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Putting the environmental impact assessment process into practice for woodland caribou in the Alberta Oil Sands Region

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Abstract: Since 1985, woodland caribou (*Rangifer tarandus caribou*) have been designated as a threatened species in Alberta. Populations studied since the 1970s have been stable or declining, with no population increases documented. Resource expansion into previously undeveloped areas and associated increases in access have been implicated as possible causes for the declines. To facilitate development on caribou ranges, while ensuring the integrity and supply of caribou habitat, standing committees have been formed. The primary role of the committees is to act as advisory bodies to the government and to search for effective and efficient industrial operating guidelines. Recent research has been conducted on the responses of woodland caribou ecotypes to increased human and predator access. Based on this research, operating guidelines have been refined and implemented through Caribou Protection Plans. I discuss how the current operating guidelines are put into practice and linked to the Environmental Assessment process within the Oil Sands Region of Alberta. In particular, I discuss the origination of impact predictions, specific mitigation measures to reduce impacts and monitoring.

Key words: Caribou Protection Plans, Environmental Impact Assessment, mitigation, monitoring, oil sands, operating guidelines, *Rangifer tarandus caribou*.

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Introduction

Woodland caribou are listed as a threatened species in Alberta (Alberta Wildlife Act 2000) and nationally in Canada (COSEWIC, 2003). Since 1991, populations of woodland caribou in Alberta have been stable or declining, and no population increases have been documented (Dzus, 2000; McLoughlin *et al.*, 2003). Concurrently, resource-based industries have expanded at a rapid rate into previously undeveloped areas, and associated increases in access have been implicated as possible causes for declines of caribou populations (Edmonds, 1988). To sustain industrial activity on caribou ranges, while ensuring the integrity and supply of caribou habitat (Alberta Department of Energy, 1991), multi-stakeholder standing committees were formed throughout the province. The primary role of the committees is to advise the government and to search for effective and efficient industrial operating guidelines (Rippin *et al.*, 1996). Currently, two guideline documents are applied to industrial activities occuring within woodland caribou ranges in the province (Boreal Caribou Committee [BCC], 2001; West-Central Alberta Caribou Standing Committee, 1996).

Current operating guidelines address habitat targets and activity targets within caribou ranges, range planning, adaptive management initiated through on-going research, and best operating practices. The best operating practices are industry-specific and are applied through each developer's annual Caribou Protection Plan (CPP). The CPPs provide a tool for land managers to make decisions on proposed activities within each caribou range and provide a venue for cooperation among developers to utilize common access corridors and other infrastructure in an effort to minimize cumulative disturbances to caribou.

Research to date

A primary objective of the industrial guidelines is to apply adaptive management initiated through

