Human Development

To identify the quantities of primary and secondary moose habitat lost between the pre-and post-hydroelectric development periods, the terrestrial habitat model indicating the portions of primary and secondary habitat available (Table 6.10.5-3) was applied to the size of the human footprint.

Human development resulted in the loss of regional primary and secondary moose habitat in the Taiga Shield Ecozone (Table 6.10.5-4). The loss of moose habitat due to infrastructure and flooding was less than 1% in the Bradshaw (0.02%) and Upper Churchill (<0.01%) terrestrial regions, but was 1% of the habitat available in the Southern Indian Terrestrial Region. Overall, the loss of moose habitat in the Taiga Shield Ecozone due to human development was 0.32%. The portion of human development attributable to hydroelectric development in each ecozone and terrestrial region was effectively 100% due to the relative absence of other development features. Due to this there is no difference in the calculated totals for the percent of the region as affected by hydroelectric development and the total for all development projects combined (Table 6.10.5-4). Once exception to this is the calculated portion of human development for Southern Indian Region which indicates that habitat loss due to hydroelectric development was 0.98% of available habitat but where overall there was 1.00% habitat loss.

There was no terrestrial moose habitat lost due to flooding in the Bradshaw and Upper Churchill terrestrial regions. In the Southern Indian Terrestrial Region, however, there was a loss of 12,844 ha of habitat through flooding. Based on the habitat model, the amount of flooding reduced the amount of available primary habitat by 7474 ha and the amount of secondary habitat by 5370 ha (Table 6.10B.5-4). Further change and loss of moose habitat are reviewed for shore zone wetlands, shore bank height, shoreline debris and shoreline width attributes in the On-system Habitat Loss section, below.
Table 6.10.5-4: Regional Effects of Hydroelectric Development on Primary and Secondary Moose Habitat in the Taiga Shield Ecozone

<table>
<thead>
<tr>
<th>Moose Habitat</th>
<th>Terrestrial Region (TR) or Ecozone</th>
<th>Habitat (ha) Pre-Hydro</th>
<th>Habitat (ha) Post-Hydro</th>
<th>% of Region Affected by Human Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Bradshaw TR</td>
<td>568,936</td>
<td>568,818</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Upper Churchill TR</td>
<td>759,551</td>
<td>759,519</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Southern Indian TR</td>
<td>774,929</td>
<td>767,216</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Taiga Shield Ecozone</td>
<td>2,100,085</td>
<td>2,093,298</td>
<td>0.32</td>
</tr>
<tr>
<td>Secondary</td>
<td>Bradshaw TR</td>
<td>876,900</td>
<td>876,716</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Upper Churchill TR</td>
<td>676,545</td>
<td>676,517</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Southern Indian TR</td>
<td>556,793</td>
<td>551,251</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Taiga Shield Ecozone</td>
<td>2,113,569</td>
<td>2,106,739</td>
<td>0.32</td>
</tr>
<tr>
<td>Total</td>
<td>Bradshaw TR</td>
<td>1,445,836</td>
<td>1,445,534</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Upper Churchill TR</td>
<td>1,436,096</td>
<td>1,436,036</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Southern Indian TR</td>
<td>1,331,722</td>
<td>1,318,467</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Taiga Shield Ecozone</td>
<td>4,213,654</td>
<td>4,200,037</td>
<td>0.32</td>
</tr>
</tbody>
</table>

1. Total accounts for hydroelectric and other cumulative factors affecting habitat loss.

The quantity of terrestrial shoreline moose habitat was affected by CRD and the dewatering of the lower Churchill River. For the Taiga Shield Ecozone as a whole, 15,859 ha of terrestrial land area was added to the ecozone post-hydroelectric development from dewatering. This habitat change is treated primarily in On-system Habitat Loss. For example, some dewatered areas have a potential for increased willow growth which moose feed on which can benefit moose (Brandson 2012; D. Hedman pers. comm. 2015).

Negative effects include changes in shoreline width and reduced shoreline access through increased debris levels. The breakdown of dewatered habitat by terrestrial region includes 1437 ha in the Bradshaw, 12,031 ha in the Upper Churchill, and 2391 ha in the Southern Indian terrestrial regions.

Fragmentation

Harvester and predator access to moose populations can be assessed, in part based on the extent of anthropogenic linear features occurring on the landscape. As of 2013 for the Taiga Ecozone, linear feature density was 0.01 km/km² (Intactness, Table 6.2.5-2). This level of linear feature density corresponds to a low level of disturbance. Fragmentation was < 0.01 km/km² for linear features attributed to hydroelectric development (transmission lines, access roads), with <0.01 km/km² of linear features associated with other non-hydroelectric anthropogenic development (e.g., provincial roads, railways).

Only limited quantities of transmission lines (94 km) exist throughout the entire ecozone, but form the basis of approximately 34% of the linear features present (Intactness, Table 6.2.5-2). In total, hydroelectric infrastructure comprises 70% of the linear features present in this ecozone.
Intactness varied by terrestrial region within the Taiga Shield Ecozone, with hydroelectric development starting in the Bradshaw and Upper Churchill terrestrial regions in 1974 and in Southern Indian Terrestrial Region in 1971 (Intactness, Section 6.2.5). The onset of hydroelectric development for the Bradshaw and Upper Churchill terrestrial regions is based on the date the CRD came into operation and affected these terrestrial regions through changes in river flow, and are not based on the construction dates for the linear features. Prior to hydroelectric development, the Upper Churchill and Southern Indian terrestrial regions did not have linear features present. In 2013, linear feature densities remained below the 0.01 km/km$^2$ level for both the Bradshaw and Upper Churchill terrestrial regions but was about 0.01 km/km$^2$ in the Southern Indian Terrestrial Region. All linear feature densities at the terrestrial region level indicated a low level of potential effects on moose. The quantity of linear features associated with the hydroelectric development in each of the terrestrial regions is less than 0.01 km/km$^2$ (Map 6.10.4-2).

**On-System Habitat Loss**

Flooding on Southern Indian Lake has impacted riparian areas, which were previously identified as being high quality moose habitat capable of sustaining high moose densities (Goulden et al. 1968)

The quality of moose habitat has declined dramatically on the shorelines of Southern Indian Lake, as a result of flooding and the operation of the CRD since full supply level was reached in 1976, and subsequently with the Augmented Flow Program. Flooding on Southern Indian Lake, including the flooding of forested areas adjacent to the lake, reduced the amount of high quality riparian habitat. In the process, flooding has permanently altered shoreline habitats which were previously used to a large extent by the local moose population. Water level regulation also resulted in the slumping of trees in forested peatlands that were adjacent to the water (Photo 6.10.5-1). These trees become shoreline debris in the lake (D. Hedman pers. comm. 2015). Over time, slumping has also increased erosion along shorelines, further changing riparian areas in ways that are unsuitable for moose.

The flooding of Southern Indian Lake reduced the availability of aquatic vegetation preferred by moose. Shallow water areas that previously supported aquatic plant growth are no longer found on the lake due to the high water levels maintained by water regulation and due to continued erosion and sediment deposition (Photo 6.10.5-2) (D. Hedman pers. comm. 2015). The impoundment of Southern Indian Lake not only changed the environmental growing conditions under which aquatic plants had previously thrived, it made any remaining aquatic plants inaccessible to moose, which tend to forage in shallow water. On-going effects include the continued melting and erosion of permafrost and peatlands. Finally, new shorelines do not appear to sustain the aquatic forage plants species preferred by moose due to shoreline soil composition and growing conditions than had occurred prior to the CRD.

The flooding of forested areas on Southern Indian Lake resulted in the creation of debris, mainly comprised of dead trees which still litter shorelines almost 40 years post-impoundment (D. Hedman pers. comm. 2015). Shoreline tree debris is problematic to moose because it decreases accessibility of shoreline habitats, including islands on the lake, which play a beneficial role to moose cows during the calving and post-calving periods. While some clearing of a small portion of forested areas in the flooded area occurred in anticipation of flooding, the continued erosion of shoreline areas has since added to the level of shoreline debris.
The dewatering of the lower Churchill River, as a result of CRD, has led to increased shoreline width in some areas (Photo 6.10.5-3). In these areas there is often increased willow growth that is suitable as moose forage (Brandson 2012; D. Hedman *pers. comm.* 2015); however, there are also often negative impacts associated with increased shoreline width and debris (see Human Development section, above). Riparian and wetland areas considered as good moose habitat are those which have minimal human development and are naturally occurring. Wetland areas often occur within proximity to other habitat types which moose can make use of for forage and cover (Photo 6.10.5-4) (D. Hedman *pers. comm.* 2015). The shallow portions of lakes are particularly important as sources of aquatic vegetation as well as for thermoregulation and insect avoidance in the summer months (Photo 6.10.5-5).

Photo 6.10.5-1: Example of Shoreline Debris and Erosion on Southern Indian Lake

Source: D. Hedman, June 2015
Photo 6.10.5-2: Example of Eroding Island in South Indian Lake

Photo 6.10.5-3: Example of the Lower Churchill River Shorelines Following the Churchill River Diversion
Photo 6.10.5-4: Example of Moose Habitat in an Off-system Area

Photo 6.10.5-5: Example of Moose Habitat in an Off-system Lake
On-system habitat was evaluated for the Upper Churchill and Southern Indian terrestrial regions within the Taiga Shield Ecozone. The Southern Indian Terrestrial Region was primarily impacted through flooding associated with the CRD while the Upper Churchill Region was affected through the dewatering of the Churchill River, both resulting from the same project. It is expected that the Bradshaw Terrestrial Region, located along the Churchill River, would have also been affected through dewatering although, due to data limitations, was not evaluated.

Multiple on-system habitat attributes were used to assess moose habitat change: shore zone wetland habitat, offshore wetland habitat, shoreline debris and the presence of tall shrub communities. A description of the models used to assess changes in available moose habitat can be found in Appendix 6.10A.

For the Taiga Shield Ecozone, changes in the quantity of high, moderate and low quality shore zone wetland habitat were identified by comparing the pre- and post-hydroelectric development periods (Figure 6.10.5-1). For the Upper Churchill Terrestrial Region, there has a small decrease (21.0 to 15.2%) in high quality habitat but a large increase in moderate habitat (0.1 to 67.4%). This is likely due to the dewatering of the Churchill River creating suitable moose habitat, which was comparatively limited prior to the CRD. The Southern Indian Terrestrial Region had almost its entire area of high quality wetland habitat depleted (8.0 to 0.3%), with a slight increase in moderate habitat (4.0 to 4.8%). Detailed calculations showing changes in shore zone wetland habitat types are presented in Tables 6.10B.5-5 and 6.10B.5-6.
Changes in offshore wetlands were also apparent in comparing the pre- and post-hydroelectric development periods (Figure 6.10.5-2). The Upper Churchill Terrestrial Region experienced a small decrease in high quality offshore wetland habitat (7.0 to 6.0%) with a comparatively larger increase in moderate quality habitat (0.3 to 15.5%). This increase in moderate habitat is likely due to the dewatering process creating additional shallower, wetland areas. In the Southern Indian Terrestrial Region, there was a decrease in high quality wetland habitat (2.8 to 1.1%) but a small increase in moderate quality wetland habitat (0.2 to 1.3%). Detailed calculations showing changes in offshore wetland areas have been presented in Tables 6.10B.5-7 and 6.10B.5-8.
There was no change in levels of shoreline debris pre- and post-hydroelectric development for the Upper Churchill Terrestrial Region (Figure 6.10.5-3). There was, however, an increase in the levels of shoreline debris in the Southern Indian Terrestrial Region. This is based on the increase in shoreline areas with “difficult” access from 0 to 8.3% and areas with “moderate” access from 0 to 21.3%. Based on increased levels of shoreline debris, it is expected that moose have more difficulty accessing shoreline areas, with shoreline areas also being less accessible to harvesters. A further description in the changes of shoreline debris in these terrestrial regions can be found in Tables 6.10B.5-9 and 6.10B.5-10.
The vegetative characteristics of shorelines can often be affected through changes in the water regime, such as changes in tall shrub communities occurring in riparian areas. Increases in tall shrub communities can provide moose with less access to shoreline areas, while also supplying a source of forage that was previously unavailable. Increases in tall shrub communities, such as willows, can also serve to limit harvester access and visibility to shoreline areas and therefore limit harvest opportunities.

Riparian tall shrub communities increased within the Upper Churchill and Southern Indian terrestrial regions from the pre- to the post-hydroelectric development period (Figure 6.10.5-4). In the Upper Churchill Terrestrial Region, shoreline areas consisting of high quantities of tall shrubs increased from 4.3 to 5.8%. For the Southern Indian Terrestrial Region the increase was less marked, changing from 0.2 to 0.8%. A further description of those changes in tall shrub communities can be found in Tables 6.10B.5-11 and 6.10B.5-12.
Predation

Incidental observations of wolves were recorded by Elliot (1985). In particular, of nine occurrences where wolves were observed, three were adjacent to a moose kill. Only a single wolf occurrence was recorded in the Taiga Shield Ecozone north of Waskaiowaka Lake, inside the Upper Churchill Terrestrial Region. Elliot (1985) indicated that although wolf tracks and kill sites were located throughout the survey area, predation was not a serious limiting factor for moose populations at that time.

Probable levels of moose predation by wolves was calculated for each MMU surveyed in the Split Lake RMA (CNP 2013). For the five MMUs which occur or partially occur within the Taiga Shield Ecozone (the Manteosippi, Oopawaha, Numaykoosani, Kakwasanseesi and Wasekanooses MMU), levels of predation ranged from 6.5% (Wasekanooses) to 13.2% (Oopawaha) of the total moose population yearly (Table 6.10E-1). These quantities include predation levels associated with resident wolf packs, as well as transient wolf packs moving into the Split Lake RMA when following migratory caribou herds.

In the Split Lake RMA, wolf pack locations were identified based on ATK, local knowledge, aerial surveys as well as from moose biomass estimates. In particular, the Kakwasanseesi and Oopawaha MMU were demonstrated to have six of the 10 resident wolf packs in the Split Lake RMA occurring within its borders.
The Manteosippi and Numaykoosani MMU had little to no interaction with the 10 identified wolf packs. This was in part based on the absence of high moose densities in these MMUs and which would otherwise be needed to support a wolf pack.

