Managing Environmental Impacts of Linear Corridors and Infrastructure

November 7–8, 2007
Revelstoke, British Columbia
Canada

Columbia Mountains Institute of Applied Ecology

Print or CD copies of this document are available at cost plus shipping from the Columbia Mountains Institute of Applied Ecology.

This document is available as a free PDF download from the web site of the Columbia Mountains Institute, at *www.cmiae.org* in the “Past Events” section.

Pages have been left blank intentionally to allow for correct pagination when this document is printed.

Columbia Mountains Institute of Applied Ecology
Box 2568, Revelstoke, British Columbia, Canada V0E 2S0
Phone: 250-837-9311 Fax: 250-837-9311
Email: office@cmiae.org
Web site: www.cmiae.org

Table of Contents

Acknowledgements

This conference was hosted by the
Columbia Mountains Institute of Applied Ecology

The CMI is proud to work with these agencies, which contributed financial or in-kind assistance in support of this conference:

- **British Columbia Ministry of Transportation**
- **Canadian Pacific Railway**
- **Community Initiatives Program of the Columbia Basin Trust**
- **CN**
- **Columbia Basin Trust**
- **Dillon Consulting Limited**
- **Parks Canada**
- **Quantum Emergency Response**
- **The Land Conservancy of British Columbia**

Thanks also to our speakers and the people who brought posters and displays. We are grateful for your willingness to share your expertise with us.

The members of the organizing committee were: Tony Clevenger, Parks Canada; Chris Dane, Dillon Consulting Limited; Luanne Patterson, CN; Susan Hall, Parks Canada; Brent Persello, British Columbia Ministry of Transportation; and David Spata, Canadian Pacific Railway. Jackie Morris of the Columbia Mountains Institute provided guidance and administrative support for the conference.

Special thanks go to our volunteer Benjamin Dorsey from Montana State University. His willingness and ability to run the conference computer, and cue up the PowerPoint presentations was especially appreciated.

Our presenters and participants travelled from various communities in British Columbia, Alberta, and Montana. We are grateful for their participation and for the support of their agencies in sending them to our conference.

Conference Description

This conference was the sixth in a series of conferences hosted by the Columbia Mountains Institute to address issues related to environmental management of highways and railways. This year the conference theme was expanded to include all types of linear corridors: railways, highways, pipelines, transmission lines, and seismic lines. The following topics were addressed:

- Update on regulatory requirements and standards for water
- Corridors and wildlife—reducing mortality, improving permeability
- Right-of-way management—vegetation, etc.
- Project planning and management—case studies, cumulative impacts
- Emergency response: prevention, planning, and preparedness

Presenters and posters were solicited through a call for papers, augmented by a few talks that the organizing committee thought were central to the success of the event. The summary of comments on the evaluation forms, found at the end of this document, provides lots of suggestions for future topics.

About 135 people attended the conference. Participants were multidisciplinary, and included staff from various government offices, resource managers, public interest groups, consulting biologists, protected areas staff, and academia. A senior science class from Revelstoke Secondary School attended part of the conference. The Columbia Basin Trust, through the Community Initiatives fund, kindly subsidized registration fees for the Revelstoke students.

The summaries of presentations in this document were provided by the speakers.
Aside from small edits to create consistency in layout and style,
the text appears as submitted by the speakers.

The information presented in this document has not been peer reviewed.

About the Columbia Mountains Institute of Applied Ecology
www.cmiae.org

The Columbia Mountains Institute of Applied Ecology (CMI) is a non-profit society based in Revelstoke, British Columbia. The CMI is known for hosting balanced, science-driven events that bring together managers, researchers, educators, and natural resource practitioners from across southeastern British Columbia. CMI members include resource managers, consultants, government staff, public interest groups, and academics, who share an interest in improving the management of ecosystems in southeastern British Columbia. Our web site offers many resources, including conference summaries for all of our past events.

Conference Agenda

Wednesday, November 7, 2007

8:30 a.m.	**Welcome** on behalf of the Columbia Mountains Institute of Applied Ecology by Jackie Morris, CMI Executive Director. **Welcome** on behalf of the City of Revelstoke by Councillor Nelli Richardson.

Session Chair: Tony Clevenger, Parks Canada and Western Transportation Institute

8:45 a.m.	**The Water Act: Provincial Water Legislation, what you need to know,** Kristen Murphy, British Columbia Ministry of Environment
9:05 a.m.	**Approaches to mitigation and compensation for linear development impacts on fish and fish habitat in southeastern British Columbia: An update,** Brian Ferguson, Fisheries and Oceans Canada
9:30 a.m.	**Mitigating the impacts of animal/vehicle collisions while maintaining permeability on two highway construction projects in British Columbia,** Bill Harper, Kicking Horse Canyon Project and Osiris Consulting
9:55 a.m.	**Road Watch in Crowsnest Pass: Web-based citizen science involvement in wildlife data collection,** Tracy Lee, Miistakis Institute for the Rockies
10:20 a.m.	*Coffee break*
10:40 a.m.	**Banff's highway crossing structures: Past and future development,** Terry McGuire, Parks Canada **Measuring gene flow across the Trans Canada Highway and population-level benefits of road crossing structures for grizzly and black bears in Banff National Park,** Mike Sawaya, Western Transportation Institute
11:15 a.m.	**Wildlife issues related to the reconstruction of Highway 93 on the Flathead Indian Reservation**, Dale Becker, Confederated Salish and Kootenai Tribes
11:45 a.m.	**Introduction** of people who brought posters
12:15 p.m.	*Lunch, provided*

Session Chair: David Spata, Canadian Pacific Railway

1:15 p.m.	**Effective planning in the oil and gas industry,** Susan Patey Ledrew and Catherine Watson, EnCana Corporation
1:45 p.m.	**Effectiveness of above-ground pipeline crossing structures for wildlife movement,** Bridget Dunne, University of Calgary
2:15 p.m.	**Wabamun: A large scale spill response in a prairie lake,** Luanne Patterson, CN
3:00 p.m.	*Coffee break*
3:15 p.m.	**Keeping a project on track: A successful approach to managing environmental issues during new rail construction**, Paul Schaap, Dillon Consulting Limited
3:45 p.m.	**Cumulative environmental effects management,** Barry Wilson, Silvatech Consulting Limited
4:15 p.m.	**Managing unexpected and unpredicted wildlife migrations: The western toad tsunami on the Vancouver Island Inland Highway,** Leonard Sielecki, British Columbia Ministry of Transportation

- Reception at Revelstoke Railway Museum -

Thursday, November 8, 2007

Session Chair: Chris Dane, Dillon Consulting Limited

8:30 a.m.	**Environmental management on the Sea to Sky Highway upgrade project: Lessons learned,** Grant Bruce and Cheryl McQuillan, Hatfield Consultants Partnership
9:00 a.m.	**Environmental issues of arctic winter roads,** Steve Moore, EBA Engineering Consultants Ltd.
9:30 a.m.	**Influence of cutting time on brush response: Implications for herbivory in linear (transportation) corridors,** Roy Rea, University of Northern British Columbia
10:00 a.m.	**Scour protection for pipeline crossings of urban creeks using flexible concrete mats,** Matt Gellis, northwest hydraulic consultants
10:30 a.m.	*Coffee break*
10:45 p.m.	**Canadian Pacific Railway's integrated vegetation management program,** and an update on reducing grain spills, David Spata, Canadian Pacific Railway
11:20 a.m.	**Assessment of change in invasive plant distribution on FortisBC rights-of-way through the Boundary from 1999 to 2007,** Barb Stewart, Stewart Consulting, and Maureen Grainger, FortisBC
11:50 a.m.	**A process to conserve species and communities at risk along rights-of-way**, Gilbert Proulx, Alpha Wildlife Research & Management Ltd
12:20 p.m.	**Wrap-up comments**

Presentations on Wednesday, November 7, 2007

1. The Water Act: What you need to know about Section 9, "Changes in and about a Stream"

Kristen Murphy, Water Stewardship Division, BC Ministry of Environment,
Nelson, British Columbia

The provincial government retains ownership of all waterways and water bodies. The *Water Act* is the primary provincial statute regulating water resources. This includes all streams, rivers, lakes, ponds, sloughs, and groundwater resources. Under Section 9 of the *Water Act*, approval is required for any changes to Crown land on or adjacent to a water source. Kristen Murphy's presentation addressed the process for making an application under Section 9.