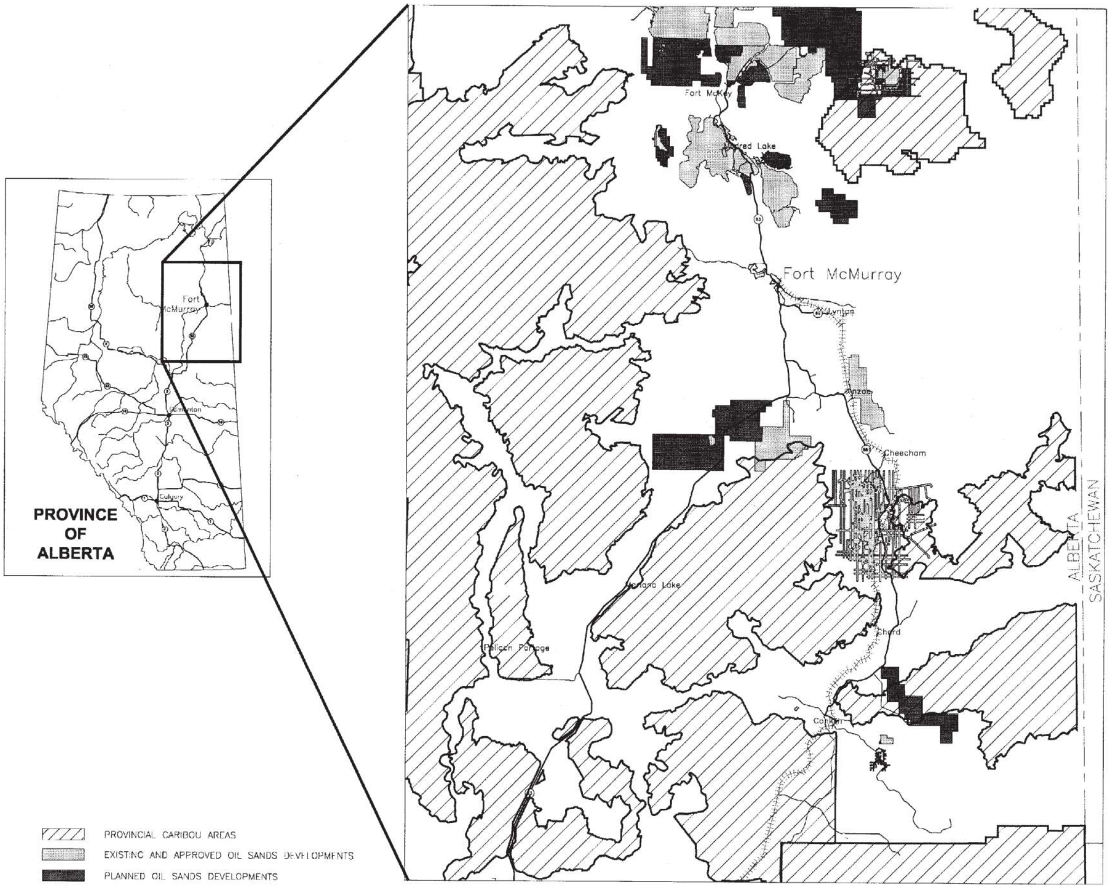

Fig. 1. Location of caribou areas in association with existing and planned oil sands developments in the Oil Sands Region. (Diagonal lines indicate caribou range, shaded blocks are proposed or active oil and sands developments).

on-going research. Research has focused on increased human and predator access within caribou ranges. Caribou response to instantaneous human activity, increased predation risk resulting from linear corridors (e.g., roads, seismic lines), indirect habitat loss associated with caribou avoidance of industrial development, roads and cutlines as barriers to movement, and the influence of fire on habitat use have been examined in an effort to refine the industrial guidelines.

Caribou response to "instantaneous" human activity (i.e., simulated seismic programs) appears to be short term, with caribou moving away from areas of human activity but returning once activity has been terminated (Bradshaw *et al.*, 1997). Wolf distribution and kill site locations have been studied in the context of caribou avoidance and potential increased predation as a result of disturbances. James (1999) found that woodland caribou demonstrated a pattern of habitat selection that differed from that of moose and wolves. Caribou tended to occur further from linear developments, while wolves and their kill sites were closer than random to linear developments (James, 1999; James & Stuart-Smith, 2000). In addition, wolves use linear developments as travel routes and have been documented travelling up to 2.8 times faster on linear developments than in surrounding forest (James, 1999), which may improve their predation efficiency. Human-caused mortalities have also been documented closer to linear corridors (James & Stuart-Smith, 2000).

Although woodland caribou utilize land near industrial development, use is less than expected and varies depending on the season and the type of development. Dyer (1999) reported that the density of caribou locations was significantly lower than expected in areas closer to roads, wellsites and seismic lines. Such avoidance patterns will reduce the useable habitat available to caribou. In addition, these linear developments may form barriers to the free movement of caribou between patches of undisturbed habitat (Dyer *et al.*, 2001; Dyer *et al.*, 2002).

Avoidance of seismic lines by boreal woodland caribou appears to be greater during the late winter when seismic lines may act as winter roads on frozen ground (Dyer, 1999). Conversely, radio locations of mountain woodland caribou (mountain ecotype) do not appear to be influenced by the distribution of seismic lines. However, research on the mountain ecotype occurred on caribou ranges with considerable natural reforestation on older seismic lines and all newer seismic lines were developed using low impact seismic techniques (Oberg, 2001).

