Assessing the Impacts of the Mackenzie Gas Project on Kendall Island Migratory Bird Sanctuary

Intervener Report

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1 THE ROLE OF PROTECTED AREAS IN ENVIRONMENTAL PLANNING AND MANAGEMENT

One of Nature Canada's concerns regarding the implementation of the Mackenzie Gas Project (MGP) is the impact of the Project on birds and bird habitat within Kendall Island Migratory Bird Sanctuary (KIBS) and the other Important Bird Areas (IBAs) found within the project study area. Although the IBAs (other than KIBS) located within the regional study area of the MGP do not have official protected status under any legislation in Canada, they do represent globally significant areas of critical bird habitat and are, therefore, candidate sites for protected status. A second concern is that the Project will be implemented prior to the establishment of a network of protected areas designed to conserve the biodiversity of the Northwest Territories.

In this section we review the two major roles of protected areas in environmental planning and management with an emphasis on the benefits, for both the environment and for industry, of establishing a network of protected areas prior to large-scale land development such as the MGP.

1.1 Limits to Cumulative Effects

The first role of protected areas is to limit the cumulative effects of development. A universal problem of all environmental planning exercises is considering the potential environmental impact of proposed development in the context of the impacts of past and possible future development. Failure to consider previous effects can lead to a biased view of how much an environment has already been altered by development. The slow, steady pace of development can lead to minor changes over short periods, but the cumulative effect of these minor changes over many years can amount to substantial effects. This is particularly true of environmental components that are rarely observed, such as many species and ecological processes. Assessing the cumulative effects of past development can be difficult because data on the historical status of the environment is rare. For example, data on the historical distribution of species is often formed from *ad hoc* surveys, which may be biased or incomplete (Hijmans, Garrett et al. 2000; Graham, Ferrier et al. 2004; Guralnick and Van Cleve 2005).

While most environmental planning exercises explicitly require that cumulative effects be assessed and considered, many potential effects may lie outside the scope of the proposed project (Snell and Cowell 2006) or may not be recognized as significant cumulative effects. In addition, the effect of a specific project may be relatively small and considered insignificant, although the cumulative effect of many such projects may be substantial, but entirely invisible to project-specific environmental planning exercises.

Future cumulative effects are equally difficult to incorporate into environmental planning for a number of reasons. First, the environmental effects themselves are difficult to predict. Second, cumulative effects may depend on the decisions of individuals, groups or institutions not involved in the planning process. Third, both of these factors are often dependent on environmental, political and economic conditions which may not be similar to present conditions.

A simple approach to limiting cumulative effects is to determine, prior to extensive development, what proportion of the landscape should be exempt from development in order to protect its pre-existing natural values. By establishing protected areas within which development is prohibited, protected areas set an upper limit on the net consequences of cumulative effects. This strategy is similar to the 'fixed escapement' approach used to manage salmon fisheries, in which fishing activity is prohibited until a given number of salmon have reached freshwater streams and are no longer susceptible to harvest (Potter, MacLean et al. 2003). Similarly, establishing a system of reserves prior to extensive development allows for a 'fixed escapement' of wildlife habitat and populations. An added benefit of creating a network of reserves is it provides the opportunity for stakeholders to explicitly address the question of what environmental components they value the most and what the limits to development should be. Because the scope of such a planning exercise would be much larger than any one development project, the exercise can incorporate and assess cumulative effects beyond the scope of individual projects.

1.2 Ecological Baselines

A second role of protected areas is to serve as ecological baseline controls (Arcese and Sinclair 1997; Sinclair, Mduma et al. 2002). In order to determine the effects of human activities (potentially positive or negative) on the functioning of ecosystems, there must exist control sites within which human activities are absent. Without these controls, it is impossible to know whether observed environmental changes are a result of human activity or not. Consequently, protected areas are not just a means to achieve conservation objectives, but an integrated part of the learning process inherent in effective environmental planning and management across the entire landscape. Such learning is an explicit component of comprehensive reviews conducted under the Canadian Environmental Assessment Act (CEAA). Following approval of a project, section 38 of the CEAA allows for federal authorities to implement follow-up programs designed to:

> (a) verify the accuracy of the environmental assessment of a project, and
>
> (b) determine the effectiveness of any measures taken to mitigate the adverse environmental effects of the project.

Further, Section 38 also states that the results of follow-up programs may be used for implementing adaptive management measures or for improving the quality of future environmental assessments.

Adaptive management refers to the process through which uncertainty about the outcome of development or a prescribed management action is addressed as an explicit component of management itself (Holling 1978; Walters 1986; Walters and Holling 1990). To do this, the prescribed management action is implemented within an experimental framework that will allow managers to determine whether the action had the desired effect or not. This knowledge is then used to improve future management prescriptions. In the best cases experiments are designed not only to test whether or not the prescribed management resulted in the expected outcome, but also to test why it was successful or not.

In order to achieve the goals for follow-up programs in the CEAA, protected areas could serve as control sites in which human activity is absent. To verify the accuracy of the environmental assessment of a project, sites within the project area would be compared to similar sites within protected areas. The effectiveness of mitigation measures would be tested by comparing mitigated and unmitigated project sites with sites in the protected areas. The more similar the mitigated sites are to sites within the protected area compared to the unmitigated sites, the more successful the mitigation action.