Additional information you will need for the Kootenay region (Terms and conditions, Timing windows):
http://wlapwww.gov.bc.ca/kor/wateract/terms_conditions.html

For more information, visit the Water Stewardship Division web site:
http://www.env.gov.bc.ca/wsd/
Choose "Changes in and about a stream"
Scroll down to "Complete application package"

For application forms, visit:
www.frontcounterbc.gov.bc.ca
Choose "Application Forms Library"
Choose "Water Approval and Notification Changes" in the alphabetized list

If you have any questions regarding any of the above, please contact Frontcounter BC at 1-877-855-3222.

2. Approaches to mitigation and compensation for linear development impacts on fish and fish habitat in southeastern British Columbia: An update

Brian Ferguson, Fisheries and Oceans Canada
fergusonbr@pac.dfo-mpo.gc.ca

No summary provided.

3. Mitigating the impacts of animal/vehicle collisions while maintaining permeability on two highway construction projects in British Columbia

Bill Harper, Kicking Horse Canyon Project and Osiris Consulting, Victoria, British Columbia
bill.harper@shaw.ca

Animal/vehicle collisions are becoming an increasing problem on modern highways with faster design speeds. The frequency of animal/vehicle collisions is primarily a function of four factors:

1. traffic volume,
2. traffic speed,
3. pattern of traffic flow, and
4. the abundance and distribution of animals.

Upgrading a highway to four lanes will increase average traffic speed and reduce vehicle “platooning,” thus increasing the number of lead vehicles that are at greatest risk of striking animals. Animal/vehicle collisions can increase on the order of 2.5 times over baseline when two lane highways are upgraded to four lanes and mitigation measures have not been used (Woods 1988, Dodd *et al.* 2005). The large reduction in vehicle “platooning” on four lane highways is suggested as one of the primary causes of this level of increase in animal/vehicle collisions.

The amount of vehicle damage and risk of human injury is a function of the vehicle speed, and the mass and height of the animals struck. Heavy, tall animals such as elk and moose are more dangerous to vehicles and their occupants compared to smaller species such as deer and bighorn sheep. The most effective way to reduce animal/vehicle collisions in areas with high wildlife concentrations is to prevent animals from accessing the right-of-way through exclusion fencing (Clevenger *et al.* 2001).

The 82-km-long Okanagan Connector is a four lane, divided freeway constructed in the late 1980s with a system of wildlife exclusion fencing (including 22 crossing structures and 277 one-way escape gates) that has been 97% effective in preventing animal/vehicle collisions. A 2005 audit of this system indicated most of the crossing structures were functioning as intended, but problems were identified with structures that are shared with cattle or in areas with high levels of human disturbance.

The Kicking Horse Canyon Project is twinning 26 km of the Trans Canada Highway between Golden and Yoho National Park (Kicking Horse Canyon Project 2007). Data on roadkill pickups through the Wildlife Accident Reporting System estimated animal/vehicle collision rates ranging from 0.2 to 5.7 per km per year (mostly deer and elk), and RCMP records show wild animals were more likely than any other factor to contribute to reported accidents (Harper 2007). To improve public safety and conserve wildlife resources, mitigation measures for reducing animal/vehicle collisions are being planned at the east and west segments of the project where animal/vehicle collisions are highest. Wildlife fencing, crossing structures (both underpasses and overpasses), ungulate guards, one-way escape gates, and one-way earthen escape ramps (Hammer 2001) are part of the mitigation measures being considered.

References

Clevenger, A.P., B. Chruszcz, and K.E. Gunson. 2001. Highway mitigation fencing reduces wildlife-vehicle collisions. Wildlife Society Bulletin 29:646–653.

Dodd, N.L., J.W. Gagnon, S. Boe, and R.E. Schweinsburg. 2005. Characteristics of elk-vehicle collisions and comparison to GPS-determined crossing patterns. *In* Proceedings of the 2005 International Conference on Ecology and Transportation. C.L. Irwin *et al.*(editors). Center for Transportation and the Environment, North Carolina State University, Raleigh, NC. pp. 461–477. [Available at http://www.icoet.net/ICOET_2005/05proceedings_directory.asp, accessed Dec 18, 2006].

Hammer, M.L. 2001. Effectiveness of earthen escape ramps in reducing big game mortality in Utah. M.Sc. Thesis, Utah State University, Logan, Utah. [Available at http://www.cnr.usu.edu/faculty/jbissonette/documents/MHammerthesis.pdf, accessed Nov 30, 2006].

Harper, W.L. 2007. Preliminary design considerations for wildlife exclusion fencing and crossing structures–Phase 3 East. Unpublished Kicking Horse Canyon Project report to the BC Ministry of Transportation, Golden, BC.

Kicking Horse Canyon Project 2007. Project fact sheet—fall 2007. BC Ministry of Transportation and Transport Canada, Golden, BC. [Available at www.kickinghorsecanyon.ca, accessed Nov 10, 2007].

Woods, J.G. 1988. Effectiveness of fences and underpasses on the Trans Canada Highway and their impact on ungulate populations project. Second Progress Report (Sep 1985 to May 1988) Banff National Park, Canadian Parks Service, Environment Canada, Banff, AB.

For more information about the Kicking Horse Canyon project
view the project's web site at:

www.kickinghorsecanyon.ca

4. Road Watch in Crowsnest Pass: Web-based citizen involvement in wildlife data collection

Tracy Lee, Miistakis Institute for the Rockies
tracy@rockies.ca
Michael Quinn, University of Calgary, Calgary, Alberta
Danah Duke, Miistakis Institute for the Rockies

Abstract

"Road Watch in the Pass" is a community-based monitoring project designed to identify wildlife movement patterns along a major transportation corridor in the Canadian Rocky Mountains. Road Watch represents a unique approach to data collection in that it engages citizen to enter their wildlife observations along Highway 3 through an on-line interactive mapping tool. Since implementation in 2004, the project has documented many successes and challenges. Road Watch has proven to be a successful model for engaging the community and generating a large dataset of wildlife observations along the highway. Spatial analysis of the results has demonstrated the value of the data in identifying high observation zones along Highway 3. To date, Road Watch data and results have been used in two conservation planning processes and by a local citizen to build support for protecting a movement corridor. One of the challenges is keeping volunteers motivated; participation tends to ebb and flow resulting in data fragmentation (periods when overall entries are low). Additionally, the current methodology of data collection is not systematic and participants have identified areas along Highway 3 that are under-represented. Road Watch is a community project that is managed adaptively to address these challenges and concerns as they arise. Project direction is set during meetings between participants, a local project coordinator, and Miistakis Institute researchers.