As fire is the dominant natural landscape influence in the boreal forest, Dunford (2003) examined the response of woodland caribou to habitat loss and alterations associated with fire. Large-scale distribution patterns of caribou appeared to have little relationship to the loss of lichens due to wildfires, and changes in forage availability resulting from wildfires did not alter caribou distribution or range fidelity (Dunford, 2003). Caribou avoidance of burned areas declined as the areal extent of burned areas increased, possibly because caribou were selecting unburned patches within burned areas in their home ranges. Large home ranges appear to allow caribou to meet their forage requirements even when lichen availability is reduced as a result of fire.

Based on the research to date, operating guidelines have been refined and implemented at a local scale by industrial developers through the use of best operating practices as outlined within the current guidelines (BCC, 2001; WCACSC, 1996).

Putting process into practice

Alberta's Oil Sands Region

The Oil Sands Region (OSR) of Alberta encompasses almost the entire northeastern portion of the province. This boreal forest region has experienced a rapid expansion of industrial development, including oil sands extraction (open-pit mining and Steam-Assisted Gravity Drainage [SAGD] in-situ operations), gas extraction and processing, forestry activities and peat mining. These developments are associated with infrastructure such as roads, pipelines (above and below ground), utility corridors and seismic exploration programs. Specific impacts from the oil sands extraction developments include the direct loss of habitat from large-scale open pit mines, and multiple well-pads with aboveground pipelines from in-situ operations. Current projects that have been approved or planned in the OSR overlie a number of woodland caribou (boreal ecotype) ranges (Fig. 1). Assessment of the impacts from oil sands developments is required under the Alberta Environmental Protection and Enhancement Act (AEPEA 110/93). Assessments must include a baseline (Baseline Case), project (Application Case) and cumulative effects assessment (CEA Assessment) for species of concern, including woodland caribou.

In this paper, I discuss how the multi-stakeholder Boreal Caribou Committee's operating guidelines and research results are incorporated into an Environmental Impact Assessment (EIA) for woodland caribou in the OSR of Alberta. In particular, I discuss the origin of impact predictions, specific mitigation measures to reduce impacts and long-term monitoring programs.

Baseline case

The baseline case provides a summary of wildlife observations and habitat found within a local study area (LSA). Woodland caribou are classified as a Priority 1 Key Indicator Resource (KIR) species within the OSR (Westworth, 2002) as a result of their status in the province and traditional value for indigenous people (First Nations). Because of their ecological and traditional importance, baseline surveys completed prior to the completion of an EIA focus on identifying the presence of caribou and their relative density and habitat use within the LSA. Aerial surveys, winter track count surveys, pellet surveys and historical database searches (e.g., Biodiversity/Species Observation Database [BSOD] and caribou range maps [Dzus, 2000]) are completed at a local scale to determine baseline conditions for caribou within the LSA. Historical data at the regional scale are also compiled to determine caribou locations and important habitat areas (e.g., historical calving locations). If caribou are present within the LSA, planning for the location of the development footprint (e.g., plant site, camp location, wellpads) considers caribou location information (e.g., calving sites, potential movement corridors and range boundaries) to minimize the overall impact of the project on caribou within the LSA.

Application case

The purpose of the Application Case is to assess specific effects on wildlife, identify strategies to minimize potential project-related effects, and to discuss the potential to return wildlife habitat within the LSA to predisturbance conditions. Oil sands development activities affect woodland caribou through several pathways including habitat loss and alteration, direct and indirect mortality (e.g., vehicle–wildlife collisions, implications of physiological stress from sensory disturbance on calving and recruitment), and changes in access and use.

In the OSR, direct habitat loss results from clearing and is greatest during the site clearing phase of a development. Indirect habitat loss results from

Table 1. Zones of influence (ZOI; m) and disturbance coefficients (DC) for 3 types of disturbance likely to affect woodland caribou in the Alberta Oil Sands Region.