KIBS may, ultimately, be the only protected area located within the Mackenzie River Delta. Consequently, in theory, it may provide the only suitable control for assessing the impacts of the MGP and any future development in the delta region. Unfortunately, past exploration activities have already reduced the value of KIBS as a baseline control and the existing plans to build infrastructure within its limits will compromise any remaining value.

1.3 Benefits of Early Establishment of Protected Areas

Currently the Northwest Territories is fortunate to have large expanses of habitat that are unaffected by direct impacts of large-scale development. These conditions provide a very rare opportunity to plan a network of protected areas prior to large scale development. Early establishment of protected areas will lead to a more efficient network, from the perspective of both industry and conservation.

The current state of the art in creating reserve networks involves a systematic approach to selecting candidate reserves (Margules and Pressey 2000). This approach contrasts sharply with the past approach of *ad hoc* reserve selection following extensive development, in which reserves were established in regions that were of little economic value to industry (Pressey 1994). The systematic approach attempts to select a set of candidate reserves which, when combined with existing reserves, will create a network that optimises the trade-offs between the benefits and costs of the network (Pressey, Humphries et al. 1993; Rothley 1999; Margules and Pressey 2000). Any type of costs and benefits can be included, as long as data are available to quantify the relative costs and benefits of candidate and existing reserves.

Benefits generally address one or two objectives of avoiding species losses from reserves: species representation and species persistence (Araujo and Williams 2000; Rodrigues, Gaston et al. 2000; Rodrigues, Gregory et al. 2000; Williams and Araujo 2000; Araujo, Williams et al. 2002; Cabeza 2003; Cabeza, Araujo et al. 2004). Species representation refers to how many reserves in the network currently maintain a population of a particular species. Species persistence refers to the likelihood that a particular species will continue to exist in the reserve after protection has been established. The former objective is much easier to evaluate as it depends only on having reliable data on species' current distributions. The latter objective is more difficult to quantify because it depends, in part, on the degree of development that occurs outside the reserve (Gurd, Nudds et al. 2001; Gurd 2006). Representation tends to increase with the number of reserves in the network because species' ranges often do not overlap. Persistence is primarily dependent on the area and population density of individual reserves because both allow for larger population sizes (Rodrigues, Gregory et al. 2000). The degree to which organisms can move between reserves or are present in multiple reserves also influences persistence. Consequently, the conservation benefits of a network generally increase with its total area.

Costs generally include direct costs of establishing and maintaining the reserve system, which are often assumed to increase with the total area of the network. Costs may also include the value of lost development opportunities if they are greater than the economic gains created by the establishment of a reserve. From the point of view of industry, the cost of reserve networks will also increase with the size of the network. A larger network implies more lost opportunities for development.

In this simple example the trade-off to be optimised is obvious: both the costs and conservation benefits increase with area. However, the quality of the candidate reserves greatly affects the net cost of a network. We illustrate this point with an example. Assume the optimum solution to the trade-off is to create a reserve network (network A) with ten reserves. These 10 reserves represent the most efficient sites in terms of the greatest conservation gain at the lowest cost. Essentially, these sites offer the best conservation value. If the establishment of network A is delayed and one of these ten candidate sites is developed, how will this affect the conservation value of the next best network (network B)? Because candidate sites are unlikely to be identical in their conservation value, loss of a high quality site will reduce the conservation value of network B compared to network A. Network B will cost more to provide the same conservation benefit. The best solution for both conservation and development interests is to create a system of reserves as early as possible, before the candidate reserves with the highest conservation value are impacted by development.

2 EFFECTS OF DEVELOPMENT ON BIRD HABITAT IN THE KENDALL ISLAND MIGRATORY BIRD SANCTUARY

Kendall Island Migratory Bird Sanctuary (KIBS) was designated to protect habitat for the high densities of migratory birds using the area for foraging, nesting, moulting and staging (Canadian Wildlife Service 1992). This sanctuary was designated in particular for the long-term protection of the lesser snow geese breeding colony on the outer islands. The sanctuary also protects key nesting and staging habitats for 83 other bird species including waterfowl, waterbirds, shorebirds, grouse, raptors and passerines (Canadian Wildlife Service 1992). The boundaries of the Kendall Island Migratory Bird Sanctuary include an area of 606 km^2 (Canadian Wildlife Service 1992) of which 335 km^2 is terrestrial habitat (Ashenhurst 2004).

The Canadian Wildlife Service has mandated a maximum 1% anthropogenic footprint on the land within the sanctuary (Government of Canada 2006). This footprint may fluctuate between 0-1% as old impacts recover and new impacts are created (Government of Canada 2006). An old impact has recovered when the combination of flora and fauna there does not differ from that which existed prior to oil and gas industrial activities (Government of Canada 2006).

