010	Oct-Dec	Wolf Predation (Fall)	12	moose	154	156	81	390	yes	40	20	40		149	153	76	378	-12			
2010	All Year	Black Box Mortality	3	per cent	149	153	76	378	no				11	145	149	74	367	-11			
2011	Jan	Population At Year Start			145	149	74	367											39%	40%	20%
2011	Jan-Mar	Wolf Predation (Winter)	12	moose	145	149	74	367	yes	40	20	40		140	146	69	355	-12			
2011	Mar	Winter Kill	2	per cent	140	146	69	355	no				7	137	143	68	348	-7			
2011	Jun	Reproduction			137	143	68	348						171	177	122	470	122			
2011	Jul-Aug	Postnatal Mortality	30	per cent	171	177	122	470	yes	0	0	100	37	171	177	85	433	-37			
2011	Sep	First Nations Harvest	30	moose	171	177	85	433	yes	70	20	10		150	171	82	403	-30			
2011	Sep	Resident Licensed Hunting	3	moose	150	171	82	403	yes	100	0	0		147	171	82	400	-3			
2011	Sep	Nonresident Licensed Hunting	5	moose	147	171	82	400	yes	100	0	0		142	171	82	395	-5			
2011	Sep	Wounding Mortality	15	per cent	142	171	82	395	yes	90	5	5	6	137	171	82	390	-6			
2011	Oct-Dec	Wolf Predation (Fall)	12	moose	137	171	82	390	yes	40	20	40		132	168	77	378	-12			
2011	All Year	Black Box Mortality	3	per cent	132	168	77	378	no				11	128	163	75	366	-11			
2012	Jan	Population At Year Start			128	163	75	366											35%	45%	20%
2012	Jan-Mar	Wolf Predation (Winter)	12	moose	128	163	75	366	yes	40	20	40		123	161	70	354	-12			
2012	Mar	Winter Kill	2	per cent	123	161	70	354	no				7	121	158	69	347	-7			
2012	Jun	Reproduction			121	158	69	347						155	192	134	481	134			
2012	Jul-Aug	Postnatal Mortality	30	per cent	155	192	134	481	yes	0	0	100	40	155	192	94	441	-40			
2012	Sep	First Nations Harvest	30	moose	155	192	94	441	yes	70	20	10		134	186	91	411	-30			
2012	Sep	Resident Licensed Hunting	3	moose	134	186	91	411	yes	100	0	0		131	186	91	408	-3			
2012	Sep	Nonresident Licensed Hunting	5	moose	131	186	91	408	yes	100	0	0		126	186	91	403	-5			
2012	Sep	Wounding Mortality	15	per cent	126	186	91	403	yes	90	5	5	6	121	186	91	397	-6			
2012	Oct-Dec	Wolf Predation (Fall)	12	moose	121	186	91	397	yes	40	20	40		116	183	86	385	-12			
2012	All Year	Black Box Mortality	3	per cent	116	183	86	385	no				12	113	178	83	374	-12			
2013	Jan	Population At Year Start			113	178	83	374											30%	48%	22%
2013	Jan-Mar	Wolf Predation (Winter)	12	moose	113	178	83	374	yes	40	20	40		108	176	78	362	-12			
2013	Mar	Winter Kill	2	per cent	108	176	78	362	no				7	106	172	77	355	-7			
2013	Jun	Reproduction			106	172	77	355						144	210	146	501	146			
2013	Jul-Aug	Postnatal Mortality	30	per cent	144	210	146	501	yes	0	0	100		144	210	102	457	-44			
2013	Sep	First Nations Harvest	30	moose	144	210	102	457	yes	70	20	10		123	204	99	427	-30			
2013	Sep	Resident Licensed Hunting	3	moose	123	204	99	427	yes	100	0	0		120	204	99	424	-3			
2013	Sep	Nonresident Licensed Hunting	5	moose	120	204	99	424	yes	100	0	0		115	204	99	419	-5			
2013	Sep	Wounding Mortality	15	per cent	115	204	99	419	yes	90	5	5	6	110	204	99	413	-6			
2013	Oct-Dec	Wolf Predation (Fall)	12	moose	110	204	99	413	yes	40	20	40		105	202	94	401	-12			
2013	All Year	Black Box Mortality	3	per cent	105	202	94	401	no				12	102	196	91	389	-12			
2014	Jan	Population At Year Start			102	196	91	389											26%	50%	23%
2014	Jan-Mar	Wolf Predation (Winter)	12	moose	102	196	91	389	yes	40	20	40		97	193	87	377	-12			
2014	Mar	Winter Kill	2	per cent	97	193	87	377	no				8	95	189	85	370	-8			
2014	Jun	Reproduction			95	189	85	370						138	232	161	531	161			
2014	Jul-Aug	Postnatal Mortality	30	per cent	138	232	161	531	yes	0	0	100	48	138	232	113	482	-48			
2014	Sep	First Nations Harvest	30	moose	138	232	113	482	yes	70	20	10		117	226	110	452	-30			
2014	Sep	Resident Licensed Hunting	3	moose	117	226	110	452	yes	100	0	0		114	226	110	449	-3			
2014	Sep	Nonresident Licensed Hunting	5	moose	114	226	110	449	yes	100	0	0		109	226	110	444	-5			
2014	Sep	Wounding Mortality	15	per cent	109	226	110	444	yes	90	5	5	6	104	226	109	439	-6			
2014	Oct-Dec	Wolf Predation (Fall)	12	moose	104	226	109	439	yes	40	20	40		99	223	105	427	-12			
2014	All Year	Black Box Mortality	3	per cent	99	223	105	427	no				13	96	217	102	414	-13			
2015	Jan	Population At Simulation Finish			96	217	102	414											23%	52%	25%