Access (roads)		Facilities and development		Utility corridors[a]	
ZOI	DC	ZOI	DC	ZOI	DC
100	0				
250	0.25	250	0.5	100	0.5
500	0.50				
1000	0.75				

[a] Seismic lines, powerlines, pipelines.

fragmentation, changes in hydrology (e.g., drainage of peatlands), barriers to movement, sensory disturbance and air emissions. Indirect habitat loss occurs when habitat is still physically present, but caribou choose not to, or may not be able to, use habitat as a result of barriers to movement, fragmentation, sensory disturbance and air emissions (i.e., reduction in lichen). Indirect habitat loss also includes habitat which has reduced effectiveness for caribou due to its proximity to a development feature (e.g., roads, seismic lines, well site) and the reduced use by caribou (Dyer, 1999). Direct habitat loss and initial fragmentation are closely associated with the construction phase of developments, while indirect habitat loss is more closely associated with the operational phases.

To determine the magnitude of direct and indirect habitat loss, Habitat Suitability Index (HSI) models are generated for assessing quantity and quality of caribou habitat (see Petro-Canada, 2001 for model description). The HSI models are research driven, derived from research results on woodland caribou habitat use (e.g., Anderson, 1999; Schneider *et al.*, 2000; Stuart-Smith *et al.*, 1997) and the effects of disturbance on caribou use of habitat (e.g., Dyer, 1999). Using a Geographic Information System (GIS), habitat quantity and quality are examined under the Baseline Case, the Application Case and the CEA Case. For example, habitat loss calculations for the Application Case are based on the direct and indirect removal of habitat in the LSA as a result of the development. Indirect habitat loss is quantified by buffering the development footprint by Zones of Influence (ZOI). A ZOI is the estimated maximum distance to which a disturbance (e.g., noise) influences caribou habitat use. A Disturbance Coefficient (DC) is applied to the ZOI. The DC is the effect a disturbance has on habitat use within a ZOI. For example, a DC of 0.5 represents a 50% reduction in habitat effectiveness for caribou and can be characterized as all caribou using a ZOI 50% of the time or 50% of the caribou using ZOI all the time. Different ZOI and DC coefficients are applied for each development activity type for caribou (Table 1). Indirect habitat loss is quantified by multiplying the area within ZOIs with appropriate DCs. Total habitat loss as a result of the development (the Application Case) is the sum of all direct and indirect habitat loss within the LSA. Changes in hydrology and impacts to terrestrial lichen abundance predicted from air emissions (i.e., acid deposition) are also added to the indirect habitat loss for caribou using the habitat modelling results overlaid with an isopleth for the predicted hydrology drawdown areas and an isopleth for the predicted potential acid input in excess of the critical load values adopted for use in Alberta (CASA, 1999).

Fragmentation indices are measures of the change in the forest landscape from extensive and continuous forest. Because caribou prefer large tracts of uninterrupted habitat, or a "well-connected" landscape, fragmentation indices are generated for caribou HSI habitat classes (low/moderate/high). To determine changes in landscape composition and structure, indices for the number of habitat patches and mean patch size are generated. Mean nearest neighbor distance is used to assess changes in landscape connectivity. For caribou, fragmentation is considered to be a negative impact when a proposed development is predicted to result in fewer, larger patches and high nearest neighbor distances.

Empirical data collected from the baseline surveys, as well as from wildlife surveys completed for other Oil Sands projects are used to test the predictions of HSI models. Once the HSI modelling is complete, the quantity of low, moderate and high quality caribou habitat which will be both directly and indirectly affected by the development are summarized.

Indirect mortality may result from sensory disturbance from construction and operations. Direct mortality may result from changes in human and predator access. Increased human and predator access may lead to increased predation, illegal and legal (First Nations) hunting, and the potential for increased vehicle–wildlife collisions. These effects are primarily a result of construction and operation activities. Professional judgment is used for assessing the magnitude of indirect and direct mortality. For caribou, research results (e.g., James, 1999), traditional knowledge (i.e., on the approximate amount of native harvest) and road mortality data from government agencies are used to form the assessment.