Linear features may be associated with predator movement corridors for species such as grey wolf, for example, in hunting for prey species such as moose. However, as linear feature density levels are low (<0.01 km/km²) in the Taiga Shield Ecozone, it is not expected that increased fragmentation levels post-hydroelectric development have contributed to considerable increases in wolf efficiency in accessing moose populations. In dewatered areas along the Churchill River, there is a potential for increased moose densities based on increased willow growth in the dry riverbed, which may precipitate increased wolf densities in some localized areas.

**DISEASE AND PARASITES**

The northern range of white-tailed deer is likely limited by the severity of the winters and the limited food supply (MCWS 2014a). There are no recently published occurrences of white-tailed deer in the Taiga Shield Ecozone. Incidental observations of white-tailed deer are infrequently reported. The Taiga Shield Ecozone is comprised of portions of GHAs 1 and 9, both of which are not within an identified Deer Hunting Zone recognized by MCWS (2013). As such, there is assumed to be little potential for the spread of brainworm from deer to moose, and there have been no recorded occurrences of moose fatalities occurring through brainworm transmission in northern Manitoba.

**HARVEST**

Portions of GHAs 1 and 9 coincide with the Taiga Shield Ecozone (Map 6.10.5-2). These GHAs experience varying degrees of harvest pressure based on the length of the hunting season and restrictions placed on which moose can be harvested. In this region, the use of motorized off-road vehicles is permitted during the hunting season to facilitate harvester access to moose populations.

The Taiga Shield Ecozone has been characterized as having relatively low levels of moose harvest. This is primarily due to limited access within this area relative to other potential hunting locations. In the early 1970s (Figure 6.10G-9), as part of the Northern Region which comprised of GHAs 1–11 at this time GHA 1 was considered an inaccessible harvest area. GHA 9 was considered an accessible harvest area (i.e., where many harvest areas were accessible by car) (Jahn 1977)). Moose harvest in the combined Split Lake – Nelson House survey area (Figure 6.10G-7) had light harvest pressure based on few people travelling throughout the area. Access was limited mainly to travelling rivers and lakes. Elliot (1985) indicated that the Churchill, Burntwood, Odei and Nelson rivers and their associated lakes provided good access to hunting areas, and that PR 280 provided access to very good moose habitat in proximity to Split Lake. However, much of the larger Split Lake RMA (Map 6.10E-1), particularly those portions inside the Taiga Shield Ecozone, remained inaccessible to harvesters due to the absence of roads and access routes.

In 1974, GHA 9 had a relatively sparse moose population, but there was a high local hunter population from the surrounding communities including Thompson and Nelson House (Jahn 1974). For GHA 1, Jahn (1975, 1977) indicated there was little information available on moose hunting levels although most
harvesters tended to be local resource users. For the 1974 season, it was noted however that in the Gillam area there were 54 known kills (25 of which were domestic harvest) with an additional 10 probable (Jahn 1975). This level of moose harvest was the first reported moose harvest of this magnitude and it may be due to increased interest and utilization of areas once considered less important. While hydroelectric developments were not explicitly identified as causing an increase in harvest pressure, the Kettle GS was being built around this time. Based on the location of the Taiga Shield Ecozone relative to the lower Nelson River and the community of Gillam, there may have been some light increased hunting pressure in the Taiga Shield Ecozone as a result, but most of this increase would have occurred in the Eastern Boreal Shield and Hudson Plains ecozones.

Aerial surveys conducted for GHA 9 in 2000 indicated relatively low hunting pressure with no need for more restrictive hunting regulations to sustain the moose population (Elliot and Hedman 2001). In GHA 9 these low levels of harvest pressure were partially based around low levels of harvester access where southern GHAs (particularly 9a) was indicated as having a higher level of harvester access from road networks developed to sustain forestry activities. Linear feature density has not changed substantially from pre-hydroelectric to post hydroelectric development (Intactness, Table 6.2.5-2) in the Taiga Shield Ecozone. Based on the low levels of linear features in all the terrestrial regions, and the Taiga Shield Ecozone as a whole, it is likely that there has only been a very limited increase in harvester efficiency. It should be noted that prior to hydroelectric development there were no linear features present in either the Southern Indian or Upper Churchill terrestrial regions that may have increased harvester access in these areas.

Moose hunting on Southern Indian Lake was once associated with fishing activities, especially in late fall, and most moose were taken along the shoreline of the lake. Following the CRD, there was reduced moose harvest potential for residents of Southern Indian Lake. This was based on the flooding of shoreline areas destroying moose feeding areas and, as a result, reducing the number of moose occurring, visible, and accessible on shorelines that had been prime hunting areas (LWCNRSB 1975, D. Hedman pers. comm. 2015). Currently, this problem of reduced moose availability for harvesters is not apparent on lakes located off-system from Southern Indian Lake and the Churchill River. Instead, these declines have been localized to shorelines around Southern Indian Lake (D. Hedman pers. comm. 2015).

To offset the effects of the Keeyask Generation Project on traditional practices and customs (which would include reduced opportunities to hunt moose in the immediate Project footprint), TCN and WLFN each negotiated Adverse Effects Agreements, under which community-specific Offsetting Programs are run. Among a wide range of programs to facilitate a continued relationship with the land in the Split Lake RMA, the TCN Access and WLFN Improved Access programs, while not specifically hunting programs, facilitate the domestic harvest of moose outside of project-affected areas. As one means of increasing access among these programs, resource users have an opportunity to be flown out to traditional hunting areas and distribute harvest pressure more broadly, irrespective of access corridors.

Moose harvest levels in the Split Lake RMA were assessed in the preparation of the Moose Harvest Sustainability Plan (CNP 2013). Of the seven MMUs in the Split Lake RMA, five occur or partially occur within the Taiga Shield Ecozone, including the Manteosippi, Oopawaha, Numaykoosani, Kakwasanseesi and Wasekanoosees MMU (Map 6.10E-1). In assessing what level of domestic harvest is sustainable
from each MMU, non-resident and resident licensed harvest, and other moose mortality sources were considered (CNP 2013).

A range of harvest levels were reported for MMUs in the Split Lake RMA based on the contribution of moose harvested by band members as well as based on resident and non-resident licensed harvesters (Table 6.10E-1). When considering levels of domestic harvest alone, those levels were highest in the Oopawah MMU with 24 moose, or 10.2% of the population, harvested yearly. The Numaykoosani MMU had a single moose harvested for domestic consumption which is less than 1% of the population being harvested yearly. The annual rate of licensed and domestic moose harvest ranges from 3.4%, in the Manteosippi MMU, to 18.7% of the population, in the Oopawah MMU.

6.10.5.2 Cumulative Effects of Hydroelectric Development

6.10.5.2.1 Regional Effects

INDICATOR RESULTS

The Taiga Shield Ecozone is found towards the northern fringe of the known moose range in Manitoba. Moose populations in this area are naturally sparsely distributed but have had the potential to be affected by various land use projects, including hydroelectric development. Those factors which have potentially affected moose populations in the Taiga Shield Ecozone are summarized in Table 6.10.5-5.
### Table 6.10.5-5: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Taiga Shield Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydroelectric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size</td>
<td>Population estimates, density</td>
<td>Early 1950s RTL Section Reports</td>
<td>Split Lake, Nelson House and South Indian Lake (c. 1985) – 871 moose (LCI 1129, UCI 2613) 0.05 moose per km²</td>
<td>In the early 1950s there was little certainty as to moose population growth trends in the ecozone. Predator control program in place from the 1950s to 1970 was thought to have increased moose populations. Consecutive aerial surveys around the Split Lake Resource Area indicated strong possibility of stable to increasing moose populations. The portion of Southern Indian Lake identified as having a high moose density in the 1950s had much lower moose densities when surveyed in 1973 and 1984. Aerial surveys conducted of the NFA Moose Survey area and GHA 9 indicate stable to increasing moose population densities from 1984 to 2000.</td>
<td>Hydroelectric development has influenced moose populations in the Taiga Shield Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Indian Lake 0.027 to 0.037 moose per km²</td>
<td>Split Lake 0.006 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Split Lake 0.020 to 0.030 moose per km²</td>
<td>Split Lake – Nelson House (c. 1985) - 750 moose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bryant (1955) Range of moose densities from &lt;0.013 moose per km² to 0.386 moose per km²</td>
<td>Split Lake – Nelson House (c. 1986/87) - 904 moose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High densities west of South Indian Lake at 0.077 to 0.386 moose per km²</td>
<td>Split Lake Resource Management Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited information available for low density moose areas based on lack of survey information</td>
<td>Mantecosipi MMU (c. 2010) – 410 moose, 0.046 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Howard and Larche (1975)</td>
<td></td>
<td>0.04 moose per km² over the area of interest based on types of habitat available.</td>
<td>Oopawahwa MMU (c. 2010) – 235 moose, 0.046 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Indian Lake Area</td>
<td></td>
<td>0.10 moose per km² (c. 1973)</td>
<td>Numaykoosani MMU (c. 2010) – 190 moose, 0.030 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFA Aerial Surveys</td>
<td>Kakwasanseesi MMU (c. 2010) – 502 moose, 0.086 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Split Lake Resource Management Area</td>
<td>Wasekanosees MMU (c. 2010) – 369 moose, 0.086 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Good calf production” (c. 1993)</td>
<td>GHA Aerial Surveys</td>
<td>Recruitment rates are not available for pre-hydroelectric development period. Aerial surveys conducted of the NFA Moose Survey area and GHA 9 indicate stable to increasing moose population densities from 1984 to 2000.</td>
<td>Hydroelectric development has influenced moose recruitment in the Taiga Shield Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td></td>
<td>Recruitment rates</td>
<td>No data available</td>
<td>GHA 9 (c. 2000) – 6822 moose (LCI – 3406, UCI – 10238) 0.116 moose per km²</td>
<td>Recruitment rates for the portion of the Taiga Shield occurring within the Split Lake RMA indicated stable to potentially increasing moose population from 1993 to 2010.</td>
<td></td>
</tr>
</tbody>
</table>
Table 6.10.5-5: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Taiga Shield Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydroelectric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>ha of high quality habitat by type</td>
<td>Moose densities highest in riparian and recently burnt areas.</td>
<td>Reduced availability of habitat in each terrestrial region (TR): Bradshaw TR (-0.02%) Upper Churchill TR (-0.01%) Southern Indian TR (-1.00%) Taiga Shield Ecozone (-0.32%) in the Southern Indian TR and 32 km in the Upper Churchill TR based on reduced shoreline width.</td>
<td>Habitat loss through flooding and anthropogenic land uses. Less potential primary moose habitat than was available pre-hydroelectric development.</td>
<td>Hydroelectric development has influenced moose habitat in the Taiga Shield Ecozone. Benchmarks: Moderate for the Southern Indian Terrestrial Region. Low for the Bradshaw and Upper Churchill terrestrial regions as well as Taiga Shield Ecozone as a whole.</td>
</tr>
<tr>
<td>Percentage on-system high quality riparian habitat</td>
<td>Shore zone wetland</td>
<td>Upper Churchill - 21.0% high, 0.1% moderate Southern Indian - 6.0% high, 4.0% moderate</td>
<td>Riparian habitat in Southern Indian Terrestrial region affected by changes related to the CRD, particularly flooding of Southern Indian Lake. Riparian habitat in the Upper Churchill Terrestrial Region affected through the dewatering of the low Churchill River as a result of the CRD. Reduced high quality shore zone wetland habitat for Southern Indian Terrestrial Region. Considerably increased shoreline debris in Southern Indian Terrestrial Region, which has served to limit moose and harvester access to shoreline areas. Far increased moderate quality shore zone wetland habitat in the Upper Churchill Terrestrial Region.</td>
<td>No riparian information available for the Bradshaw Terrestrial Region, which was affected through dewatering of the Churchill River. Similar effects expected as to Upper Churchill Terrestrial Region.</td>
<td>Hydroelectric development has influenced moose habitat in the Taiga Shield Ecozone. Benchmarks: Low for the Bradshaw and Upper Churchill terrestrial regions. Moderate for the Southern Indian Terrestrial Region.</td>
</tr>
<tr>
<td></td>
<td>Offshore wetland</td>
<td>Upper Churchill - 7.0% high, 0.3% moderate Southern Indian - 2.8% high, 0.2% moderate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoreline debris</td>
<td>Upper Churchill - 100.0% easy access Southern Indian - 100.0% easy access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tall shrub communities</td>
<td>Upper Churchill – 4.3% high, 95.7% low Southern Indian - 0.2% high, 99.8% low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest</td>
<td>Change in harvest pressure</td>
<td>Most of northern Manitoba considered inaccessible to non-Treaty harvest. Fluctuations in moose harvest based on availability of other game species (i.e. migratory caribou). Typically reduced moose populations within close proximity to communities. Domestic and licensed harvest primarily based on access including roads and waterways. Harvest of moose in northern portions of Taiga Shield Ecozone limited because of sparse distribution and limited access. No linear features present in the Southern Indian or Upper Churchill TRs. Only low levels of linear features present in Bradshaw TR based on rail line running through far-eastern portion of area. Early 1950s RTL Reports South Indian Lake – 5 – 10% of moose population harvested annually.</td>
<td>GHAs 1and 9 still largely inaccessible post-hydroelectric development. Indication of increased harvest around Gillam in the 1970s when hydroelectric development activities were occurring. May have contributed to moose harvest in the Taiga Shield Ecozone. Level of access remains low based on constructed linear features (see Fragmentation Indicator) Split Lake Resource Management Area Manteosippi MMU (c. 2010) – 14 moose harvested annually (3.41% of population) Ooporaha MMU (c. 2010) – 44 moose harvested annually (18.72% of population) Numaykoosani MMU(c. 2010) – 9 moose harvested annually (4.74% of population) Kikivaseemawen MMU (c. 2010) – 28 moose harvested annually (0.56% of population)</td>
<td>The accessing of moose pre-hydroelectric development was done in a largely limited way and restricted based on limited access into moose population areas. Water travel was important to access moose populations. In areas close to human settlement or where there has been increased linear feature development there is the potential for increased harvester access. Harvest pressure has remained fairly consistent. The rate of moose harvest in the1950s ranged from 2 to 14% of the population where harvest levels in the Split Lake RMA in 2010 ranged from 3 to 19%. Based on small increases in linear feature density, the Taiga Shield Ecozone remains largely inaccessible. This is supported by the GHAs in this area currently considered as part of northern zone were the distribution of roads and licensed harvesters is considered to be sparse. Flooding of Southern Indian lake has resulted in a considerable reduction moose harvest opportunities from this area.</td>
<td>Hydroelectric development has influenced moose harvest in the Taiga Shield Ecozone by increasing access. Benchmarks: Low for the Bradshaw, Upper Churchill and Southern Indian terrestrial regions as well as Taiga Shield Ecozone as a whole.</td>
</tr>
</tbody>
</table>
### Table 6.10.5-5: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Taiga Shield Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydroelectric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Split Lake – 2% of moose population harvested annually.</td>
<td>Wasekanoooses MMU (c.2010) – 14 moose harvested annually (3.79% of population)</td>
<td>Reports of substantially reduced harvest opportunities around Southern Indian Lake as a result of impoundment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nelson House – 8 – 14% of moose population harvested annually.</td>
<td></td>
<td>Offsetting program available to community members at Tataskweyak Cree Nation and War Lake First Nation to harvest moose throughout the Split Lake Resource Management Area and allow for the distribution of harvest pressure among MMUs, regardless of road access.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prior to CRD</td>
<td>Approximately 50 moose harvested annually from shores of Southern Indian Lake.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fragmentation</td>
<td>km/km² of linear features</td>
<td>From Intactness Section (6.2.5): Bradshaw TR - &lt;0.01 km/km²</td>
<td>Low fragmentation levels pre-hydroelectric development based on near absence of linear features. This includes the absolute absence of linear features in two terrestrial regions: Upper Churchill and Southern Indian. Pre- and post-hydroelectric development, fragmentation mostly increased within the Southern Indian Terrestrial Region but levels still remain low. Based on low linear feature density levels, there has likely been little increase in harvester or predator access to moose populations.</td>
<td>There has been little increase in linear features in the Taiga Shield Ecozone since the pre-hydroelectric development period.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Upper Churchill TR - 0 km²/km²</td>
<td></td>
<td>Benchmark: Low for the considered terrestrial regions and Taiga Shield Ecozone as a whole.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Southern Indian TR - 0 km²/km²</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Taiga Shield Ecozone - &lt;0.01 km²/km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disease and Parasites</td>
<td>Distribution of white-tailed deer</td>
<td>Sparse distribution of white-tailed deer based on trapper reports.</td>
<td>No occurrences of white-tailed deer have been reported in the Taiga Shield Ecozone other than anecdotal reports, and this area is thought to be outside the historic and current range of this species. Limited potential for brainworm to be spread from white-tailed deer to moose in this ecozone. There are no known reports of brainworm in northern Manitoba.</td>
<td>Hydroelectric development has not changed deer distribution in the Taiga Shield Ecozone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Early 1950s RTL Reports South Indian Lake – none recorded</td>
<td>No reports of brainworm.</td>
<td>Benchmark: No change - white-tailed deer populations have not expanded into the ROI compared to pre-hydroelectric development.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Split Lake – none recorded</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Nelson House - 0.008 deer per km² (Nelson House RTL only occurs within a limited portion of ecozone)</td>
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<td></td>
<td></td>
<td></td>
<td>No reports of brainworm.</td>
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<td></td>
<td></td>
<td></td>
<td>Taiga Shield Ecozone occurs outside of licensed deer hunting areas established by Manitoba Conservation and Water Stewardship.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>No reports of brainworm.</td>
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</tbody>
</table>
EVALUATION OF EFFECTS

