Human Development

Effects of human development have resulted in the loss of primary and secondary moose habitat in the Coastal Hudson Bay Ecozone (Table 6.10.7-2). The loss of moose habitat due to infrastructure, dewatering, rewatering, flooding and water regulation was less than 1% in the Hudson Coast (0.20%), Warkworth (0.04%) and Fletcher (0.01%) terrestrial regions. As a result of all human activities, the loss of moose habitat in the Coastal Hudson Bay Ecozone was 0.11% of available habitat overall (Table 6.10.7-3).

Table 6.10.7-3: Regional Effects of Hydroelectric Development on Primary and Secondary Moose Habitat in the Coastal Hudson Bay 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></td>
<td></td>
<td>Hydroelectric</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>Hudson Coast TR</td>
<td>38,915</td>
<td>38,835</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Warkworth TR</td>
<td>8566</td>
<td>8563</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Fletcher TR</td>
<td>109,783</td>
<td>109,691</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Coastal Hudson Bay Ecozone</td>
<td>157,264</td>
<td>157,093</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Secondary</td>
<td>Hudson Coast TR</td>
<td>622,905</td>
<td>621,631</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Warkworth TR</td>
<td>607,706</td>
<td>607,491</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Fletcher TR</td>
<td>596,218</td>
<td>595,716</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Coastal Hudson Bay Ecozone</td>
<td>1,826,829</td>
<td>1,824,834</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Total</td>
<td>Hudson Coast TR</td>
<td>661,820</td>
<td>660,466</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Warkworth TR</td>
<td>616,272</td>
<td>616,054</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Fletcher TR</td>
<td>706,001</td>
<td>705,407</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>Coastal Hudson Bay Ecozone</td>
<td>1,984,093</td>
<td>1,981,927</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>

The availability of terrestrial shoreline moose habitat was affected by CRD and the dewatering of the Churchill River outside of habitat loss. For the Coastal Hudson Bay Ecozone as a whole, 3696 ha of terrestrial moose habitat was added from the ecozone post-hydroelectric development. This total does not consider hydroelectric and non-hydroelectric infrastructure, which resulted in a loss of primary and secondary moose habitat (Table 6.10.7-3, Table 6.10B.7-4). There is a potential for these areas to have an abundance of willow species, which moose feed on (Brandson 2012). The breakdown of dewatered habitat by terrestrial region includes 926 ha in the Fletcher, 2479 ha in the Warkworth, and 291 ha in the Hudson Coast Terrestrial Region.
Fragmentation

Access to moose populations can be measured in part by the abundance of linear features on the landscape. As of 2013, for the Coastal Hudson Bay Ecozone as a whole, linear feature density was 0.03 km/km² (Intactness, Table 6.2.7-2). Based on selected benchmarks, this level of fragmentation is associated with a low level of disturbance. Fragmentation was measured at 0.01 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). Transmission lines and the Churchill weir are the only linear features created through hydroelectric development activities; and account for 0.01 and <0.01 km/km² of linear features on the landscape, respectively.

Intactness varies by terrestrial region in the Coastal Hudson Bay Ecozone. The start date of hydroelectric development in the Hudson Coast, Warkworth and Fletcher terrestrial regions is 1974. The Hudson Coast Terrestrial Region as of 2013 had the highest linear feature density of 0.04 km/km², of which <0.01 km/km² (or 5.5%) can be attributed to hydroelectric development (Intactness, Table 6.2.7-2). The Fletcher Terrestrial Region had the second highest linear feature density in 2013 with 0.02 km/km² with hydroelectric development corresponding to 0.01 km/km² (or 45.9% total linear features for this area). An illustration of those linear features within the Coastal Hudson Bay Ecozone is provided in Map 6.10.7-1.

On-System Habitat Loss

Shoreline areas have been identified as particularly important areas for moose in this ecozone (Hedman 2000; Knudsen and Berger 2014). These areas are preferred by moose for drinking water, increased forage availability, obtaining essential nutrients (e.g., sodium which is required to compensate for nutrient deficits acquired during winter), thermoregulation, and the use of shoreline areas and islands as escape cover from predators (Section 6.10.1.1.1).

Waterbodies, watercourses and adjacent habitat that have been affected by hydroelectric development are referred to as on-system habitat. The Coastal Hudson Bay Ecozone was affected by water regulation during the post-hydroelectric development period, but no flooding occurred in the ecozone or individual terrestrial regions. This 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).

Data were not available to quantitatively evaluate changes to on-system moose habitat in the Coastal Hudson Bay Ecozone.

PREDATION

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 grey wolf use to increase their hunting efficiency (James and Stuart-Smith 2000). Linear feature density in the Coastal Hudson Bay Ecozone remained relatively low at 0.03 km/km² with 0.01 km/km² attributable to hydroelectric development. Linear feature density in the Hudson Coast Terrestrial Region was the highest at 0.04 km/km² with 0.01 km/km² attributable to hydroelectric development.
(see Fragmentation section, above). The level of linear features in the Warkworth and Fletcher terrestrial region were less at 0.01 and 0.02 km/km², respectively.

Average moose densities (0.017 moose per km²) in the Fox Lake RMA were insufficient for 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. Coastal areas associated with potential calving habitat for the migratory caribou herds are located in the Coastal Hudson Bay Ecozone. Caribou select these habitats during spring and summer to avoid predators such as gray wolf. As a result, the moose population which overlaps with caribou habitat most likely faces low predator pressure for at least part of the year.

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 known occurrences of white-tailed deer in the Coastal Hudson Bay Ecozone although there have been isolated reports of white-tailed deer near Herchmer, located approximately 140 km south of Churchill (MCWS 2014a). The Coastal Hudson Plains Ecozone is comprised of portions of GHAs 1, 2 and 3, which all occur outside of the Deer Hunting Zone identified by MCWS (2013). As such, 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

Due to its relative inaccessibility, the Coastal Hudson Bay Ecozone is slow to experience increases in harvest pressure relative to more southerly GHAs. Moose harvest was predominantly water access-based activity prior to hydroelectric development. Dewatering of the Churchill River due to the CRD has altered habitat for maintaining moose populations (Brandson 2012; D. Hedman pers. comm. 2015). Water access for moose harvesting was reduced considerably from the dewatering of the lower Churchill River. Access improvement occurred for a short section of the lower Churchill River, however, with the construction of the Churchill Weir.

Currently, the Coastal Hudson Bay Ecozone largely overlaps GHA 2 with small portions of GHAs 1 and 3 (Map 6.10.7-1). As of 2013, all these GHAs remain open to licensed moose harvests, including for resident and non-residents. 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). The linear feature density for the Coastal Hudson Bay Ecozone was 0.03 km/km², over the ecozone as a whole, with the highest densities occurring within the Hudson Coast Terrestrial Region (0.04 km/km²).
6.10.7.2 Cumulative Effects of Hydroelectric Development

6.10.7.2.1 Regional Effects

INDICATOR RESULTS

The Coastal Hudson Bay 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 through the use of varied response and driver indicators, the results of which are summarized in Table 6.10.7-4.
Table 6.10.7-4: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Coastal Hudson Bay Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydro Electric 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 RTS</td>
<td>York-Shamattawa 0.004 to 0.008 moose per km²</td>
<td>Moose populations occur at naturally low levels in the Hudson Plains Ecozone. Moose densities were low during the pre-hydroelectric development period and have remained low post-hydroelectric development. The clustering of moose populations based on the availability of riparian habitat areas may have been affected by changes in dewatering, flooding and water regime; however this is difficult to substantiate due to reports of low moose populations prior to hydroelectric development.</td>
<td>Hydroelectric development has influenced moose populations in the Coastal Hudson Bay Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bryant (1955)</td>
<td>&lt;0.013 moose per km²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Howard and Larche (1975)</td>
<td>0.019 moose per km² based on regional habitat availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recruitment rates</td>
<td>Recruitment rates</td>
<td>Early 1950's RTS</td>
<td>York-Shamattawa “calf population is good with many sets of twins being noted” 106 calves per 100 cows (c. 1955)</td>
<td>Recruitment rates indicate the potential for healthy and increasing moose populations in the Coastal Hudson Bay Ecozone for both the pre- and post-hydroelectric development periods.</td>
<td>Hydroelectric development may have influenced moose recruitment in the Coastal Hudson Bay Ecozone. Refer to driver indicator results.</td>
</tr>
<tr>
<td>Habitat</td>
<td>ha of high quality habitat by type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moose densities highest in coastal and riparian habitat areas</td>
<td>There were only low levels of terrestrial habitat loss and/or alteration. No terrestrial habitat was lost through flooding.</td>
<td></td>
<td>Hydroelectric development has influenced moose habitat in the Coastal Hudson Bay Ecozone. Benchmarks: Low for the Fletcher, Warkworth and Hudson Coast terrestrial regions as well as Coastal Hudson Bay Ecozone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced availability of habitat in Terrestrial Regions (TR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hudson Coast TR (-0.08%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warkworth TR (-0.04%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fletcher TR (-0.20%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coastal Hudson Bay Ecozone (-0.11%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage on-system high quality riparian habitat</td>
<td>Percentage on-system high quality riparian habitat</td>
<td>No data available</td>
<td>No data available</td>
<td>Riparian habitat in the Upper Churchill Terrestrial Region affected through the dewatering of the low Churchill River as a result of the CRD. Section of the Churchill River inside the Hudson Coast Terrestrial Region partially rewatered as a result of the Churchill Weir. Changes to on-system habitat are not clear, but dewatering of the Churchill River would likely have increased terrestrial browse and decreased aquatic forage plants. Changes in harvester access on the Churchill River put potential for increased moose shore zone wetland habitat as per modeling conducted for the Taiga Shield Ecozone.</td>
<td>Hydroelectric development has affected riparian moose habitat in the Coastal Hudson Bay Ecozone. Benchmarks: Low for the Fletcher, Warkworth and Hudson Coast terrestrial regions.</td>
</tr>
</tbody>
</table>
### Table 6.10.7-4: Potential Impact of Hydroelectric Development on the Moose Regional Study Component in the Coastal Hudson Bay Ecozone