D-6 Unit 6: Askekosani

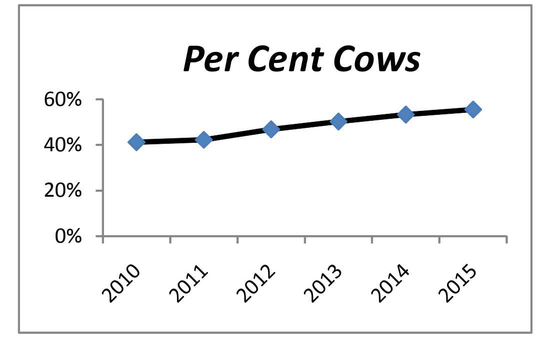
INPUT

Start Year	2010	
Bulls (Start)	254	
Cows (Start)	229	
Calves (Start)	74	
Total (Start)		557
Total Wolf Predation	42 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	45 moose	
Resident Licensed Kill	6 moose	
Nonresident Licensed Kill	10 moose	
Wounding Mortality	15 %	
Black Box Mortality	3 %	

RESULTS



January Population	
Year	**Moose**
2010	557
2011	548
2012	541
2013	547
2014	565
2015	596



Year	% Bulls	% Cows	% Calves
2010	46%	41%	13%
2011	37%	42%	21%
2012	32%	47%	21%
2013	26%	50%	23%
2014	22%	53%	25%
2015	19%	56%	26%

