ROADS, RAILS AND THE ENVIRONMENT: WILDLIFE AT THE INTERSECTION IN CANADA'S WESTERN MOUNTAINS

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PAPER TO BE PRESENTED AT THE "TRANSPORTATION RELATED WILDLIFE MORTALITY SEMINAR" APRIL 30, 1996, ORLANDO, FLORIDA

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INTRODUCTION

The Canadian Pacific Railway (CPR) and Trans-Canada Highway (TCH) form a primary transportation route linking the Pacific Coast with the rest of Canada. This west-east Trans-Canada Corridor (TCC) crosses the Canadian Cordillera in British Columbia and adjacent Alberta.

In 1885, the CPR completed Canada's first transcontinental transportation link. Route-finding, construction, and operational difficulties plagued this line from its onset (Berton 1974). The 400 km railway traverse of the Rocky and Columbia mountains presented a particular problem (Woods 1985). Following a parallel route to the railway, the TCH opened in 1962. Both the railway and highway continue to be primary transportation routes in terms of traffic volumes and tonnage. On the highway, traffic volumes may exceed 10,000 vehicles (average annual daily average) with a summer maximum (Woods 1990).

The TCC through the mountains has a history of wildlife-transportation conflicts (Klenavic 1979, Paradine 1987, Holland and Coen 1983, Holroyd and Van Tighem 1983, Van Tighem and Gyug 1984, Woods and Harris 1989, Woods 1990, Irwin et al. 1992). As the highway and railway expand capacity, these issues are likely to intensify both individually and collectively.

In this review, we provide a perspective on the challenge presented by the intersection of a national transportation corridor with the Columbia and Rocky Mountains from a wildlife conservation point-of-view. We conclude by suggesting ways to integrate wildlife issues with other aspects of highway and railway operation.

We would like to thank Mike Gibeau, Tom Hurd, Bruce McLellan, Paul Paquet, and Pat Wells for ideas which contributed to this review.

Natural Setting

The Canadian Cordillera of southern Alberta and British Columbia are a complex of ranges, trenches and plateaux approximately 640 km wide between the Interior Plains and the Coast Mountains (Holland 1976). The principle alignment of the Cordillera is north-west / south-east. Although there is considerable variation in topography and climate from range to range, the mountains are generally rugged with summit elevations exceeding 3000 m. Most valleys are narrow and steep-sided. Precipitation increases from west to east, and from low elevations to high with considerable winter snowfall. Glaciers and snow avalanches are common.

In terms of biodiversity, the lowest elevations have the greatest species richness (Achuff et al. 1984) and, where snow accumulation is minimal, valley bottoms are important ungulate late autumn, winter, and early spring ranges (Woods 1990). The principal natural corridors for wildlife movements follow the northwest-southeast alignment of the major valleys. East-west animal movements across the Cordillera are more constrained. A limited number of mountain passes (low routes between watersheds) are important travel routes for both people and wildlife (Woods 1990, Irwin et al. 1992).

The TCC area has a diverse large mammal population including: grizzly bear (*Ursus arctos*), black bear (*Ursus americanus*), wolverine (*Gulo gulo*), timber wolf (*Canis lupus*), coyote (*Canis latrans*), mountain lion (*Felis concolor*), lynx (*Lynx canadensis*), bighorn sheep (*Ovis canadensis*), mountain goat (*Oreamnos americanus*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), moose (*Alces alces*), elk (*Cervus elpahus*), and caribou (*Rangifer tarandus*).

Although less well known, numerous species of small mammals and birds live in the Canadian Cordillera adjacent to the TCC (Holroyd and Van Tighem 1983, Van Tighem and Gyug 1984). The majority of land birds breed in the Cordillera and winter in the tropics or sub-tropics (neotropical migrants). Erratic invasions of nomadic "winter finches" are a feature of the Columbia Mountains (J. Woods, unpubl. data, Parks Canada). For example, from year-to-year, pine siskins (*Carduelis pinus*), may vary from being the most abundant land bird to being entirely absent (Revelstoke Christmas Bird Count, unpubl. data).

Wildlife distribution is a complex function of climate, slope, aspect, elevation, vegetation, and past history. Since these attributes are highly variable from place to place within the Cordillera, wildlife abundance changes abruptly over relatively short horizontal distances along the TCC.