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Pre-Hydro Electric Development</th>
<th>Existing Environment</th>
<th>Evaluation of Effects</th>
<th>Role of Hydroelectric Development</th>
</tr>
</thead>
</table>
| Harvest            | Change in harvest pressure                  | 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 63% of the estimated population.  
Caribou the more frequently harvested and relied on game species with increased harvest levels based on migration patterns.  
Low levels of licensed harvest for 1968 – 1974 hunting seasons | GHA 1, 2 and 3 still considered largely inaccessible as part of the "Northern Zone."  
Caribou still considered important for domestic harvest  
Potential for increased moose harvest based on additional linear features increasing harvester access to moose populations  
Indication of increased moose harvest levels occurring in proximity to Churchill MB following the completion of the CRD project. | 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.  
The Hudson Coast Terrestrial Region already had a limited linear feature density prior to hydroelectric development and included roads which often facilitate harvester access.  
Increases in linear feature density due to hydroelectric development occurred principally (98%) based on the construction of transmission lines, but this increase has likely only marginally increased access to moose populations because the linear feature density in all terrestrial regions remain very low.  
Dewatering resulted in decreased access to the moose population, except for a short stretch of river rewatered by the Churchill Weir.  
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. | Hydroelectric development has influenced moose harvest in the Coastal Hudson Bay Ecozone by increasing access.  
**Benchmarks:**  
Low for the Fletcher, Warkworth and Hudson Coast terrestrial regions, as well as Coastal Hudson Bay Ecozone. |
| Fragmentation      | km/km² of linear features                  | From Intactness Chapter (6.2)  
Hudson Coast TR - 0.03 km/km²  
Warkworth TR - 0.01 km/km²  
Fletcher TR - 0.01 km/km²  
Coastal Hudson Bay Ecozone - 0.01 km/km² | From Intactness Chapter (6.2)  
Hudson Coast TR - 0.04 km/km²  
Warkworth TR - 0.01 km/km²  
Fletcher TR - 0.02 km/km²  
Coastal Hudson Bay Ecozone - 0.03 km/km² | 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 very low linear feature density. | Hydroelectric development has increased the level of fragmentation in the Coastal Hudson Bay Ecozone.  
**Benchmarks:**  
Low for the Fletcher, Warkworth and Hudson Coast terrestrial regions, as well as Coastal Hudson Bay Ecozone. |
| Disease and Parasites | Distribution of white-tailed deer | 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. | As white-tailed deer remain absent, no effects are reported. | Hydroelectric development has not changed deer distribution in the Coastal Hudson Bay Ecozone.  
**Benchmarks:**  
No change |
EVALUATION OF EFFECTS

The habitat loss and fragmentation indicators used for identifying changes in the function and availability of moose habitat in the Coastal Hudson Bay Ecozone remained in the low magnitude of effects range. A comparison of the Hudson Coast, Warkworth and Fletcher terrestrial regions indicates that all areas remain largely undisturbed. Instead of fire, which is the main driver of moose habitat quality and quantity in other ecozones, the availability of coastal and riparian habitat is likely more important. The lower Churchill River has been affected by dewatering, and a small amount of rewatering from the Churchill Weir. In some areas along the Churchill River, the old riverbed supports the growth of willow, and may have increased moose habitat, but only in some localized areas over the short term. In some areas along the Nelson River towards the southern fringe of this ecozone, the local quality of riparian habitat has been altered as a result of hydroelectric development but there has been no net loss of habitat through flooding.

Increased access in the Coastal Hudson Bay Ecozone occurred with the development of linear features (i.e., roads, rail, transmission lines), and somewhat marginally improved the accessibility of moose populations to harvesters. The highest quantities of linear features present in the Coastal Hudson Bay Ecozone occur in the Hudson Coast Terrestrial Region, which increased from 0.03 km/km², pre-hydroelectric development, to 0.04 km/km², post hydroelectric development. Increases in linear feature density based on hydroelectric development were overwhelmingly (98%) due to the construction of transmission lines, with a small quantity attributed to the construction of the Churchill weir. In comparison to roads, transmission lines, while increasing linear feature densities, are not seen as greatly improving harvester access. Although it is unclear how a specific moose subpopulation might have been affected by increased transmission lines, high density moose areas (which are often clustered) can be disproportionately affected through increased demand and harvest opportunities. For, example dewatering of the Churchill River, where moose became clustered within riparian areas, as well as became more visible along portions of some shorelines, has led to increased harvest opportunities for some residents of Churchill. These increases in moose harvest opportunities may subside if these areas mature and become less suitable to moose as habitat. In areas without linear features, or along the Churchill River that remains dewatered, and with the exception of areas nearest Churchill, access to moose has most likely decreased considerably.

Predator control programs in the Coastal Hudson Bay Ecozone likely played a limited role in increasing moose population numbers as there were few moose naturally occurring in the area. Instead, the predator control program in the York-Shamattawa RTL sections was thought to increase the availability of caribou for harvesters. Based on a low abundance of grey wolves in the region and limited change in the density and distribution of linear features, predation is not expected to have had substantial effects on the moose population.

No change occurred in the presence of white-tailed deer. 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 Coastal Hudson Bay Ecozone has remained at stable population levels. Based on surveys indicating high recruitment rates, and that moose populations have only expanded into this area relatively recently, the small moose population appears to remain healthy and has not been substantially affected by hydroelectric and other developments. While the number of studies focused on assessing moose in this area are limited, these studies have indicated that hydroelectric development, and other anthropogenic activities, have not had a substantial effect on the 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 Coastal Hudson Bay Ecozone due to inherent natural limitations of this area in supporting a large moose population. While because of data limitations, it is difficult to identify if the moose population size has changed, 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 Coastal Hudson Bay Ecozone, as a result of hydroelectric development or other development, have not had a substantial impact on moose populations. Because this population is so reliant on riparian areas and it exists at low numbers, caution is warranted where moose population sustainability is influenced by even small anthropogenic disturbances, unless substantive mitigation measured are applied.

6.10.7.2.2 Local Effects

Local effects on moose habitat and moose subpopulations in some areas along the Nelson River (“on-system”) would be different from those assessed for moose habitat and 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.

Localized effects were also described for the dewatered areas along the lower Churchill River. The residents of Churchill described a variety of effects to moose from the CRD in the 1990s (Four Direction Consulting Group 1994) and 2000s (Edye-Rowntree et al. 2006). Access-related effects included lower water levels not being as congenial to boat or snowmobile travel, with equipment damage occurring due to exposed rocks. Reduced access to moose populations potentially allowed the moose population to grow. As a result of increased shoreline habitat in dewatered areas along the Churchill River, it was also noted that moose now needed to come out into the open to access the river (Edye-Rowntree et al. 2006). There was also a resident who reported decreased moose hunting opportunities close to the river. Despite increased harvesting potential, declines in the availability of moose by residents of Churchill were not described. Residents indicated that increased habitat availability may be driving increased moose population numbers. Riverbed areas that once occurred within the Churchill River were taken over by willows, which are a preferred forage source for moose.
McDonald et al. (1997) indicated 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 Ecozone area, Cree have indicated increased moose mortalities occurring through drowning.

Moose have also been affected by the loss or alteration of habitat occurring as a result of hydroelectric development and other anthropogenic land use projects. Shorelines in rivers that were exposed as a result of river diversions (e.g., the CRD) have resulted in the drying up of trees and tall shrubs (i.e., willows) that had been depended on by different species including beaver and moose. McDonald et al. (1997) indicated that along the Nelson River there was a loss of moose habitat for about 16 km upstream from Marsh Point, with no moose present at Marsh Point.
6.10.8 Effects of Hydroelectric Development in the Region of Interest on Moose

- Changes in the suitability for each the six ecozones in the RCEA ROI to sustain moose were evaluated using a set of indicators that could factor in the life history characteristic of moose.

**POPULATION**

- Moose have been experiencing localized population declines in different areas of North America; the reasons for this remain uncertain, but may include climate change, increasing predator pressure, or disease and parasites.
  - In the RCEA ROI, the factors affecting the moose population are largely understood based on provincial government reports and local knowledge.
- Pre-hydroelectric development population surveys generally showed a gradient of moose densities over the RCEA ROI, with decreasing densities from the southwest to the northeast.
  - Intermittent patches of high moose densities were identified within the Western and Eastern Boreal Shield ecozones, largely in areas where forest fires had created suitable moose habitat.
  - Riparian habitats were also recognized as having high value for moose and often served as a means of accessing moose for resource harvesters.
- Post-hydroelectric development, aerial surveys of the RCEA ROI have shown changing population dynamics.
  - Aerial surveys conducted within the NFA area (which overlaps portions of both the Western and Eastern Boreal Shield ecozones) in 1983/84, 1992/93 and 2001 have shown increasing or decreasing moose densities, depending on the availability of young mixedwood habitat. Densities ranged from 0.03 to 0.12 moose /km\(^2\) over this period.
  - Recent surveys of GHA 9a, undertaken in 2013 in both the Western and Eastern Boreal Shield ecozones, indicated a declining moose population trend with density estimates (0.02 moose per km\(^2\)) below those seen following past survey efforts.
  - The Boreal Plains Ecozone (portions of GHAs 7, 7a and 10), was surveyed semi-regularly; density estimates ranged from 0.03 (GHA 10 in 2013) to 0.10 (GHA 7A in 2000) moose per km\(^2\).
  - Surveys of the Split Lake RMA (largely within the Taiga Shield Ecozone, and portions of the Western and Eastern Boreal Shield and Hudson Plains ecozones) have shown densities between 0.03 and 0.09 moose per km\(^2\).
  - Some ecozones received little survey effort post-hydroelectric development; particularly those overlapping GHAs 1, 2, 3 and 3a. This limits the ability to infer current population status.
- Calf recruitment rates provide another means of assessing moose population health. Recruitment rates below 30 calves per 100 cows may be inadequate for supporting moose population growth.
  - Many survey areas within the RCEA ROI had recruitment rates that far exceeded this minimum.
  - Recruitment rates tended to be highest in the Hudson Plains and Coastal Hudson Bay ecozones, which were close to 100 calves per 100 cows.
  - Recruitment rates were more variable elsewhere in the RCEA ROI, including the Taiga Shield Ecozone, where rates currently range from 31.3 to 44.9 calves per 100 cows (Table 6.10E-1).
within the Split Lake RMA. These recruitment rates are similar to those derived elsewhere in the province, including GHAs GHA 9 and 9a.

○ In the Boreal Plains Ecozone, recruitment rates from 1973 to 1983 (in GHA 10) or from 1973 to 1990 (GHA 7 and 7a) indicated fluctuations in population size, with recruitment rates ranging from 25 calves per 100 cows to 85 calves per 100 cows.

HABITAT

• Habitat availability and changes in habitat are a crucial means of assessing the suitability of ecozones within the RCEA ROI for supporting moose populations.

○ Primary moose habitat was assessed based on the availability of habitat areas affected by forest fires in the past 6 to 30 years, as well as certain select habitat types preferred by moose.

○ Primary habitat areas are seen as currently supporting increased moose population densities where secondary habitat areas are of reduced quality but may become primary if burned.

○ The potential for each ecozone to support moose is based on the quantities of modelled primary and secondary habitat (Table 6.10.8-1).