Migratory bird sanctuaries are established to provide long-term protection to migratory bird populations and their key habitats (Canadian Wildlife Service 1992). The rationale that underlies designating reserves and sanctuaries is to offer habitat protection for flora and fauna so that in the face of habitat loss in unprotected areas a reserve of high quality, important habitat will remain for use by wildlife. As habitat is lost in surrounding areas; reserves, parks and sanctuaries become increasingly important.

The current proposal for development in KIBS includes 2 anchor field facilities, gathering pipelines and support infrastructure (MGP 2004). According to the environmental impact statement (EIS) prepared by the proponents, the locations of the Niglintgak and Taglu facilities do not coincide with known concentrations of waterfowl and that the closest colony is the greater white-fronted goose colony which is within 2-5 km of project activities (MGP 2004).

The destruction, degradation or alteration of nesting or foraging habitats has negative consequences for wildlife. The direct loss of habitat (i.e. from vegetation clearing, building man made features, or flooding of terrestrial habitat) has clear negative effects on populations, since habitat is no longer there for use for daily activities etc. Habitat loss can also occur indirectly through effects that decrease habitat effectiveness (quality), such as increases in noise, predation, or human disturbance.

Habitat loss and degradation is the underlying cause of population declines of North American migrant birds. As habitat is destroyed or degraded individuals must relocate to alternative habitat which may already house a population of birds. High quality habitats that offer an abundance of food, ample nest sites, and safety from predators are in high demand. Birds compete for these habitats and the best competitors usually occupy the highest quality habitat (Sutherland and Parker 1985). Similarly, high quality habitats usually support the highest densities of animals (Fretwell and Lucas 1970; Sutherland 1996). When high quality habitats, such as those that are located in sanctuaries, parks, and reserves, are lost or degraded birds must relocate elsewhere. If alternative habitat is scarce, fewer individuals may reproduce, or may produce fewer offspring. Furthermore, as displaced birds move into alternative habitats the per capita resource availability declines in that habitat, reducing its quality. Habitat loss may then lead to population declines if the survival or reproduction of individuals in the population is negatively impacted.

Here we outline what factors should be included to calculate the 1% anthropogenic footprint of the Mackenzie Gas Project in the Kendall Island Bird Sanctuary. We include direct habitat loss (vegetation clearing for project components and construction and land subsidence from operations), indirect habitat loss (via noise, disturbance, and increased predator abundance), and the cumulative effects of prior oil and gas development as factors that should be included in the calculation. We cover several major sources of impacts on wildlife in KIBS; however our list is by no means exhaustive, and may not cover all of the specific impacts within each category.

2.1 Calculating the 1% footprint

According to Environment Canada there can not be more than a 1% anthropogenic footprint in the sanctuary (Government of Canada 2006). However, there may be a variety of approaches that are taken to calculate the 1% impact, furthermore, there is a question of what should be included in the calculation.

The most straightforward way to calculate the 1% anthropogenic footprint would be to determine the percent of area of habitat impacted (where the combination of flora and fauna differs from that which existed prior to oil and gas industrial activities) out of the sanctuary area. There are two issues that exist in this approach, what to include as impacts in the numerator, and what to include as the sanctuary area in the denominator.

In the EIS, the proponents produce a table (10-145) that calculates the total footprint of proposed development in the Kendall Island Bird Sanctuary as 0.28%. However, in this approach the proponent only appears to include in the numerator the area of habitat impacted directly by the building components (the facilities and lateral lines) and neglects to include indirect losses of habitat caused by increased noise, predator, or human disturbance. Furthermore, this table includes the total sanctuary area in the denominator. However, throughout the EIS the proponents only consider the impacts of the project on terrestrial habitats to affect birds. They fail to acknowledge that impacts on aquatic habitats may affect birds in the sanctuary, even though many of the species in the sanctuary use both terrestrial and aquatic habitats. Should the proponent only consider impacts on birds in KIBS in terrestrial habitats, it seems reasonable that only the area of terrestrial habitat be included as the denominator in the calculation of the 1% footprint. If the terrestrial habitats are considered as the denominator, the impact of the footprint on terrestrial habitats is 0.49% (Table 1).

Table 1 (based on Table 10-145 in the EIS) calculates the percentage impact of the development components on habitat in KIBS if the total sanctuary area is considered as the denominator (606 km^2 - as calculated by the proponents) and compares the percentage impact on development components if only the area of terrestrial habitat (335 km^2) is considered as the denominator.

Table 1 The percent impact of the development components on total and terrestrial habitat in KIBS.

Development Component	Component footprint (ha)	Percentage of total Sanctuary Area	Percentage of terrestrial habitat
Access roads	15.9	0.03	0.05
Niglintgak lateral	47	0.08	0.14
Taglu lateral	6.1	0.01	0.02
Niglintgak	82	0.14	0.25
Taglu	13	0.02	0.04
Total	**164**	**0.28**	**0.49**

Alternatively, the footprint could be calculated separately for terrestrial and aquatic habitats with neither the total impact for each habitat type, nor the combined total to exceed 1%.

The second issue here is what to include in the numerator as the area of habitat impacted by the project. In the preceding table the proponents appear to only consider the area occupied by the project components. It is not clear if they include other effects identified as having an impact in the EIS such as direct habitat loss due to vegetation clearing, and land subsidence, or the effects causing indirect loss of habitat such as noise, predator and human disturbance. How each of these issues affects the bird species in KIBS are discussed at length in the following sections of this report.