Transportation Setting

The Rocky and Columbia Mountains form a formidable barrier to the construction and operation of the railway and highway. The TCH and CPR follow major watercourses through valleys of varying widths and connect across drainages over three mountain passes (Kicking Horse, Rogers, and Eagle). Steep, rugged terrain, glaciers, rock slides, and frequent snow avalanches, have resulted in few terrain options for transportation corridor alignment. These conditions have constrained both the highway and railway to parallel routes across the mountains and put the highway and railway into close physical proximity in many areas. Along the TCC, there are numerous operational challenges including: steep grades, extreme winter weather (snow removal, freezing rain, snow avalanches), extreme summer weather (floods), slope and rock-cut instabilities, and collisions with wildlife.

Planning, construction and operations of the TCC through the Rocky and Columbia Mountains is a multi-agency responsibility. Four agencies are directly responsible for different portions of the highway: the Alberta Ministry of Highways, the British Columbia Ministry of Highways, Parks Canada, and Public Works Canada. CP Rail is the sole owner of the railway.

Wildlife/Transportation Conflicts

In this area, the intersection of the highly constrained west-east trending TCC with northwest-southeast aligned mountains and valleys has produced a number of conflicts with wildlife. These can be categorized as: 1) direct habitat loss, 2) indirect habitat loss , 3) habitat fragmentation, 4) animal mortality, and 5) public safety.

1. Direct habitat loss.

All forms of human use including the highway, the railway, and other roads are concentrated in the low elevation zones with the greatest biodiversity and highest value as ungulate winter range. This results in a severe competition for space. Habitat losses include the areas of right-of-way (e.g. road surface and shoulder vegetation) and the losses to burrow pits and operational requirements (e.g. equipment compounds).

While these habitat losses may seem inconsequential in terms of area, because they occur within the scarcest habitat types, they may be large in terms of impact on wildlife. For example, the only known breeding location for the Northern Long-eared Bat (*Myotis septentrionalis*) is bisected by the TCH within Mount Revelstoke National Park (Van Tighem and Gyug 1984, Nagorsen and Brigham 1993). This species may be a low-elevation, old-growth specialist. Concurrent development of low-elevation sites for other human uses (logging, recreation, settlement) within the TCC suggest a significant potential cumulative environmental impact.

2) Indirect Habitat Loss

The railway and highway may form a sensory barrier to wildlife. Although this form of habitat loss has the potential to alienate a much wider habitat corridor than the right-of-way, sensory disturbance by highways and railways is poorly understood. Preliminary studies of caribou and grizzly bears adjacent to the TCC suggest that some individuals of these species may be reluctant to closely approach or cross the TCH road surface, even in the absence of physical barriers (Woods and McLellan 1995, R. H. Munro, unpubl. data, UBC, B. N. McLellan, unpubl. data).

Winter avalanche control along the TCC presents another form of potential sensory disturbance. Rogers Pass is the largest mobile, direct-control avalanche area in the world. As many as 1000 rounds of explosives are used annually to control avalanches above the TCH and CPR in this area.

This activity can extend the area of disturbance for up to 8 km from the right-of-way and result in both sensory disturbance and direct animal mortalities.

3) Habitat Fragmentation

Although habitat is naturally fragmented in this highly dissected mountain landscape, the intersection of the west-east TCC with the northwest-southeast trending valleys suggests an additional major challenge to regional connectivity for wildlife. This conflict is heightened by the likelihood that most major mountain passes connecting drainages are used by both the TCC and wildlife.

Barriers to animal movements can take several forms. For example, ungulate-proof fencing designed to reduce direct animal mortality could increase habitat fragmentation if provision is not made for wildlife crossing. The variety of wildlife within the TCC confounds the problem: solutions which work for one species may not work for another. Woods (1990) described a combination fencing/wildlife crossing installations on part of the TCH in Banff National Park. Although these structures successfully reduced ungulate roadkills without severing connectivity, the same structures appear to be a barrier to carnivores (M. Gibeau, T. Hurd, P. Paquet, pers. com.). Therefore, in a multi-species area such as the Rocky and Columbia Mountains, mitigation programs will be challenged by varying responses and effectiveness from species to species.

We see habitat fragmentation and the creation of "fracture zones" as a major transportation-related wildlife issue. In addition, increasing traffic volumes, expansion of highway capacity, and increases to secondary developments may intensify habitat fragmentation. If the highway or the railway rights-of-way become "fracture zones" for animal movements, there is the potential to severely limit dispersal and gene flow.