○ In the Boreal Plains and portions of the Western and Eastern Boreal Shield ecozones, the quantity of primary habitat is limited due to forest fire suppression.

○ In ecozones where fire suppression is not practised, there has been less change in the availability of primary habitat.

○ While fires do occur within the Hudson Plains and Coastal Hudson Bay ecozones, they are often geographically limited due to low levels of vegetative biomass.

• Based on the benchmark values used to evaluate habitat loss, the RCEA ROI as a whole has experienced a moderate magnitude level of habitat loss, 1.1% (at the low end of the moderate magnitude scale), with 0.9% attributable to hydroelectric flooding and infrastructure (Table 6.10.8-2).

○ A moderate magnitude level of habitat loss or alteration has been identified for the Western and Eastern Boreal Shield ecozones (Table 6.10.8-2). The Boreal Plains, Taiga Shield, Hudson Plains and Coastal Hudson Bay ecozones all experienced a low magnitude level of habitat loss.

○ With the exception of the Boreal Plains Ecozone, hydroelectric development contributed the majority of the habitat loss within each ecozone.

○ Most of the overall habitat loss which occurred in the RCEA ROI was due to flooding, with smaller amounts of habitat loss or alteration attributable to hydroelectric infrastructure (e.g., transmission lines).

• On-system changes have also affected the presence and availability of high quality moose habitat.

○ In the Western Boreal Shield Ecozone, flooding along the Rat-Burntwood river system from the CRD resulted in the loss of shore zone and offshore wetland habitat valued as high quality moose habitat, and created access-related issues through increased shoreline debris.

○ Similarly, portions of the Taiga Shield Ecozone, particularly Southern Indian Lake, experienced decreased suitability of shoreline areas for sustaining moose populations and have limited moose and harvester access to shoreline areas.

○ In the Taiga Shield and the Coastal Hudson Bay ecozones, moose habitat located along the lower Churchill River was affected through dewatering.
Those ecozones occurring alongside the Nelson River, particularly portions of the Eastern Boreal Shield affected by LWR, have experienced decreased shore zone habitat quality as well as some localized increases in tall shrub communities, which limit harvester access to shoreline areas.

**FRAGMENTATION, ACCESS AND DISEASE**

- Prior to hydroelectric development, rivers and lakes played an important role for harvester access to areas where moose were located, as anthropogenic linear features, such as roads, occurred at low densities (Table 6.10.8-3).
  - Following hydroelectric development, linear features have increased in all ecozones, but only a portion of this increase is attributable to hydroelectric infrastructure (Table 6.10.8-3).
  - Linear features have the potential to increase the rate at which moose populations are harvested based on increasing harvester access to locations where moose are found.
  - High moose density areas that become accessible to harvesters can result in the overharvesting of moose populations, potentially leading to reduced moose population numbers.
  - The Boreal Plains and the Western and Eastern Boreal Shield ecozones have had the largest increases in linear feature development, with other developments, such as forestry, contributing considerably to these increases.

- Based on the benchmarks, all ecozones, except for the Boreal Plains Ecozone, had a low magnitude level of effect from habitat fragmentation.
  - The Boreal Plains Ecozone had a moderate magnitude level of effects based on cumulative levels of linear features in this area, with 0.07 km/km² of the total 0.27 km/km² of linear density attributable to hydroelectric development.
  - Transmission lines have been used to access moose populations in the Boreal Plains Ecozone, based on reporting done for GHA 7 in 2000.
  - Those terrestrial regions with increased linear feature densities also have reduced moose population densities, particularly along the Bipole III Transmission Project, transmission line ROW (Table 6.10F-1).
  - Further development of the Bipole III Transmission Project, transmission line right-of-way in areas where there are other existing linear features may serve to increase harvest accessibility within these terrestrial regions and potentially affect moose populations.
  - It is important to note that 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, particularly in northern ecozones, limits their use to the winter along much of their length.

- There are no data to support that white-tailed deer range has expanded into northern Manitoba resulting from increased linear feature densities, including transmission lines. No accounts of brainworm were reported for moose in the RCEA ROI.
CONCLUSIONS
• Cumulatively, reduced habitat availability and increased harvester access may be acting to reduce moose populations in a portion of the RCEA ROI.
  o Hydroelectric development has contributed to the majority of landscape alteration, though this quantity of habitat loss is small (~1%) relative to the historic contribution of forest fires. Due to fire suppression in some terrestrial regions (particularly the Paint, Upper Nelson and possibly William terrestrial regions), less primary habitat is becoming available over time, which is serving to limit moose population growth in these areas, particularly when compared to those density levels observed in the mid-1980s when the NFA area was surveyed.
  o On-system moose habitat has been considerably degraded in some areas of the Nelson River and the Burntwood-Rat river system due to flooding and water regulation. Moose habitat on the Churchill River has not degraded as severely from dewatering, with some limited increases in habitat areas preferred by moose.
  o The Paint, Upper Nelson and William terrestrial regions also have been fragmented, with linear feature density levels in the moderate magnitude range. This likely corresponds to increased harvester access into these areas that can serve to reduce moose populations.
• As a whole, the RCEA ROI remains largely intact in the post-hydroelectric development period, where there are few non-naturally occurring factors affecting moose populations.
  o Much of the area remains unchanged and serves as potential moose habitat.
  o Moose populations have only relatively recently expanded into the tundra and taiga and have not been pushed back as a result of hydroelectric – or other – development.
  o Continued low levels of harvester access remain in most areas due to the absence of roadways and other linear features used for access.

Table 6.10.8-1: Proportion of Primary and Secondary Moose Habitat within the Regional Cumulative Effects Assessment Region of Interest

<table>
<thead>
<tr>
<th>Ecozone</th>
<th>Primary Habitat (%)</th>
<th>Secondary Habitat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Boreal Shield</td>
<td>36.9</td>
<td>63.1</td>
</tr>
<tr>
<td>Eastern Boreal Shield</td>
<td>31.7</td>
<td>68.3</td>
</tr>
<tr>
<td>Boreal Plains</td>
<td>25.8</td>
<td>74.2</td>
</tr>
<tr>
<td>Taiga Shield</td>
<td>49.8</td>
<td>50.2</td>
</tr>
<tr>
<td>Hudson Plains</td>
<td>25.1</td>
<td>74.9</td>
</tr>
<tr>
<td>Coastal Hudson Bay</td>
<td>8.1</td>
<td>91.9</td>
</tr>
</tbody>
</table>
### Table 6.10.8-2: Amount of Moose Habitat Pre- and Post-Hydroelectric Development in Ecozones in the Regional Cumulative Effects Assessment Region of Interest

<table>
<thead>
<tr>
<th>Ecozone</th>
<th>Habitat pre-hydroelectric development (ha)</th>
<th>Habitat post-hydroelectric development (ha)</th>
<th>Hydroelectric Development</th>
<th>All Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Change in Habitat (ha)</td>
<td>Change in Habitat (%)</td>
<td>Benchmark</td>
<td>Change in Habitat (ha)</td>
</tr>
<tr>
<td>Western Boreal Shield</td>
<td>4,007,363</td>
<td>3,914,262</td>
<td>69,934</td>
<td>1.7</td>
</tr>
<tr>
<td>Eastern Boreal Shield</td>
<td>4,755,836</td>
<td>4,684,113</td>
<td>63,447</td>
<td>1.3</td>
</tr>
<tr>
<td>Boreal Plains</td>
<td>866,604</td>
<td>858,944</td>
<td>3040</td>
<td>0.4</td>
</tr>
<tr>
<td>Taiga Shield</td>
<td>4,213,654</td>
<td>4,200,037</td>
<td>13,418</td>
<td>0.3</td>
</tr>
<tr>
<td>Hudson Plains</td>
<td>1,509,427</td>
<td>1,503,611</td>
<td>4796</td>
<td>0.3</td>
</tr>
<tr>
<td>Coastal Hudson Bay</td>
<td>1,984,093</td>
<td>1,981,927</td>
<td>415</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Total</td>
<td>17,336,977</td>
<td>17,142,894</td>
<td>155,050</td>
<td>0.9</td>
</tr>
<tr>
<td>Ecozone</td>
<td>Linear Feature Density Pre-Hydroelectric Development (km/km²)</td>
<td>Linear Feature Density Post-Hydroelectric Development (km/km²)</td>
<td>Benchmark</td>
<td>Linear Feature Density All Development (km/km²)</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Western Boreal Shield</td>
<td>0.01</td>
<td>0.02</td>
<td>Low</td>
<td>0.12</td>
</tr>
<tr>
<td>Eastern Boreal Shield</td>
<td>&lt;0.01</td>
<td>0.02</td>
<td>Low</td>
<td>0.10</td>
</tr>
<tr>
<td>Boreal Plains</td>
<td>0.03</td>
<td>0.07</td>
<td>Low</td>
<td>0.27</td>
</tr>
<tr>
<td>Taiga Shield</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>Low</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hudson Plains</td>
<td>0.02</td>
<td>0.03</td>
<td>Low</td>
<td>0.05</td>
</tr>
<tr>
<td>Coastal Hudson Bay</td>
<td>0.01</td>
<td>0.01</td>
<td>Low</td>
<td>0.03</td>
</tr>
<tr>
<td>Total</td>
<td>0.01</td>
<td>0.03</td>
<td>Low</td>
<td>0.08</td>
</tr>
</tbody>
</table>
6.10.9 Bibliography

6.10.9.1 Literature Cited and Data Sources


Crichton, V. 1985. A summary of surveys pertaining to moose, elk and woodland caribou 1983/84. Wildlife Branch, Manitoba Department of Mines and Natural Resources, Winnipeg, MB. 41 pp


Four Directions Consulting Group. 1994. Perceived impacts of the Churchill River diversion on residents of the LGD of Churchill. Four Directions Consulting Group, Edmonton, AB.


6.10.9.2  Personal Communications

6.11 Polar Bear

6.11.1 Introduction

The polar bear (*Ursus maritimus*; Photo 6.11.1-1) was selected as a Regional Study Component (RSC) because of its conservation status, public concern for its welfare, and its importance to some northern communities and to the people of Manitoba as a whole (see Land Introduction and Background, Section 6.1.2.1). The polar bear is listed as a species of Special Concern under the federal *Species at Risk Act* and as Threatened under *The Endangered Species and Ecosystems Act* of Manitoba. The global population of polar bears is divided into 19 subpopulations (Committee on the Status of Endangered Species in Canada [COSEWIC] 2008), 13 of which are found partially or entirely in Canada (Lunn et al. 2006; COSEWIC 2008). The Western Hudson Bay (WH) subpopulation occupies northeastern Manitoba and the southeastern corner of Nunavut (Map 6.11.1-1) and is the only subpopulation whose range overlaps the Regional Cumulative Effects Assessment (RCEA) Region of Interest (ROI). The Regional Assessment Area (RAA) that overlaps hydroelectric development in Manitoba includes terrestrial denning habitat and summer habitat. Movements far inland (e.g., Sundance townsite) are also considered as part of the RAA.