Background

The Crowsnest Pass is situated in a rare east-west valley through the Canadian Rocky Mountains in southwestern Alberta. Within this valley, there are four settlement areas, and a two lane highway and a railway that both run the full length of the corridor. The full complement of large mammals occurs in this area and they must traverse across Highway 3, a major transportation route, supporting over 6000 vehicles/day. Wildlife mortality caused by collisions with vehicles on Highway 3 is recognized as both a human safety concern and a wildlife conservation issue. The valley is also a high priority for conservation planning because it is a connector for regional-scale wildlife movement. Carnivore biologists have identified Highway 3 as a potential barrier to wildlife movement through the region. This has implications for maintaining the integrity of wildlife populations between northern Montana, southern Canada, and central Canada. The impact may be exacerbated due to a proposed highway expansion, from two to four lanes, and realignment by Alberta Infrastructure and Transportation. For the development of effective mitigation strategies to reduce the negative effects of Highway 3 on wildlife, decision makers require access to timely and accurate information on wildlife temporal and spatial patterns through the region. Information pertaining to wildlife movement was identified as an important information gap in the Crowsnest Pass. To address this data gap, Miistakis, a non-profit research institute affiliated with the University of Calgary, together with the local community, developed and established Road Watch in the Pass.

<u>Road Watch Development</u>

Road Watch in the Pass is a citizen science project that was developed with two key goals:

1. To address the information gap on wildlife movement by producing a large dataset on crossing and collision locations
2. To foster a learning environment in the Crowsnest Pass to encourage a community of citizens concerned with wildlife movement issues in the region

The concept of Road Watch evolved out of a conservation planning process that involved local and provincial governments, industry, conservation groups, and local citizens. Wildlife movement and collision zones were identified as a data gap that could be addressed by engaging local citizens, as numerous individuals are knowledgeable about wildlife in the region. The notion of engaging citizens in research is a concept that has been explored widely in other disciplines and fields of ecology. Research has demonstrated that experiential learning associated with involvement in community monitoring projects results in building social capacity to address conservation issues.

Road Watch was developed by Miistakis in collaboration with a local project coordinator and an informal advisory group. The project is unique in that it uses a web-based GIS for data collection and dissemination of results. The web-based mapping tool enables citizens to record their wildlife observations along Highway 3. The tool has proven to be an efficient way to collect, store, and disseminate information. Participants sign in with a username to enter observations, then they can spatially view their personal contribution to Road Watch or the entire Road Watch database. The project web site acts as the communication hub for Road Watch participants and includes a tutorial on how to enter observations, a wildlife tutorial on species identification, and a page to provide participants with regular information about the project. In additional, regular opportunities are provided through meetings, community action events, or demonstrations, for participants to meet with Road Watch staff to discuss project methods, direction, or concerns.

<u>Road Watch successes</u>

Road Watch is a successful model for engaging volunteers to participate in a community-based monitoring project and to generate a large dataset of wildlife observations along Highway 3. The project has engaged 70 users who have entered over 3000 wildlife observations. The dataset represents most of the large mammals occurring in the region, including observations of grizzly bear, black bear, lynx, and cougar, although the majority of observations are for deer. The raw data was analyzed to produce a series of maps highlighting high crossing zones as well as areas with a high number of observations for moose, elk, and bighorn sheep. Information is disseminated back to participants through regularly produced participant updates that are emailed to participants, displayed on the web site, and often printed in the local media.

One of the best measures of success has been the use of Road Watch data in two planning processes and by a local citizen to build support for protecting a movement corridor across Highway 3 from development pressure. Additionally, Road Watch presented preliminary results to Alberta Infrastructure and Transportation and the consulting companies working on the Highway 3 upgrade functional study. We received a commitment that the data will be considered when addressing wildlife conservation issues along Highway 3.

Road Watch challenges

Road Watch has faced challenges, such as engaging new volunteers and keeping existing volunteers motivated. Although we have 65 users and 70% have entered observations more than once, 74% of the records are from six key individuals who regularly enter their observations. There are periods when data entry is low, likely due to volunteers taking a break from the project. This results in data fragmentation and decreases the ability of the results to represent temporal and spatial patterns of wildlife along Highway 3. Additionally, current data collection methods are not systematic, as they are based on opportunistic observations. Participants do not necessarily drive the entire length of the study area, nor do they record when they did not observe wildlife.

To address these issues, Road Watch is working with Kylie Paul, a graduate student from the University of Montana, who has designed a wildlife systematic driving survey. This dataset will be compared to the Road Watch data to assess its ability to accurately reflect spatial and temporal movement patterns. Additionally, communication has been initiated with Road Watch participants to increase the scientific rigor of the dataset by establishing a two-pronged approach to data collection. We plan to maintain the existing data collection protocols but also assign key participants to segments of Highway 3 where they would be responsible for driving systematic surveys. The development and design of a new data collection approach will be explored during the next community meeting.

Conclusion

In summary, Road Watch in the Pass is a successful model for engaging citizens in a community-based monitoring project. Road Watch has generated a large dataset of wildlife observations in the pass that has enabled us to explore high collision/crossing zones for many of the large mammal species in the region. Preliminary results have demonstrated the value of the data in identifying wildlife crossing zones within the Pass. Additionally, Road Watch data has been used as one of the data sources in two conservation planning processes and by a local citizen interested in protecting a movement corridor within the study area.

Although the project has proven successful on many fronts, the second goal of fostering a learning environment has not been explored. In the near future we plan to survey participants to get a better understanding of their personal experience from participating in the Road Watch project. In other words, does Road Watch foster a learning environment where dialogue exchange is encouraged? Does involvement in a community-based monitoring project engage citizens to address wildlife conservation issues in the pass? Answers to these questions will help guide Road Watch direction. In addition, direction is set regularly through communication between Miistakis researchers and participants. Overall the Road Watch project demonstrates the value of engaging citizens in research related to road ecology, but it also highlights the importance of collaboration and adaptive management to address the challenges of working with volunteers.

5. Banff's highway crossing structures: Past and future development

Terry McGuire, Parks Canada, Banff, Alberta
terry.mcguire@pc.gc.ca

Terry McGuire's duties include responsibility for highway operations, maintenance, and recapitalization within the Canadian Rocky Mountain Parks of Canada. Terry has been the Project Director for the Trans Canada Highway Twinning work within Banff National Park for the past 15 years. His presentation provided a brief synopsis about previous phases of TCH Twinning in Banff and its associated wildlife mitigations. Following the presentation by Mike Sawaya on the success of these mitigations, he reviewed mitigation measures being implemented in the current phase of twinning the Trans Canada Highway.

6. Measuring gene flow across the Trans Canada Highway and population-level benefits of road crossing structures for grizzly and black bears in Banff National Park

Michael A. Sawaya, Western Transportation Institute, Montana State University
mike.sawaya@pc.gc.ca
Anthony Clevenger, Western Transportation Institute, Montana State University and Parks Canada, Banff
Steven T. Kalinowski, Western Transportation Institute, Montana State University

The purpose of the Trans Canada Highway Bear DNA Project is to evaluate the demographic and genetic benefits of wildlife crossing structures for grizzly and black bear populations in Banff National Park, Alberta.

The section of the Trans Canada Highway (TCH) that bisects Banff National Park, Alberta supports the highest volume of traffic of any road in the North American national park system and is recognized as an important stressor to the ecological integrity of the central Canadian Rockies. Wide-ranging carnivores, such as grizzly (*Ursus arctos*) and black bears (*U. americanus*), are particularly vulnerable to road mortality and habitat fragmentation caused by roads. In order to mitigate these negative impacts on wildlife, 24 crossing structures have been constructed across the TCH. More than a decade of intensive study has shown that the wildlife crossings reduce mortality and maintain wildlife movements. Track pads have recorded both bear species crossing the TCH on 1389 occasions, but the number of different individuals using the crossings, their gender, and the demographic and genetic benefits of the crossings for populations remain unknown.