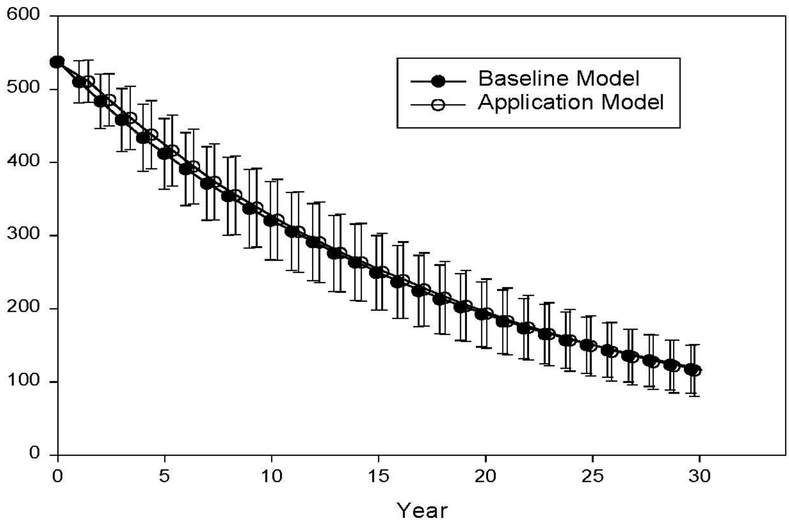

Fig. 2. Predicted change in caribou population from cumulative disturbance (modified from Petro-Canada, 2001)

CEA case

The CEA Case predicts the effects of a particular project plus existing, approved and planned developments on caribou at a regional scale, the Regional Study Area (RSA). Similar to the Application Case, the effects of the CEA Case on caribou habitat availability and effectiveness are determined through the use of HSI models in the RSA.

In addition to assessing direct and indirect habitat loss in the RSA, the cumulative impacts of development on caribou populations are assessed using a Population Viability Analysis (PVA) model (i.e., RAMAS GIS). The PVA incorporates both demographic rates and environmental variation to simulate population trajectories through space and time. The PVA is ultimately used to estimate the probability of a population becoming extirpated (Soulé, 1987; Shaffer, 1990), but also provides a tool for identifying those variables that are driving changes in population size. RAMAS® GIS is a PVA program that links habitat changes to population models (Akçakaya, 1998). Landscape data are used to calculate species HSI values and given a set of rules, RAMAS determines the patch structure and the number of potential populations (i.e., metapopulations) within the RSA. HSI models are used to generate estimates of carrying capacity and initial population size for both the baseline and cumulative effects development scenarios. Carrying capacity and initial population size are input into a population model that includes density dependence and the effects of environmental stochasticity on fecundity and survival rates. By changing carrying capacity of the landscape and initial population size, while keeping all other population parameters constant, we can quantitatively assess the cumulative effects of habitat change on the probability of woodland caribou declining below a particular threshold value. For example, results from the assessment of the Petro-Canada Meadow Creek Project indicated that the cumulative changes in habitat caused by future developments did not statistically alter the caribou population trajectory, or the risk of decline below a threshold value (Fig. 2). Rather, the models predicted a population decline that was strongly dependent on the current estimates of demographic rates for woodland caribou in Alberta and North America (Petro-Canada, 2001; Fig. 2). This conclusion was similar to that of Stuart-Smith *et al.* (1997), who predicted that with no change in growth rate, the caribou population in northeastern Alberta (adjacent to and overlapping the RSA used in our analysis) will decrease by 55% during the next 10 years.

Mitigation

During the EIA, mitigation measures to preclude or minimize potential project-related effects are provided for each impact. Mitigation measures for woodland caribou in the OSR focus on the current operating guidelines, best practices, and specific range plans developed through the multi-stakeholder caribou committees (BCC, 2001). Prior to development, environmental protection planning assists in minimizing or avoiding potentially negative impacts to caribou during construction and subsequent operation phases. Use of common corridors, route selection, low-impact seismic exploration techniques (reduced width and line of sight) and facility siting are the primary means of minimizing the impacts of habitat loss. Timing constraints (e.g., to activity during calving periods) and/or buffer zones for construction may minimize the impacts of sensory disturbance. Prompt reclamation of disturbed areas (i.e., progressive reclamation) ensures that habitat is disturbed for as short a period as possible. Reclamation and revegetation methods within caribou areas focus on minimizing the creation of suitable habitat for other ungulate species (e.g., deer [*Odocoileus* spp.], moose [*Alces alces*]) and maximizing the restoration of suitable caribou habitat. For linear developments, on-going research through the multi-stakeholder committees on caribou habitat restoration (Szkorupa, 2002) is incorporated into project mitigation.