Polar bears in the WH subpopulation hunt seals on the Hudson Bay sea ice beginning at freeze-up in October or November (Parks et al. 2006). Seal pups are born in early April and are hunted until sea ice break-up in summer (Stirling and Derocher 1993). Early spring is the important peak feeding period for polar bears (Stirling 1997; Stirling and Lunn 1997; Thiemann et al. 2006; Peacock et al. 2010), when seal pups are abundant and accessible. Sea ice is an important determinant in polar bear survival (Cook et al. 2007; Hunter et al. 2010), as it is required to reach their prey (Stirling and Derocher 1993; Hunter et al. 2010; Molnár et al. 2010) and is used for traveling and mating (Ramsay and Stirling 1986; Molnár et al. 2010).

Most WH polar bears fast (cease eating seals) for approximately four months during the open water season (Stirling and Derocher 1993) from July to October or November (Clark et al. 1997; Parks et al. 2006). Pregnant females fast for approximately eight months (Stirling and Ramsay 1986; Stirling and Derocher 1993), from sea ice break-up until March, when cubs, which are born between mid-November and mid-December (Lunn et al. 2004), are old enough to travel to Hudson Bay (Parks et al. 2006). Polar bears may occasionally consume other foods such as garbage (Lunn and Stirling 1985), berries (Derocher et al. 1993; Hobson and Stirling 1997; Hobson et al. 2009), and even lesser snow geese (*Chen caurulescens*; Isles et al. 2013) during the ice-free period. However, it is important that they build up sufficient fat reserves on the Hudson Bay sea ice (Lunn and Stirling 1985; Derocher and Stirling 1992; Hobson et al. 2009; Gormezano and Rockwell 2013) to sustain them through the fasting period. With the exception of denning females, a large proportion of WH polar bears migrate to the Churchill region in fall, before Hudson Bay freezes up (Latour 1981; Derocher and Stirling 1990).
6.11.1.1 Pathways of Effects

Major limiting factors for WH polar bears are changing sea ice conditions and reduced food accessibility due to climate change, and mortality from human activity, mainly harvesting (COSEWIC 2008). Potential pathways of the effects of hydroelectric development on the WH polar bear subpopulation are the loss or alteration of denning habitat and human-caused mortality (Figure 6.11.1-1). Indicators of effects are the loss of denning habitat to human footprints; mortality from human activity; and changes in the number of bears in the subpopulation.
Figure 6.11.1-1: Potential Pathways of Effects of Hydroelectric Development on Polar Bear
6.11.1.1.1 Climate

Historically, climate significantly influenced polar bear populations (Miller et al. 2012). As a species, polar bears have survived multiple glacial and warming phases (Hailer et al. 2012). Over millennia, populations increased as temperatures decreased and vice versa, reflecting potential future trends due to a currently warming climate (Miller et al. 2012). Because polar bears have adapted to cold climates (e.g., Harrington 2008) they are considered sensitive to climate change (Laidre et al. 2008). While polar bears have evolved with a fluctuating climate and are tolerant of sudden short-term changes, long-term, continuous warming could create substantial challenges (Laidre et al. 2008). A warming climate can result in changes in sea ice and terrestrial habitat and can affect polar bear distribution, abundance, movements and migration, demography, body condition, behaviour, and prey species (Laidre et al. 2008). Climate change affects denning habitat, sea ice and food availability, and the fire regime, and can lead to more conflicts with humans if bears are forced to spend more time ashore.

Air temperature varies considerably from year to year; however, increasing temperatures over Hudson Bay appear to be causing progressively earlier sea ice break-up in spring (Thiemann et al. 2008). A longer ice-free period has reduced the length of time polar bears can hunt seals on Hudson Bay (Derocher et al. 2004; Stewart and Lockhart 2005; Peacock et al. 2010). The resulting reduced fat stores and declining body condition (Regehr et al. 2007) affect reproductive success (Stirling and Derocher 1993; Stirling et al. 1999; Derocher et al. 2004; Stewart and Lockhart 2005; Molnár et al. 2011) and increase the mortality rate for young and older bears (Cook et al. 2007).

A warming climate may become the most important limiting factor for polar bears (COSEWIC 2008). Past climate change has affected the sea ice in Hudson Bay, resulting in declining body condition of WH polar bears due to reduced access to food. To date, no peer reviewed linkage has been found between hydroelectric development in the RCEA ROI and potential contributions to climate change, reduced access to food, or declining body condition of bears.

6.11.1.1.2 Food Availability

Ringed seals (Pusa hispida) and to a lesser extent bearded seals (Erignathus barbatus) are the main prey of polar bears (Stirling and Archibald 1977; Smith 1980; Derocher et al. 2004; COSEWIC 2008). The productivity of polar bear habitat (COSEWIC 2008) and polar bear population size (Lunn et al. 1997) are linked with the density, distribution, and size of ringed seal populations. Belugas (Delphinapterus leucas) can also contribute to the diet of some polar bear subpopulations, particularly in the High Arctic (Smith 1985; Lowry et al. 1987; Smith and Sjare 1990; COSEWIC 2008; Thiemann et al. 2008). Food availability is a major limiting factor for polar bear subpopulations (Derocher and Stirling 1992; COSEWIC 2008), and reduced access to seals due to earlier sea ice break-up was identified as the cause of the most recent decline in the WH subpopulation (Regehr et al. 2007; COSEWIC 2008). There is the potential for hydroelectric development to affect seals and beluga in Hudson Bay, thereby indirectly affecting the WH polar bear subpopulation, particularly when combined with the adverse effects of climate change.

Effects of hydroelectric development on seals are described in Part V, Chapter 5.7. Ringed seals were not evaluated for the RCEA ROI because they inhabit Hudson Bay and are sparse and uncommon in the
Churchill River and Nelson River areas; as such, it is unlikely they have been affected by hydroelectric development. The bearded seals that occupy the lower reaches of these rivers comprise a small portion of the WH polar bear diet (Stirling and Archibald 1977). The displacement of bearded seal haul-out sites on the Churchill and Nelson rivers was the main effect described due to hydroelectric development, but there is little information available about effects on population size and distribution. Local knowledge suggests that seal numbers may have increased in the lower Churchill River and its estuary over the last decade (Seals, Section 5.7.3.3.2).

There is little evidence to suggest that beluga is an important food source for WH polar bears, although elders from Arviat, Nunavut have reported that polar bears are known to eat beluga (Arviat Hunters and Trappers Organization 2011). Potential effects of hydroelectric development on beluga are described in Part V, Chapter 5.8 but are uncertain and would mainly be at or near the Churchill and Nelson river estuaries. As the effects of hydroelectric development on bearded seals and belugas appear to be limited to the lower Churchill and Nelson rivers and estuaries, there is little evidence to suggest that their availability as food for WH polar bears has been reduced by hydroelectric development. The main factor reducing food availability is lack of sea ice (COSEWIC 2008). The relative contribution of the effects of human-caused freshwater diversion or ongoing runoff regulation for hydropower on the Hudson Bay marine system cannot currently be separated from those caused by natural climatic variability. However, autumn winds and air temperatures may have a greater effect on-ice thickness than regulated runoff conditions (Saucier and Dionne 1998).

6.11.1.1.3 Summer Habitat

The WH polar bear subpopulation spends a portion of the year on land when there is no ice on Hudson Bay (Stirling and Ramsay 1986; Derocher and Stirling 1990; Clark et al. 1997). The bears come ashore at sea ice break-up in July (Derocher and Stirling 1990; Stirling 1997; Gagnon and Gough 2005; Gormezano and Rockwell 2013) at roughly the same location each year (Stirling and Ramsay 1986), and it is during this portion of their annual cycle that they may be present in the terrestrial RCEA ROI. Fidelity to terrestrial summering areas is high (Stirling et al. 1977; Ramsay and Stirling 1990; Stirling et al. 2004; Towns et al. 2010; Atkinson et al. 2012). Adult males remain near the coast, while solitary adult females, family groups (females and their young), and sub-adults move inland (Jonkel 1970a; Derocher and Stirling 1990; Clark and Stirling 1998; Towns et al. 2010), up to 100 kilometres (km) (Jonkel 1970a). Family groups have been found closer to the Hudson Bay coast in the last few years than in the past (Towns et al. 2010). As seals hunted on the Hudson Bay sea ice constitute the vast majority of the polar bear diet, WH polar bears feed very little on land (Section 6.11.1.1.2) and spend much of the ice-free season resting to conserve energy (Derocher and Stirling 1990). As such, there is no strict definition of summer habitat for this subpopulation other than where bears tend to wander inland (Photo 6.11.1-2), and the assessment of the effects of hydroelectric development on the terrestrial range of WH polar bears focused on denning habitat.
**6.11.1.4 Denning Habitat**

Polar bears from the WH subpopulation den in northern Manitoba (Figure 6.11.1-2). Western Hudson Bay polar bears construct three general types of dens in summer and autumn: surface pits, shallow dens, and deep dens, all of which are different from the snow dens constructed by bears in more northern subpopulations (Jonkel et al. 1972; Clark et al. 1997). Female polar bears dig deep maternity dens in peat along the edges of inland rivers, creeks, and lakes (Jonkel et al. 1972; Stirling et al. 1977; Clark et al. 1997; Richardson et al. 2005). Later in the winter, females expand the den into the snowdrifts above (Clark et al. 1997; Scott and Stirling 2002).

Adult females show fidelity to a general denning area year after year, but do not appear to return to the same den (Ramsay and Stirling 1990; Scott and Stirling 2002). In other subpopulations, polar bears’ successive dens range from 20 to 1,300 km apart, with a mean distance of 308 km (Linnell et al. 2000). In the WH subpopulation most dens are within 40 km (Peacock et al. 2010) to 80 km (Stirling et al. 1977) of the Hudson Bay coast, persist on the landscape, and can be re-used by polar bears for dozens of years (Scott and Stirling 2002).

Denning habitat could be affected by water level fluctuations and erosion on nearby rivers and by fire. Forest fires alter polar bear denning habitat by removing the surrounding vegetation, thawing permafrost, and causing the collapse of existing dens (Richardson et al. 2007). As such, polar bears do not den in
burned areas (Richardson et al. 2007). It can take up to 70 years for trees and shrubs to grow and regenerate suitable denning habitat (Manitoba Conservation and Water Stewardship [MCWS] [n.d.]a). There is no indication in published literature that denning habitat is currently a limiting factor for WH polar bears (e.g., Richardson et al. 2007; COSEWIC 2008).