	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

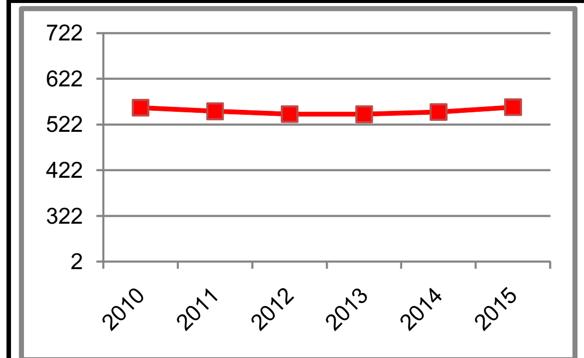
YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			254	229	74	557											46%	41%	13%
2010	Jan-Mar	Wolf Predation (Winter)	21	moose	254	229	74	557	yes	40	20	40		246	225	66	536	-21			
2010	Mar	Winter Kill	2	per cent	246	225	66	536	no				11	241	220	64	525	-11			
2010	Jun	Reproduction			241	220	64	525						273	252	187	713	187			
2010	Jul-Aug	Postnatal Mortality	30	per cent	273	252	187	713	yes	0	0	100	56	273	252	131	656	-56			
2010	Sep	First Nations Harvest	45	moose	273	252	131	656	yes	70	20	10		241	243	127	611	-45			
2010	Sep	Resident Licensed Hunting	6	moose	241	243	127	611	yes	100	0	0		235	243	127	605	-6			
2010	Sep	Nonresident Licensed Hunting	10	moose	235	243	127	605	yes	100	0	0		225	243	127	595	-10			
2010	Sep	Wounding Mortality	15	per cent	225	243	127	595	yes	90	5	5	9	217	243	126	586	-9			
2010	Oct-Dec	Wolf Predation (Fall)	21	moose	217	243	126	586	yes	40	20	40		209	239	118	565	-21			
2010	All Year	Black Box Mortality	3	per cent	209	239	118	565	no				17	202	232	114	548	-17			
2011	Jan	Population At Year Start			202	232	114	548											37%	42%	21%
2011	Jan-Mar	Wolf Predation (Winter)	21	moose	202	232	114	548	yes	40	20	40		194	227	106	527	-21			
2011	Mar	Winter Kill	2	per cent	194	227	106	527	no				11	190	223	104	517	-11			
2011	Jun	Reproduction			190	223	104	517						242	275	189	706	189			
2011	Jul-Aug	Postnatal Mortality	30	per cent	242	275	189	706	yes	0	0	100	57	242	275	133	649	-57			
2011	Sep	First Nations Harvest	45	moose	242	275	133	649	yes	70	20	10		210	266	128	604	-45			
2011	Sep	Resident Licensed Hunting	6	moose	210	266	128	604	yes	100	0	0		204	266	128	598	-6			
2011	Sep	Nonresident Licensed Hunting	10	moose	204	266	128	598	yes	100	0	0		194	266	128	588	-10			
2011	Sep	Wounding Mortality	15	per cent	194	266	128	588	yes	90	5	5	9	186	265	128	579	-9			
2011	Oct-Dec	Wolf Predation (Fall)	21	moose	186	265	128	579	yes	40	20	40		178	261	119	558	-21			
2011	All Year	Black Box Mortality	3	per cent	178	261	119	558	no				17	173	253	116	541	-17			
2012	Jan	Population At Year Start			173	253	116	541											32%	47%	21%
2012	Jan-Mar	Wolf Predation (Winter)	21	moose	173	253	116	541	yes	40	20	40		164	249	107	520	-21			
2012	Mar	Winter Kill	2	per cent	164	249	107	520	no				10	161	244	105	510	-10			
2012	Jun	Reproduction			161	244	105	510						213	297	207	717	207			
2012	Jul-Aug	Postnatal Mortality	30	per cent	213	297	207	717	yes	0	0	100	62	213	297	145	655	-62			
2012	Sep	First Nations Harvest	45	moose	213	297	145	655	yes	70	20	10		182	288	141	610	-45			
2012	Sep	Resident Licensed Hunting	6	moose	182	288	141	610	yes	100	0	0		176	288	141	604	-6			
2012	Sep	Nonresident Licensed Hunting	10	moose	176	288	141	604	yes	100	0	0		166	288	141	594	-10			
2012	Sep	Wounding Mortality	15	per cent	166	288	141	594	yes	90	5	5	9	158	287	140	585	-9			
2012	Oct-Dec	Wolf Predation (Fall)	21	moose	158	287	140	585	yes	40	20	40		149	283	132	564	-21			
2012	All Year	Black Box Mortality	3	per cent	149	283	132	564	no				17	145	274	128	547	-17			
2013	Jan	Population At Year Start			145	274	128	547											26%	50%	23%
2013	Jan-Mar	Wolf Predation (Winter)	21	moose	145	274	128	547	yes	40	20	40		136	270	119	526	-21			
2013	Mar	Winter Kill	2	per cent	136	270	119	526	no				11	134	265	117	516	-11			
2013	Jun	Reproduction			134	265	117	516						192	323	225	741	225			
2013	Jul-Aug	Postnatal Mortality	30	per cent	192	323	225	741	yes	0	0	100		192	323	158	673	-68			
2013	Sep	First Nations Harvest	45	moose	192	323	158	673	yes	70	20	10		161	314	153	628	-45			
2013	Sep	Resident Licensed Hunting	6	moose	161	314	153	628	yes	100	0	0		155	314	153	622	-6			
2013	Sep	Nonresident Licensed Hunting	10	moose	155	314	153	622	yes	100	0	0		145	314	153	612	-10			
2013	Sep	Wounding Mortality	15	per cent	145	314	153	612	yes	90	5	5	9	136	314	153	603	-9			
2013	Oct-Dec	Wolf Predation (Fall)	21	moose	136	314	153	603	yes	40	20	40		128	310	144	582	-21			
2013	All Year	Black Box Mortality	3	per cent	128	310	144	582	no				17	124	300	140	565	-17			
2014	Jan	Population At Year Start			124	300	140	565											22%	53%	25%
2014	Jan-Mar	Wolf Predation (Winter)	21	moose	124	300	140	565	yes	40	20	40		116	296	132	544	-21			
2014	Mar	Winter Kill	2	per cent	116	296	132	544	no				11	114	290	129	533	-11			
2014	Jun	Reproduction			114	290	129	533						178	355	247	780	247			
2014	Jul-Aug	Postnatal Mortality	30	per cent	178	355	247	780	yes	0	0	100	74	178	355	173	705	-74			
2014	Sep	First Nations Harvest	45	moose	178	355	173	705	yes	70	20	10		146	346	168	660	-45			
2014	Sep	Resident Licensed Hunting	6	moose	146	346	168	660	yes	100	0	0		140	346	168	654	-6			
2014	Sep	Nonresident Licensed Hunting	10	moose	140	346	168	654	yes	100	0	0		130	346	168	644	-10			
2014	Sep	Wounding Mortality	15	per cent	130	346	168	644	yes	90	5	5	9	122	345	168	635	-9			
2014	Oct-Dec	Wolf Predation (Fall)	21	moose	122	345	168	635	yes	40	20	40		114	341	159	614	-21			
2014	All Year	Black Box Mortality	3	per cent	114	341	159	614	no				18	110	331	155	596	-18			
2015	Jan	Population At Simulation Finish			110	331	155	596											19%	56%	26%