Additional mitigation may include aboveground pipeline crossing structures and gaps in snow berms and other barriers to movement (CNRL, 2000), education and awareness programs for employees and contractors, human access control measures (e.g., signs, reduced speed limits, manned gates, prohibition of recreational vehicles, busing employees to the site), and predator access control measures (e.g., tree felling). Once mitigation measures for a project have been determined, the residual impacts (i.e., postmitigation) are evaluated and discussed within the EIA.

Monitoring

Monitoring programs are incorporated throughout the life of a project to ensure that mitigation measures are effective and improved where necessary and to verify impact predictions. For example, the location and design of aboveground pipeline crossing structures, implemented to reduce barriers to movement from SAGD operations, are still in their infancy. Track count surveys and remote camera monitoring provide data on active game trails and are helping to identify proper placement of crossing structures. These data also provide evidence for use of the crossing structures by caribou (e.g., Golder, 2004). Regular aerial surveys (e.g., Bentham & De La Mare, 2003) employee sighting cards (e.g., Golder, 2004), caribou incident reports (e.g., vehicle collisions) and regular reporting of monitoring results to regulators provide a record on the distribution and conservation of caribou in relation to on-going development activities. The results from long-term monitoring programs trigger developers to modify mitigation measures when necessary to ensure caribou conservation, and will ultimately provide data on reclamation success as developments enter the closure phase.

Caribou Protection Plans

To assist provincial caribou conservation goals, the Alberta Energy and Utilities Board (1994) requires an annual CPP for all activities occurring within caribou areas (EUB IL 94-22). CPPs are used to assist the provincial government in predicting the level of activity and habitat disturbance that will occur in each caribou range. CPPs for each winter's work must be submitted to the regional Alberta Sustainable Resource Development (ASRD) office by 15 October annually. The value of the CPPs is in identifying where resource users can combine footprints and work together to help achieve effective habitat in caribou ranges.

A CPP strategy is outlined within each EIA to cover the construction, operation and reclamation activities of each project. The strategy is based on the impact assessment, mitigation and monitoring as outlined within the EIA. Each CPP reports on the results of the caribou protection strategy and any monitoring activities from the previous year. The "Strategic Plan and Industrial Guidelines for Boreal Caribou Ranges in Northern Alberta" (BCC, 2001) are incorporated into the protection measures outlined in the CPP strategy. As research on woodland caribou is conducted within the province, best practices for industry can be updated to reflect research results. Annual CPPs will incorporate these updates as well as report on development activities of the past year, results of caribou protection planning and monitoring from the past year, development plans for the upcoming year, and protection measures for the upcoming year. Additionally, once specific range plans are developed, range planning protection measures and habitat targets (e.g., BCC, 2003) will also be incorporated into the CPPs.

Conclusion

The ongoing research, current operating guidelines and caribou protection strategies provide a framework to achieve caribou conservation in Alberta. However, the success of the caribou standing committees and the operating guidelines depends upon the commitments of individual developers in the OSR. As illustrated in this paper, commitment begins during the EIA process where research findings are used to refine and improve impact predictions, impact predictions are linked to cumulative effects and regional caribou populations, mitigation measures are implemented and refined through long-term monitoring programs (e.g., Golder, 2004), and CPPs are used to document protection planning and to help identify areas for collaboration among industries throughout the life of a project (e.g., CNRL, 2000; Opti, 2000; Suncor, 2000; Petro-Canada, 2001).

Considering the rapid rate of development within the OSR of Alberta, industries recognize that they will have to work in partnership to minimize impacts to woodland caribou and to stabilize caribou populations. The success of the caribou committees and the multi-stakeholder partnerships have also provided a framework for collaboration on a number of other wildlife issues in the OSR. Proposed initiatives include additional research for species of concern (e.g., caribou, Canadian toads [*Bufo hemiophrys*]), developing effective aboveground pipeline crossing structures, and the creation of regional wildlife movement corridors. These are good news stories, with industries taking the benefits of being involved in the caribou committees and using this as a framework to work together to do the right thing for caribou, and for other species of concern in the OSR.

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