![Figure 6.11.1-2: Polar Bear Denning Areas in Northern Manitoba as Documented in the 2013 Polar Bear Park Background Information and Consultation Package]

6.11.1.5 Mortality from Human Activity

Human-caused mortality, mainly via hunting, has been a substantial limiting factor for polar bears in general (COSEWIC 2008), but harvest is currently not the primary threat to the WH subpopulation (Obbard and Walton 2011; Atkinson et al. 2012). Western Hudson Bay polar bears are harvested in Nunavut by local hunters and by non-resident hunters through guided hunts that are regulated by quotas, which are based mainly on population estimates from scientific studies (Government of Nunavut 2015), and on observations of local hunters (International Union for Conservation of Nature/Species Survival Commission Polar Bear Specialist Group 2010).

Western Hudson Bay polar bears may also be killed in defense of life or property by local residents or government officials in Nunavut and Manitoba. Human-caused mortality can increase when encounters with humans increase, for instance due to a larger polar bear population, when bears are nutritionally
stressed and seek out human-made sources of food such as garbage, or at human settlements such as the town of Churchill, where the bears congregate while awaiting sea ice freeze-up on Hudson Bay. The occurrence of sea ice freeze-up later in the year has increased the time bears spend on land in the fall and decreased the on-ice feeding period (Stewart and Lockhart 2005; Towns et al. 2009). Conflicts with humans have increased in frequency, as bears from the WH subpopulation intensify their search for food near Churchill (Stewart and Lockhart 2005; Towns et al. 2009). Polar bears could also be killed accidentally when handled (chemically immobilized) for scientific research or during relocation of problem bears (e.g., Derocher et al. 1997; Lunn et al. 2006).

6.11.1.2 Indicators and Metrics

As described in Section 6.1.2.3 (Land Introduction and Background), indicators were selected for the WH polar bear subpopulation to describe the current condition of the RSC in order to gauge the potential effects of hydroelectric development and to describe the current quality of the environment. Metrics were identified to measure changes in the indicators.

6.11.1.2.1 Driver Indicator – Denning Habitat

Suitable habitat for the construction of earth dens is likely critical for the WH subpopulation (Clark et al. 1997; Calvert et al. 1998). As such, potential effects of hydroelectric development on polar bear denning habitat were examined. There is considerable information about WH polar bear denning habitat and denning areas, particularly after the start of hydroelectric development (see Section 6.11.2.2.1). However, no maps of denning locations prior to the 1970s were located.

METRIC – AMOUNT OF DENNING HABITAT

Richardson et al. (2005) described maternity denning habitat for WH polar bears. Earth dens are mainly constructed along the edges of waterbodies such as lakes and creeks. Most are excavated in peat on the tops of banks. Banks that are a minimum of 1 m high and with moderate slope are considered ideal for denning. Spruce trees are the main type of vegetation at den sites, with relatively little herb and moss cover. Dens are frequently located near well-drained, lichen-dominated areas (Richardson et al. 2005). Vegetation, particularly tree cover, is important as it stabilizes substrate and promotes the accumulation of snow over den sites in the winter, which insulates the den and allows for future expansion (Richardson et al. 2007). Hydroelectric and other human footprints in known denning areas were quantified for an assessment of terrestrial habitat loss.

6.11.1.2.2 Driver Indicator – Mortality from Human Activity

As there is currently no polar bear harvest in Manitoba (MCWS [n.d.]).c), any mortality from human activity due to hydroelectric development would mainly be due to human/bear encounters. However, WH polar bears are harvested in Nunavut, which, while not an effect of hydroelectric activity, could have a considerable cumulative effect on the subpopulation, particularly when added to the number of bears removed from the population (killed or sent to zoos) in defense of life or property. No polar bears have been handled for or during environmental assessment studies for hydroelectric development, and
research-related mortality will not be included in the assessment of regional cumulative effects on the WH subpopulation.

**METRIC – NUMBER OF POLAR BEARS REMOVED FROM THE SUBPOPULATION**

The metric for mortality from human activity is the number of polar bears removed from the population due to harvest and conflicts with humans.

### 6.11.1.2.3 Response Indicator – Population

Several population parameters can be measured for WH polar bears (Taylor et al. 2001). Population growth rate, average age at first reproduction, average number of offspring per female, annual recruitment rate, and sustainable harvest rate are indicators of reproductive rates, age structure, and number of individuals in the population (Taylor et al. 2001). Direct effects of hydroelectric development on WH polar bears could include a smaller population caused by reduced recruitment due to loss of denning habitat and by mortality from human activity in the subpopulation's range.

**METRIC – POPULATION**

Population size is the most basic indicator of the condition of WH polar bears, and population estimates for this well-studied group have been generated over the last five decades. Typically, the estimated number of bears in the subpopulation is reported and compared with previous estimates. The WH polar bear population is currently about 1,000 animals (Atkinson et al. 2012; Stapleton et al. 2014). Detailed population estimates are provided in Section 6.11.2.2.3.

Challenges in comparing the number of polar bears in the WH subpopulation pre- and post-hydroelectric development include the scarcity of studies before development began with which to compare the population, and potential inconsistencies in the collection of data and interpretation of observations over the last few decades. There are no published population estimates prior to the mid-1960s; what information can be found is in the form of general observations and is not directly comparable to more recent estimates. Additionally, survey techniques and study areas have changed over the years, and early population estimates may not be as accurate as or directly comparable to later estimates (Stirling and Lunn 1997; Peacock et al. 2010).

Relatively recent issues with population estimates include failure to survey the entire summer range of the WH subpopulation and the disparity between observations of local hunters and scientific population estimates. No surveys were conducted in the summer range east of the Nelson River from 1978 to 1992 (Lunn et al. 2013) or in the Nunavut summer range from 1984 to 2004 (Peacock and Taylor 2007), and the population might have been underestimated. However, the resulting estimates were subsequently adjusted (Lunn et al. 2013) or were reviewed and determined to be correct (Peacock and Taylor 2007), and the revised or original estimates are considered accurate.

While these estimates indicated that the WH population was in decline from the mid-1980s to midway through the first decade of the 2000s (Regehr et al. 2007; Atkinson et al. 2012; Stapleton et al. 2014), increasing observations of polar bears near human settlements in southeastern Nunavut have been
interacted by Inuit hunters and other inhabitants as evidence of an increasing population (Tyrell 2006; Dowsley and Taylor 2007; Peacock et al. 2010; Atkinson et al. 2012; Kotierk 2012; Stapleton et al. 2014). This view was countered by scientists who considered the increased presence of polar bears near human settlements a sign that the population is in trouble; that is, nutritionally stressed bears are seeking alternative food sources (Stirling and Parkinson 2006).

6.11.1.3 Benchmarks

As indicated in Section 6.2.1.3 (Intactness), an effects benchmark for an indicator metric is a precautionary value or range of values that is well below the anticipated point where a sudden, considerable change in the RSC would be expected to occur. There are no scientifically established benchmarks for the polar bear metrics. For the RCEA, harvest quota is the benchmark against which mortality from human activity is measured, and trend (increasing, stable, or decreasing) is the benchmark for population. The benchmarks for WH polar bear indicators and metrics are presented in Table 6.11.1-1.

Table 6.11.1-1: Indicators, Metrics, and Benchmarks for the Western Hudson Bay Polar Bear Subpopulation

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Metric</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>Human footprint within denning area (km²)</td>
<td>None available</td>
</tr>
<tr>
<td>Mortality from human activity</td>
<td>Number of bears killed annually</td>
<td>Greater than, equal to, or less than the harvest quota</td>
</tr>
<tr>
<td>Population size</td>
<td>Population estimates</td>
<td>Increasing, stable, or decreasing</td>
</tr>
</tbody>
</table>

6.11.1.4 Approach and Methods

A literature review was conducted to describe WH polar bear denning habitat, mortality from human activity, and population pre-hydroelectric development. The review also facilitated the identification of changes in these parameters since hydroelectric development began in 1966, with construction of the Kettle Generating Station (GS). Where possible and/or appropriate, changes attributable to hydroelectric development since the in-service date of 1974 were highlighted.

6.11.1.5 Data Limitations

The principal data limitations for the polar bear assessment included:

- no published studies to date separating the relative effects of climate change and regulation on changing physical, biological, and biogeochemical conditions in Hudson Bay; and
- no determination to date if resolution of ice models would adequately address any potential effects of hydroelectric development on site-specific areas such as Cape Churchill.
As is the case in all long-term assessments (in this case covering more than forty-five years), limitations in available information inevitably place constraints on the analysis possible. Despite these limitations, as outlined above in the Approach and Methods section, sufficient information exists to provide data for the selected indicators and a reasonably robust assessment of the impacts of hydroelectric development on polar bear within the RCEA Region of Interest. The assessments provided below discuss these limitations for those terrestrial regions where there was potential for them to substantively alter any conclusions regarding regional cumulative effects.
6.11.2 Western Hudson Bay Polar Bear Range: Changes in Indicators over Time

Western Hudson Bay polar bear range overlaps several ecozones in the RCEA ROI. While polar bears spend the winter on the sea ice of Hudson Bay, their terrestrial range extends as far south as the Boreal Shield Ecozone and northward into Nunavut (see Map 6.11.1-1).

Construction of the Kettle GS in 1966 divides the pre- and post-hydroelectric periods. Since 1966, other hydroelectric developments in the region have included the Churchill River Diversion, Long Spruce and Limestone GSs, and the Bipole III Transmission Project. Construction of an access road and a transmission line to the potential GS site began in 1989 for the potential Conawapa Generation Project.

6.11.2.1 Before Hydroelectric Development

6.11.2.1.1 Denning Habitat

The first record of polar bear denning in Manitoba was in the 1700s (Rich 1949 in Stirling et al. 1977). In the western Hudson Bay region south of Churchill, historic written records show that inland dens have been excavated by polar bears since at least the late 1700s (Hearne 1795; Scott and Stirling 2002). Historic denning activity was identified south of Churchill by studying anomalies in tree growth near den sites, and it was determined that the WH subpopulation had been denning in the area for several hundred years (Scott and Stirling 2002). Construction of the Hudson Bay Railway line to Churchill, which crosses a portion of denning area, began in the early 1920s.

6.11.2.1.2 Mortality from Human Activity

Written reports of polar bear harvest date back to the 1700s. Hearne (1795) indicated that many bears were killed at all times of the year. Polar bears were harvested near York Factory in the mid-eighteenth century in fall, prior to their return to the sea ice (Lytwyn 2002). Preble (1902) described the harvest of a female with cubs between York Factory and Cape Tatnum in the summer of 1900.