In 2004 and 2005, a pilot study was conducted at two of the crossing structures to evaluate the feasibility of using a barbed wire hair sampling system to determine the number of individual male and female grizzly and black bears passing through the crossings. Based on the results of that pilot study, a three-year research project was initiated in 2006 to evaluate the conservation benefits of wildlife crossing structures for grizzly and black bear populations in the Bow Valley of Banff National Park. The hair sampling system was installed at 22 of 24 of the crossing structures to determine the total number of male and female bears using the crossings, and the populations of grizzly and black bears in the Bow Valley surrounding the TCH were also sampled using a combination of hair snares and rub tree surveys. The genetic information derived from those hair samples will be used to:

- assess the effectiveness of different types of crossing structures,
- estimate the population sizes for both bear species in the Bow Valley,
- calculate the proportion of the population using the crossings, and
- quantify the level of movement and gene flow across the TCH.

This presentation highlights our research objectives and presents some of the preliminary results from the 2006 field season. Eleven grizzly bears (6 males, 5 females) and 11 black bears (7 males, 4 females) were identified from the samples collected at the crossing structures, and 40 black bears (16 males, 24 females) and sixty-three grizzlies (37 males, 26 females) were identified from the samples collected from the hair snares and rub trees (overlap exists between hair collection methods). These data will be analyzed using a combination of population viability analysis and landscape genetics approaches to assess the demographic and genetic benefits of wildlife crossings for bear populations in the Bow Valley. Wildlife crossings are gaining recognition as an effective method for reducing road-caused mortality and maintaining wildlife movement, but the conservation benefits of crossings for bears at the population level has yet to be evaluated.

7. *Wildlife issues related to the reconstruction of Highway 93 on the Flathead Indian Reservation*

Dale Becker, Confederated Salish and Kootenai Tribes, Pablo, Montana
daleb@cskt.org

Abstract

Planning for the reconstruction of US Highway 93 through the Flathead Indian Reservation included substantial consideration of wildlife and wildlife habitat issues. After years of negotiation, the Confederated Salish and Kootenai Tribes, the Montana Department of Transportation, and the Federal Highways Administration reached agreement on most aspects of the project in 2000. Still to be finalized are reconstruction plans for a 19 km portion of the highway that passes through the Ninepipe-Kicking Horse wetland complex. The Memorandum of Agreement between the three governments includes provision for the construction of 42 wildlife crossing structures and other design features to enhance wildlife habitat features and maintain habitat linkages. In addition, wetland habitat mitigation will focus on avoiding wetland habitat, to the extent possible, and acquisition, restoration, and ongoing management of wetland habitat. The logic included in planning for these design features and the details of the reconstruction plans, as they apply to wildlife and habitat concerns, was presented, as were details of the designs for wildlife crossings and other mitigation plans. In an effort to assess the effectiveness of the wildlife crossing designs, pre-construction monitoring of wildlife use at several crossing sites was monitored. Post-construction monitoring at those sites will allow for comparisons between pre-and post-construction use by wildlife.

Introduction

The ancestors of the current members of the Confederated Salish and Kootenai Tribes have lived in what is today the northern intermountain region for thousands of years. The day-to-day existence of these people was tied to the natural resources of this area (Fahey 1974). The abundant wildlife resources provided for subsistence, and many of the cultural and spiritual needs of the people. As a result, their lives were intertwined with those of the animals native to the area, and their activities, movements, lifestyles, and well-being depended upon the animals. Thus, wildlife resources play dual roles, being considered as both natural and cultural resources by the Tribes. Even though the Tribes make the Flathead Indian Reservation their homeland today, they also continue to care deeply about their aboriginal territory and the animal inhabitants there. Tribal members also rely heavily upon the wildlife resources, both on and off of the Flathead Indian Reservation.

The proposal for the reconstruction of a 97 km portion of US Highway 93 located on the Flathead Indian Reservation resulted in the consideration of a wide variety of issues and concerns related to wildlife and wildlife habitat on the Reservation (Becker 1996, Federal Highway Administration and the Montana Department of Transportation 1995). Various alignments proposed for the highway right-of-way passed through a diverse array of habitats—and raised numerous concerns about the potential adverse impacts related to direct mortality of wildlife, habitat loss and degradation, habitat fragmentation, and cultural erosion. The Tribes'cultural perspective had a direct link to the wildlife issues because of the strong role that wildlife has always played in tribal culture.

The Flathead Indian Reservation

The Flathead Indian Reservation was created as a permanent homeland for the Salish, Kootenai, and Pend d'Oreille peoples under the terms of the Treaty of the Hellgate of 1855. Under that treaty, the Tribes relinquished ownership to most of Montana lying west of the Continental Divide, as well as portions of eastern Idaho and Washington, in return for exclusive use of the lands encompassed within the reservation boundaries. Later, allotment of Indian lands, government withdrawals, and finally opening of the Reservation to settlement resulted in substantial permanent changes to the environment of the Reservation. Those changes continue today, and they relate directly to the project discussed here.

The Flathead Indian Reservation encompasses approximately 505 875 ha within its exterior boundaries. The land base includes a wide variety of habitats ranging from semi-arid shrub-grasslands to diverse wetlands and riparian habitats to subalpine habitats. It consists of four distinct valley complexes that are bounded by mountains. The primary subject of this discussion is the eastern side of the Reservation, where the existing and proposed alignments of US Highway 93 are located. Dominant features are the Mission Mountain Range, which forms the eastern boundary of the Reservation with summits up to 2994 m above sea level, and the Rattlesnake Range to the south.

The dominant land use of valleys to the west of these mountains is agriculture, predominantly irrigated and dryland farming and livestock production. A significant geological feature is the extensive wetland complex centred at Ninepipe and Kicking Horse Reservoirs. Several small rivers and streams drain into the Flathead River, which bisects the Reservation.

The Reservation provides a diverse array of habitats for a large number of wildlife species. This fauna includes 309 species of birds, 66 species of mammals, 9 species of amphibians, and 9 species of reptiles (CKST Tribal Wildlife Management Program, Unpublished data).

Direct wildlife mortality issues

Wildlife use the entire US Highway 93 corridor on the Reservation, as indicated by observations and by the number of road-killed deer, bear, turtles, small mammals, non-game and game birds, and other species that one observes within the right-of-way each day. There are, however, a number of areas that receive higher levels of wildlife use than others and exhibit a corresponding increase in vehicle-related wildlife mortality. To analyze the severity of mortality, logbooks of Tribal Conservation Officers and Montana Department of Transportation maintenance personnel were reviewed. In addition, incidental observations of Tribal Wildlife Management Program staff members were included. The input of Tribal Elders and other local people was also sought.

These efforts led to the preparation of a map of the entire highway route, which showed areas that exhibited high and repeated wildlife mortality problems. An analysis of habitat features, such as vegetative cover and hiding cover, indicated where animals might be expected to attempt to cross the highway. For example, at one section of the highway (the Evaro area), this information, together with winter tracking data, was used to identify locations most likely to be used as wildlife crossings. In addition, remote-sensing cameras placed near wildlife trails provided added insight about the numbers and species of animals using the trails. The cameras worked well for larger species such as deer and bears, but were less useful for smaller species (Becker *et al.* 1993). Collectively, the information provided by these methodologies assisted in indicating where animal use was occurring and the degree of that use.

Big game mortality was somewhat random, but tended to be linked to the habitat features adjacent to the right-of-way. Most deer and bear mortality was linked to adjacent riparian areas or other forested cover types, as one might expect. A few deer were killed in open agricultural habitats, but again, this mortality generally occurred near adjacent cover.