D-7 Unit 7: Kitchisippi

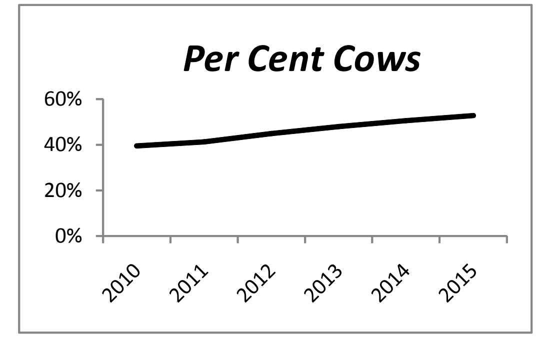
INPUT

Start Year	2010	
Bulls (Start)	154	
Cows (Start)	133	
Calves (Start)	50	
Total (Start)		337
Total Wolf Predation	19 moose	
Winter Kill	2 %	
Calves Born/100 Cows	*85*	
Postnatal Mortality	30 %	
First Nations Harvest	24 moose	
Resident Licensed Kill	9 moose	
Nonresident Licensed Kill	0 moose	
Wounding Mortality	15 %	
Black Box Mortality	6 %	

RESULTS



January Population	
Year	Moose
2010	337
2011	329
2012	323
2013	323
2014	328
2015	338



Year	% Bulls	% Cows	% Calves
2010	46%	39%	15%
2011	39%	41%	20%
2012	34%	45%	21%
2013	30%	48%	22%
2014	26%	51%	24%
2015	22%	53%	25%

	Weight	Bulls	Cows	Calves
Total Wolf Predation	yes	40	20	40
Winter Kill	no			
Postnatal Mortality	yes	0	0	100
First Nations Harvest	yes	70	20	10
Resident Licensed Hunting	yes	100	0	0
Nonresident Licensed Hunting	yes	100	0	0
Wounding Mortality	yes	90	5	5
Black Box Mortality	no			