Scott and Stirling (2002) outlined three periods from 1850 to 1993 based on the trade in polar bear hides, using information from several sources. The period from 1850 to 1899 was defined by a relatively consistent trade in polar bear hides. From 1900 to 1953 was characterized by fluctuating trade in polar bear hides due to increasing regulation of harvest and to the smaller number of people at York Factory, and 1954 to 1993 was delineated by the government ban on commercial polar bear hunting and exodus of traditional hunters from York Factory when the settlement closed. Twenty to 50 polar bear hides were traded annually at York Factory and one to four were traded at Churchill from 1840 to 1935. Denning activity increased in the region as the harvest decreased, particularly nearer York Factory, likely indicating an increase in the population of bears in the area (Scott and Stirling 2002). Fifteen polar bears were harvested in the York-Shamattawa region, in the northeastern corner of Manitoba along the Hudson Bay coast, in the 1954–1955 trapping season (Manitoba Department of Mines and Natural Resources [MDMNR] 1955).
Stirling et al. (1977) described the history of the regulated polar bear hunt in Manitoba. Legislation prohibiting the harvest of polar bears in Manitoba except for residents of the coastal regions was passed in 1949, and a season was designated from October 1 to May 1 of the next year. Harvest during the 1950s and 1960s had a pronounced effect on the WH polar bear subpopulation. Fifty to 100 bears were taken annually in the 1950s (Stirling et al. 1977) until the York Factory fur trading post closed in 1957 and the harvest was reduced (Jonkel et al. 1972; Derocher and Stirling 1995; Derocher et al. 1997). Military personnel stationed in Churchill harvested unreported numbers of polar bears from 1942 (Stirling et al. 2004) until 1964 (Derocher and Stirling 1995; Stirling et al. 2004). The harvest of polar bears by Inuit hunters was unregulated until 1968, when a quota system was introduced (Lee and Taylor 1994; Stirling et al. 2004).

Reports of encounters with humans in the Churchill region increased at the same time the York Factory settlement closed (Kearney 1989). Multiple serious encounters with humans were documented in the 1960s (Kearney 1989).

6.11.2.1.3 Population

Few estimates of the WH polar bear subpopulation are available for the pre-hydroelectric development period, as the Canadian Wildlife Service began studying the population in 1961 (Jonkel 1969). Historically, polar bears were abundant along the Hudson Bay coast of Manitoba (Jonkel et al. 1976) and polar bear observations in northern Manitoba date back to the 1600s (Gosch 1897; Dean 1978). Polar bears were reportedly common in the York Factory area after the Hudson's Bay Company trading post was opened in the early 1680s (Peacock et al. 2010). They were not often observed north of Churchill, but were said to be numerous in the York Factory region in the 1700s (Hearne 1795; Lytwyn 2002). Reports of polar bears were relatively common after the establishment of a military base at Fort Churchill, near the town of Churchill, in 1942 (Kearney 1989).

Harper (1969) described aerial surveys of the Hudson Bay coast conducted by the Manitoba Department of Mines and Natural Resources from 1960 to 1969. As survey routes and times were inconsistent, general trends in the number of polar bears observed were highlighted. There was no trend in the number of polar bears in the area between Churchill and York Factory, which was surveyed all but one year. The total number of bears over the entire survey area ranged from 17 in 1960 to 50 in 1962, and a biannual trend of increases and decreases was noted (Harper 1969).

In addition to aerial surveys, traditional knowledge of Inuit and Cree from the Hudson Bay region contributed to the understanding of the WH polar bear subpopulation prior to hydroelectric development. Shifts in polar bear distribution observed by Inuit in northwestern and eastern Hudson Bay were described by McDonald et al. (1997). Increased observations of polar bears in eastern Hudson Bay began in the 1930s, and the number increased sharply in the 1960s. This increase was not necessarily interpreted as a population increase, but rather a shift in distribution from western to eastern Hudson Bay due to hunting quotas, an extended floe edge, and an abundance of ringed seals (McDonald et al. 1997).
6.11.2.2 After Hydroelectric Development

6.11.2.2.1 Denning Habitat

A significant denning area was discovered south of Cape Churchill in 1969, between the Churchill and Nelson rivers (Jonkel 1970b in Jonkel et al. 1972; Figure 6.11.2-1). Aerial surveys were conducted from 1970 to 1976 to identify maternity dens near the western Hudson Bay coast and to count female polar bears and cubs. An estimated 60 bears had cubs in the inland and south of Cape Churchill (also called the Owl River) area over each of the winters of 1970 and 1971 (Jonkel et al. 1972). Over the seven-year survey period, an estimated 150 cubs were born to 80 females each year (Stirling et al. 1977). From 1971 to 1976, an estimated average of 162 cubs were born to an estimated average of 89 females (Cross 1976).

In 1992 and 1993, Clark et al. (1997) located and categorized polar bear dens in a study area between and encompassing the Churchill and Nelson rivers. Surveys inland and south of the Cape Churchill area indicated that it was also used for denning in the early and mid-1980s (Ramsay and Stirling 1990). An estimated 150 to 200 bears denned in the area annually from the mid-1970s (Derocher and Stirling 1995) to early 2000s (Richardson et al. 2007). Construction of the Radisson to Churchill transmission line, which crosses a portion of denning area, and largely parallels the Hudson Bay Railway line, was completed in 1987.

Over the last few decades, most of the pregnant females from the WH subpopulation have denned inland and south of Cape Churchill (Scott and Stirling 2002; Richardson et al. 2007; Figure 6.11.2-2), which is now protected in Wapusk National Park. However, Cape Tatnum, east of the Nelson River, was identified as a less-dense denning area (Figure 6.11.2-3) in 1971 (Jonkel et al. 1972; Stirling et al. 1977). Surveys in 1989 and 1990 confirmed that females were denning in the area, but its relative importance for polar bear denning was not determined (Calvert et al. 1995). In addition to Wapusk National Park’s polar bear denning area, MCWS (n.d.) recently (c. 2013) identified the inland Cape Tatnum - Kaskatamagan region as a critical denning area. Most recently, information from formal MCWS surveys of the Kaskatamagan region conducted from 2012 to 2015, as well as incidental observations from 2009 to 2011, were used to delineate an expanded Kaskatamagan study area, consisting of both denning sites and movement corridors (D. Hedman pers. comm. 2015; Figure 6.11.2-4). The area along the Hudson Bay coast is a movement corridor for females and cubs, and dens are located 15 to 80 km inland from the coast. At this time, the overall importance of the Kaskatamagan region relative to the WH polar bear population is not clearly understood; however, studies are ongoing (D. Hedman pers. comm. 2015).
Source: Duplicated from Jonkel et al. 1972

Figure 6.11.2-1: Owl River and Cape Tatnum (now known as Kaskatamagan) Maternity Denning Areas in Manitoba and General Direction of Movement to Sea During March
Source: Duplicated from Richardson et al. 2005

**Figure 6.11.2-2:** Sampled and Other Known Polar Bear Den Locations in Manitoba
Figure 6.11.2-3: Location of Six Suspected Polar Bear Dens near Cape Tatnum, Manitoba

Figure 6.11.2-4: Kaskatamagan Polar Bear Den Area and Movement Corridor Study Area, Coastal Hudson Bay Area
The known extent of WH polar bear denning areas in the RCEA ROI is depicted below in Map 6.11.2-1. The polar bear denning area in Wapusk National Park was mapped by digitizing historic and recently published den sites (Jonkel et al. 1972; Richardson et al. 2005; MCWS [n.d.];b; see Figures 6.11.1-2, 6.11.2-1, and 6.11.2-2) to create a minimum convex polygon. The Cape Tatnum/Kaskatamagan denning area polygon was generated with a similar technique, using published den sites from Jonkel et al. (1972), Stirling et al. (1977) and MCWS (n.d.); as illustrated in Figures 6.11.1-2, 6.11.2-1, and 6.11.2-3. In addition, the area was extended by using professional judgement and mapped data from MCWS, including unpublished aerial survey results (2012–2015) and incidental information gathered between 2009–2011. It should be noted that digital data were not available for this exercise; as such, these denning area polygons should be interpreted cautiously as the area identified is considered a coarse delineation.

Potential effects of hydroelectric development on denning habitat would mainly be due to erosion along the banks of the Churchill River, where some pregnant females may den. A review of the effects of the Churchill River Diversion on erosion and sedimentation on the lower Churchill River was conducted (Erosion and Sedimentation, Chapter 4.4); none were found that would have considerably altered WH polar bear denning habitat. It is unlikely that there has been any loss of denning habitat due to hydroelectric development footprints (either transmission or generation). The generating stations on the Nelson River are south or west of polar bear denning areas and a single transmission line is situated in the pre-existing railway right-of-way for most of its length in the denning area (Map 6.11.2-1). The transmission line affects less than 0.01% of the total denning area in northern Manitoba, or 2.36 km$^2$ of over 33,000 km$^2$ (Table 6.11.2-1). As polar bears do not reuse dens and select dens many kilometres apart in successive years, the loss of denning habitat in an area smaller than a home range would likely have little effect on a population, if suitable alternative habitat is available (Linnell et al. 2000).

Hydroelectric development does not typically occur in prime polar bear den areas (Linnell et al. 2000), which include Wapusk National Park and Cape Tatnum/Kaskatamagan denning areas (Photo 6.11.2-1; Map 6.11.2-1).

### Table 6.11.2-1: Human Footprint in Western Hudson Bay Polar Bear Denning Areas

<table>
<thead>
<tr>
<th>Feature</th>
<th>Area (km$^2$)</th>
<th>Percent of Area Affected</th>
<th>Percent Contribution to Habitat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road and Limited Use Road</td>
<td>0.14</td>
<td>&lt;0.001</td>
<td>2.0</td>
</tr>
<tr>
<td>Railway</td>
<td>4.15</td>
<td>0.013</td>
<td>62.4</td>
</tr>
<tr>
<td>Transmission Line</td>
<td>2.36</td>
<td>0.007</td>
<td>35.5</td>
</tr>
<tr>
<td>Denning Areas</td>
<td>32,960</td>
<td>0.020</td>
<td>–</td>
</tr>
</tbody>
</table>

1. Area was calculated by multiplying the length of the feature by 0.02 km, the approximate width of the rights of way as determined by measurements on orthophotos.