The Flathead Indian Reservation hosts four terrestrial species listed as Endangered or Threatened by the US Fish and Wildlife Service: the grizzly bear (*Ursus arctos horribilis*); the northern gray wolf (*Canis lupus*); the bald eagle (*Haliaeetus leucocephalus*); and the Canada lynx (*Lynx canadensis*). At the time of the onset of the environmental analysis for this project, the peregrine falcon (*Falco peregrinus*) was also listed. Additionally, during the period since the analysis began, the bull trout (*Salvelinus confluentus*) has been listed.

Although Highway 93 passes through habitats used by each of these species, the only mortalities of a listed species known were three sub-adult female grizzly bears, killed by vehicles in the Ninepipe Reservoir area in 1999, 2001, and 2003. Other mortalities of listed species may have occurred, but no verified records of these exist.

The Ninepipe-Kicking Horse Wetland Complex exhibited a high level of wildlife mortality, with nearly every species represented as a road-kill at least once. Of particular significance was the high mortality rate for western painted turtles (*Chrysemys picta*) each summer. Conservative estimates of the mortality of this species were estimated at a minimum of 300 per year, based upon direct counts of road-killed animals. Also significant was the number of certain avian species, particularly passerines, waterfowl, shorebirds, and raptors, which inhabit the natural and borrow pit wetland habitats adjacent to the highway. Several species of small to medium-sized mammals were also regularly killed by traffic on the highway near this wetland complex. The segment of the planned reconstruction project in this area is still undergoing study. Presently, the Supplemental Environmental Impact Statement is being finalized, and this will clear the way for planning for construction in this area.

<u>Wildlife habitat issues</u>

Wildlife habitat issues were grouped into two categories—habitat loss or degradation, and habitat fragmentation. Habitat loss was anticipated within, and immediately adjacent to, the right-of-way in places where construction activities are planned. Habitat degradation is more subtle and is harder to document. The fact that the highway will largely follow the existing right-of-way will limit habitat loss to some degree, although wider rights-of-way will result in some additional loss of adjacent habitats. With regard to wetland habitats, the Tribes' Wetland Conservation Plan (Confederated Salish and Kootenai Tribes 2000) requires that impacts be avoided whenever possible. If these impacts are unavoidable, mitigation will be undertaken to replace or restore a given amount of wetland habitat.

Habitat fragmentation has already occurred because of the highway's present configuration and alignment. The amount of traffic on the highway and the lack of any substantial existing wildlife crossing structures results in the bisection of adjacent habitats. This fragmentation is indicated by the fact that wildlife are being killed on the highway as they attempt to cross the right-of-way.

<u>Mitigation for wildlife mortality</u>

As discussed above, the sites of documented wildlife mortality, especially multiple recurring mortalities, indicate the location of many wildlife passage problems. To alleviate these problems to the greatest extent possible, a number of different design features are being included in the reconstruction plans for Highway 93. Collectively, these design features will be used to both decrease the amount of wildlife mortality caused by traffic on the highway, and to mitigate for the habitat loss, degradation, and fragmentation that currently exists.

Crossing structures

The plans for the reconstruction of the highway include construction of 42 metal pipe culverts or concrete box culverts designed to facilitate wildlife crossing the highway. Twenty-three of these structures will be culverts approximately 3.7 m x 6.5 m in size.

Ten culverts approximately 1.3 m x 2 m are also anticipated for inclusion. Seven bridges, ranging from 12 m to 110 m in length and a minimum 3.7 m of height clearance to facilitate wildlife passage and re-vegetation, will be constructed across the larger rivers and streams that bisect the highway. Finally, one over-crossing structure with a width of 46 m to 61 m will also be constructed. These plans were developed under the Memorandum of Agreement between the Tribes, the State of Montana, and the federal government (Montana Department of Transportation *et al.* 2000). Each of these structures will be designed and placed to ensure the maximum amount of wildlife passage across the highway right-of-way by a variety of the local species. Many of the concepts for these structures and those discussed below were originally developed elsewhere, but the specific locations and local concerns, in addition to more recent ideas and data from similar structures, will likely dictate some changes in design features.

Drift fencing

The plans for mitigation of wildlife mortality also includes construction of 2.6 m high wire fencing with wing fencing at terminal locations to accompany the crossing structures described above. The fencing will be placed to encourage wildlife movement toward the crossing structures. In areas where burrowing or digging animals are a concern, extension on the lower sides of the fencing will be added and buried to discourage digging animals from breaching the fencing.

Signing

Informative signing will take two forms: signs to warn motorists of potential wildlife hazards and signs to inform motorists of wildlife crossings. Warning signs will alert motorists about potential wildlife hazards in the highway right-of-way. Informative signing will assist motorists in learning about the presence of wildlife crossing structures, as well as the rationale for their construction.

Wildlife escape structures

Regardless of the presence of wildlife crossing structures, it is inevitable that wildlife will occasionally breach the fencing and enter the right-of-way. To deal with such situations, wildlife fencing will be constructed to assist wildlife in moving away from the highway toward jump-out structures terminating in 2.6 m vertical walls that will allow them to exit through the fencing and leave the right-of-way. These types of structures have been installed elsewhere and have been used successfully by big game animals.

Monitoring and research

Because of the number and types of wildlife crossing structures anticipated for this project and the need to evaluate the utility and degree of use of the various designs, an extensive monitoring program is being developed. Several opportunities for research to assess the use of the structures by wildlife and their impact upon wildlife use will be possible. These efforts will be co-ordinated by representatives of the three governments, academic institutions, and other entities to achieve the greatest degree of knowledge possible.

Mitigation for habitat loss or degradation

The primary habitat mitigation identified in the proposals for the reconstruction of Highway 93 has been associated with anticipated loses of wetland habitat due to construction activities. The Confederated Salish and Kootenai Tribes' Wetlands Conservation Plan (Confederated Salish and Kootenai Tribes 2000) outlines an approach that preserves and mitigates for adverse impacts to wetland and riparian habitats. This plan established a goal of halting the loss of the remaining wetland and riparian habitats and the decline in wetland and riparian quality on the Reservation. The long-term goal of the plan is to increase the acreage of wetlands and riparian areas, and improve the quality of the resource. It outlines a strategy for conservation and mitigation of adverse impacts upon wetland and riparian habitats, as well as procedures to address these issues.

The three governments developed a unique wetland reserve project to appropriately mitigate for the anticipated wetland impacts. Under the directives of this project, the Tribes acquired a tract of drained and degraded wetland habitat; restored the habitat; and then sold the wetland mitigation credits to the Montana Department of Transportation to assist the agency in meeting its wetland mitigation obligations under the Federal Clean Water Act and US Army Corps of Engineers regulations for wetland mitigation.

Habitat fragmentation is a constant concern on the Flathead Indian Reservation, and fragmentation due to land uses, highway and road construction, and subdivision activities are major issues (Confederated Salish and Kootenai Tribes 1994, 1996). The Tribes' concerns have a direct bearing on the Highway 93 reconstruction project. As a result, the Tribes use a variety of policies and planning tools on Tribal lands to manage human growth pressures, habitat degradation issues, highway construction impacts, and subdivision pressures. Because much of the Reservation consists of non-Tribal lands, the Tribes also work closely with other appropriate governmental agencies at the local, county, state, and federal levels in an attempt to decrease the adverse impacts of some of these activities upon Tribal resources.

Conclusions

The planning effort for the reconstruction of US Highway 93 through the Flathead Indian Reservation has been a long and arduous task that continues toward resolution. Instead of merely paving a sterile right-of-way over the shortest route between two points and allowing the impacts to occur, it now seems both possible and practical to achieve positive outcomes for wildlife and habitat when designing a highway. The insistence of the Tribes that the US Highway 93 Reconstruction Project highway be designed as a safe, environmentally-friendly road will ensure the continuance of wildlife and the habitats they require.

