The Effects of Linear Developments on Wildlife: A Review of Selected Scientific Literature

Prepared by: M.G. Jalkotzy, P.I. Ross, and
M.D. Nasserden
Arc Wildlife Services Ltd.
2201 - 34 St. S.W., Calgary
Alberta T3E 2W2
Canada

Prepared for: Canadian Association of Petroleum Producers
2100, 350 - 7 Avenue S.W., Calgary, Alberta
T2P 3N9 Canada

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Arc
Wildlife Services Ltd.

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Abstract: This report is a reference to be used when information is required regarding the effects of linear development on wildlife. It is divided into a number of sections. The basis of the literature review was an electronic search of biological and related electronic databases. The scope of this research is detailed in Section 2. Since the basis for understanding the effects of linear developments on wildlife is the ecology of landscapes, Sections 3 provides an introduction to the basic concepts of landscape ecology and Section 4 outlines the major functions of disturbance corridors. The effects of linear developments on wildlife can be divided into 6 major groupings, and these are outlined in Section 5. Section 6 examines the effects of linear corridors from the perspective of corridor type. Sections 5 and 6 are meant to be brief overviews of their respective topics. Section 7 forms the bulk of the report and examines, in detail, the effects of linear developments on different wildlife species and species groups. Large mammals are dealt with at the species level, whereas medium-sized carnivores are dealt with as a group, as are birds. The final section, Section 8, briefly reviews mitigative measures currently in use.

Mitigation techniques vary in their usefulness depending on a wide variety of factors including the target wildlife species, geographic location, and disturbance corridor type. Unfortunately, the efficacy of many of these techniques has not been rigorously examined even in areas where they have been in use for extended periods (650). There is an urgent need to conduct these kinds of assessments (e.g., 650, 16140).

8.1 Regional Planning

Since development and disturbance corridors have their greatest effects at the landscape level (e.g., 80), it is appropriate that the most effective measures to mitigate the effects of these corridors should occur at the same scale. In addition, many species that are sensitive to disturbance have land requirements that must be viewed at this scale (e.g., grizzly bears, wolverines). Planning development corridors at the regional or landscape scale provides the greatest opportunities for mitigating the effects of these disturbance corridors on these species. McLellan (86, 2240) felt that management and planning for wide-ranging species like the grizzly bear should focus habitat management and planning in areas that are gradually being settled. These areas that lie between relatively wild habitats are very important to conservation today since they are currently under the most human pressure. Regional habitat fragmentation will occur if these areas are lost; wilderness areas will become islands, and wildlife in them will be isolated. Isolation of populations is viewed as a serious threat to the long-term persistence of wide-ranging mammalian species in many areas (86). Apps (951684) and Gibeau et al. (950707) are using this approach in their assessments of grizzly bear habitats in the Rocky Mountains.

There are several examples of regional research and planning groups in existence or proposed in Alberta. Caribou have provided the focus for 2 such groups, the North East Regional Standing Committee on Woodland Caribou (NERSC) was formed in 1991 with a mandate to discuss and support research on caribou conservation and industrial development (950557). There are over 30 companies and government divisions involved. The goal of NERSC is to develop a knowledge-based management plan for woodland caribou in northeastern Alberta. The area is under pressure from many different human activities such as oil and gas development, forest harvest, agriculture, and recreation, and linear developments have proliferated. A group with a similar emphasis on woodland caribou, planning processes, and coordination of development activities has formed in northwestern Alberta (951704). Herrero and Herrero (80) recommended a management advisory board involving various regional, provincial, and federal stakeholders to oversee regional-level carnivore research and planning in the westcentral Rockies where Cardinal River Coals Ltd. has recently proposed to develop coal reserves. West of Calgary, the Banff-Bow Valley Task Force's objectives were to develop a vision and goals for the Banff-Bow Valley that would integrate ecological, social, and economic values, to complete a comprehensive analysis of existing information, and to provide direction on the management of human use and development in a manner that will maintain ecological values and provide sustainable tourism (951734). The development of a strategy that will

ensure the conservation of large carnivores in the Rocky Mountains has been the goal of an international multi-stakeholder group in a process initiated by WWF Canada in 1979 (250). There are many other examples across Canada and in the international arena. These initiatives have in common a regional research and planning perspective that takes into account all the developments that are occurring or that may occur in the future. Only at this level can the cumulative effects of development in general, and development corridors in particular, be adequately addressed. This inclusive, multi-stakeholder approach avoids piece-meal efforts and mitigation that have occurred in the past when individual companies assessed the impact of their operations in the immediate locale they were working without regard for broader-scale effects at the landscape level, and other developments within the region they were operating.