2. Area was calculated by multiplying the length of the transmission line overlapping the denning area by 0.02 km, the approximate width of the right-of-way as determined by measurements on orthophotos. The maintained and licensed width of the Radisson to Churchill transmission line right-of-way is 50 m (Manitoba Hydro 1987).
Denning polar bears can be affected by human disturbance from recreation, resource extraction (Linnell et al. 2000) and scientific research (Lunn et al. 2004) activities, resulting in a loss of effective habitat (i.e., otherwise suitable habitat that is avoided due to sensory or other disturbance). Females may tolerate some disturbances (e.g., overhead flights) but may abandon maternity dens if the disturbance is greater (i.e., handling by scientific researchers; Lunn et al. 2004). A potential effect of the Churchill Weir on polar bear was sensory disturbance due to blasting activity during construction (Manitoba Hydro and the Town of Churchill 1997). No polar bear dens were identified in the study area from 1994 to 1997, and noise-related effects were expected to be minimal (Manitoba Hydro and the Town of Churchill 1997).

Denning habitat is not a limiting factor for polar bears (Richardson et al. 2007; COSEWIC 2008), and the Churchill and Nelson rivers are low-density denning areas (MCWS [n.d.]b; see Figure 6.11.1-2). While some females den in the lower Nelson River region (D. Hedman pers. comm. 2015), no dens were identified along the Nelson River in the literature reviewed (see Figures 6.11.2-1 to 6.11.2-3) or during historic and recent surveys (D. Hedman pers. comm. 2015). As such, there has likely been little opportunity for hydroelectric development on the river to have influenced polar bear denning.


Photo 6.11.2-1: Polar Bear Den South of Wapusk National Park, Manitoba
Map 6.11.2-1

Polar Bear Denning Areas and Human Footprints Post-Hydroelectric Development
Hudson Bay Area

Legend
- RCEA Region of Interest
- Polar Bear Denning Areas
  - Kaskatamagan Denning Area
  - Wapusk Denning Area

Human Footprints
- Airport
- Borrow Area
- Clearing
- Dewatered
- Flooding
- Generating Station
- Highway
- Limited-use Road
- Railway
- Road
- Settlement
- Transmission Line
- Transmission Station
- Weir
- Winter Road

DATA SOURCE:
- Manitoba Hydro
- Government of Manitoba
- Government of Canada
- ECOSTEM Ltd.
- 08-OCT-15

DATE CREATED:
- 04-DEC-15

CREATED BY:
- snitowski

COORDINATE SYSTEM:
- NAD 1983 UTM Zone 14N

FILE LOCATION:
- Z:\Workspaces\RCEA\Support\Mammal\Polar Bear Denning Ranges with Human Full Extent.mxd

MANITOBA HYDRO: Government of Manitoba; Government of Canada; ECOSTEM Ltd.; Manitoba Hydro; Jonkel et al. (1972); Richardson et al. (2005); Kaskatamagan Denning Area - Jonkel et al. (1972); Settlements (1969-1974); Manitoba Hydro; Incidental data (2009-2011).
6.11.2.2.2 Mortality from Human Activity

The total allowable harvest (formerly quota) of WH polar bears has fluctuated since the early 1990s. In the late 1990s, the estimated sustainable harvest of the WH population was 55 bears (Lunn et al. 2002). A total allowable harvest of 28 bears was allocated to Nunavut and 27 to Manitoba, most of which Manitoba transferred to Nunavut (Lunn et al. 2002). The total allowable harvest was 47 from 2000 to 2003 increased to 56 in 2004, reduced to 38 in 2007, and then reduced to eight in 2008 (Government of Nunavut 2013). The total allowable harvest was increased to 21 bears in 2011 (Nunavut Wildlife Management Board [NWMB] 2011; NWMB 2014a) and to 24 bears in 2012 (NWMB 2014a), where it has remained for three years (NWMB 2012; NWMB 2014a). The NWMB had committed to set the total allowable harvest in time for the 2015/16 harvest, which began in July 2015 (NWMB 2014b), but a final decision was unavailable as of November 2015. The actual harvest of polar bears in Nunavut is generally at or below the total allowable harvest, with exceptions in the 2009/2010, 2010/2011, and 2011/2012 harvest seasons, when it was exceeded (NWMB 2014a). There is no polar bear harvest in Manitoba (MCWS [n.d.]).

Apart from the regulated harvest, conflicts with humans are a source of polar bear mortality. One or two people annually were attacked, and sometimes killed, between 1966 and 1968 (Jonkel et al. 1976). Encounters with humans were mainly attributed to the presence of garbage dumps in and near the town of Churchill, which attracted the bears (Jonkel et al. 1976). At this time, polar bears in western Hudson Bay were reportedly feeding at dump and hunting camp sites on meat caches and on motor oil, which was considered by some local residents to be a recently sought-after component of the polar bear diet (McDonald et al. 1997). Such bears were said to have lost their hunting skills and to have become more aggressive. Bears that were chemically immobilized by researchers were later found to be in poor condition by hunters and were also said to have lost their natural abilities due to being handled, tattooed, tagged, and having their teeth removed. Such activity was viewed by many Inuit and First Nations members as disrespectful and unnecessary (McDonald et al. 1997).

In 1969, a conservation officer was assigned to the town of Churchill as part of the Polar Bear Control Program (Cross and Robertson 1969; Jonkel et al. 1976) and additional personnel were added when required (Cross and Robertson 1969). Improvements to garbage handling and storage methods were made in the 1960s and 1970s (Jonkel et al. 1976), as the garbage dumps in and near town were identified as polar bear attractants (Stirling et al. 1977). The Jockville garbage dump in town was closed, which resulted in an immediate decrease in the number of polar bears observed in the adjacent residential neighbourhood (Cross and Robertson 1969). Fewer polar bears were observed at the Fort Churchill dump in 1972 than in previous years, which was attributed to the practice of burning garbage that began in 1969 and to an early freeze-up on Hudson Bay (Cross 1972). Most of the problem bears were determined to be sub-adults two to three years old (Cross 1972). In 1973, the area in which garbage was deposited was restricted at the Fort Churchill dump, and the practice of burning garbage was continued (Cross 1973). Fewer bears were observed at the dump than in previous years, which was partly credited to an early freeze-up (Cross 1973). No other reason was identified.

Polar bear observations increased in the town of Churchill in 1974, when early fall temperatures were below average but freeze-up was later than usual (Cross 1975a). A nearby construction camp kitchen
was a significant attractor of polar bears that year (Cross 1975b). Polar bear observations also increased in 1975, mainly due to the kitchen at the work camp (Cross 1975b). However, an incinerator built at the Fort Churchill dump was put into operation, and fewer polar bears than usual were observed at that location (Cross 1975b). Reports of polar bear observations continued from 1978 to 1980 (Dean 1978, 1979; John 1980), with 1980 being the slowest year for polar observations on record (John 1980). Between one (in 1980) and 10 (in 1972) polar bears were destroyed annually by conservation officers from 1960 to 1980, and a total of 10 individuals were sent to zoos.

A predicted effect of hydroelectric development on the lower Churchill River was delayed formation of shoreline ice at Cape Churchill, which appeared to be related to the reduced amount of fresh water discharged by the Churchill River (Webb and Foster 1974). Webb and Foster (1974) suggested that delayed ice formation would lengthen the time polar bears congregated near Churchill and increase the potential for conflicts between bears and humans. Monitoring of the situation and the re-establishment of higher fall flows if feasible were recommended (Web and Foster 1974). It is unclear if delayed ice formation at Cape Churchill was a result of hydroelectric development. However, Manitoba Hydro is participating in research studying the role freshwater plays in the Hudson Bay marine and coastal systems (the BaySys Project). This research aims to provide a scientific basis to separate the relative effects of climate change and regulation for hydropower on changing physical, biological, and biogeochemical conditions in Hudson Bay. Further discussion is required to determine if the resolution of the ice models would adequately address site-specific areas such as Cape Churchill.

More recently (beginning in the late 1990s), an average of eight polar bears have been removed (destroyed, killed accidentally, or sent to zoos) from the Churchill region each year (Lunn et al. 2002; Dowsley and Taylor 2007). The small number of bears removed from Manitoba does not affect the population (MCWS [n.d.]). From 1976 to 1986, at least 265 polar bears from various subpopulations were killed in defense of life or property in the Northwest Territories (Stenhouse et al. 1988), which at the time encompassed the area that is now Nunavut. These kills were included in communities' total allowable harvest at the discretion of local hunters and trappers organizations; only 35 were included over the 10-year period (Stenhouse et al. 1988). At least 264 polar bears were removed from the WH subpopulation from 1966 to 1992, via defense kills, deaths during handling, and removal to zoos (Derocher et al. 1997). An average of 5.7 ±1.0 problem bears were killed each year during this period, peaking at 26 in 1976 (Derocher et al. 1997).

In Nunavut, there are no restrictions on harvesting polar bears in defense of life or property (NWMB 2010; Government of Nunavut 2014). Kills in defense of life or property are currently accounted for in the total allowable harvest (Environment Canada 2009; Government of Nunavut 2015). Defense kills averaged approximately 10 per year from 2002 to 2007 (Peacock and Taylor 2007) and approximately eight per year from 2008 to 2012, ranging from one in 2012/13 to 14 in 2010/11 (Government of Nunavut 2013). Conflicts between polar bears and people occur mainly in the absence of sea ice during the open water season (Stirling and Parkinson 2006; Clark et al. 2012), which has increased in length due to increasing temperatures in the Arctic (Clark et al. 2012). The number of bears dealt with in Churchill increased considerably from the mid-1980s to the mid-1990s (Stirling and Parkinson 2006). In the 1990s, York Factory residents described polar bears observed in fall as "skinny," and very lean bears were observed in the Whale Cove and Chesterfield Inlet areas of Nunavut (McDonald et al. 1997).
Traditional knowledge from residents of Churchill and Arviat has indicated that more polar bears have been observed in and near their communities in the past decade than in previous years (Tyrell 2006). Attracted to garbage and other human-made food sources, the bears were said to have lost their fear of humans and their increasing presence was a public safety issue. Some residents viewed this scavenging at dumps as an adaptation to climate change, and asserted that polar bear numbers are increasing (Tyrell 2006). Polar bears were also said to have lost their fear of humans because of tourism and handling for scientific research, and were scavenging more at garbage dumps and meat caches. Collared bears were perceived as unhealthy, skinny, and unable to hunt. Collared bears were mostly observed at garbage dumps (Arviat Hunters and Trappers Organization 2011).

The increased number of polar bears observed since the 1960s has resulted in concerns for human safety (Government of Nunavut 2015). Before the 1940s, there was little concern for the safety of the residents of local communities when camping, as polar bears did not pose a serious threat. Currently, armed monitors are required in campsites. Property damage and the destruction of meat caches are affecting Inuit residents (Government of Nunavut 2015). The larger WH polar bear population and resulting increase in encounters with humans are widely attributed by locals to low total allowable harvests (e.g., Dowsley and Taylor 2007; Peacock et al. 2010), and also to behavioural changes following handling for scientific research, habituation to ecotourism activities, and attraction to unmanaged garbage dumps (e.g., McDonald et al. 1997; Tyrell 2006; Arviat Hunters and Trappers Organization 2011; Atkinson et al. 2012). No local effects of hydroelectric development on WH polar bear numbers, habitat, or encounters with humans were described.