YEAR	MONTHS	FACTOR	AMOUNT OF CHANGE	APPLIED AS	BULLS BEFORE	COWS BEFORE	CALVES BEFORE	POPULATION BEFORE	UNEVEN MORTALITY?	% BULLS	% COWS	% CALVES	% MORTALITY AS NUMBER OF MOOSE	BULLS AFTER	COWS AFTER	CALVES AFTER	POPULATION AFTER	POPULATION CHANGE	% BULLS	% COWS	% CALVES
2010	Jan	Population At Simulation Start			154	133	50	337											46%	39%	15%
2010	Jan-Mar	Wolf Predation (Winter)	9.5	moose	154	133	50	337	yes	40	20	40		150	131	46	328	-10			
2010	Mar	Winter Kill	2	per cent	150	131	46	328	no				7	147	128	45	321	-7			
2010	Jun	Reproduction			147	128	45	321						170	151	109	430	109			
2010	Jul-Aug	Postnatal Mortality	30	per cent	170	151	109	430	yes	0	0	100	33	170	151	76	397	-33			
2010	Sep	First Nations Harvest	24	moose	170	151	76	397	yes	70	20	10		153	146	74	373	-24			
2010	Sep	Resident Licensed Hunting	9	moose	153	146	74	373	yes	100	0	0		144	146	74	364	-9			
2010	Sep	Nonresident Licensed Hunting	0	moose	144	146	74	364	yes	100	0	0		144	146	74	364	0			
2010	Sep	Wounding Mortality	15	per cent	144	146	74	364	yes	90	5	5	5	140	146	74	359	-5			
2010	Oct-Dec	Wolf Predation (Fall)	9.5	moose	140	146	74	359	yes	40	20	40		136	144	70	350	-9			
2010	All Year	Black Box Mortality	6	per cent	136	144	70	350	no				21	128	136	66	329	-21			
2011	Jan	Population At Year Start			128	136	66	329											39%	41%	20%
2011	Jan-Mar	Wolf Predation (Winter)	9.5	moose	128	136	66	329	yes	40	20	40		124	134	62	319	-10			
2011	Mar	Winter Kill	2	per cent	124	134	62	319	no				6	121	131	61	313	-6			
2011	Jun	Reproduction			121	131	61	313						152	161	111	424	111			
2011	Jul-Aug	Postnatal Mortality	30	per cent	152	161	111	424	yes	0	0	100	33	152	161	78	391	-33			
2011	Sep	First Nations Harvest	24	moose	152	161	78	391	yes	70	20	10		135	157	76	367	-24			
2011	Sep	Resident Licensed Hunting	9	moose	135	157	76	367	yes	100	0	0		126	157	76	358	-9			
2011	Sep	Nonresident Licensed Hunting	0	moose	126	157	76	358	yes	100	0	0		126	157	76	358	0			
2011	Sep	Wounding Mortality	15	per cent	126	157	76	358	yes	90	5	5	5	121	156	75	353	-5			
2011	Oct-Dec	Wolf Predation (Fall)	9.5	moose	121	156	75	353	yes	40	20	40		118	154	71	344	-10			
2011	All Year	Black Box Mortality	6	per cent	118	154	71	344	no				21	111	145	67	323	-21			
2012	Jan	Population At Year Start			111	145	67	323											34%	45%	21%
2012	Jan-Mar	Wolf Predation (Winter)	9.5	moose	111	145	67	323	yes	40	20	40		107	143	63	313	-10			
2012	Mar	Winter Kill	2	per cent	107	143	63	313	no				6	105	140	62	307	-6			
2012	Jun	Reproduction			105	140	62	307						136	171	119	426	119			
2012	Jul-Aug	Postnatal Mortality	30	per cent	136	171	119	426	yes	0	0	100	36	136	171	84	391	-36			
2012	Sep	First Nations Harvest	24	moose	136	171	84	391	yes	70	20	10		119	167	81	367	-24			
2012	Sep	Resident Licensed Hunting	9	moose	119	167	81	367	yes	100	0	0		110	167	81	358	-9			
2012	Sep	Nonresident Licensed Hunting	0	moose	110	167	81	358	yes	100	0	0		110	167	81	358	0			
2012	Sep	Wounding Mortality	15	per cent	110	167	81	358	yes	90	5	5	5	105	166	81	353	-5			
2012	Oct-Dec	Wolf Predation (Fall)	9.5	moose	105	166	81	353	yes	40	20	40		102	164	77	343	-9			
2012	All Year	Black Box Mortality	6	per cent	102	164	77	343	no				21	96	155	72	323	-21			
2013	Jan	Population At Year Start			96	155	72	323											30%	48%	22%
2013	Jan-Mar	Wolf Predation (Winter)	9.5	moose	96	155	72	323	yes	40	20	40		92	153	69	313	-10			
2013	Mar	Winter Kill	2	per cent	92	153	69	313	no				6	90	150	67	307	-6			
2013	Jun	Reproduction			90	150	67	307						124	183	127	434	127			
2013	Jul-Aug	Postnatal Mortality	30	per cent	124	183	127	434	yes	0	0	100		124	183	89	396	-38			
2013	Sep	First Nations Harvest	24	moose	124	183	89	396	yes	70	20	10		107	178	87	372	-24			
2013	Sep	Resident Licensed Hunting	9	moose	107	178	87	372	yes	100	0	0		98	178	87	363	-9			
2013	Sep	Nonresident Licensed Hunting	0	moose	98	178	87	363	yes	100	0	0		98	178	87	363	0			
2013	Sep	Wounding Mortality	15	per cent	98	178	87	363	yes	90	5	5	5	93	178	86	358	-5			
2013	Oct-Dec	Wolf Predation (Fall)	9.5	moose	93	178	86	358	yes	40	20	40		90	176	83	348	-10			
2013	All Year	Black Box Mortality	6	per cent	90	176	83	348	no				21	84	166	78	328	-21			
2014	Jan	Population At Year Start			84	166	78	328											26%	51%	24%
2014	Jan-Mar	Wolf Predation (Winter)	9.5	moose	84	166	78	328	yes	40	20	40		80	164	74	318	-10			
2014	Mar	Winter Kill	2	per cent	80	164	74	318	no				6	79	161	72	312	-6			
2014	Jun	Reproduction			79	161	72	312						115	197	136	448	136			
2014	Jul-Aug	Postnatal Mortality	30	per cent	115	197	136	448	yes	0	0	100	41	115	197	96	407	-41			
2014	Sep	First Nations Harvest	24	moose	115	197	96	407	yes	70	20	10		98	192	93	383	-24			
2014	Sep	Resident Licensed Hunting	9	moose	98	192	93	383	yes	100	0	0		89	192	93	374	-9			
2014	Sep	Nonresident Licensed Hunting	0	moose	89	192	93	374	yes	100	0	0		89	192	93	374	0			
2014	Sep	Wounding Mortality	15	per cent	89	192	93	374	yes	90	5	5	5	85	192	93	369	-5			
2014	Oct-Dec	Wolf Predation (Fall)	9.5	moose	85	192	93	369	yes	40	20	40		81	190	89	360	-10			
2014	All Year	Black Box Mortality	6	per cent	81	190	89	360	no				22	76	178	84	338	-22			
2015	Jan	Population At Simulation Finish			76	178	84	338											22%	53%	25%