Alternative approaches to habitat loss might also be considered in the 1% anthropogenic impact on the bird species in KIBS. For example, a 1% impact might be considered as a 1% decline of a particular bird population in KIBS caused by oil and gas development.

2.1.1 Direct habitat loss

The direct loss or alteration of habitat has clear negative effects on the distribution and abundance of migratory bird populations. Habitat loss relating to the Mackenzie Gas

Project will occur from vegetation clearing for project components and their construction, and from land subsidence expected during the facilities operations.

2.1.1.1 Vegetation Clearing

Vegetation clearing will occur during project construction, operation and decommission. Vegetation clearing affects wildlife through the direct removal of habitat and may cause direct mortality. The proponents estimate that the net loss of habitat due to vegetation clearing will be 148 ha (0.44% of terrestrial area or 0.24% of total sanctuary area).

The direct removal of habitat by clearing vegetation for the project will occur primarily during winter construction. However, the effects of the habitat change will extend into other seasons where habitat is degraded or replaced by project facilities and infrastructure (MGP 2004). Where habitat is completely replaced by project components, the effect of habitat destruction will persist throughout the duration of the project, and will not be reclaimed until project decommissioning and abandonment. For vegetation that is cleared or degraded during construction, reclamation may occur during project operations, however, since arctic ecosystems are particularly fragile and recover slowly from anthropogenic disturbances (Babb and Bliss 1974) the impact of vegetation clearing may be long term. Vegetation clearing may also cause direct mortality of wildlife, including adults, young, and eggs, when it is cleared outside of the winter season.

2.1.1.2 Land subsidence

According to the EIS land subsidence might cause direct changes in habitat availability near gas reservoirs around Niglintgak and Taglu (MGP 2004). As gas is withdrawn from the reservoirs, land currently subject to periodic flooding might be more susceptible to flooding for longer periods than in the past, which will affect the value of habitats in these areas for birds (MGP 2004).

Land subsidence will cause a long term, adverse effect on habitat availability for terrestrial species in KIBS since land flooded by subsidence will result in loss of nesting and foraging habitat for birds. According to a report submitted to the Joint Review Panel by NRCan (2006) the **minimum** land subsidence at Taglu over the 30 year lifespan of the project would amount to 232 ha (0.38% of total sanctuary, 0.69% of terrestrial habitat) of land inundated. At Niglintgak the estimates are that between 25-30 ha (0.04% of total sanctuary, 0.07% of terrestrial habitat) will be lost to subsidence over 30 years (NRCan 2006).

NRCan acknowledges that there is some uncertainty around these estimates of land subsidence. In particular there is uncertainty around the relationship between water levels measured at the time of the survey and the long-term mean water levels of the lakes. NRCan is also aware that the use of LidAR for the purpose of water level estimation is not without potential problems. While one hopes the extent of flooding from land subsidence is overestimated, should it be underestimated, there will be a greater impact on habitat for migratory birds in the sanctuary. Uncertainty about the long-term water level remains a significant issue for estimation of submergence (NRCan 2006).

2.1.2 Indirect loss

The indirect loss of habitat occurs when a habitat has not been directly disturbed or destroyed, but effects from other sources cause adjacent habitat to decline in quality (effectiveness). Effects on indirect habitat loss considered here include noise disturbance and increased predator abundance.

The indirect loss of habitat is much more difficult to quantify than direct habitat loss, since the habitats affected might appear otherwise unchanged following development. Furthermore, birds may continue to use these habitats, but may suffer decreased productivity, leading to population decline. These effects can be more extensive and pervasive than the effects of direct habitat loss depending on the range of influence of the effects.

2.1.3 Sensory disturbance: Effects of noise

The proponents define sensory disturbance as any visual, auditory, tactile or olfactory stimulus that changes the attractiveness of an area to wildlife (MGP 2004). Sensory disturbances to wildlife is expected to occur during all phases of the project, although the highest levels are expected to occur during construction, which should occur primarily during winter (MGP 2004). Sensory disturbance can have a negative impact on wildlife habitat effectiveness from disturbances including noise from construction, facility operation, aircraft and boat disturbance.

Noise disturbance from the project will occur throughout construction and operations (MGP 2004). Noise will emit from well sites from flaring, compressor stations, and other facilities. The movements of vehicles, helicopters, airplanes and barges are also known to disturb wildlife. High levels of noise affect wildlife by masking acoustic signals, potentially making it more difficult for animals to defend territories, attract mates or attend other important communication signals such as begging, alarm or distress calls. Increased noise could affect a population by decline or movement, and is likely species specific (Efroymson and Suter 2001).

The habitat models developed by the proponent incorporate reduced habitat effectiveness in the zones of influence stemming from sensory disturbances, which is based on visual and noise sources (MGP 2004). It is difficult to assess whether the effect of noise disturbance from aircraft or boat traffic has been incorporated into the proponents’ habitat models.