Based on available information, the selected indicators for moose, such as modelled habitat loss and alteration associated with flooding, dewatering, infrastructure, water regulation and fragmentation remained in the low magnitude of effects range for the ecozone as a whole. Habitat quality throughout much of this ecozone is limited, with only a smaller portion being considered productive moose habitat capable of supporting high moose densities, as found by Elliot (1985, 1986a), with the productivity of that habitat strongly affected by age after fire. The Taiga Shield Ecozone, particularly the northern sections for example, contain heath and bog habitat which is generally not used by moose and only supports low moose densities. The habitat model used in this RCEA focused on the availability of habitat areas associated with more productive forests and recent forest fires. Since the time of Elliot’s (1985, 1986a) observations, based on the habitat modelling results for the current period, there is likely an abundance of young forest in the Taiga Shield Ecozone, but the extent to which it may support increased moose densities is less apparent.

Although only a limited amount of terrestrial moose habitat has been affected in the Taiga Shield Ecozone, the quality of moose habitat has been considerably reduced for on-system waterbodies, where moose densities were likely higher pre-hydroelectric development. The most substantial change has been a decline of high quality wetland habitat along affected shorelines that moose had relied on for food, nutrients, insect relief, escape cover, and thermoregulation. Changes in water regime resulting from the CRD have permanently reduced the quality of moose habitat. In particular, the flooding and water regulation of Southern Indian Lake resulted in a net decrease of available shore zone and offshore wetlands, which was critically important for supporting the local moose population. Continued erosion of shorelines and the inability of the aquatic plant community to recover on Southern Indian Lake continues to diminish the quality of shoreline habitat and also contributes to levels of shoreline debris that further limits moose use of shorelines. Based on these factors, and others, the Southern Indian Terrestrial Region was identified at the low end of the moderate magnitude scale for habitat loss.

Increased access in the Taiga Shield Ecozone occurred with the development of linear features (i.e., roads, transmission lines), and improved the accessibility of moose populations to harvesters. To date, hydroelectric development contributed about 70% of the increase in linear features (including transmission lines) and therefore, to potential increased access. Compared to benchmarks, linear feature density is low, and is in the small magnitude of effects range. Transmission line ROW are low-use access features compared with roads because they are not constructed to support traffic and because the terrain in the ecozone limits their use to the winter along much of their length. Although it is unclear how a specific moose subpopulation might have been affected by the change, high density moose areas (which are often clustered) can be disproportionately affected through increased demand and harvest opportunities. Based on available rates of moose harvest for the pre- and post-hydroelectric development period, the rate of moose population harvest has remained stable at between 3 to 18% annually.

Prior to hydroelectric development, moose harvest in the Taiga Shield Ecozone was primarily limited to areas along waterways. Following hydroelectric development, much of this access has been reduced as a result of reduced suitability of shoreline habitat areas for moose hunting, as well as the reduced flow of
the Churchill River. Flooding of Southern Indian Lake limited the use of this area for harvesters and has
negatively impacted harvest opportunities, particularly the domestic harvest of moose by residents of
South Indian Lake (Summary of Community Information, Section 3.5.11). Dewatering of the lower
Churchill River within the Taiga Shield Ecozone further reduced potential harvester access along the river
as compared to the level of harvester access prior to hydroelectric development. The includes
consideration of some of the smaller rivers branching off the lower Churchill River becoming dried up and
no longer being accessible as waterways.

A comparison of the Bradshaw, Upper Churchill and Southern Indian terrestrial regions indicates that the
Southern Indian Terrestrial Region has been subject to the majority of environmental effects in the Taiga
Shield Ecozone. This includes a moderate magnitude level of habitat loss; largely due to the flooding of
12,844 ha of terrestrial habitat in this terrestrial region. The Bradshaw and Upper Churchill terrestrial
regions had low magnitude levels of habitat loss, where some additional short-term habitat was gained
based on the dewatering of the Churchill River, resulting in growth on the margins of moderate quality
shore zone wetland habitat and early successional age forest species. Billard, Fidler and Northern Indian
lakes continue to be important moose areas due to the presence of suitable marsh habitat (D. Hedman
pers. comm. 2015). The Southern Indian Terrestrial Region also saw the largest increases in linear
feature density to 0.01 km/km². Although this level of fragmentation is associated with only low magnitude
level of effects, this is higher than what occurred in the Bradshaw and Upper Churchill terrestrial regions.

No change occurred for white-tailed deer in the ecozone, which therefore posed no increased risk to
moose populations through transmission of brainworm.

Based on a low abundance of gray wolves in the region and limited change in the density and distribution
of linear features, increased predation is not expected to have had substantial effects on the moose
population. There is a potential for localized increases in the moose population based on the short-term
creation of high quality habitat areas, including those riverbed areas on the Churchill River which
following dewatering supported early successional stage forest species preferred by moose.

Overall, although occurring at low population densities both pre- and post-hydroelectric development, the
moose population in the Taiga Shield Ecozone appears to remain stable and to not have been
considerably adversely affected by hydroelectric development. Uncertainty is moderate because of the
lack of population information from the pre-hydroelectric development period, and from the area
surrounding Southern Indian Lake. However, recent recruitment rates for moose in the Split Lake RMAs
are high, and suggest a growing moose population in that area.

REGионаl CUMULATIVE EFFECTS CONCLUSION

While the cumulative effects of human development, including hydroelectric development, on the moose
population in the Taiga Shield Ecozone have been adverse, these effects remain within the low to
moderate range in terms of magnitude. The effects of hydroelectric development have been particularly
apparent in the Southern Indian Terrestrial Region, where flooding associated with the CRD depleted
shore zone habitats and led to considerably less moose using near-shore areas and diminished harvest
opportunities. The effects of the dewatering of the lower Churchill River on moose populations is less
certain but there is expected to have been an overall reduction in harvester access. Based on recent
survey results, moose populations appear to be stable to increasing in much of Taiga Shield Ecozone. This result is based, however, mainly on surveys from the taiga portions of the Split Lake RMA in the Upper Churchill and Bradshaw terrestrial regions.

6.10.5.2.2 Local Effects

Local effects on moose in the Taiga Shield Ecozone associated with hydroelectric development predominately relate to the effects of flooding on Southern Indian Lake and the dewatering of the lower Churchill River.

Prior to hydroelectric development, Southern Indian Lake was characterized as a shallow, clear water lake with a range of valuable moose habitats, based on the availability of riparian habitat and islands. Riparian habitat in Southern Indian Lake provided high quality aquatic vegetation for moose in shallow water areas and in shore zone wetlands. These were also important for moose to cool themselves as well as to find insect relief. Islands provided high quality calving habitat, with larger islands often supporting multiple moose.

The flooding of moose habitat on Southern Indian Lake has resulted in the loss of wetland as well as increased debris along shorelines. The flooding of habitat areas has resulted in reduced quantities of aquatic plants available to moose. Those areas where aquatic plants were previously available are now under water. Due to erosion of shoreline areas, trees which were formally part of the shoreline are also now underwater and act as barriers to moose movement on and off of riparian areas and in accessing the lake. Levels of shoreline debris also impede the movements of moose onto islands. This is a particularly important consideration during the calving and rearing season as calves are less mobile and are further limited by shoreline debris.

Prior to hydroelectric development, the shoreline areas of Southern Indian Lake provided for the domestic harvest of approximately 50 moose annually (Summary of Community Information, Section 3.5.11). This was based on moose frequently accessing shoreline areas and appearing out in the open where they could be observed and harvested. Available habitat for moose included multiple back-bays to Southern Indian Lake where moose were often encountered and harvested (D. Hedman pers. comm. 2015).

Moose harvesting opportunities have decreased on Southern Indian Lake following hydroelectric development. This has occurred due to moose no longer using many shoreline areas where they were previously visible and accessible to harvesters (Summary of Community Information, Section 3.5.11). In addition, levels of shoreline debris impede harvester movements on and off of shoreline areas, as well as creating additional impediments to travel by motorboat and snowmobile.

The dewatering of the lower Churchill River, as part of the CRD, served to further alter the accessibility of moose as a harvestable resource. McDonald et al. (1997) indicated fluctuating water levels can create precarious travelling conditions for moose and result in changes in movement patterns. Shoreline habitat areas in rivers that were dried out as a result of river diversions have in some areas also resulted in the drying up of trees and willows that had been depended on by moose. The dewatering of these river areas also serves to reduce the use of these historic waterways for moose hunting, particularly where these
rivers are shallow or completely dried up and had only been previously accessible through the use of a
 canoe or other shallow-draft boat.

Some areas along the CRD route continue to be suitable for moose. Billard, Northern Indian and Fiddler
 lakes are important moose areas due to the presence of marsh vegetation, which has emerged in some
 areas of the lakes due to lower water levels (D. Hedman pers. comm. 2015).

In summary, while overall the moose population in the Taiga Shield Ecozone does not seem to have been
 substantially affected by hydroelectric development, appreciable changes have taken place in their
distribution and use of areas surrounding Southern Indian Lake and the lower Churchill River. After a
period of nearly 40 years since the major alteration of these areas by the CRD, it is not apparent that the
resulting negative habitat changes are markedly improving in a way that moose will benefit in the near
future.
6.10.6  Hudson Plains Ecozone

The Hudson Plains Ecozone contains a number of hydroelectric and non-hydroelectric developments. Some of the major hydroelectric developments in the ecozone include the Kettle, Long Spruce, and Limestone generation projects, as well as the Henday Converter Station. While the construction and start of operation of these projects spans several decades, the year considered the cut-off for the pre-hydroelectric development period in this study was 1966, marked by the start of construction on the Kettle Generation Project. Non-hydroelectric development in this region is limited, and includes a portion of the Hudson Bay Railway.

Map 6.10.6-1 outlines the terrestrial regions found within the Hudson Plains Ecozone, overlain with the hydraulic zones used in the physical and aquatic environment portions of the RCEA Phase II report.
6.10.6.1 Changes in Indicators over Time

To assess changes in moose populations, five indicators were evaluated using seven different metrics applied to the pre- and post-hydroelectric development periods. Further information on how these metrics were derived is available in Section 6.10.1.2. While not an indicator or metric, predator pressure was evaluated as a factor affecting moose populations based on the role of predator species, particularly grey wolf and black bear. The results and comparison of evaluated metrics for this ecozone are summarized in Section 6.10.6.2.