Literature Cited

Agreement Among Split Lake Cree First Nation, Canada, Manitoba and Manitoba Hydro, 1992 (NFA Implementation Agreement). Available online at http://www.hydro.mb.ca/community/agreements/sla/t_of_c.htm

Ballard, W. B., L.A. Ayres, P.R. Krausman, D.J. Reed and SG. Fancy. 1997. Ecology of wolves in relation to a migratory caribou herd in northwest Alaska. Wildlife Monographs 135. 47 pp.

Bjørneraas, K., E.J, Solberg, I. Herfindal, B. Van Moorter, C.M. Rolandsen, J.-P. Tremblay, C. Skarpe, B.-E. Sæther, R. Eriksen, and R. Astrup. 2011. Moose Alces alces habitat use at multiple temporal scales in a human-altered landscape. Wildlife Biology 17: 44-54.

Boutin, S. 1992. Predation and moose population dynamics: a critique. Journal of Wildlife Management 56(1): 116-127.

Campbell, M. January 2005. The Monitoring of Qamanirjuaq caribou (Rangifer tarandus groenlandicus) using satellite telemetry. Government of Nunavut, Department of Environment, Status report: 13, Iqaluit, 20 pp

Campbell, M. 2007. Wildlife research in the Kivalliq Region of Nunavut with implications to the needs of Nunavummiut. Government of Nunavut, Department of Environment, Final Wildlife report: 18, Iqaluit, 34 pp.

Campbell, M., Nishi, J., and J. Boulanger. 2010. A calving ground photo survey of the Qamanirjuag Migratory Barren-ground Caribou (Rangifer tarandus groenlandicus) population, June 2008. Dept. Of Environment, Government of Nunavut – Technical Report Series 2010 – No. 1 – 10.