There is little hydroelectric development in the Hudson Plains Ecozone, which overlaps a portion of WH polar bears’ Manitoba range (see Map 6.11.2-1). Manitoba Hydro’s generating stations are well south of the typical limits of polar bear distribution, and there has been very little mortality from human activity via the removal of bears in defense of life or property. In 1990, an adult male was destroyed when it entered the Sundance townsite (I.D. Systems Ltd. 1993). A sub-adult was removed from the Bird landfill one month later, which was immobilized and relocated to Churchill and released on Hudson Bay (D. Hedman pers. comm. 2015). Numerous polar bears were observed by field staff engaged in research for the potential Conawapa Generation Project over several years (Photo 6.11.2-2). However, all bears were well downstream of the potential GS site and near Hudson Bay; close encounters were very rare; and no bears were killed. No measurable effect of WH polar bear mortality due to human activity from hydroelectric development in the RCEA ROI could be found.
Aerial surveys for WH polar bears were conducted on the Manitoba Hudson Bay coast from 1965 to 1997 (Stirling et al. 2004). While these surveys did not produce population estimates, population trends were inferred. Based on the observations of 152 polar bears at Cape Churchill during a Canadian Wildlife Service aerial survey in fall 1968, an estimated 200 to 250 individuals were at Cape Churchill (Jonkel 1969), and it was estimated that 250 polar bears congregated near Cape Churchill in fall to await the formation of sea ice in the early 1970s, prior to the development of the Churchill River Diversion (F.F. Slaney & Company Limited 1973). The number of polar bears increased in Manitoba from the mid-1960s to the mid-1970s, then stabilized (Stirling et al. 2004) during the 1980s and 1990s (Derocher and Stirling 1995; Stirling and Lunn 1997), after which a decline was observed until midway through the first decade of the 2000s (Regehr et al. 2007; Atkinson et al. 2012; Stapleton et al. 2014). The population did not change between 1978 and 1992 (Derocher et al. 1997); a mean of 1,000 bears was observed over the 15-year period, with estimates ranging from 537 to 1,268 individuals (Derocher and Stirling 1995). In 1987 the WH population was estimated at 1,194 bears (95% CI = 1,020–1,368) and in 1995 the estimate was 1,200 ± 250 bears (Lunn et al. 1997). There were an estimated 977 ± 108 bears in 2003 and a declining trend was noted (Richardson et al. 2006). The population decreased to 935 bears (95% CI = 794–1,076) in 2004 (Regehr et al. 2007), and is thought to have been stable since then (Lunn et al. 2013). In 2011, estimates were 806 (95% CI = 653–984) (Lunn et al. 2013), 1,000 (95% CI: 715–1,398) (Atkinson et al. 2012), or 1,030 bears (95% CI = 754–
1,406), the latter which, while not interpreted as contradicting predictions of population decline, suggested that improvements in population monitoring are required (Stapleton et al. 2014). The WH subpopulation has declined since the late 1980s, but currently the population is relatively stable (Lunn et al. 2013; Environment Canada 2014; International Union for Conservation of Nature/Species Survival Commission Polar Bear Specialist Group 2014).

An aerial survey for polar bears was conducted on the lower Nelson River and at Hudson Bay in summer 2013 as part of the environmental studies for the potential Conawapa Generation Project (LaPorte et al. 2015). Seventeen polar bears were observed, distributed from the Gillam Island area to Marsh Point. Single bears and females with cubs of the year and yearlings were observed.

Incidental observations of polar bears were also made during aerial surveys for beluga and ground surveys for mammals in the Conawapa region (Atkinson et al. 2013). Polar bear observations were numerous during summer aerial surveys for beluga in 2003 and 2005. Sixty-nine bears were observed in 2003 and 166 were observed in 2005, on the eastern and western coasts of Hudson Bay near the Nelson and Hayes river estuaries. A total of 145 polar bear tracks were found on ground-tracking transects from 2005 to 2007. Most were observed on the shores or islands of the Nelson and Hayes rivers near Hudson Bay. Tracks were generally observed at or downstream of Deer Island in the Nelson River; however, a polar bear track was observed on a transect near the Limestone GS in 2005. Other incidental observations of polar bears reported by Conawapa Generation Project environmental assessment researchers totalled 141 from 2004 to 2008 and were mainly downstream of Deer Island and along the Hudson Bay coast, not near the potential GS site (Atkinson et al. 2013).

Traditional knowledge of Inuit and Cree from the Hudson Bay region has provided a different perspective on the recent state of the WH polar bear subpopulation. Consultations for management of the WH polar bear subpopulation were conducted with representatives from hunters and trappers associations and other Nunavut residents in 2005 (Dowsley and Taylor 2007). Participants expressed their disagreement with scientific research that indicated the population was in decline, stating that there were more bears observed than ever before and the population was stable or increasing. The population was said to have decreased by one participant, particularly in Churchill. However, a redistribution northward because of climate change was also described. The Inuit were not concerned, the participant stated, because the bears had exceeded their carrying capacity and the number of bears must be reduced (Dowsley and Taylor 2007).

Residents of Churchill and Arviat, Nunavut, also indicated that more bears were being observed in and near their communities, not only prior to the fall freeze-up but in summer as well (Tyrell 2006). Arviat residents polled in 2011 indicated that there were too many polar bears compared to the few observed from the 1960s to the 1980s (Arviat Hunters and Trappers Organization 2011). In 2012, an opinion poll conducted in the Nunavut communities that harvest WH polar bears (Kotierk 2012). Results indicated that residents were observing more polar bears than ever before, and that there were perhaps too many bears. Most respondents were not concerned about the future of the WH subpopulation (Kotierk 2012).
6.11.3 Cumulative Effects of Hydroelectric Development

6.11.3.1 Regional Effects

INDICATOR RESULTS

The cumulative effects of hydroelectric development on the WH polar bear subpopulation have been negligible to none. There has been very little hydroelectric development in WH polar bear denning areas and there is no indication that denning habitat has been lost as a result. The harvest of polar bears in Nunavut has generally been at or below the total allowable harvest, with some recent exceptions that were unrelated to hydroelectric development in Manitoba. Removals of problem bears in Manitoba are predominantly in or near the town of Churchill, and there has been negligible mortality from human activity due to hydroelectric development. The WH polar bear subpopulation has declined since the late 1980s but is currently stable.

EVALUATION OF EFFECTS

There is no indication that hydroelectric footprints have negatively affected denning habitat. There is no indication that the Churchill River Diversion affected denning habitat along the river, and the generating stations on the Nelson River are well removed from the denning areas located in Wapusk National Park and the Kaskatamagan regions. As denning habitat is not a limiting factor for WH polar bears, it is unlikely that the single transmission line to Churchill has affected the subpopulation.

There have been no effects on WH polar bear mortality due to human activity attributable to hydroelectric development. Total allowable harvests of the WH subpopulation have fluctuated since the quota system was introduced in the late 1960s. While polar bears are no longer harvested in Manitoba, a few are removed from the population each year due to conflicts with humans. Few if any of these removals are a result of hydroelectric development. The destruction of a male at the community of Sundance during the construction of Limestone GS is the only documented instance of mortality directly attributable to hydroelectric development. The average of eight individuals removed from the population annually due to conflicts with humans in Manitoba has no measurable effect on the population. The WH subpopulation is still hunted in Nunavut, but with the quota system, the harvest is considered sustainable.

The number of polar bears in the WH subpopulation has fluctuated historically and over the past few decades. While there is little historical information about polar bear numbers, they appeared to be abundant. The population declined with increasing human presence in northern Manitoba near Hudson Bay, but increased in the 1950s and 1960s when York Factory closed, the number of personnel at Fort Churchill was reduced, and the harvest was regulated. The population remained stable until the late 1980s and had declined by 2004. As a result of the declining trend, MCWS listed the polar bear as Threatened in Manitoba. This most recent decline was attributed to changing sea ice conditions due to a warming climate. The WH polar bear subpopulation currently appears to be stable.
REGIONAL CUMULATIVE EFFECTS CONCLUSION

While there have been many changes in northern Manitoba due to hydroelectric development, these changes have not overlapped substantially with the WH polar bear terrestrial range. The major limiting factors for polar bears are changing sea ice conditions due to climate change and mortality from human activity. To date, no peer reviewed linkage has been found between hydroelectric development in the RCEA ROI, potential contributions to climate change, reduced access to food, and declining body condition of polar bears. While den sites were not identified prior to hydroelectric development, females continue to return to traditional denning areas, and there has been no effect of hydroelectric development observed or reported for this habitat in northern Manitoba. As there is at best a tenuous link between hydroelectric development and polar bear mortality in defense of life or property, there has been no measurable effect on the WH subpopulation.

While polar bears are a listed species at risk facing several challenges, there is no indication that hydroelectric development in northern Manitoba has adversely affected the WH subpopulation, and there have been no cumulative effects of successive projects on polar bears.

6.11.3.2 Local Effects

Many changes have been observed in the WH polar bear subpopulation by Inuit hunters and other inhabitants of the Hudson Bay region over the last several decades. However, no effects documented as being caused by hydroelectric development were found. While no information from residents of northern Manitoba was found, several published compilations of traditional knowledge from, and consultations with, Inuit and Cree were reviewed. Local effects on WH polar bears have predominantly been attributed by northern residents to low total allowable harvests, local human activity, research conducted on the bears, and occasionally to climate change.
6.11.4 Effects of Hydroelectric Development in the Region of Interest on Polar Bears

- There are very few direct physical impacts of hydroelectric development in the two large denning areas in northern Manitoba, with the exception of the Radisson to Churchill transmission line.
  - The amount of denning habitat affected has been negligible.
- Over the period of hydroelectric development, only one polar bear death has been attributed to hydroelectric development, caused by the defense of life and property.
  - Any recent declines in polar bear abundance, general body condition, or vital rates are believed to be directly related to an extended ice-free period on Hudson Bay due to the effects of climate change.
- No link between population fluctuations and hydroelectric development was found in the literature.
- Western Hudson Bay polar bears and their denning habitat do not appear to have been materially affected by the cumulative effects of hydroelectric development within the RCEA ROI, and there has been no appreciable effect on the subpopulation.
6.11.5 Bibliography

6.11.5.1 Literature Cited and Data Sources


### 6.11.5.2 Personal Communications