2.1.3.1 Construction and operations

Noise produced from the production facilities during construction and operations can have a negative impact on habitat effectiveness for nesting, staging, and foraging birds.

Experimental evidence shows that arctic birds in breeding and migratory staging stages of their life cycle are negatively impacted by noise produced by gas compressors (Gollop and Davis 1974; Gollop, Goldsberry et al. 1974).

Nests of terrestrial breeding birds suffered higher predation rates on experimental plots adjacent to a sound simulator which produced the types and levels of sounds which would be encountered at a gas compressor station. The noise levels ranged from 60-80 dBA within 620 m of the noise simulator. Predation of Lapland longspur nests was higher on disturbance areas (gas compressor noise simulator disturbance) than controls (3 of 21 nests depredated compared to 0 of 9). Eggs laid on control plots had a greater chance of hatching (93.7%) than on disturbance plots (80.6%). However, fledgling success was similar between plots since most hatchling mortality was affected by a storm causing abandonment which was equal between plots (Gollop, Goldsberry et al. 1974).

Snow geese staging for migration were also impacted at areas with noise disturbance (Gollop and Davis 1974). To encourage migrants to land snow goose decoys were located 45, 140, 175, 320 m from the simulators. Staging snow geese avoided landing near the decoys when the simulators were on, compared to control sites. When the simulator was first turned on flocks within 4.8 km relocated further away. Some eventually returned to within 2.4 km. The arrival of a float plane later drove the remaining birds away and they did not return throughout the duration of the study which lasted for 2 more days.

A report prepared by ATCO Noise Management (2006) on the sound propagated from the Taglu gas conditioning facility suggests that according to the standard acoustic installation models, the noise level will be between 45-47 dBA 1.5 kilometres away from the acoustic centre. These models predict that sound levels of 40 dBA are expected between 2.6 and 3.4 km. This indicates that around the facilities there is an area between 21.2 and 36.3 km^2 where sound levels greater than 40dBA are expected. Also a sound pressure greater than 50 dBA is expected approximately 1.1 km from the plant, equal to an area of 3.8 km^2.

Alternatively, if the proponents implement ‘full noise abatement’ (maximizing noise mitigation based on available technology), the sound levels will be significantly lower. In this model the sound levels would be reduced to 32-35 dBA at a distance of 1.5 km from the facility’s acoustic focal point. A sound level of 40 dBA is achieved at 900 m equating to an area of 2.5 km^2. Furthermore, a level of 50 dBA is achieved at a distance approximately 300 m, equating to an area of 0.3 km^2.

A sound level of 40 dBA is the EUB (Energy Utilities Board) guideline for the level of noise produced at 1.5 km from the source. Noise levels of 35 dBA are equivalent to the noise produced by a whisper or that measured in typical quiet outdoors (MGP 2004).

2.1.3.2 Aircraft

Aircraft disturbance can affect the behaviour of nesting, foraging, and staging birds. Bird responses to aircraft flights depend on distance from aircraft, aircraft type, aircraft altitude, frequency of disturbance and bird species. The proponent’s EIS outlines several studies in which aircraft significantly affect the behaviour of birds (Davis and Wiseley 1974; Salter and Davis 1974).

According to Davis and Wiseley (1974) snow geese fly farther after being flushed by large aircraft (i.e. Hercules or DC-3) than by small (i.e. Cessna 185 or Beaver) or medium-sized (i.e. Twin Otter) aircraft. Snow geese flushed farther from helicopters than from all sizes of fixed-wing aircraft, but there was a longer interruption periods in response to small fixed-wing aircraft (average 6.3 min duration) than helicopters (average 5 min duration). Overall snow geese were equally likely to flush from nearby helicopters as from a small fixed-wing aircraft.

Salter and Davis (1974) observed the reactions of snow geese to flights of a Cessna 185 flown at experimental heights. All flocks flushed 1.6-8 km away when flying at 90-120 m, at 210 m all flocks flushed 3.2-14.4 km away, at 300m and 1500 m all flocks flushed 3.2-8 km away. At 1800 m they still flushed but distance was difficult to estimate. There was evidence of habituation to frequent over flights, i.e. for flights with 30 min intervals fewer geese flushed in afternoons than mornings. During oilfield expansion near the Mackenzie River at Norman Wells snow geese were the waterfowl species most sensitive to aircraft flights.

Brant geese staging for migration in south-western Alaska show strong effects of disturbance by aircraft overflights (Ward, Stehn et al. 1999). The majority of brant flocks (75%) flew in response to aircraft overflights. More flocks of brant flew in response to rotary (51%) than fixed-wing (33%) aircraft, and to high noise (exceeded 76 dBA for fixed-wing aircraft and 80 dBA for rotary wing at 152 m altitude) (49%) than low-noise (40%) aircraft. Responses occurred up to 1219 m altitude and 4.8 km lateral distances from the flocks. Response of brant decreased with increasing lateral distances, regardless of aircraft type or noise. Response generally decreased with increased altitude of fixed-wing and low noise aircraft, but remained the same or increased with rotary-wing and high noise aircraft. Canada geese were much more tolerant of aircraft and rarely responded to fixed-wing (5% of flocks responded) or rotary-wing (11% of flocks responded) aircraft.