6.10.6.1.1 Before Hydroelectric Development

For the pre-hydroelectric development period, moose population trends in this report are based primarily on provincial government RTL section reports. In the early 1950s, Split Lake, Limestone and York-Shamattawa RTL sections partially overlapped the Hudson Plains Ecozone. Historic references to moose in this ecozone are limited, and stem principally from Bryant (1953, 1955) and Howard and Larche (1975).

POPULATION

Bryant (1955) and Howard and Larche (1975) reported that the distribution of moose in the Hudson Plains Ecozone was sparse because moose populations in this ecozone existed at the northern fringe of the known moose range in Manitoba. Moose were still extending their range in the early 1900s. Bryant (1955) indicated that factors, including climactic control and the availability of browse species, limited the distribution of moose in northern sections of Manitoba. Moose populations occurred at low densities, and tended to be sparse due to poor forage availability and plant growing conditions. Due to the sparse distribution of moose in this ecozone, information on population trends, including population size estimates and recruitment rates, is limited.

In the early 1950s, the MDMNR asked trapline holders to estimate the number of moose on their traplines by counting signs and animals observed from freeze-up to December 31st (MDMNR 1951a, Bryant 1955). In this manner, pre-hydroelectric development moose population trends are available for the Split Lake, Limestone and York-Shamattawa RTL sections (Figure 6.10G-2).

In the early 1950s, moose were very sparse in the Split Lake RTL Section (MDMNR 1951b). Between 1950 and 1955, only a single estimate, for 1951/52, was available and indicated a density of 0.006 moose per km² (Table 6.10C-1). Based on the 1952 season, it was unknown if the moose population was increasing or decreasing (MDMNR 1952a).

In the Limestone RTL Section, moose were described as scarce (MDMNR 1951g).

For the combined York-Shamattawa RTL Section from 1952 to 1955, the estimated moose density ranged from 0.004 to 0.007 moose per km² (Table 6.10C-1). During the 1953/54 season, the York-Shamattawa RTL Section reported that the calf population was good, with many sets of twins noted (MDMNR 1955d). For the 1954/55 season, Bryant (1955) indicated a calf:cow ratio of 106 calves per 100 cow for this section.
Bryant (1955) summarized moose densities in northern Manitoba. The generalized density and distribution of moose around 1953/54 is presented in Figure 6.10G-1. Historically, the Hudson Plains Ecozone had low moose densities, ranging between 16 to 30 square miles per moose (0.013 to 0.024 moose per km²) to over 30 square miles per moose (<0.013 moose per km²). Bryant (1955) indicated that the northern boundary of moose densities in the Hudson Plains Ecozone was largely speculative based on limited observations and census accounts for this area.

HABITAT

Moose rely on a variety of habitat types to meet their life requisites. In the Hudson Plains Ecozone, moose primarily appeared to use a limited number of riparian areas, with most terrestrial habitats being deficient in suitable forage and cover. This led to the historic reports of low population densities, where often much habitat in the Hudson Plains Ecozone was of low or no value in supporting moose populations.

Howard and Larche (1975) reported that moose range in Manitoba gradually shifted northwards from the 1600s to the 1900s. The range extension occurred partially based on a slow post-glacial range re-occupation aided by human activities and forest fires, which resulted in the creation of younger forest areas preferred by moose. In the Hudson Plains Ecozone, moose only started to occupy this area in the early 1900s (Bryant 1955; Howard and Larche 1975).

Historically, fire was recognized as an important driver of moose populations in Manitoba. Bryant (1955) indicated that good moose habitat was mainly dependent on fire-produced openings in the coniferous forest. Crichton (1981) indicated that forest fires are of great benefit to moose populations by reducing mature and overmature forests into preferred younger seral stage forests. It was noted by Crichton (1981) that increases in forest fire-fighting efficiency restricted most large-scale fires to inaccessible areas of northern Manitoba. Conversely, accessible areas in southern Manitoba tended to have more limited burns, including those areas where fire is actively suppressed (e.g., areas of value for forestry) (Howard and Larche 1975; Crichton 1981). The limited occurrence of new burns in some areas could reduce the availability of moose habitat, which would otherwise be periodically rejuvenated in a natural fire cycle.

Howard and Larche (1975) described variations in moose densities resulting primarily from landscape-level habitat differences (Figure 6.10G-3). Howard and Larche (1975) indicated the Hudson Plains Ecozone is found primarily in the Hudson Bay Lowlands moose habitat section, which contains poorly drained relief, except for beach ridges occurring inland from Hudson Bay. This section includes vast areas of swamp, bog and muskeg. Forested areas tend to be made of black spruce found in open fens and muskegs. In areas with better drainage there is a limited potential for white spruce, balsam poplar and white birch stands. Understory shrub species (e.g., willow, alders and Labrador tea) occur, but commonly without an overstory (Howard and Larche 1975).

The Hudson Plains Ecozone was estimated to have a moose density of a 0.05 moose every square mile (or 0.019 moose per km²) (Howard and Larche 1975). This density was the lowest reported moose density for a habitat section in Manitoba, and much lower than the provincial average (0.30 moose per mile² or 0.12 moose per km²) (Figure 6.10G-3) (Howard and Larche 1975).
Rivers in the Hudson Plain Ecozone were particularly important for sustaining moose populations in the region. The York-Shamattawa RTL Section (MDMNR 1955d) substantiated this importance by identifying areas of high moose densities near various rivers, including the Kettle and Nelson-Weir rivers.

**PREDATION**

Wolf populations were most likely limited in the Hudson Plains Ecozone due to the relative absence of prey species, notably moose, which wolves rely on to sustain their population. To some degree, wolf populations in this ecozone were supported by the migratory herds of caribou that move through the area (MDMNR 1952a). Targeted predator control programs were reported to be successful in reducing gray wolf numbers in the early 1950s. However, high rates of wolf predation were unlikely as moose populations tended to remain sparse and localized near riparian areas.

Predator control programs in the Split-Lake, Limestone and York RTL sections were reported to increase the availability of caribou for harvesters as there were few moose naturally occurring in the area. The predator control program documented 22 wolves killed in the Split Lake RTL Section (MDMNR 1952a). There was no discussion regarding whether the reduced wolf numbers resulted in an increased moose population, but it was suggested that future predator control programs would be more successful if they targeted wolves that followed the fall migration of caribou herds (MDMNR 1952a).

For the York-Shamattawa RTL Section, both adults and wolf pups were killed (MDMNR 1950). Of the 9, 12 and 69 wolves killed in 1948/49, 1949/50 and 1950/51 respectively, about half of the wolves killed were pups found in dens (MDMNR 1950). Seal meat was used in one year to attract wolves onto the tidal flats where eight were successfully shot (MDMNR 1950). In 1951/52 and 1953/54, bounties were paid for harvesting 36 and 22 wolves, respectively (MDMNR 1953g). An additional nine wolves were killed over the 1954/55 season by trapping, shooting and poisoning (MDMNR 1955d).

The York-Shamattawa RTL Section reported a marked decrease in the wolf population, with at least 88 wolves controlled, including a pack of 10 wolves (MDMNR 1955d). Only one moose was reported to be depredated by wolves along the Hayes River (MDMNR 1955d). Despite the apparent successes of the predator control program, there were no identified changes in the moose population in this area.

**DISEASE AND PARASITES**

Based on available RTL section reports for the Split Lake, Limestone and York-Shamattawa RTL sections, there were no reports of white-tailed deer, or “Virginia deer” in the early 1950s. It is expected that the Hudson Plains Ecozone is too far north to sustain a deer population, which would limit the potential for the spread of brainworm into the moose population.

**HARVEST**

The extent of moose harvest prior to hydroelectric development was variable based on reports from RTL sections in the Hudson Plains Ecozone. The limited number of survey records indicated that moose hunting pressure was relatively low, with most harvest occurring along rivers and other access routes. Moose harvest intensity often increased near human settlements and resulted in lower (or absent) local moose subpopulations in these areas.
Moose harvest is largely influenced by the availability of access along roads and waterways. For the 1964 early moose season, Ransom (1965) reported that most harvesting in the Northeast Region occurred up to 1.5 miles (2.41 km) from roads but mainly along shorelines. Similarly, based on the 1966 early moose season,Bidlake (1966) indicated that most moose harvests occurred within one mile (1.6 km) of roads in the area, with the majority of hunting confined to waterways.

The level of linear features present in the Hudson Plains Ecozone prior to hydroelectric development was 0.02 km/km², based on 235 km of linear features (Intactness, Table 6.2.6-2) mainly comprised of 192 km of railway in the Limestone Rapids Terrestrial Region. The Deer Island Terrestrial Region had no linear features present prior to hydroelectric development. The low level of linear features in the ecozone meant low levels of harvester access through the use of such corridors.

Bryant (1955) indicated that moose harvest varied among traditional use areas, ranging from 2 to 20% utilization of local moose populations. In northern Manitoba, First Nations harvest accounted for 80% of all harvested moose (Bryant 1955). The number of licensed hunters in the north at this time was limited.

The Split Lake RTL Section reported four moose harvested out of an estimated 264 animals (i.e., about 1.5% of the total population) (MDMNR 1952a). Resource officers present in the Split Lake RTL Section had asked local communities not to harvest moose because numbers were scarce and the Split Lake residents may have been concerned their moose kills would be taken away if they admitted to harvesting them (MDMNR 1951b, 1952a). Bryant (1955) estimated an annual kill of 29 moose for the combined Split Lake and Limestone RTL sections in the 1952/53 and 1953/54 seasons.

For the combined York-Shamattawa RTL Section, 53 moose were harvested in 1950/51, and 104 moose for the 1952/53 season (MDMNR 1953g). For the York group alone, the estimated harvest was 22 moose (or about 42% of the total harvest). Harvest rates for the York-Shamattawa RTL Section in 1952/53 was 104 moose, or approximately 29% of the moose population (MDMNR 1953g). For the 1953/54 season, the harvest rate was 104 moose, or 31% of the total population. In the 1954/55 season, 105 of the estimated 283 moose were harvested (37% of the total population) (MDMNR 1955d).

Within those RTL sections considered as part of the Hudson Plains Ecozone, barren-ground caribou was a substantially more valuable country food item at the time compared to moose. Pre-hydroelectric development, caribou were harvested much more frequently than moose because of increased availability. This may have served to reduce the amount of harvest pressure on moose, aside from the fact that moose were often being considered scarce (MDMNR 1951b). For example, compared to the 53 moose harvested in the York-Shamattawa RTL Section in 1950, 589 caribou were harvested (MDMNR 1950). The Split Lake RTL Section estimated that 3000 barren-ground caribou were harvested in 1952 compared to four moose killed (MDMNR 1952a). It should be noted that at this time, records did not differentiate between barren-ground caribou and other herds such as Pen Islands coastal caribou.

### 6.10.6.1.2 After Hydroelectric Development

Post-hydroelectric development, the status of moose populations in the Hudson Plains Ecozone is based primarily on information from environmental studies of potential or current hydroelectric developments.
and from government reports. Indicators examined include population, habitat, predation, disease and parasites, and harvest.

Hydroelectric developments inside this ecozone include the Long Spruce and Limestone GSs as well as associated infrastructure, and the Bipole III Transmission Project, including the Keewatinohk Converter Station, which is currently being constructed.

POPULATION

Following hydroelectric development, moose populations continued to remain sparse and clustered in the Hudson Plains Ecozone. Moose population surveys for the Fox Lake and York Factory RMAs proportionally overlapped most of the Hudson Plains Ecozone and provided the best population trends, while data from the Split Lake RMA overlapped only a small portion of the ecozone, and its usefulness was limited. As such, higher moose densities in the Fox Lake and York Factory RMAs were most often associated with riparian habitat. Modelled terrestrial habitat areas had very low moose densities. Moose population recruitment rates appeared to be sustainable. No directly comparable data were available pre-and post-hydroelectric development, which would improve our understanding of the existing environment.

The Hudson Plains Ecozone primarily overlaps portions of GHAs 2 and 3 as well as small portions of GHAs 1 and 9 (Map 6.10.6-2). Provincial moose aerial surveys were not conducted in GHAs 1 and 2 because of extra low moose densities. Surveys of GHA 3 were limited to one survey year (Hedman 2000) in the York Factory RMA. Hedman (2000) selected sample strata representative of high and low moose densities. All high moose densities were almost exclusively located around rivers and creeks and away from the Hudson Bay Coast. The moose population in GHA 3 was estimated at 589 moose with an approximate calf:cow ratio of 88 calves per 100 cows.

An aerial survey of the Fox Lake RMA was conducted in 2013. The modified Gasaway-style survey estimated a population of 138 moose; however, no confidence intervals were provided due to the paucity of data and low moose densities (Knudsen and Berger 2014). Based on the 8,022 km² survey area, the moose density was about 0.017 moose per km². The calf:cow ratio was 76.2 calves per 100 cows.

From 1985 to 1993, the Department of Natural Resources conducted a few aerial surveys for moose in the NFA area. Although a portion of this area, specifically the Split Lake RMA, covered a portion of the Hudson Plains Ecozone, the aerial surveys performed did not extend this far east. The results of these surveys are covered in more detail in the Western Boreal Shield (section 6.10.2.2.1) and Eastern Boreal Shield (section 6.10.3.2.1) ecozones. Assessment of the Limestone Generation Project by Elliot (1986b, 1989) was similarly based on surveys which occurred west of the Hudson Plains Ecozone; the results of which are considered with the Eastern Boreal Shield (section 6.10.3.2.1).