Child, K. N.1998. Incidental mortality. pp. 275-302 in The Ecology and Management of the North American Moose. A.W. Franzmann and C.C. Schwartz, eds. Smithsonian Institution Press. 733 pp.

CNP (Cree Nation Partners) Keeyask Environmental Evaluation Report. 2012. Keeyask Environmental Evaluation: A report on the environmental effects of the proposed Keeyask Project on Tataskweyak Cree Nation and War Lake First Nation. January 2012.

Coady, J.W. 1982. Moose. pp. 902-922 in: Wild Mammals of North America. J.A. Chapman and G.A. Feldhamer, eds. The Johns Hopkins University Press.

Constitution Act, 20-21 George V, 1930, c.26 (UK).

Constitution Act, 1982, c.11 (UK) Schedule B.

Courtois, R. and J.-P. Ouellet. 2007. Modeling the impact of moose and wolf management on persistence of woodland caribou. Alces 43:13-27.

Crête, M. and R. Courtois. 1997. Limiting factors might obscure population regulation of moose (Cervidae: Alces alces) in unproductive boreal forests. Journal of Zoology 242: 765-781.

Crichton, V. 1992.Six year (1986/87-1991/92) summary of in utero productivity of moose in Manitoba, Canada. Alces 28:203-214.

Dussault, C.,J.-P. Ouellet, R. Courtois, J. Huot, L. Breton, and H. Jolicoeur. 2005. Linking moose habitat selection to limiting factors. Ecography 28: 619-628.

Edwards, A.J., M. Schrage and M. Lenary 2004. Northeastern moose management - a case study in cooperation. Alces 40: 23-31.

Fuller, T.K., L.D. Mech and J.F. Cochrane. 2003. Wolf population dynamics. pp. 161-191 in: Wolves: Behavior, Ecology and Conservation. L.D. Mech and L. Boitani, eds. University of Chicago Press. 448 pp.

Gasaway, W. C., R.D. Boertje, D.V. Grangaard, D.G. Kellyhouse, R.O. Stephenson and D.G. Larsen. 1992. The role of predation in limiting moose in low densities in Alaska and Yukon and implications for conservation. Wildlife Monographs 120. 59 pp.

Irwin, L.J. 1975. Deer-moose relationships on a burn in northeastern Minnesota. Journal of Wildlife Management 39(4): 653-662.

Joint Keeyask Development Agreement (2009). Available online at http://www.hydro.mb.ca/projects/keeyask/pdf/JKDA_090529.pdf

Joly, K., P.A. Duffy, and T.S. Rupp. 2012. Simulating the effects of climate change on fire regimes in Arctic biomes: implications for caribou and moose habitat. Ecosphere 3(5): 36. http://dx.doi.org/10.1890/ES12-00012.1

Keeyask Generation Project Environmental Impact Statement (2012). Available online at http://keeyask.com/wp/the-project/environmental-assessment-process/eis

Knudsen, B., R. Berger, S. Johnstone, B. Kiss, J. Paillé and J. Kelly. 2010. Split Lake Resource Management Area Moose Survey 2009 and 2010. Keeyask Project Environmental Studies Program Report # 10-01. Prepared by Knudsen Wildlife Management Systems and Wildlife Resource Consulting Services MB Inc., Winnipeg, for Manitoba Hydro, Winnipeg. 144pp.

Kolenosky, G. B. and R. O. Stanfield. 1975. Morphological and ecological variation among gray wolves (Canis lupus) of Ontario, Canada. in: Fox, M. W. ed. The Wild Canids. New York. Van Nostrand.

Lankester, M.W. and W.M. Samuel. 1998. Pests, parasites and diseases. pp. 479-518 in The Ecology and Management of the North American Moose. A.W. Franzmann and C.C. Schwartz, eds. Smithsonian Institution Press. 733 pp.

Mabille, G., C. Dussault, J.-P. Ouellet, and C. Laurian. 2012. Linking trade-offs in habitat selection with the occurrence of functional responses for moose living in two nearby study areas. Oecologia 170: 965-977.

Maier, J.A.K., J.M. Ver Hoef, A.D. McGuire, R.T. Bowyer, L. Sapterstein, and H.A. Maier. 2005. Distribution and density of moose in relation to landscape characteristics: effects of scale. Canadian Journal of Forest Research 35: 2233-2243.