References

Becker, D.M. 1996. Wildlife and wildlife habitat impact issues and mitigation options for reconstruction of US Highway 93 on the Flathead Indian Reservation. *In*

G.L.Evink, P. Garrett, D. Ziegler, and J. Berry. Trends in Addressing Transportation Related Wildlife Mortality–Proceedings of the Transportation Related Wildlife Seminar. Florida Department of Transportation, Tallahassee, FL.

Becker, D.M., D.J. Lipscomb, and A.M. Soukkala. 1993. Evaro Corridor wildlife use study and mitigation recommendations. US Highway 93 Reconstruction Project, Final Report. Confederated Salish and Kootenai Tribes Pablo, MT.

Confederated Salish and Kootenai Tribes. 1994. Flathead Indian Reservation Comprehensive Land Use Plan. Confederated Salish and Kootenai Tribes, Pablo, MT.

Confederated Salish and Kootenai Tribes. US Highway 93 Land Use and Growth Study. Confederated Salish and Kootenai Tribes, Pablo, MT.

Confederated Salish and Kootenai Tribes. 2000. Wetlands Conservation Plan for the Flathead Indian Reservation. Confederated Salish and Kootenai Tribes, Pablo, MT.

Fahey, J. 1974. The Flathead Indians. University of Oklahoma Press, Norman, OK.

Federal Highways Administration and the Montana Department of Transportation. 1995. Draft Environmental Impact Statement and Section 4(f) Evaluation. F 5-1(9) 6 US Highway 93, Evaro-Polson, Missoula and Lake Counties, Montana. Montana Department of Transportation, Helena, MT.

Montana Department of Transportation, Federal Highway Administration, and Confederated Salish and Kootenai Tribes. 2000. Memorandum of Agreement. US Highway 93–Evaro to Polson. Skillings-Connolly Engineering, Missoula, MT.

8. Effective planning in the oil and gas industry

Susan Patey Ledrew, EnCana Corporation
susan.pateyledrew@encana.com
Catherine Watson, Encana Corporation
catherine.watson@encana.com

Legislative requirements all have some level of influence on oil and gas activities. This paper outlines what EnCana Corporation (EnCana) does to meet the various regulatory requirements for oil and gas activities in southern Alberta. In addition, some of the challenges that face the oil and gas industry while trying to meet these various regulatory requirements will be discussed. Items in this document are based on current EnCana practices and polices. While this paper identifies issues associated with regulatory requirements and development of sweet shallow gas (gas situated in geological formations ranging from 350 to 1000 m deep, and composed of 97% methane with the remainder being nitrogen and water), many of the concerns identified in this document are shared throughout the oil and gas industry, and may be applicable to other different types of development.

One of the overall goals of the current guidelines and regulations of the Alberta provincial government is to minimize the industrial footprint on the prairie landscape. Minimizing disturbance involves reducing the impact of an activity by making its "footprint" on the land smaller. This is accomplished by avoiding sensitive areas completely and by timing the activity for periods when prairie soils, vegetation, and wildlife are less at risk. A number of technologies have evolved that help to reduce industrial footprints. Two examples are no-stripping of lease areas for shallow gas wells and minimizing the width of a pipeline right-of-way through the use of specialized equipment. Minimum disturbance practices were originally implemented by oil and gas companies to reduce known and potential impacts of development activities conducted in native prairie and parkland landscapes. The last decade has seen a gradual progression to integrate the principles of minimal disturbance into the whole lifecycle of a project. The concept of minimal disturbance is also being applied by other industries in a wider variety of landscapes.

It is important to understand that not all companies are created equal. Each of us (the oil and gas industry, various regulators, stakeholders, and other industries) has their own best practices, their own ways of doing things, and their own expectations when it comes to minimizing an environmental footprint.

EnCana operates throughout Alberta (and other provinces) on provincial and federal lands where both federal and provincial regulations apply to some of their mineral holdings. These regulations can relate to wildlife (migratory birds and species at risk), water (use, crossing, and encroachment), application processes, and general environmental expectations. In order to reconcile all of these expectations in a duly diligent manner, effective planning must be used.

Site selection and effective planning

The following information provides a brief background on how the oil and gas industry chooses a location for development. Many factors dictate where, when, and the type of development that will or will not occur. The type of well (e.g., deep gas vs. shallow gas vs. oil), the method of well construction (including the ability to directionally drill or not), and associated infrastructure will be determined depending upon what type of geological formation the company is targeting.

Described below are the four main parameters development geologists and project engineers use to locate well sites and their associated infrastructure (note that these are usually preliminary locations, since there has to be a starting location/point):

1. Distance from other wells
2. Placement of future wells in the section of land

3. Surface land limitations such as topography, water bodies, species at risk setbacks, and landowner requests
4. Alberta Energy and Utilities Board spacing or holding regulations (e.g., infill drilling and the number of wells per section)

Once preliminary locations are chosen by the development team, a map of the preliminary well locations, pipelines, access routes, and any associated infrastructure is created. A key factor during the planning stage is to consider all phases of a project. Things to consider are:

- Can existing roads be used?
- Can areas of existing disturbance be used?
- Can right-of-way be shared or paralleled?
- How close is the construction to areas of water or areas that may become flooded in wet years?
- How will the site be oriented? How will water flow across the site? Will drainage be maintained?
- Are there potentially sensitive areas including wildlife issues, habitat issues, and historical resources? Can they be avoided, rerouted, or relocated at the planning stage?
- Will timing be an issue? How will the construction schedule be influenced by restrictions due to landowner activities, the presence of wildlife, and various regulatory requirements?
- Can time and money be saved, and regulatory requirements better met, by planning the well site, pipeline, and access road construction together?
- Is there an area with existing disturbance that can be used instead of clearing a new area (e.g., cultivated land versus native prairie or forests)?
- What are the options for construction—is multipad, boring, or directional drill feasible?

Issues such as these are best dealt with early in the planning phase as decisions made at the onset of the planning process have long-term implications. Effective planning can help determine regulatory requirements and allow time for any permits or approvals to be obtained. A company may apply a proactive approach and take the opportunity to hold planning meetings prior to construction to discuss potential mitigation alternatives to minimize or reduce disturbance. This may involve project and development engineers (for facilities, pipelines, and well sites), operations personnel (to discuss implications for operational issues), geologists, environmental specialists, and construction personnel.

Mitigation and minimal disturbance methods

To reduce overall disturbance and minimize cumulative effects, companies may decide to place several wells on multipads using existing leases and existing access routes. By minimizing the amount of additional or new surface disturbance, overall habitat loss is decreased and potential impacts to critical habitat and sensitive areas can be avoided. It is interesting to note that there are some landowners who don't want companies to use existing leases (multipads) because the wells are not considered new sites and, thus, landowners do not receive additional revenue. However, multipads may not always be an option as directional drilling may cause interference in other geological zones and may be limited by proximity to existing vertical wells. There may also be other technological limitations of this drilling practice depending upon the targeted geological formation.

At the pre-construction and planning phase, minimal disturbance mitigation may also include discussions with the project team around the following:

- Use of no-strip for lease areas for shallow gas wells.
- Use of multipads and other directional drilling opportunities (including directional boring of water crossings or coulees).
- Use of existing access (accounting for how often the well is accessed, and what type of ongoing maintenance and operation that facility might need in order to design the appropriate access).
- Construction of deep gas wells that minimize the amount of soil stripping. Note, however, that there are safety issues relating to oil well leases, and rig set-up and physical structure for safety and regulatory requirements must be met.
- Use of rig matting to protect land while drilling or for access.