The lateral distance between aircraft and flocks of birds, as well as its altitude, type and noise level are important parameters to predict waterfowl behaviour due to aircraft noise exposure (Ward, Stehn et al. 1999).

Waterfowl populations are also affected by float planes, especially in their usage of small lakes (0.15-0.21 km^2), where populations were reduced by 60% after 4 days of flights (Schweinsburg 1974). Aircraft disturbance also affects breeding birds, as evidenced by the higher fledging success of Lapland longspurs on controls (55.9% success) compared to aircraft disturbance (34.5%) plots (Gollop, Davis et al. 1974).

As demonstrated by these studies, aircraft disturbance has significant negative impacts nesting, foraging, and staging bird species. In addition to aircraft disturbance having a negative impact on snow geese behaviour (disruption of foraging from flushing) aircraft over flights negatively impacted habitat effectiveness for these birds. By the end of the study by Salter and Davis (1974) 60% (1425 of 2400) of the geese that had been present at the beginning of the study left the area after they had been subjected to aircraft disturbance, while on control plots goose numbers increased from 1400 at the initiation of the study to 1700 at its conclusion.

Oddly, the proponents cite (Table 2-5 AMEC Americas Limited 2005) eight different studies that observed geese being disturbed by aircraft at distances greater than 2 km, and up to 14.5 km, yet they consider the zone of influence to be less than 2 km for all project components. The precautionary principle suggests that decisions be based on the data that are most conservative in terms of avoiding impacts. In our opinion, assuming that habitat beyond 2 km will not be negatively influenced is overly optimistic given the available data and falls well short of precautionary.

2.1.4 Effects of predators

Project components, including the facilities and roads in the production area are likely to attract predators that prey on birds in the Kendall Island Bird Sanctuary. Predators of birds in KIBS are likely to be attracted to the area because the presence of roads increases ease of access, facilities that increase nesting or denning sites for predators, and by the presence, disturbance and odours produced humans (MGP 2004). Bears, fox, ravens, gulls and other avian predators, which prey on the nesting, staging and foraging birds in the sanctuary, can be attracted to human presence and activity at operation and construction facilities (MGP 2004).

Many of these predators are attracted to worksites and camps by food, garbage and other aromatic waste materials (MGP 2004). For example bears are attracted to synthetic products such as glycol and antifreeze, fuels, grease, petroleum products, plastic gas cans, rubber and other similar products (Eliot 1998). This has been reported at industrial developments, such as oil field and pipeline projects and outfitter operations in Alaska and Northern Canada (Follman and Hechtel 1990). Predators of birds are also attracted to projects such as these by the development of roads, or areas where vegetation is cleared, which allows them to access a wide range of prey more easily via these thorough fares. Finally, the structures built as a part of the project facilities can provide nesting and denning sites for predators, attracting them to the area where appropriate breeding sites may have been previously absent from the landscape.

Increased predator populations can cause both increased bird mortality and decreased habitat effectiveness as birds adjust habitat usage to avoid predators. Increased access to the area by predators can increase predation pressure on wildlife, resulting in increased mortality risk. Habitat effectiveness for wildlife can also be negatively impacted as animals might avoid an area where predators are more common (Lima and Dill 1990). Increased predator populations to the production area will have a negative, adverse impact on bird populations via mortality and will reduce habitat effectiveness throughout the home range of the predators.

2.1.4.1 Increased mortality

The attraction of predators to facilities in the production area can result in increased mortality of wildlife and can decrease habitat effectiveness as prey alter behaviour to avoid areas with increased predator abundance (i.e. Lima and Dill 1990).

In the environmental impact statement the proponents review much evidence that increases in avian and mammalian predators such as glaucous gulls, common raven, arctic and red fox, and grizzly bear near facilities can affect local bird populations such as waterfowl and shorebirds (MGP 2004). Despite the body of evidence they review, the proponents neglect to include the effects of increased predator populations on bird habitat in their models of habitat change caused by the development.

Eagles, foxes, wolves and polar bears are potential predators of adults and juveniles. Glaucous gulls, ravens, jaegers, Arctic foxes and occasionally grizzly bears are major predators of eggs and fledglings (MGP 2004).

Project facilities such as those in the production area might increase the presence of food waste or denning and nesting sites associated with structures could attract predators such as ravens, gulls, arctic fox and bears (Burgess 2000; Shideler and Hechtel 2000). Arctic fox are known to be significant predators on waterfowl including snow geese (Burgess 2000), grizzly bears will prey on adult birds, young and eggs when encountered (Day 1998; Johnson 2000; Shideler and Hechtel 2000).

In Alaska North Slope oil field developments, increased grizzly bear populations have caused the snow goose colony there to suffer nearly complete annual predation (Shideler and Hechtel 2000). These impacts on increased mortality can be significant, on Howe Island on the Alaska North Slope grizzly bears and Arctic fox were known or suspected to have eaten or destroyed most or all snow goose eggs on the island. In the Northwest Territories two polar bears ate about 13000 eggs from an eider colony containing 4500 nests in 5 days (Day 1998).