A number of aerial surveys were conducted in the Split Lake RMA. One of seven MMUs, the Kitchisippi MMU, extended past the community of Bird, within the Limestone Rapids Terrestrial Region of the Hudson Plains Ecozone. Of all MMUs surveyed, the Kitchisippi Moose Management Unit was considered the most accessible to harvesters as it was located along the Nelson River and included Provincial Road (PR) 280 and PR 290 (Map 6.10E-1). In 2010, the Kitchisippi MMU had 337 moose
(0.054 moose per km\(^2\)) and a calf: cow ratio of 37.6 calves per 100 cows (CNP 2013) (Table 6.10E-1).
The moose population increased from 337 to 446 moose in 2015 (0.072 moose per km\(^2\)) (Wildlife
Resource Consulting Services MB Inc, unpubl. data), suggesting that recruitment rates, harvest patterns
and/or other combinations and measures of limiting factors in the Kitchisippi MMU, resulted in moose
population growth between 2010 and 2015.
HABITAT

Post-hydroelectric development, moose habitat has changed by various degrees, both directly and indirectly, in the Hudson Plains Ecozone. Habitat loss and alteration has occurred through flooding, water regulation, the development of linear corridors, infrastructure, increased access and potentially, fire. This section focuses mainly on direct habitat effects from hydroelectric development. Overall, there has been low levels of habitat loss in the Limestone Rapids and Deer Islands terrestrial regions and for the Hudson Plains Ecozone as a whole. On-system habitat effects were associated with potential changes in shore zone and offshore wetlands, shoreline debris and riparian tall shrub communities.

Fire history information available for the Hudson Plains Ecozone indicates that numerous forest fires have affected this area in the past 44 years (Terrestrial Habitat, Map 6.3.1.7). Northern portions of the Limestone Rapids and Deer Islands terrestrial regions had portions affected within the last 20 years. The more southerly portions of these ecozones, proximal to the lower Nelson River, show more limited recent fire activity as well as fires more than 25 years old.

As part of the aerial moose surveys conducted of the Fox Lake RMA, Fox Lake resource users were asked to indicate on a map where they anticipated there to be high moose densities (Knudsen and Berger 2014). Based on a response of one individual, the specific areas included portions of the Weir, Nelson, Angling and Fox rivers. Although the survey sample was very low, the areas identified corresponded closely to where moose were seen during aerial surveys. Based on aerial survey results, higher moose densities were still only 0.06 moose per km². Low moose densities were in the order of less than 0.01 moose per km². Both values demonstrated that the relative distribution of moose is often difficult to assess and apply range-wide, where often only riparian areas are capable of supporting moose, and in some cases, at low densities even in the best potentially available habitats in a region.

Hedman (2000) conducted surveys in the Hudson Plains Ecozone inside a portion of GHA 3 in the York Factory RMA. Survey locations were based on personal knowledge of the area and where moose would most likely be found. The selection of strata was based primarily around the sampling of riparian and non-riparian habitats. As the area encompassed by the Hudson Plains Ecozone does not include portions of the Hudson Bay coast (refer to Coastal Hudson Bay Ecozone Section 6.10.7), there are few high density delta areas in the ecozone. The Deer Island Terrestrial Region contains a portion of the Hayes River and high quality island habitat. Large portions of the low habitat strata types are present in both the Limestone Rapids and Deer Island terrestrial regions. The identified high density strata on islands and deltas had roughly twice the number of moose as the low density strata found on riparian edges and minor watersheds (Table 6.10.6-1).
Table 6.10.6-1: Moose Densities by Habitat Strata Sampled in GHA 3 Inside the York Factory Resource Management Area (modified from Hedman 2000)

<table>
<thead>
<tr>
<th>Habitat Strata</th>
<th>Size (km²)</th>
<th>Moose Density (moose per km²)</th>
<th>Refined Habitat Strata Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>1166</td>
<td>0.317</td>
<td>Islands in the Hayes River and deltas of major river draining into Hudson Bay</td>
</tr>
<tr>
<td>Low</td>
<td>1325</td>
<td>0.165</td>
<td>The riparian edge of the Hayes, Nelson and Pennycuttaway River and all minor watersheds draining into Hudson Bay</td>
</tr>
<tr>
<td>Nil</td>
<td>0</td>
<td>0.000</td>
<td>Off-system areas</td>
</tr>
<tr>
<td>Total</td>
<td>2491</td>
<td>0.231</td>
<td></td>
</tr>
</tbody>
</table>

Regional Habitat Model

For the existing environment, a summary of the moose model used to describe primary and secondary moose habitat is found in Appendix 6.10A. Moose habitat is distributed throughout the Hudson Plains Ecozone (Map 6.10.6-3). Large quantities of primary moose habitat were identified for the existing environment in the Limestone River Terrestrial Region (35.1%) the Deer Island Terrestrial Region (14.6%) and overall (25.1%) in the Hudson Plains Ecozone (Table 6.10.6-2). Based on the restrictive nature of primary moose habitat in this ecozone, which is located adjacent to riparian areas, primary habitat values are likely lower than quantified. This portion of the habitat model is descriptive only.

Based on the moose habitat model, forested areas affected by forest fires in the previous 6 to 30 years were the most commonly identified primary habitat type available for moose in the Limestone Rapids (Table 6.10B.6-1) and Deer Island (Table 6.10B.6-2) terrestrial regions. As Elliot (1985, 1986a) noted, caution should be used to identify the quality of moose habitat attributed to fire for various vegetation cover types and age classes.

Table 6.10.6-2: Proportion of Primary and Secondary Moose Habitat in the Hudson Plains Ecozone

<table>
<thead>
<tr>
<th>Terrestrial Region (TR) or Ecozone</th>
<th>Primary Habitat</th>
<th>Secondary Habitat</th>
<th>Total Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>%</td>
<td>ha</td>
</tr>
<tr>
<td>Limestone Rapids TR</td>
<td>271,050</td>
<td>35.1%</td>
<td>500,382</td>
</tr>
<tr>
<td>Deer Island TR</td>
<td>106,800</td>
<td>14.6%</td>
<td>625,366</td>
</tr>
<tr>
<td>Hudson Plains Ecozone</td>
<td>377,850</td>
<td>25.1%</td>
<td>1,125,748</td>
</tr>
</tbody>
</table>
Human Development

Effects of human development have resulted in the loss of primary and secondary moose habitat in the Hudson Plains Ecozone (Table 6.10.6-3). The loss of moose habitat due to infrastructure, flooding and water regulation was 0.74% of the available habitat in the Limestone Rapids Terrestrial Region and 0.02% of available habitat in the Deer Island Terrestrial Region. Overall as a result of all human activities, the loss of moose habitat in the Hudson Plains Ecozone as a whole was 0.39%.

The loss of moose habitat due to flooding was 1654 ha in the Limestone Rapids and 0 ha in the Deer Island terrestrial regions (Table 6.10B.6-3). Water regulation continues to affect local moose habitat by reducing habitat quality (see On-system Habitat Effects, below).

Table 6.10.6-3: Regional Effects of Hydroelectric Development on Primary and Secondary Moose Habitat in the Hudson Plains Ecozone

| Terrestrial Region (TR) or Ecozone | Habitat (ha) Pre-Hydro | Habitat (ha) Post-Hydro | % of Region Affected by Human Development | Hydroelectric | Total
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone Rapids TR</td>
<td>273,049</td>
<td>271,050</td>
<td>0.6</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Deer Island TR</td>
<td>106,817</td>
<td>106,800</td>
<td>0.0</td>
<td>&lt;0.1</td>
<td></td>
</tr>
<tr>
<td>Hudson Plains Ecozone</td>
<td>379,311</td>
<td>377,850</td>
<td>0.3</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone Rapids TR</td>
<td>504,073</td>
<td>500,382</td>
<td>0.6</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Deer Island TR</td>
<td>625,483</td>
<td>625,379</td>
<td>0.0</td>
<td>&lt;0.1</td>
<td></td>
</tr>
<tr>
<td>Hudson Plains Ecozone</td>
<td>1,130,116</td>
<td>1,125,761</td>
<td>0.3</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone Rapids TR</td>
<td>777,122</td>
<td>771,432</td>
<td>0.6</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Deer Island TR</td>
<td>732,300</td>
<td>732,178</td>
<td>0.0</td>
<td>&lt;0.1</td>
<td></td>
</tr>
<tr>
<td>Hudson Plains Ecozone</td>
<td>1,509,427</td>
<td>1,503,611</td>
<td>0.3</td>
<td>0.4</td>
<td></td>
</tr>
</tbody>
</table>

1. Total accounts for hydroelectric and other cumulative factors affecting habitat loss.

In the assessment of the potential effects of hydroelectric development on moose, Howard and Larche (1975) suggested that the construction of a large transmission line from Upper Limestone Rapids and continuing through the Interlake to Dorsey Station by Winnipeg would likely suppress vegetative growth and should enhance moose food supplies. Didiuk (1975) indicated the potential for moose travel routes as well as improved food sources with the construction of transmission lines associated with generating stations on the lower Nelson River. Both Howard and Larche (1975) and Didiuk (1975) indicated that there were only low numbers of moose on the Lower Nelson River which could be affected by hydroelectric reservoir development.

Moose habitat loss resulting from the Bipole III Transmission Project was estimated to be less than 5% of the available moose habitat in the portion of the Project Study Area located within the Hudson Bay Lowland Ecoregion (Manitoba Hydro 2011). The loss of moose habitat associated with the presence of
transmission lines is small where cleared areas remain largely accessible to moose. The creation of edge habitat and maintenance during operations of young seral-stage browse species preferred by moose can be beneficial to this species (Manitoba Hydro 2011). As a method of maintaining the ecological integrity of riparian areas located along the Wuskwatim and Bipole III Transmission Project, transmission lines, setback distances (i.e., buffers) were used to minimize tree and shrub clearing and prevent habitat disruption in the ROW adjacent to waterbodies and watercourses. Riparian areas provide important cover and food for moose (Manitoba Hydro 2011).

Fragmentation

Access to moose populations can be measured in part by the abundance of linear features on the landscape. As of 2013, for the Hudson Plains Ecozone as a whole, linear feature density was 0.05 km/km² (Intactness, Section 6.2.6). Based on selected benchmarks, this level of fragmentation is associated with a low level of disturbance. Fragmentation was measured at 0.03 km/km² for linear features attributed to hydroelectric development (transmission lines, access roads), with an additional 0.02 km/km² associated with other non-hydroelectric anthropogenic development (e.g., provincial roads, railways). Of note, transmission lines and railways both account for 0.02 km/km² in the linear feature density estimates. Prior to hydroelectric development (i.e., in 1965), linear feature density was 0.02 km/km² (Intactness, Table 6.2.6-2).

Intactness varies by terrestrial region in the Hudson Plains Ecozone, with hydroelectric development starting in the Limestone Rapids Terrestrial Region in 1966 and in the Deer Island Terrestrial Region in 1970 (Intactness, Table 6.2.6-2). The Limestone Rapids Terrestrial Region as of 2013 had a linear feature density of 0.10 km/km², of which 0.06 km/km² (or 60%) can be attributed to hydroelectric development (Intactness, Table 6.2.6-2). The overall increase above the 0.03 km/km² measured prior to hydroelectric development occurred in the western portion of the terrestrial region (Map 6.10.6-2). For the Deer Island Terrestrial Region, linear feature density was maintained at <0.01 km/km² in the post-hydroelectric development period, with 0 km/km² attributable to hydroelectric development (Map 6.10.6-2).

On-System Habitat Loss

Within the Hudson Plains Ecozone, the alteration of riparian habitat has primarily occurred through the “alteration of the Lower Nelson River from a relatively shallow, fast-moving river to a series of deep relatively slow-current reservoirs” (Didiuk 1975).

On-system habitat was evaluated for the reach of Nelson River within the Hudson Plains Ecozone extending to Gillam Island. Habitat availability prior to hydroelectric development in 1966 was compared to the existing environment in 2013. Multiple on-system habitat attributes were used to assess moose habitat change. Shore zone wetland habitat, offshore wetland habitat, shoreline debris and riparian tall shrub communities were selected as important components of on-system moose habitat. A description of the models used to assess changes in available moose habitat can be found in Appendix 6.10A. Both terrestrial regions in this ecozone were assessed for changes in on-system habitat.

There were only very small increases in shore zone wetland habitat in the Limestone Rapids Terrestrial Region, with a slight increase (0 to 0.3%) in the quantity of moderate quality moose habitat post-
hydroelectric development (Figure 6.10.6-1). The Deer Island Terrestrial Region showed no increase in shore zone wetland habitat quality between the pre- and post-hydroelectric development periods. Further details of these is available in Tables 6.10B.6-4 and 6.10B.6-5.

![Figure 6.10.6-1: Changes in Shore Zone Wetland Habitat Quality Pre- and Post-Hydroelectric Development in the Hudson Plains Ecozone](image)

Figure 6.10.6-1: Changes in Shore Zone Wetland Habitat Quality Pre- and Post-Hydroelectric Development in the Hudson Plains Ecozone

There were only very small changes in offshore wetland habitat between the pre- and post-hydroelectric development periods (Figure 6.10.6-2). Those changes which did occur were in the Limestone Rapids Terrestrial Region, where the quantity of high quality habitat increased from 0 to 0.1%. The Deer Island Terrestrial Region did not show any changes in the availability of offshore wetland habitat. Further detail regarding offshore wetlands in the Limestone Rapids and Deer Islands terrestrial regions is available in Tables 6.10B.6-6 and 6.10B.6-7, respectively.
There were some changes in shoreline debris levels between the pre- and post-hydroelectric development periods (Figure 6.10.6-3). These changes primarily occurred in the Limestone Rapids Terrestrial Region where there was an increase in moderate access areas from 0 to 7.9% and in difficult access areas from 0 to 10.0%. It is assumed that increases in shoreline debris served to limit harvester movements in shoreline areas, as well as for moose. There were no changes in moose access based on modelled levels of shoreline debris in the Deer Island Terrestrial Region. Changes in shoreline debris based on this model have been presented in Tables 6.10B.6-8 and 6.10B.6-9.
Some changes in tall shrub communities were noted for both the Upper Churchill and Deer Island terrestrial regions (Figure 6.10.6-4). For the Limestone Rapids Terrestrial Region there was an increase in the portion of shoreline areas with high quantities of tall shrub vegetation (0 to 6.2%). There was alternatively a decrease in the quantity of shoreline areas with high quantities of tall shrub vegetation in the Deer Island Terrestrial Region (7.8 to 0%). Changes in the quantity of tall shrub habitat in the Limestone Rapids and Deer Island terrestrial regions have been further detailed in Tables 6.10B.6-10 and 6.10B.6-11, respectively.
Figure 6.10.6-4: Changes in Density of Tall Shrub Communities Pre- and Post-Hydroelectric Development in the Hudson Plains Ecozone

PREDATION

Post-hydroelectric development, populations of grey wolves appeared to remain sparse in the Hudson Plains Ecozone. There are not enough data to suggest that the number of predators or predation rates in northern environments have changed after hydroelectric development. Targeted wolf control measures no longer occur in northern Manitoba. Based on published findings in the Hudson Plains Ecozone, predator pressure was not indicated to affect moose population numbers.