Most landscapes and regions are affected by development and development corridors to some degree and in many cases disturbance to wildlife occurs as a result of many different factors. Given that the detrimental effects of disturbance may accrue in wildlife populations without generating obvious population responses (e.g., precipitous declines), regional planning in the future may require that different interests use regions or landscapes in a staggered fashion. By reducing the levels of human use in a landscape over a given period, the deleterious cumulative effects of several disturbance activities occurring at the same time can be avoided. This staggering of use should include public access. Public access for recreational purposes, particularly hunting, probably results in the most detrimental disturbance effects of development corridors.

Cumulative effects assessment (CEA) in combination with geographic information systems (GIS) technology has been used as a powerful tool in assessing the impacts of linear developments on wildlife (e.g., 4270, 950707, 280, 80). The development of CEA techniques and the use of GIS for analysis is an area of on-going research. Several new techniques are currently being developed. One such technique is a linkage zone prediction model used by Servheen and Sandstrom (18820), Apps (951684), and Gibeau et al. (950707) to assess the degree of habitat fragmentation caused by the cumulative impacts of various human actions along development corridors. These linkage zones can be spatially identified on detailed maps so that management emphasis can address future human actions in these areas. Managers can implement land management activities and public education to minimize future habitat fragmentation or enhance linkages between areas that are being fragmented by development corridors.

Once planning at the regional or landscape scale has identified the kinds of disturbance effects that may occur as a result of linear development, then specific remedial actions can be planned. The first and foremost way to avoid the disturbance effects of development corridors is to minimize the number of corridors that are constructed. The necessity of each and every disturbance corridor in a planned development should be reviewed as to its purpose, necessity, and redundancy. There are many examples of ways that the number of disturbance corridors into an area can be reduced through thoughtful planning and cooperation within and between different resource sectors. Many of these options are

currently being used in northern Alberta by development interests (e.g., 950557). Where possible, corridors should be amalgamated to reduce the fragmentation effect of many small corridors. Rights-of-way can be designed to serve dual functions as road and pipeline corridors. When more than 1 operator is working in a area, access should be shared. Any reductions in the number of development corridors in an area will be beneficial to wildlife since additional disturbance effects are avoided.

Open road densities are a useful measure of the ecological effects of roads on a landscape (18880). Road density thresholds -- the density of roads above which a species no longer occurs in an area -- have been determined for wolves in the northcentral U.S.; wolves rarely occupy areas with road densities greater than 0.6 km/km^2 (e.g., 9670, 6830). Allowable road densities in grizzly bear recovery zones in the U.S. range from 0.47 km open road/km^2 to 0.62 km/km^2 (18760). In areas where the conservation of these species is an objective, open road densities should be maintained below these thresholds.

8.2 Corridor Attributes and Location

External and internal attributes of disturbance corridors can be altered to reduce their filter or barrier effect. Whenever possible, corridor width should be minimized. Hand-cut seismic lines are preferred to 8-m wide conventional lines. Curvilinearity should be increased where possible. For example, doglegs in pipelines to reduce lines of sight should be incorporated. Roads should be developed and maintained to the minimum standard necessary for their stated purpose. Low road standards deter use, and promote lower vehicle speeds and reduce the likelihood of collisions. Along natural wildlife movement corridors such as drainages and ridge lines, shrub growth should be promoted to the edges of the road. Most changes that promote increases in connectivity between habitats on either side of disturbance corridors carry costs, often involving increased operating expenses and time, and, in the case of roads, reduced travel speed and safety. However, if the objective is to reduce the impact of linear developments on wildlife, traveling slower and with increased vigilance should be a cost that is acceptable.

The effects of disturbance corridors can be substantially reduced by routing them to avoid areas where disturbance may be greater or unacceptable. Prior knowledge of wildlife use in a landscape is necessary to plan the alignment of a development corridor to minimize the effects of disturbance. For example, elk and deer migration routes are often areas where disturbance corridors have a significant impact because of high collision rates in these areas (e.g., 8810, 5860). Similarly, roads through moose winter range are frequently high road kill areas for moose (e.g., 4800). Transmission corridors that cross water or other open landscapes affect migrating cranes and waterfowl (18450, 6540). In the case of transmission lines, the route planning process should include mapping of topographical features which represent flight lanes for migrating birds and/or are important for local movements of resident species, and key areas for birds (16140). If disturbance corridors are routed to avoid these areas, disturbance impacts can be reduced.