Common ravens, which are known to prey on the eggs and young of birds, and to benefit from the presence of humans, are attracted to landfills and food waste at human settlements. Furthermore, ravens nest on buildings and other elevated structures and towers, so the project facilities could allow ravens to expand into areas like the Mackenzie delta which currently have very few because of the lack of elevated structures for nesting.

Glaucous gulls are known to include birds and their eggs as their major prey (Day 1998). Large gulls such as these can also have an effect on smaller colonial nesting geese, i.e. snow geese (Johnson 2000). Ducks nesting in high densities (especially eiders), can lose eggs to glaucous gulls (Day 1998). Human activities can increase local gull populations by increasing available food waste.

2.1.4.2 Decreased habitat effectiveness

The presence of predators in an area has a significant effect on the behaviour of their prey (Lima and Dill 1990). Nesting, foraging, and staging birds in the Kendall Island Bird Sanctuary would be affected by increases in predators because of the costs associated with avoiding predation.

Animals are known to trade off the benefits of feeding with the costs of avoiding predators in a wide variety of ecological situations (see reviews in Lima and Dill 1990; Brown and Kotler 2004). Birds may join larger flocks (despite costs of increased competition) or increase the amount of time they spend looking for predators (despite lost feeding time) to decrease their probability of being killed (Elgar 1989; Cresswell 1994; Barbosa 1997; Bednekoff and Lima 1998; Whitfield 2003; Downes and Hoefer 2004).

Increases in predator abundance requires birds to allocate more time to anti-predator behaviours, and less time to foraging, incubating eggs, or feeding their young; habitat effectiveness (quality) then is lower in habitats where predators live and hunt. Many animals, including birds, are known to adjust their usage of habitats to increase their safety from predators. As their habitats become more dangerous, they are more likely to use safer habitats even if food resources are lower there (Grubb and Greenwald 1982; Brown 1988; Lindström 1990; Kotler 1992; Kotler, Brown et al. 1993; Suhonen 1993). A seemingly high quality, productive habitat, may shift from being used by large numbers of nesting or foraging birds to unused, if predator abundance increases.

Increased predator populations could have a profound, indirect effect, on habitat loss in the production area. Habitats high in habitat quality could shift from being used by birds in KIBS to not being used, or if used, much less productive throughout the home range of a predator in the area. The indirect effect of predators on bird habitat in KIBS will depend on the probability of predator attraction to the production area by the project, the species of predator attracted, the range over which the predator hunts, and its lethality to prey species (Brown, Laundre et al. 1999).

Predicting the effect of indirect habitat loss by disturbances induced by noise, human activities or predators on birds in KIBS is not without its challenges. Behaviour-based models have the potential to assess the effect of such disturbance on populations (West, Goss-Custard et al. 2002; Stillman, West et al. 2005).

2.1.5 Cumulative effects

Cumulative effects are changes to the environment that “are likely to result from the project in combination with other projects that have been or will be carried out” (Government of Canada 2003). Oil and gas exploration in the Kendall Island Bird Sanctuary began in the 1960’s, and the seismic exploration on the land in the sanctuary has occurred since 1966. Ashenhurst (2004) calculates that there are now 1002 km of 6 m wide seismic lines in the sanctuary (6 km^2 or 1.8% of terrestrial habitat or 0.99% of the total sanctuary area), 21 drill pads (2.02 km^2 or 0.60% of terrestrial habitat or 0.32% of the total sanctuary area) a gravel pile, two staging areas, and a permanent camp that includes buildings and an airstrip (0.39 km^2 or 0.12% of terrestrial habitat, or 0.06% of the total sanctuary area). Seismic lines crush vegetation and disturb the active layer depths (Felix and Raynolds 1989; Felix, Raynolds et al. 1992). Seismic lines and drill pads in the sanctuary negatively affect the abundance of shorebirds and passerines in the sanctuary (Ashenhurst 2004). The total effect of oil and gas development on KIBS is currently 2.5 % of the terrestrial habitat or 1.4% of the total sanctuary area (Ashenhurst 2004). Even minimal disturbances that do not damage the substrate and slightly damage the vegetation may take 5-20 years to recover (Babb and Bliss 1974). If both the substrate and vegetation are impacted recovery usually takes more than 100 years, if at all (Babb and Bliss 1974; Walker and Walker 1991).

According to the Canadian Wildlife Service a maximum 1% anthropogenic footprint will be allowed within the Kendall Island Migratory Bird Sanctuary (Government of Canada 2006). This footprint may fluctuate between 0-1% as old impacts recover and new impacts are created (Government of Canada 2006). Old impacts are considered recovered if the combination of flora and fauna there does not differ from that which existed prior to oil and gas industrial activities (Government of Canada 2006). Since Ashenhurst (2004) has demonstrated that the existing seismic lines and drill pads within KIBS have not returned to their original flora or fauna, and that the combined footprint of these disturbances exceeds the 1% limit set by Environment Canada.