The configuration of available habitat on the landscape is an important component of predator-prey dynamics. This can be partly understood through an assessment of linear features, which predator species such as gray wolf use to increase their hunting efficiency (James and Stuart-Smith 2000). Linear feature density in the Hudson Plains Ecozone remained relatively low at 0.05 km/km² with 0.03 km/km² attributable to hydroelectric development. Linear feature density in the Limestone Rapids Terrestrial Region is higher at 0.10 km/km² with 0.06 km/km² attributable to hydroelectric development (see Fragmentation). There are minimal linear features (< 0.01 km/km²) in the Deer Island Terrestrial Region.

Although no wolves were observed, 13 sets of wolf tracks were found in 2009 around the Gull Rapids area during Bipole III Transmission Project studies (Manitoba Hydro 2011). Wolf density in this area
appeared to be low. Based on construction of the Bipole III Transmission Project, Manitoba Hydro (2012) suggested that there would be potential for increased wolf movements, which could lead to greater predation rates in the area of the transmission line.

In the existing environment, moose predation by gray wolf was modelled for the Kitchisippi MMU. Here, the total annual wolf predation was estimated at 19 moose, or 5.6% of the annual moose population (Table 6.10E-1) (CNP 2013). This estimated rate of predation may be in part be due to linear feature presence in the area between the Kettle and Limestone GSs, but these features only distributed in a very small portion of the ecozone.

Average moose densities (0.017 moose per km²) in the Fox Lake RMA were insufficient to sustain a wolf population (Knudsen and Berger 2014). Knudsen and Berger (2014) did however indicate that wolves could potentially adapt to hunt in riparian areas where moose densities were higher and result in an increased wolf abundance being supported in those habitats.

DISEASE AND PARASITES

The northern range of white-tailed deer is limited by the severity of the winters and limited food supply (MCWS 2014a). No white-tailed deer have been observed during aerial surveys conducted in the Split Lake and Fox Lake RMAs. While there have been isolated reports of white-tailed deer near Herchmer, a railway stop, located approximately 140 km south of Churchill (MCWS 2014a), these occurrences are not considered sufficient for measurably increasing the risk of spreading brainworm to moose, for which white-tailed deer is an important host.

HARVEST

Moose harvest was predominantly a water access-based activity pre-hydroelectric development. Moose harvest has remained at relatively low levels in the Hudson Plains Ecozone. Increased access along linear features plays a very limited role in affecting harvest due to the sparse distribution of moose. Although transmission line rights-of-way can be used to access and harvest moose, access is often limited in northern environments because the dominance of wet peatlands makes travel much more difficult compared to the drier and mineral-based moose habitat in southern Manitoba. Based on intactness calculations, slightly increased access was available post-hydroelectric development in the Limestone Rapids Terrestrial Region. Increased linear feature density in the Deer Island Terrestrial Region has been negligible.

Currently, the Hudson Plains Ecozone predominately encompasses portions of GHAs 2 and 3 with the very small portions of GHAs 1 and 9 also overlapping (Map 6.10.6-2). The GHAs are all considered part of the Northern Zone, which is characterized as areas having fewer roads and where travel by off-road recreational vehicles for hunting is acceptable (MCWS 2013).

Moose harvest is largely influenced by the availability of access along roads and waterways. For the 1964 early moose season, Ransom (1965) reported that most harvesting in the Northeast Region, including both Thompson and Wabowden, occurred up to 1.5 miles (2.41 km) from roads but mainly along shorelines. Similarly, based on the 1966 early moose season, Bidlake (1966) indicated that most moose harvests occurred within one mile (1.6 km) of roads in the area, with the majority of hunting confined to
Due to its relative inaccessibility, the Hudson Plains Ecozone is slow to experience increases in harvest pressure relative to more southerly GHAs.

In the early 1970s, a number of GHAs were considered inaccessible, including those GHAs comprising portions of the Hudson Plains Ecozone (Figure 6.10G-9). For these GHAs, Jahn (1975) indicated there was little information available on moose hunting levels and that little effort was placed on monitoring harvest activities.

Howard and Larche (1975) indicated that GHAs 1 and 3 (which would later encompass GHAs 2 and 3) received low harvest pressure by licensed harvesters from 1968 to 1974, due in part to remoteness. The total number of moose harvested in GHAs 1 and 3 accounted for 4.5% (in 1968) to 6.4% (in 1971) of the total provincial harvest (Table 6.10D-2). Both GHAs 1 and 3 had roughly equivalent levels of harvest with GHA 1 having slightly higher resident licensed harvest and GHA 3 having higher levels of non-resident licensed harvest. The total moose harvest by resident and non-resident licensed harvesters in GHAs 1 and 3 ranged from 4.0% (in 1968) to 6.3% (in 1972) of the provincial total (Table 6.10D-4).

Elliot (1986b, 1989) noted the potential for overharvesting moose populations in the Limestone GS area. He indicated that increased harvest pressure on moose could be construed as a secondary impact of the Kettle Rapids and Long Spruce hydroelectric developments, with increased hunters and new roads. To mitigate the potential for increased harvest of moose, the Manitoba government revised the bag limit for this area, classified within GHA 3 (Elliot 1989). In addition, Elliot (1989) reported that the harvest pressure expected with the influx of construction workers in the region did not occur; partially based on changes to the work schedule which reduced the recreational opportunities for prospective hunters. In addition, harvest limits in 1987 were changed in the creation of a fall bulls-only season and in creation of GHA 3a in 1988 (Elliot 1986b, 1989).

Manitoba Hydro (2012) reported that with the construction of the Bipole III Transmission Project, transmission line ROW, harvest access would increase and potentially affect the harvesting of moose. Proposed mitigation measures to prevent the overharvest of moose included routing the transmission line to avoid known moose concentrations, reducing and regulating public access, and the use of setback areas (i.e., buffers) to prevent the clearing of forested areas near waterbodies and watercourses.

To offset the effects of the Keeyask Generation Project on traditional practices and customs (which would include reduced opportunities to hunt moose in the immediate Project footprint), TCN and WLFN each negotiated Adverse Effects Agreements, under which community-specific Offsetting Programs are run. Among a wide range of programs to facilitate a continued relationship with the land in the Split Lake RMA, the TCN Access and WLFN Improved Access programs, while not specifically hunting programs, facilitate the domestic harvest of moose outside of project-affected areas. As one means of increasing access among these programs, resource users have an opportunity to be flown out to traditional hunting areas and distribute harvest pressure more broadly, irrespective of access corridors.

Current levels of domestic harvest in the Split Lake RMA, including the WLFN Traditional Use Area, were assessed as to their sustainability (CNP 2013). Of the seven MMUs considered in this report, only the Kitchisippi MMU occurs within the Hudson Plains Ecozone (CNP 2013). To predict future conditions, harvest levels were estimated for domestic harvest, and resident and non-resident licensed harvest. In
the Kitchissippi MMU, there was an estimated domestic harvest of 24 moose annually, with nine and zero moose harvested by licensed resident and non-residents respectively. Including wounding mortality, 38 moose (11.3% of the moose population), are harvested annually (Table 6.10E-1). These harvest rates were projected to result in a long-term decline in the moose population without applying sustainable management principals. Based on population surveys conducted five years later (2015), the moose population in this MMU appears to have increased (Wildlife Resource Consulting Services MB Inc., unpubl. data).

6.10.6.2 Cumulative Effects of Hydroelectric Development

6.10.6.2.1 Regional Effects

INDICATOR RESULTS

The Hudson Plains Ecozone has gradually become a range used by moose, since this species was largely absent from the area prior to the early 1900s. Today, moose populations remain sparse in the area. Moose are primarily found in riparian areas and are excluded from most other terrestrial habitats. Based on their current distribution and habitat use patterns, there are a number of ways moose have potentially been affected by anthropogenic developments and changes in natural conditions. These changes were assessed based on the use of varied response and driver indicators, the results of which are summarized in Table 6.10.6-4.
Table 6.10.6-4: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Hudson Plains Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydroelectric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size</td>
<td>Population estimates, density</td>
<td>Early 1950’s RTL section reports Split Lake 0.008 moose per km² Limestone “Scarce” York-Shamattawa 0.004 to 0.008 moose per km² Bryant (1955) &lt;0.013 to 0.024 moose per km² Howard and Larche (1975) 0.019 moose per km² based on regional habitat availability</td>
<td>York Factory Resource Area 589 moose (c. 2000) 0.317 moose per km² in ‘high’ strata 0.165 moose per km² in ‘low’ strata 0 moose per km² in ‘nil’ strata Split Lake Resource Area Kitchisippi MMU (c. 2010)– 337 moose 0.054 moose per km² Kitchisippi MMU (c. 2015)– 446 moose 0.072 moose per km² Fox Lake Resource Area 136 moose (c.2013) 0.017 moose per km² 0.050 to 0.060 moose per km² in high density areas</td>
<td>Moose populations occur at naturally low levels in the Hudson Plains Ecozone. Low moose densities appear stable when comparing pre- and post hydroelectric development periods. Highest moose densities only occur in riparian areas. The clustering of moose populations based on the availability of riparian habitat areas may have been affected by changes in water regime; however this is difficult to substantiate due to reports of low moose populations prior to hydroelectric development. The lack of repeat surveys makes it difficult to assess changes in moose population numbers over time and in response to different environmental/anthropogenic factors.</td>
<td>Hydroelectric development has influenced moose populations in the Hudson Plains Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td>Recruitment rates</td>
<td>Early 1950’s RTL section reports York-Shamattawa “calf population is good with many sets of twins being noted” 106 calves per 100 cows (c. 1955)</td>
<td>York Factory Resource Area 88 calves per 100 cows (c. 2000) Split Lake Resource Area Kitchisippi MMU (c. 2010) – 37.6 calves per 100 cows Fox Lake Resource Area 76.2 calves per 100 cows (c. 2013)</td>
<td></td>
<td>Current recruitment rates indicate potential for healthy and increasing moose populations in the Fox Lake and York Factory Resource Areas. Although the Kitchisippi MMU recruitment rate is lower and may reflect in part increased harvest and predation pressures around the Nelson River, the moose population increased between 2010 and 2015.</td>
<td>Hydroelectric development may have influenced moose recruitment in the Hudson Plains Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td>Habitat</td>
<td>ha of high quality habitat by type</td>
<td>Moose densities highest in riparian habitat and recently burnt areas Moose densities lowest in mature coniferous forests, muskeg Reduced availability of habitat in Terrestrial Regions (TR): Limestone Rapids TR (-0.79%) Deer Island TR (-0.02%) Hudson Plains Ecozone (-0.39%)</td>
<td></td>
<td>Habitat loss through flooding and anthropogenic land uses.</td>
<td>Hydroelectric development has influenced moose habitat in the Hudson Plains Ecozone. <strong>Benchmarks:</strong> Low for the Limestone Rapids and Deer Island terrestrial regions as well as Hudson Plains Ecozone</td>
</tr>
<tr>
<td>Percentage on-</td>
<td>system high quality riparian habitat</td>
<td>Shore zone wetland Limestone Rapids -100.0% low quality Deer Island -100.0% low quality Offshore wetland Limestone Rapids -100.0% low quality Deer Island -100.0% low quality Shoreline debris Limestone Rapids -100.0% easy access Deer Island -100.0% easy access Tall shrub communities Limestone Rapids – 100.0% low Deer Island - 7.8% high, 92.2% low</td>
<td>Shore zone wetland Limestone Rapids - 0.3% moderate, 99.7% low quality Deer Island- 100.0% low quality Offshore wetland Limestone Rapids -0.1% high, 99.9% low quality Deer Island -100.0% low quality Shoreline debris Limestone Rapids -82.0% easy, 7.9% moderate, 10.0% difficult access Deer Island - 100.0% easy access Tall shrub communities Limestone Rapids – 6.2% high, 93.8% low Deer Island-100.0% low</td>
<td>Riparian habitat in Limestone Rapids and Deer Island terrestrial regions affected by changes in the Lower Nelson River through successive hydroelectric generating stations. Low availability of shore zone and offshore wetlands pre- and post hydroelectric development. Increased shoreline debris levels and tall shrub communities in the Limestone Rapids Terrestrial Region which has potentially served to limit moose and harvester access to shoreline areas.</td>
<td>Hydroelectric development has influenced moose habitat in the Hudson Plains Ecozone. <strong>Benchmarks:</strong> Low for the Limestone Rapids and Deer Island terrestrial regions.</td>
</tr>
</tbody>
</table>
Table 6.10.6-4: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Hudson Plains Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydroelectric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest</td>
<td>Number of moose harvested</td>
<td>Most of northern Manitoba considered inaccessible to non-Treaty harvest. Harvest primarily based on access including roads and waterways. Typically reduced moose populations within close proximity to communities. For the combined York-Shamattawa RTL section the annual rate moose harvest from 1950 to 1956 ranged from 29 to 37% of the estimated population. Caribou the more frequently harvested and relied on game species with increased harvest levels based on migration patterns.</td>
<td>GHAs 2 and 3 still considered largely inaccessible. Low levels of licensed harvest for 1968 – 1974 hunting seasons Indication of increased harvest in Gillam area (1970s) Caribou still considered important for domestic harvest Potential for increased moose harvest based on additional linear features increasing harvester access to moose populations. Offsetting program available to community members of Tataskweyak Cree Nation and War Lake First Nation to harvest moose throughout the Split Lake Resource Management Area and allow for the distribution of harvest pressure among MMUs regardless of road access.</td>
<td>Access to moose populations pre-hydroelectric development is apparent based on reported harvest by the York-Shamattawa RTL Sections. Likely limited to the use of riparian areas and railway. Increases in linear feature density occurred since hydroelectric development and has likely increased access to moose populations. However, moose harvest is still dominant along waterways where most of the moose population resides. Increased access into areas where there are low (or absent) moose populations would not have a substantial effect on harvest success. Alternately increased access to riparian areas could increase the potential for moose harvest opportunities.</td>
<td>Hydroelectric development has influenced moose harvest in the Hudson Plains Ecozone by increasing access. <strong>Benchmarks:</strong> Low for the Limestone Rapids and Deer Island terrestrial regions and Hudson Plains Ecozone as a whole.</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>km/km² of linear features</td>
<td>From Intactness Chapter (6.2) Limestone Rapids TR - 0.03 km/km² Deer Island TR - 0.01 km/km² Hudson Plains Ecozone - 0.02 km/km²</td>
<td>From Intactness Chapter (6.2) Limestone Rapids TR - 0.10 km/km² Deer Island TR - 0.01 km/km² Hudson Plains Ecozone - 0.05 km/km²</td>
<td>Low fragmentation levels prior to hydroelectric development based on absence of linear features (other than Hudson Bay Railway). During and after hydroelectric development, fragmentation increased. Cumulative levels described for contributions from hydroelectric and non-hydroelectric development remain low. Increased linear feature density has likely resulted in some increased moose harvest opportunities but much of area remains inaccessible. Increased linear feature density has likely only had a limited effect increasing predator efficiency based on the limited occurrence of gray wolves and low linear feature density.</td>
<td>Hydroelectric development has increased the level of fragmentation in the Hudson Plains Ecozone <strong>Benchmarks:</strong> Low for the Limestone Rapids and Deer Island terrestrial regions and Hudson Plains Ecozone as a whole.</td>
</tr>
<tr>
<td>Disease and</td>
<td>Distribution of white-</td>
<td>No indication of white-tailed deer present in the early 1950s based on RTL section reporting. No reports of brainworm. White-tailed deer not present in ecozone. No reports of brainworm.</td>
<td></td>
<td>As white-tailed deer remain absent, no effects are reported.</td>
<td>Hydroelectric development has not changed deer distribution in the Hudson Plains Ecozone. <strong>Benchmarks:</strong> No change</td>
</tr>
<tr>
<td>Parasites</td>
<td>tailed deer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