4. Direct wildlife mortality.

Wildlife road-kills and rail-kills are frequent along the TCC through the mountains and are the best documented conflict between transportation developments and wildlife. Although this is true for both the highway and railway, the wildlife collision problems on the CPR and TCH are not identical. For example, the number of TCH road-kills peak in the spring and autumn. Most rail-kills occur during the winter (Woods 1990).

Along both the highway and the railway, wildlife collisions are highly variable from place to place. Of the large mammals, elk are the principle road-kill species in the Rocky Mountains and black bears are the most frequent road-kills in the Columbia Mountains (Woods and Harris 1989, Woods 1990).

In addition to the intersection of the transportation corridor with wildlife movement corridors, road-kill and rail-kill problems can be intensified by any factor which attracts wildlife into the proximity of the right-of-way. For example, vegetation used to stabilize slopes and soils may attract wildlife (e.g. clover planted along the railway and highway). Salt and abrasives may attract ungulates and birds. Highway and railway accidents can create unnatural concentrations of food which attract wildlife to the dangerous roadside area (e.g. ruptured grain cars, cattle cars). And lastly, the roads may become wildlife travel corridors, especially during times of heavy snowfall.

Highway and railway collisions with small mammals and birds are generally poorly documented (Woods and Harris 1989). A notable exception is the known mortality of pine siskins on the TCH within the Columbia Mountains invasion winters (Van Tighem and Gyug 1984). At these times, thousands of birds may be attracted the road surface by salt and sand and hundreds may be killed by a single passing vehicle.

Several mitigations have been attempted to reduce wildlife collisions along the TCC. They include fencing, public information, reduced speeds, vegetation management, and accident clean-ups. Of these, fencing has proven to be effective in the low snowfall ungulate ranges on the eastern side of the corridor. Most of the other wildlife collision issues within the TCC remain unresolved (Woods and Harris 1989, Woods 1990).

5). Public Safety
Wherever there is a large mammal road-kill wildlife problem, there is a public safety problem. In the Canadian Cordillera, there are numerous cases of vehicle damage and human injury related to either collisions with wildlife, or driver efforts to avoid collisions with wildlife. By contrast, rail-kills are rarely implicated in either human injury or train damage.

Summary and Recommendations
1. In Western Canada, the primary west-east transportation corridor intersects the northwest-southeast trending Canadian Cordillera . This presents both a formidable challenge to highway and railway construction and a high potential for environmental impact on wildlife.
2. Along the TCC through the Rocky and Columbia Mountains, biodiversity and winter range values are highest on the lands best suited for highway and railway construction. There is severe competition for space which is cumulative with other human uses of the landscape. Highway and railway designs which minimize right-of-way width, vegetation manipulation, burrow pits, and equipment maintenance areas would help reduce direct habitat loss.
3. At the landscape scale, environmental conflicts between the TCC and wildlife are not uniform. Small scale environmental analyses driven by individual construction projects may fail to identify the significant issues at the ecological scale. This suggests the need for a strategic, multi-jurisdictional approach to identify, rank, and address wildlife conflicts.
4. No formal or informal mechanism of inter-agency cooperation along the TCC currently exists. Given the complexity of wildlife-transportation issues and potential costs of solutions within the TCC, new funding mechanisms and partnerships are required. For example, automobile insurance companies would benefit from decreased road-kill accidents and therefore may be willing to invest in solutions. Right-of-way vegetation management techniques may be interchangeable between the railway and highway. A TCC scale (landscape level) inter-agency committee would facilitate these forms of cooperation and information sharing.
5. Wildlife-transportation issues need to be addressed at both the planning/construction and the

on-going operational levels. Operational practices such as spreading abrasives, road surface de-icing, and accident clean-up may have as much environmental impact as route alignment and construction methods.
6. Given the complexity of the landscape and the area's species richness, mitigation of railway and highway impacts needs to address the range of species and issues (e.g. road-kills versus fragmentation). The solution to one problem (wildlife fencing) may well create another problem (fracture zones).
7. The close proximity of the railway and highway to each other and to other linear features (human settlement, watercourses) will make the analysis of environmental impacts and mitigation successes difficult. This suggests a coordinated mitigation program throughout the TCC within an adaptive management framework (trial and evaluation).

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