2.1.6 Unforeseen impacts

The proponents do not acknowledge the effect that spills, contamination, or accidents may have on bird habitat in the Kendall Island Bird Sanctuary. Although the effects of accidental spills of fuel, lubricants, hydraulic fluids, or contaminated bilge water are considered for marine species in the EIS (MGP 2004) they are not considered to affect terrestrial or aquatic bird habitat in the sanctuary. The impacts of spills on bird mortality, and bird habitat, can be severe. Furthermore, hydrocarbons can persist in the environment for decades, leading to long-term negative population level impacts (Peterson, Rice et al. 2003).

Any calculation of a 1% maximum anthropogenic footprint in the Kendall Island Bird Sanctuary could quickly become a minimum estimate should an unexpected accident or spill impact bird habitat in the sanctuary. Since there is uncertainty around the future impacts of the project on habitat in the sanctuary the proponents should consider implementing a buffer around the estimate of the 1% maximum footprint to protect unforeseen loss of habitat.

2.2 Calculating impacts of the project on bird habitat in KIBS

2.2.1 Habitat models in the EIS

To calculate the impact of the proposed development on KIBS the proponents developed habitat models to estimate the loss of habitat from vegetation clearing under project footprints and the zones of influence stemming from sensory disturbances, which is based on visual and noise sources (MGP 2004). The results of the models are presented for 'effective habitat' throughout the assessment, which represents the primary habitats that can be used by VC's for food and cover, including those habitats ranked as very high, high and moderate quality based on model results (MGP 2004).

The approach appears to omit other effects considered here including land subsidence (section 1.2), the effect of aircraft noise (section 2.1.2), the effects of predators (section 2.2), the cumulative impacts on the sanctuary (section 3), and the possible effects of unforeseen circumstances (section 4) all of which could have an adverse, long term, negative impact on bird habitat in KIBS.

Furthermore, this approach considers only the changes in 'effective habitat' throughout the assessment, which represents the primary habitats that can be used by VC's for food and cover, including those habitats ranked as very high, high and moderate quality based on model results (MGP 2004). This is problematic for two reasons. First, although the proponent considers the effects of the project on the highest quality habitats, it ignores lower quality habitats which may be used, even if less productive, by the VC's in the sanctuary. Lower quality habitats may be less productive, but should still be considered as habitat impacted by the project in the calculation of the 1% footprint in the sanctuary.

Secondly, the proponent only considers effective habitat for the species considered 'valued components' in the assessment. The habitats identified as 'ineffective' for the VCs may in fact be high quality habitat for several of the other 78 bird species living in the sanctuary. A more conservative approach would be to include the entire range of habitats that will be impacted by the project in KIBS.

Despite the shortcomings of these models the proponents generate the table (10-146) which calculates the amount of habitat disturbed in KIBS for each valued component during construction and operations.

The amount of disturbed habitat in KIBS as calculated by the proponent's habitat model for each species appears to approach the 1% maximum anthropogenic footprint mandated by the Canadian Wildlife Service (Table 2). For example, if the impact is considered as a percentage of the total sanctuary area, the loss of Tundra Swan nesting habitat during construction alone is 0.68%. If the effect of habitat change is considered as a percentage of the terrestrial habitat sanctuary the impact on this habitat is 1.24%.

Table 2. Area and percent impact of habitat change in KIBS on each valued component as predicted by the habitat models in the EIS (based on Table 10-146 in the EIS).

		Baseline	Construction			Operations		
Valued Component Model	Habitat Value	Habitat Area (ha)	Habitat Change (ha)	% Sanctuary Area	% Terrestrial Area	Habitat Change (ha)	% Sanctuary Area	% Terrestrial area
Greater white fronted goose nesting habitat	Effective	2 713	-138	0.23	0.41	-56	0.09	0.17
Greater white fronted goose foraging habitat	Effective	29 022	-169	0.28	0.50	-71	0.12	0.21
Tundra Swan nesting habitat	Effective	6 909	-415	0.68	1.24	-184	0.30	0.55
Tundra Swan foraging habitat	Effective	321 272	-106	0.17	0.32	-60	0.10	0.18
Greater Scaup nesting habitat	Effective	267	-6	0.01	0.02	-3	0.00	0.01
Whimbrel nesting habitat	Effective	1 172	-7	0.01	0.02	-5	0.01	0.01
Whimbrel foraging habitat	Effective	1 173	-3	0.00	0.01	-3	0.00	0.01

2.2.2 Summary

To calculate the impact of the proposed project on the Kendall Island Bird Sanctuary it is essential to include several factors that will have a significant negative impact on bird habitat in the sanctuary.

- Direct habitat loss

- Sensory disturbance, this calculation should include decreased habitat effectiveness from noise emitted during construction and operation of the facilities and especially include the effects of aircraft on bird disturbance.

- Increased predator populations, this calculation should include the home range of potential predators that could negatively impact bird mortality and habitat effectiveness for birds in the area surrounding the facilities in the production area.

- Cumulative effects, it is essential that the calculation of the footprint include the existing effects of oil and gas development in the sanctuary since the seismic lines and infrastructure that currently exist in the sanctuary continues to negatively impact bird abundance.

- Unforeseen effects, it is crucial that the proponents include the risks of spills, accidents, fires, etc and their impact on terrestrial habitat in KIBS.

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