It has been demonstrated many times over that this process substantially reduces costs, particularly when it comes to eliminating redundancy (e.g., multiple surveys for the same area or constructing two different access routes instead of one) and allows for a more efficient and collaborative process.

Once the locations are chosen, a Surface Landman will visit the landowner. Typically in these meetings, a project overview is discussed with the landowner. This is the best opportunity for the landowner to share information and ask questions. The landowner often knows what the issues are on their land, especially when it comes to environmental, wildlife and livestock concerns, operating procedures and practices, or future planning on their land.

<u>Field (site) assessment</u>

Once planning is complete, a site visit is conducted where required. Visits are done by a team that may consist of someone from construction, wildlife experts, or other specialists (e.g., botanists or archeologists, depending upon what has been identified in the preliminary database and literature searches, and pre-siting assessments). The team works with survey crews to locate wells, access routes, and pipelines.

Keeping minimal disturbance and reducing the project footprint in mind while balancing regulatory requirements, the appropriate equipment and installation methods are tailored to different soil and vegetation types, land use, and other considerations. There may be multiple surveys undertaken depending, for example, upon the time of year, the type of project, the species of concern, the sensitivity of the landowner (access to private lands may not be granted), and timing of construction activities.

Possible mitigation

One method of mitigation that is particularly effective for wildlife and species at risk is to construct the project during the appropriate times where there is minimal impact—for example, in the winter when activities can occur outside of critical wildlife activity periods (e.g., migration or breeding) or when plants are dormant and frozen to minimize damage to root systems. Again, the key is an efficient upfront planning process to determine the ideal time for construction.

As discussed above, there are new (and evolving) technologies being developed to help minimize overall disturbance. EnCana has used coil tubing rig technology for drilling shallow gas well sites. These rigs have hydraulic lifts that can level safely while meeting the Alberta Energy and Utilities Board safety standards and minimizing the amount of area that would have to be levelled or cleared to safely set the rig. Coil tubing rigs typically have quicker drilling times, are lighter in weight, and require no stripping or levelling. The rig can be set up safely resulting in a minimal amount of disturbance. On minimal disturbance drilling sites, timing is the key. Soils must be firm (dry or frozen). Access may need to be watered in dry conditions to control dust and conserve root systems. Drilling operations are suspended during unfavourable conditions.

After the well has been completed, facility and pipeline construction commences. At the same time, pipeline construction ties individual wells into a group system. For shallow gas, facilities construction installs a gas compressor central to a specific gathering system.

Challenges for the oil and gas industry

Landowner concerns
Landowners often express concerns if they are asked by companies about species at risk or about wildlife surveys being conducted on their property. Often, landowners do not want us to report sightings of species at risk to the relevant regulators. The feeling is that if these locations are reported, there may be implications to the landowners in terms of restrictions being imposed on what they can do on their lands. However, if regulators know about a species at risk, this information can actually help the regulators and the species that is at risk. For example, this information can be used by subsequent companies that develop on that particular landowner’s land and thus ensure appropriate mitigation is developed for the species at risk already identified on that parcel of land.

Some landowners prefer oil and gas development to occur in areas that cannot be farmed and that would be considered environmentally sensitive (e.g., adjacent to or in wetlands, treed areas, adjacent to coulees or slopes, and native pasture).

Data quality
Quality of information can be an issue, particularly when it comes to data sharing and data reporting between different government agencies. Often companies are reluctant to

share data between companies. While regulatory bodies do provide information to companies, it is often difficult to get a response in a timely manner depending upon the work load of the regulator (due to a shortage of resources) and the time of year (e.g., staff are most busy during the summer field season). Industry contributes a large amount of data to the data pool such as information on rare plants, wildlife, archaeological and paleontological resources. This information is a very important source of data to share among regulatory bodies and industry.

Access to current, long–term, and accurate data is necessary. It is important to note that the decisions that are made about development locations are only as good as the data that is provided. Information regarding population trends, habitat use, critical habitat, and site fidelity, for example, are needed to make informed decisions when it comes to cumulative effects and appropriate mitigation.

Regulatory challenges
In terms of current legislation and regulatory requirements, clear direction and flexibility must be provided to ensure regulatory compliance both provincially and federally while still providing workable solutions for stakeholders. Solutions must be workable and flexible to meet various stakeholder needs and to address problems of administering regulations in a context of widespread existing, current, and ongoing social and economic considerations. Without clear direction from government it is difficult to determine the appropriate mitigative measures to prevent and/or limit environmental impacts.

The oil and gas industry strives to be compliant with regulatory requirements. Overlapping regulatory requirements between the different regulations such as the *Migratory Birds Convention Act* or other provincial or federal species at risk acts and legislation requires harmonization to ensure consistency between the regulations and the enforcement of these regulations. The regulatory process must be flexible enough to reflect regional and sectoral differences, and provide for a fair regulatory environment. The current regulatory environment does not provide adequate regulatory certainty as the defence of due diligence is not sufficient, especially without guidelines on acceptable or prohibited activities.

Moving forward

Regulators have the opportunity to drive incidental effects discussions and the development of codes of practice, conservation plans, best management practices (BMPs) or Operational Statements. All stakeholders need to be encouraged to participate in the process of developing these BMPs. Transparent and effective consultations are key to the overall acceptance and willingness to use and apply these documents. The oil and gas sector has already developed and supports the use of BMPs (for example, the development of BMPs for activities in caribou ranges).

Conservation and protection are emerging themes across several aspects of federal and provincial environmental jurisdictions. Additional forethought is expected prior to development through integrated land-use planning. Regulators expect cooperation between different stakeholders to reduce their overall footprint on the landscape. While many oil and gas companies try to do this, there are unwilling stakeholders who do not want to take part in the process; and they are not required to do so. The challenge of the oil and gas industry is to try and engage all interested parties to share information and work together cooperatively. At the same time, there must be a level playing field for all stakeholders. We believe that many stakeholders do have the common goal of minimizing environmental impact and the regulatory environment needs to improve to make it happen.

9. *Effectiveness of above-ground pipeline crossing structures for wildlife movement*

Bridget Dunne, Faculty of Environmental Design, University of Calgary, Calgary, AB
bmdunne@ucalgary.ca
Michael Quinn, Faculty of Environmental Design, University of Calgary, Calgary, AB
Roger Creasey, Shell Canada Energy Limited, Calgary, AB
Danah Duke, Miistakis Institute for the Rockies

Project rationale

This two-year project was completed in coordination with Shell Canada in Peace River, Alberta. As most people are aware, the pace of oil and gas development in Alberta is rapidly increasing. The majority of the province's oil and gas reserves (approximately 80%) cannot be extracted through conventional open pit mining as the reserves are too far below the surface. The most common method of extraction from these reserves is *in situ* development, which requires above-ground pipelines to transport the bitumen from the extraction site to a processing facility. These pipelines pose a significant barrier to wildlife, particularly at such a large scale.

Above-ground pipelines create a physical barrier to wildlife movement, especially to moose given their large physical size. Habitat fragmentation is another concern as the landscape is fragmented into smaller and smaller units, similar to the effects of other linear disturbances. There are two means of mitigating such impacts; the first is with elevated sections of pipeline to facilitate wildlife movement underneath the pipeline. The second is to build wildlife crossing structures to facilitate movement over the pipeline. Research on the benefits of elevated sections of pipeline has been completed, primarily along the Trans Alaska Pipeline. However, this is the first study to specifically research the efficacy of wildlife crossing structures over pipelines.