Manitoba Conservation. 1997. Five Year Report to the Legislature on Wildlife, April 1 1992 – March 31, 1997.

Manitoba Conservation. 2009. Manitoba Conservation Annual Report 2008–2009. Government of Manitoba. 204 pp. Available from http://www.gov.mb.ca/conservation/annual-reports/conservation/con_annual_report_2008_09_web.pdf.

Manitoba Conservation and Water Stewardship. 2012. 2012 Manitoba Hunting Guide. Available from http://www.gov.mb.ca/conservation/wildlife/hunting/pdfs/hunting%20guide_2012_web.pdf [accessed August 29, 2012].

Manitoba Hydro. 2011. Bipole III Transmission Project Mammals Technical Report. Prepared for Manitoba Hydro by Joro Consultants Inc. and Wildlife Resource Consulting Services MB Inc. Winnipeg, MB. 164 pp.

Månsson, J. 2009. Environmental variation and moose Alces alces density as determinants of spatio-temporal heterogeneity in browsing. Ecography 32: 601-612.

Månsson, J., N. Bunnefeld, H. Andrén, and G. Ericsson. 2012. Spatial and temporal predictions of moose winter distribution. Oecologia 170: 411-419.

McLaren, B.E., B.A. Roberts, N. Djan-Chekar and K.P. Lewis 2004. Effects of overabundant moose on the Newfoundland landscape. Alces 40: 45-59.

Mech, L.D. 1970. The Wolf: The Ecology and Behavior of an Endangered Species. University of Minnesota Press. 384 pp.

Mech L.D. and L. Boitani. 2003. Wolf social ecology. pp. 1-34 in: Wolves: Behavior, Ecology and Conservation. L.D. Mech and L. Boitani, eds. University of Chicago Press. 448 pp.

Mech, L.D., R.E. McRoberts, R.O. Peterson, and R.E. Page. 1987. Relationship of deer and moose to previous winters' snow. Journal of Animal Ecology 56: 615-627.

Messier, F. 1994. Ungulate population models with predation: a case study with the North American moose. Ecology 75:478-488.

Moose Conservation Closure Regulation 122/2011. Available online at http://www.web2.gov.mb.ca/laws/regs/w130e.php

Osborne, T .O., T.F. Paragi, J.L. Bodkin, A.J. Loranger and W.N. Johnson. 1991. Extent, causes and timing of moose calf mortality in western interior Alaska. Alces 27:24-30.

Parker, G.R. 1973. Distribution and densities of wolves within barren-ground caribou range in northern mainland Canada. Journal of Mammalogy 54:341-348.

Parker, K.L., C.T. Robbins, and T.A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. Journal of Wildlife Management 48(2): 474-488.

Peterson, R.O. 1977. Wolf ecology and prey relationships on Isle Royale. U. S. National Park Service Scientific Monograph Series 11. 210 pp.

Peterson, R.O. and P. Ciucci. 2003. The wolf as a carnivore. 104-130 in: Wolves: Behavior, Ecology and Conservation. L.D. Mech and L. Boitani, eds. University of Chicago Press. 448 pp.

Pettorelli, N., T. Coulson, S.M. Durant, and J.-M. Gaillard. 2001. Predation, individual variability and vertebrate population dynamics. Oecologia 167: 305-314.

Seip, D.R. 1991. Predation and caribou populations. Proceedings of the Fifth North American Caribou Workshop: 46-52.

Solberg, E.J., B.-E. Saether, O. Strand, and A. Loison. 1999. Dynamics of a harvested moose population in a variable environment. Journal of Animal Ecology 68(1): 186-204.

Species at Risk Act, S.C. 2002, c.29.

Split Lake Resource Management Board. 1994. Moose conservation plan. Produced by the Split Lake Resource Management Board and Manitoba Conservation.

TCN Adverse Effects Agreement (2009). Available online at http://www.hydro.mb.ca/projects/keeyask/tataskweyak_aea.pdf

Timmerman, H.R. and M.E. Buss. 2007. Ecology and management of the North American Moose. In Population and Harvest Management. Edited by A. Franzmann and B. Schwartz. Wildlife Management Institute, Boulder, CO. pp. 559-615.

WLFN Adverse Effects Agreement (2009). Available online at http://www.hydro.mb.ca/projects/keeyask/war_lake_aea.pdf