December 2015
EVALUATION OF EFFECTS

Historically, moose have expanded their range from central to northern Manitoba. Populations in the Hudson Plains Ecozone were sparse and concentrated mainly in riparian habitats. Moose harvest occurred but at low levels. Caribou were traditionally harvested rather than moose. Access used to harvest moose was limited to waterways and locations near communities. Predator control programs were used to increase the availability of caribou and moose for harvest. At the time, predator control was thought to be successful, but moose populations in this area remained sparse.

Indicators such as habitat loss and alteration associated with flooding, infrastructure, water regulation and fragmentation remained in the low magnitude of effects range. The main driver of habitat quality and quantity in this ecozone is the availability of suitable riparian areas, which are limited. Because terrestrial habitats tend to be of insufficient quality where food supplies are limited due to nutrient poor soils, moose populations in the Hudson Plains Ecozone are unlikely to be maintained at high densities. Hydroelectric development that has affected the lower Nelson River appears not to have decreased the availability of shore zone and offshore wetland habitat that is often used by moose. There has however been some reduction in on-system riparian tall shrub communities on which moose may rely. Other on-system habitat changes do not appear to have had a substantial effect on moose populations.

Increased access in the Hudson Plains Ecozone occurred with the development of linear features (i.e., roads, transmission lines), and improved the accessibility of moose populations to harvesters. To date, hydroelectric development contributed about 60% of the increase in linear features (including transmission lines) and therefore, to potential increased access. Compared to benchmarks, linear feature density is low, and is in the low magnitude of effects range. Transmission line rights-of-way are low-use access features compared with roads because they are not constructed to support traffic and because the terrain in the ecozone limits their use to the winter along much of their length. Although it is unclear how a specific moose subpopulation might have been affected by the change, high density moose areas (which are often clustered) can be disproportionately affected through increased demand and harvest opportunities. Bipole III Transmission Project for example, was routed to avoid the Nelson River, and in this case, appeared to avoid potentially higher density riparian moose habitat in this ecozone.

A comparison of the Limestone Rapids and Deer Island terrestrial regions indicates that the former has been subject to almost all the anthropogenic effects in the ecozone, with the Deer Island Terrestrial Region remaining largely undisturbed. This is represented by the increased amounts of habitat loss associated with flooding and infrastructure, alteration and fragmentation for the Limestone Rapids Terrestrial Region, but which is still considered to be at a low level of disturbance (Map 6.10.6-2). The greatest linear feature density and physical habitat loss has occurred in the western portion of the Limestone Rapids Terrestrial Region partially as a result of hydroelectric development. Moose subpopulations in this part of the region are more at increased risk of increased access and overharvest.

Based on a low abundance of gray wolves in the region and limited change in the density and distribution of linear features, increased predation is not expected to have substantial effects on the moose population.
No change occurred for white-tailed deer presence in the ecozone as a result of hydroelectric or other activities. As the distribution of white-tailed deer continues to be negligible in this area, it is expected that there is little likelihood of brainworm transmission from white-tailed deer to moose.

Overall, although occurring at low population densities both pre- and post-hydroelectric development, the moose population in the Hudson Plains Ecozone appears to remain stable and to not have been adversely affected by hydroelectric development. Uncertainty is moderate because of the lack of information from the pre-hydroelectric development period. However, recent recruitment rates calculated for the Fox Lake and York Factory RMAs are high, and suggest a growing moose population.

REGIONAL CUMULATIVE EFFECTS CONCLUSION

While the cumulative effects of human development, including hydroelectric development, on the moose population have been adverse, these effects remain in the low magnitude range. Moose populations remain sparse in the Hudson Plains Ecozone due to inherent natural limitations of this area in the life requisites required to support a large moose population. While it is difficult due to data limitations to identify if the moose population size has changed in the ecozone, recent aerial surveys reported a small, but healthy moose population sustained through high recruitment with few external limiting factors. The importance of the riparian moose habitat in this ecozone cannot be understated in sustaining the regional moose population. Currently, changes to the Hudson Plains Ecozone as a result of hydroelectric development or otherwise, have not had a substantial impact on moose populations. Because this population is so reliant on riparian areas and it exists in low numbers, caution is warranted where moose population sustainability is influenced by even small anthropogenic disturbances, unless substantive mitigation measured are applied.

6.10.6.2.2 Local Effects

Local effects on moose habitat and moose subpopulations in some areas along the Nelson River ("on-system") would be perceived differently than those assessed for moose habitat and for the moose population in the whole ecozone. First Nations communities have described the impacts of successive hydroelectric developments in northern Manitoba as having large negative effects on wildlife populations. Fox Lake Cree Nation (2012) reported that moose habitat loss occurred with hydroelectric development. Localized changes were also reported for the distribution of moose. McDonald et al. (1997) indicated that, along the Nelson River, there was a loss of moose habitat for about 16 km upriver from Marsh Point and that there were no moose present at Marsh Point.

McDonald et al. (1997) also suggested that fluctuating water levels can create precarious travelling conditions for moose. This has the potential to alter travel routes used by moose and result in effective loss of habitat. In the Western Hudson Bay area, Cree have indicated increased moose mortalities occurring through drowning.

Fox Lake Cree Nation has indicated a number of potential effects on moose occurring as a result of hydroelectric activities. Moose are susceptible to the impacts of sensory disturbances, including construction noise and overhead flights by helicopters (FLCN 2012). The negative effect of sensory disturbances includes reduced success of bull moose during the rut in attracting a cow, which could lead
to fewer births and fewer moose in the region (FLCN 2012). Based on the construction of generating stations and transmission lines in the region there is the potential for short-term decreases in the moose population based on the increased harvest of moose by construction workers (FLCN 2011 and 2012). There is also the potential for increased moose-vehicle collisions through increased traffic on the highways in the region (FLCN 2012).
6.10.7 Coastal Hudson Bay Ecozone

The Coastal Hudson Bay Ecozone contains very little hydroelectric or non-hydroelectric development. The major hydroelectric developments located in the ecozone are the Churchill Weir and the Radisson-Churchill transmission line. Despite few hydroelectric developments, the lower Churchill River has been substantially altered due to upstream developments (i.e., the CRD). The pre-hydroelectric development period is defined in the Coastal Hudson Bay Ecozone as occurring before the operation of the CRD in 1976. The Churchill Weir was operational in 1999. Non-hydroelectric development in the ecozone includes the town and port of Churchill and a portion of the Hudson Bay Railway.

Map 6.10.7-1 outlines the terrestrial regions found within the Coastal Hudson Bay Ecozone, overlain with the hydraulic zones used in the physical and aquatic environment portions of the RCEA Phase II report.
6.10.7.1 Changes in Indicators over Time

To assess changes in moose populations, five indicators were evaluated using seven different metrics applied to the pre- and post-hydroelectric development periods. Further information on how these metrics were derived is available in Section 6.10.1.2. While not an indicator or metric, predator pressure was evaluated as a factor affecting moose populations based on the role of predator species, particularly grey wolf and black bear. The results and comparison of evaluated metrics for this ecozone are summarized in Section 6.10.7.2.

6.10.7.1.1 Before Hydroelectric Development

For the pre-hydroelectric development period, moose population trends in this report are based primarily on provincial government RTL section reports. In the early 1950s, the Churchill and York RTL sections partially overlapped the Costal Hudson Bay Ecozone (Figure 6.10G-2). Historic references to moose in this ecozone are also reported by Bryant (1953, 1955) and Howard and Larche (1975).

POPULATION

In the early 1950s, the MDMNR asked trapline holders to estimate the number of moose on their traplines by counting signs and animals observed from freeze-up to December 31st (MDMNR 1951a, Bryant 1955). As a result, pre-hydroelectric development moose population trends are available for the Coastal Hudson Bay Ecozone from the York-Shamattawa RTL Section reports (Figure 6.10G-2). Reports from the Churchill RTL Section were not available.

For the combined York-Shamattawa Section from 1952 to 1955, the estimated moose density ranged from 0.004 to 0.007 moose per km² (Table 6.10C-1). During the 1953/54 season, the York-Shamattawa Section reported that the calf population was good, with many sets of twins noted (MDMNR 1955d). For the 1954/55 season, Bryant (1955) indicated a calf:cow ratio of 106 calves per 100 cows for this section.

Bryant (1955) summarized moose densities in northern Manitoba. The generalized density and distribution of moose around 1953/54 is presented in Figure 6.10G-1 and indicates the Coastal Hudson Bay Ecozone had low moose densities of over 30 square miles per moose (<0.013 moose per km²). Bryant (1955) indicated that the northern boundary of moose densities in the Coastal Hudson Bay Ecozone was largely speculative based on limited observations and census accounts for this area.

HABITAT

This Coastal Hudson Bay Ecozone intersects the northern fringe of known moose range in Manitoba. Bryant (1955) and Howard and Larche (1975) reported that the distribution of moose in this ecozone is sparse due to climactic and habitat related factors. Moose were still extending their range towards the Coastal Hudson Bay Ecozone in the early 1900s. This range extension occurred partially based on a slow post-glacial range re-occupation aided by human activities and forest fires, which resulted in the creation of younger forests preferred by moose.
Rivers in the Coastal Hudson Bay Ecozone were particularly important for sustaining moose populations. The York-Shamattawa Section substantiated the importance of rivers by identifying areas of high moose densities near Cape Tatnam as well as the Nelson and Weir rivers (MDMNR 1955d).

Howard and Larche (1975) described variations in moose densities resulting primarily from landscape-level habitat differences (Figure 6.10G-3). The Coastal Hudson Bay Ecozone is principally located in the Hudson Bay Lowlands moose habitat section defined by Howard and Larche (1975), which contains poorly drained relief, except for beach ridges occurring inland from Hudson Bay. This section includes vast areas of swamp, bog and muskeg. Forested areas tend to be black spruce and muskeg stands found in open fens and muskegs. In areas with better drainage, there is a limited potential for white spruce, balsam poplar and white birch stands. Understory shrub species (e.g., willow, alders and Labrador tea) occur, but commonly without an overstory.

Based on the habitat attributes of the Hudson Bay Lowlands habitat sections, the Coastal Hudson Bay Ecozone is estimated to have had an approximate moose density of a 0.05 moose every square mile (or 0.019 moose per km²) (Howard and Larche 1975). This density was the lowest reported moose density for a habitat section in Manitoba, and much lower than the provincial average (0.30 moose per mile² or 0.12 moose per km²) (Figure 6.10G-3).

PREDATION

Wolf populations were most likely limited in the Coastal Hudson Bay Ecozone due to the relative absence of prey species, notably moose, which wolves rely on to sustain their population. To some degree, wolf populations in this ecozone are supported by the migratory herds of caribou that move through the area, and as indicated in the consideration of the Split Lake RTL Section (MDMNR 1952a). Targeted predator-control programs were reported to be successful in reducing gray wolf numbers in the early 1950s. However, high rates of wolf predation were unlikely as moose populations tended to remain sparse and localized near riparian areas.

There were varying numbers of wolves killed in the early 1950s with the predator-control program in the York-Shamattawa RTL section targeting both adult and wolf pups (MDMNR 1950). Varied techniques were used for attracting wolves, including the use of seal meat to attract wolves onto the tidal flats where they could be shot (MDMNR 1950).

In 1951/52 and 1953/54, bounties were paid for harvesting 36 and 22 wolves, respectively (MDMNR 1953g). An additional nine wolves were killed over the 1954/55 season by trapping, shooting and poisoning (MDMNR 1955d). For the 1954/55 season, the York-Shamattawa RTL Section reported a marked decrease in the wolf population with at least 88 wolves killed, including a pack of 10 (MDMNR 1955d). Only one moose was reported to be depredated by wolves along the Hayes River (MDMNR 1955d). Despite the apparent successes of the predator control program, there were no identified increases in the moose population.

DISEASE AND PARASITES

Based on available RTL section reports for the York-Shamattawa RTL Section there were no reports of white-tailed deer, or ‘Virginia deer’ in the early 1950s. It is expected that the Coastal Hudson Bay
Ecozone is too far north to sustain a deer population, which would limit the potential for the spread of brainworm into the moose population. As far back as 1932, Bryant (1955) indicated that there were no reports of “moose disease” affecting moose in Manitoba.

**HARVEST**

Bryant (1955) indicated that moose harvest varied among traditional use areas, ranging from 2 to 20% utilization of local moose populations. In northern Manitoba as a whole, First Nations harvest accounted for 80% of all harvested moose (Bryant 1955). The number of licensed hunters in the north at this time was limited.

For the combined York-Shamattawa RTL Section, 53 moose were harvested in 1950/51, and 104 moose for the 1952/53 season (MDMNR 1950, 1953g). For the York group alone, the estimated harvest was 22 moose (or about 42% of the total harvest). Harvest for the combined York-Shamattawa RTL Section in 1952/53 was 104 moose, or approximately 29% of the moose population (MDMNR 1953g). For the 1953/54 season, the harvest rate was 106 moose, or 63% of the total estimated population. In the 1954/55 season, 105 of the estimated 283 moose were harvested (37% of the total population) (MDMNR 1955d).

Within those RTL sections considered as part of the Coastal Hudson Bay Ecozone, barren-ground caribou was a substantially more valuable country food item compared to moose due their increased availability. For example, compared to the 53 moose harvested in the York-Shamattawa RTL Section in 1950, 589 caribou were recorded as harvested (MDMNR 1950).

Moose harvest is largely influenced by the availability of access along roads and waterways. For the 1964 early moose season, Ransom (1965) reported that most harvesting in the Northeast Region occurred up to 1.5 miles (2.41 km) from roads but mainly along shorelines. Similarly, based on the 1966 early moose season, Bidlake (1966) indicated that most moose harvests occurred within one mile (1.6 km) of roads in the area, with the majority of hunting confined to waterways.

The level of linear features present on the landscape prior to hydroelectric development in the Coastal Hudson Bay Ecozone was 0.03 km/km² (Intactness, Table 6.2.7-2). The presence of linear features in this ecozone was largely based on quantities of railway line (162 km) and roads (99 km) that accounted for 87.87% of the total linear feature density with 0 km attributable to hydroelectric development. In the Warkworth and Fletcher terrestrial regions the presence of linear features was entirely based on the railway line that runs through these areas. The lack of linear features such as roads indicates that most hunting in these areas likely occurred along waterways. The availability of roads, albeit limited, in the Hudson Coast Terrestrial Region, would have facilitated the harvest of moose by allowing greater harvester access to moose populations through the use of motorized vehicles.

In the early 1970s, a number of GHAs were considered inaccessible, including those GHAs comprising portions of the Coastal Hudson Bay Ecozone. For these GHAs, Jahn (1975) indicated there was little information available on moose hunting levels and that little effort was placed on monitoring harvest activities.
Howard and Larche (1975) indicated that GHAs 1 and 3 (which would later encompass GHAs 2 and 3) received low harvest pressure by licensed harvesters from 1968 to 1974, due in part to their remoteness. From 1968 to 1973, the total number of moose harvested in GHAs 1 and 3 accounted for 4.49% (in 1968) to 6.42% (in 1971) of the total provincial harvest by licensed resident harvest (Table 6.10D-1, Table 6.10D-2). Both GHAs 1 and 3 had roughly equivalent levels of harvest with GHA 1 having slightly higher resident licensed harvest and GHA 3 having higher levels of non-resident licensed harvest (Table 6.10D-2, Table 6.10D-3). The total moose harvest by resident and non resident licensed harvesters in GHAs 1 and 3 ranged from 3.97% (in 1968) to 6.27% (in 1972) of the provincial total (Table 6.10D-6).

6.10.7.1.2 After Hydroelectric Development

Post-hydroelectric development, the status of moose populations in the Coastal Hudson Bay Ecozone is based primarily on information from environmental assessments of potential or current hydroelectric developments and from government reports. Indicators examined include population, habitat, predation, disease and parasites, and harvest.

Hydroelectric developments inside this ecozone include the transmission line to Churchill in 1985. Other habitat changes are associated with the CRD, after operation of the Missi Falls Control Structure began in 1974, the Churchill Weir in 1999, and hydroelectric generating stations outside this ecozone on the lower Nelson River that influence flow and land area encompassed by the Churchill and Nelson Rivers.

POPULATION

Following hydroelectric development, moose populations continued to remain sparse and clustered within the Coastal Hudson Bay Ecozone. Higher moose densities in the Fox Lake and York Factory RMAs were most often associated with riparian habitat. Moose population recruitment rates appeared to be sustainable. No directly comparable data were available pre- and post-hydroelectric development, which would improve our understanding of the existing environment.

Surveys to evaluate the population size and status of moose populations in the Coastal Hudson Bay Ecozone are limited. The Coastal Hudson Bay Ecozone primarily overlaps GHA 2, which has not been systematically surveyed as a singular survey area (Map 6.10.7-2). Small portions of GHAs 1 and 3 also occur within this ecozone but, similarly to GHA 2, have not been surveyed in their entirety. Only those portions of the GHAs inside the York Factory (GHA 3) and Fox Lake (GHAs 2 and 3) RMAs have been surveyed in 2000 and 2013, respectively.

An aerial survey of the Fox Lake RMA was conducted in 2013. The modified Gasaway-style survey estimated a population of 138 moose (Knudsen and Berger 2014). No confidence intervals were provided due to the paucity of data and low moose densities. Only the extreme eastern portion of this survey area occurred within the Coastal Hudson Bay Ecozone. Moose densities derived for Fox Lake RMA as a whole was 0.017 moose per km². This density is thought to be roughly equivalent with the density of moose in the broader Coastal Hudson Plains Ecozone.
Surveys of the York Factory RMA, overlapping a portion of GHA 3, are limited to one survey year (Hedman 2000). Hedman (2000) selected sample strata representative of high and low moose densities where all high moose densities were almost exclusively located around rivers and creeks and away from the Hudson Bay Coast (where the Coastal Hudson Bay Ecozone is primarily located). The moose population in the York Factory RMA was estimated at 589 moose with an approximate calf:cow ratio of 88 calves per 100 cows.

Didiuk (1975) performed aerial surveys from mammal species along portions of the Hudson Bay coast in anticipation of future hydroelectric developments, namely near Gillam Island at the fringe of the Coastal Hudson Bay Ecozone. The moose populations in this area occurred at a low density. Moose were only observed on the mouth of the Hayes River (Marsh Point). Didiuk (1975) suggested that flooding of habitat associated with hydroelectric development on the lower Nelson River would have a limited effect on mammals populations, including moose.
Game Hunting Areas
Coastal Hudson Bay Ecozone

Legend
- Terrestrial Region
- RCEA Region of Interest

Game Hunting Areas
1
2
3

Infrastructure and Footprints
- Limited-use Road
- Road
- Rail
- Transmission Line (Existing)

Footprints and terrestrial regions - ECOSTEM Ltd.; Game hunting areas and water - Manitoba Conservation.

DATA SOURCE:
DATE CREATED:
CREATED BY:
VERSION NO:
REVISION DATE:
QA/QC:
COORDINATE SYSTEM:
NAD 1983 UTM Zone 14N
0
0
10
10
20
20
Miles
Kilometres

Scale: 1:1,113,000
File Location: Z:\Workspaces\RCEA\Support\Mammal\GHAs in the Coastal Hudson Bay.mxd

NOTE: Footprint polygons exaggerated slightly to enhance visibility.

Map 6.10.7-2
HABITAT

Post-hydroelectric development, moose habitat has changed by various degrees, both directly and indirectly, in the Coastal Hudson Bay Ecozone. Habitat loss and alteration has occurred through dewatering, rewatering, water regulation, the development of linear corridors, infrastructure, increased access and potentially, fire. This section focuses mainly on direct habitat effects from hydroelectric development. Overall, there has been a very low level of habitat loss in the Hudson Coast, Warkworth, and Fletcher terrestrial regions and for the Coastal Hudson Bay Ecozone as a whole. On-system habitat effects were associated with potential changes in shore zone and offshore wetlands, shoreline debris and tall shrub communities; however, data were not available in the ecozone to quantify these results.

In evaluating the impacts of future hydroelectric development projects on the lower Nelson River, Didiuk (1975) indicated there was only a limited availability of moose habitat downstream of the community of Gillam, MB. His observations of increased lichen cover drew him to conclude that this area was better suited for caribou.

The availability of winter forage was identified by Didiuk (1975) as a limiting factor for moose. Some shoreline areas that supported extensive willow and alder appeared to support moose whereas other available forage sources were often limited due to snow depths in the region. Shoreline areas that supported grass and forb species provided spring and fall forage, with other plant species (including mushrooms and lichens) also occasionally consumed. The effect of fire on habitat was identified as potentially important for the early successional stage vegetation preferred by moose. As part of the aerial moose surveys conducted of the Fox Lake RMA, Fox Lake resource users were asked to indicate on a map where they anticipated there to be high moose densities (Knudsen and Berger 2014). Based on the response of one individual, high moose densities were not identified in the portion of the RMA inside the Coastal Hudson Bay Ecozone. Portions of the Weir, Nelson, Angling and Fox rivers, inside the Hudson Plains Ecozone (Section 6.10.6), were identified as high quality habitat; indicating the importance of riparian areas for supporting moose.

Only small amounts of the Coastal Hudson Bay Ecozone have been affected by forest fires in the past 44 years (Terrestrial Habitat, Map 6.3.1-7). A comparison of all the ecozones in the RCEA ROI indicates that the Coastal Hudson Bay Ecozone has the lowest average annual area burned (0.17%) in comparison with other ecozones (Terrestrial Habitat, Table 6.3.1.8). This is likely due to this area mostly consisting of taiga and tundra, which are not conducive to extensive fires relative to other ecozones.

Hedman (2000) conducted an aerial survey in the southern portion of the Coastal Hudson Bay Ecozone occurring within the York Factory RMA. Survey locations were based on personal knowledge of the area of where moose would most likely be found. The selection of strata was based primarily around the sampling of riparian and non-riparian habitats. Pre-selected high density strata had roughly twice the number of moose as the low density strata (Table 6.10.7-1). As the area encompassed by the Coastal Hudson Bay Ecozone includes those river deltas draining into Hudson Bay, there are likely a few high and low moose density areas; however, the majority of Coastal Hudson Bay Ecozone would most likely consist of the “Nil” habitat strata. Hedman (2000) observed numerous moose beds along the coast within the low tide edge.
Further north in the ecozone, as outlined in the Resource Use portion of this report (Summary of Community Information, Section 3.5.4.4), several Churchill residents reported that moose hunting along the river improved following CRD as a result of increased foraging habitat (i.e., willow and grass growth along the dewatered or exposed riverbed) (Edye-Rowntree et al. 2006; Brandson 2012). However, most acknowledged that a variety of reasons could have contributed to the increase in moose availability (e.g., forest fires, climate change), including increased visibility in the dewatered river corridor (Edye-Rowntree 2007).

Table 6.10.7-1: Moose Densities by Habitat Strata Sampled in Game Hunting Area 3 Inside the York Factory Resource Management Area (modified from Hedman 2000)

<table>
<thead>
<tr>
<th>Habitat Strata</th>
<th>Size (km²)</th>
<th>Moose Density (moose per km²)</th>
<th>Refined Habitat Strata Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>1166</td>
<td>0.317</td>
<td>Islands in the Hayes River and deltas of major river draining into Hudson Bay</td>
</tr>
<tr>
<td>Low</td>
<td>1325</td>
<td>0.165</td>
<td>The riparian edge of the Hayes, Nelson and Pennycuttaway River and all minor watersheds draining into Hudson Bay</td>
</tr>
<tr>
<td>Nil</td>
<td>0</td>
<td>0.000</td>
<td>Off-system areas</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2491</td>
<td>0.231</td>
<td></td>
</tr>
</tbody>
</table>

Regional Habitat Model

For the existing environment, a summary of the moose model used to describe primary and secondary moose habitat is found in Appendix 6.10A. Primary habitat in each terrestrial region varied from 1.4% (for the Warkworth Terrestrial Region) to 15.6% (for the Fletcher Terrestrial Region) (Table 6.10.7-2). In total, the Coastal Hudson Plains Ecozone consisted of 8.1% of primary habitat. Primary habitat distribution was largely clustered (Map 6.10.7-3 to Map 6.10.7-4). Tables 6.10B.7-1, 6.10B.7-2 and 6.10B.7-3 summarize the quantity of habitat type present in the Coastal Hudson Plains Ecozone, by terrestrial region.

Table 6.10.7-2: Proportion of Primary and Secondary Moose Habitat in the Coastal Hudson Bay Ecozone

<table>
<thead>
<tr>
<th>Terrestrial Region (TR) or Ecozone</th>
<th>Primary Habitat</th>
<th>Secondary Habitat</th>
<th>Total Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>%</td>
<td>ha</td>
</tr>
<tr>
<td>Hudson Coast TR</td>
<td>39,882</td>
<td>5.9%</td>
<td>638,459</td>
</tr>
<tr>
<td>Warkworth TR</td>
<td>9156</td>
<td>1.4%</td>
<td>650,934</td>
</tr>
<tr>
<td>Fletcher TR</td>
<td>123,666</td>
<td>15.6%</td>
<td>671,753</td>
</tr>
<tr>
<td>Coastal Hudson Plains Ecozone</td>
<td>172,704</td>
<td>8.1%</td>
<td>1,961,145</td>
</tr>
</tbody>
</table>
Moose Habitat Quality
Coastal Hudson Bay Ecozone

Legend
- Terrestrial Region
- RCEA Region of Interest

Moose Habitat Quality
- Primary Habitat
- Secondary Habitat

Infrastructure
- Transmission Line (Existing)
- Rail

File Location: Z:\Workspaces\RCEA\Support\Mammal\Moose\Moose Habitat CHB.mxd

DATA SOURCE:

DATE CREATED:

CREATED BY:

VERSION NO:

REVISION DATE:

QA/QC:

COORDINATE SYSTEM:

Regional Cumulative Effects Assessment

Manitoba Hydro; Government of Manitoba, Government of Canada;
ECOSTEM Ltd.