Research questions

Three research questions were addressed in this study. The first was to understand how wildlife interacts with above-ground pipelines. A range of pipeline heights were monitored to identify the pipeline clearances required for carnivores, deer, and moose to cross. This provided an understanding of wildlife interactions and barrier effects due to above-ground pipelines in order to address the second question of how wildlife interacts with pipeline crossing structures. Finally, we analyzed how effective pipeline crossing structures are in facilitating wildlife movement.

Study area

This research was completed at Shell Canada's Peace River complex, 55 km northeast of the town of Peace River in northern Alberta. Two study sites were used: the crossing structure area with five crossing structures, and a control area without any crossing structures.

Three types of pipeline crossing structures have been used to date: a culvert style, wooden/earthen style, and an earthen style. The first two have only been monitored during environmental impact assessments, and no long-term studies have been completed to determine their efficacy. My study used earthen structures as shown in Figure 1, costing approximately $37 000 each. Steel was placed around the pipe for stability with gravel and topsoil placed to form a mound over the pipeline. The structures were then seeded in the spring. This is the first study to monitor any type of pipeline crossing structure over the long term.

Figure 1: Construction of earthen pipeline crossing structures.

<u>How do wildlife interact with above-ground pipelines?</u>

During winter snow tracking, 330 tracks were recorded in the structure area and 290 in the control area. The winter of 2006–2007 had much higher snowfall levels than normal with 274.8 cm of snowfall unlike the 83.8 cm that fell the previous year. Tracks were recorded as crossing the pipeline, deflecting away from the pipeline, or moving parallel to the pipeline (as shown in Figure 2). Coyote, lynx, deer, wolf, and moose were recorded. Moose were of primary concern as the pipeline poses a greater barrier to them given their physical size and life history characteristics.

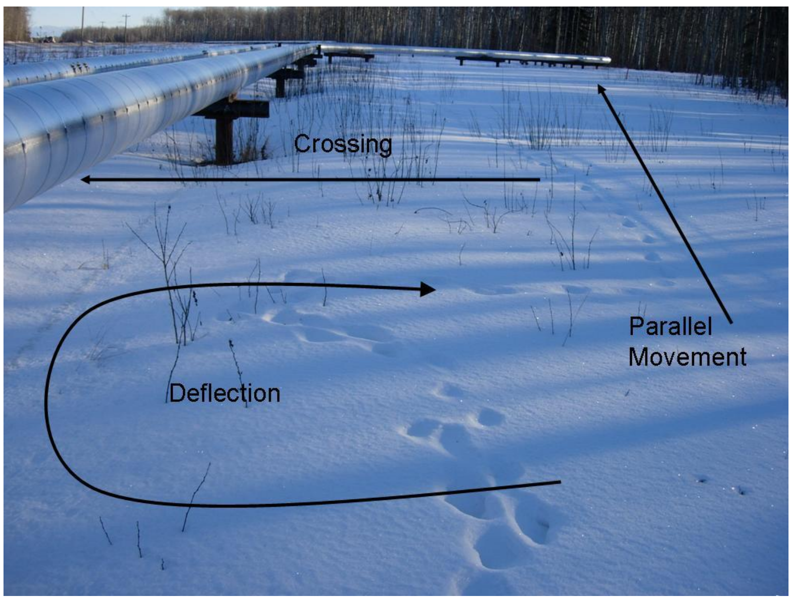

Figure 2: Crossing, deflecting and paralleling the pipeline.

Snow depth, pipeline height, distance to moose habitat, distance to water, and distance to roads were used to analyze moose movements through t-tests, ANOVA, and logistic regressions. Moose deflection sites were located at significantly higher snow depths and farther from water. Moose crossing sites were located at significantly higher pipeline clearances. Pipeline height was the best predictor of moose crossing locations in the structure area (83.3%) and control (85.7%) areas.

Moose activity and crossings were much more common in the control area, which was built in 2000. Only one deflection occurred along the control area while 11 occurred at the structure area, built in 2006. Thirty of 37 moose movements were observed next to elevated sections of pipeline with a 200 cm clearance. This suggests that moose are becoming habituated to locations of elevated pipeline along the older control area.

The carnivorous species (coyote, lynx, and wolf), crossed pipeline locations with an average clearance of 90 cm, ranging from 47 to 200 cm. Carnivores showed a preference to cross the pipeline at pipeline clearances less than 90 cm.

Deer crossing locations had a clearance ranging from 80 to 200 cm with an average of 156 cm. Deer crossed the pipeline in proportion to its availability with a slight preference for locations above 100 cm.

Moose crossed the pipeline with heights ranging from 115 to 200 cm with an average of 190 cm. The locations where moose crossed the pipeline with a clearance less than 140 cm were calves or cows with calves. Adult moose crossed the pipeline 84.8% of the time with a clearance of at least 140 cm. Of these crossings, the majority (43.5%) occurred with a pipeline clearance between 185 and 256 cm.

How do wildlife interact with crossing structures?

Two cameras were placed on each side of the crossing structure to monitor wildlife movement, as shown in Figure 3. Crossings were defined as an animal actively approaching and walking onto the structure, then proceeding across the structure. Deflections were defined as an animal making an active attempt to cross by walking onto the structure then turning away. Parallel movement was defined as an animal making no attempt to approach the structure and instead, walking along the pipeline right-of-way.

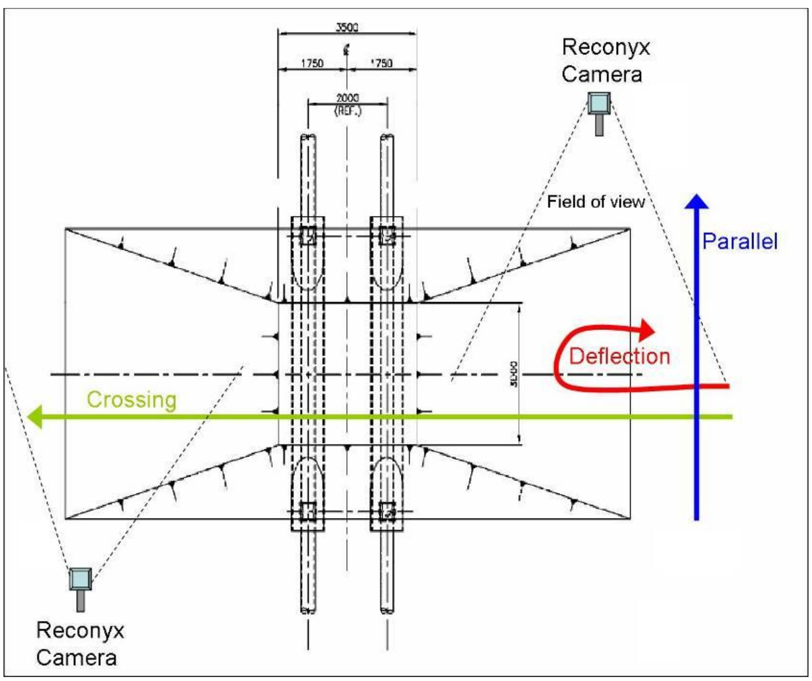

Figure 3: Crossing, deflecting and paralleling the crossing structure.

Due to bear attacks and heavy snowfall the camera data was not continuous and was standardized by working days prior to analysis. Structure use was analyzed using chi-square tests for movement type, species, season, weekend-weekday, and day-night comparisons. Snow depth, pipeline height, distance to moose habitat, distance to water, and distance to roads were used to interpret crossing structure use.

All five of the crossing structures were used much less during the winter months, predominantly due to high snow depths. The crossing structures were used by all species, mostly by deer, moose, coyote, bear, lynx, and then wolf. The pipeline height adjacent to the crossing structure greatly influenced success rate, with lower pipeline heights (< 115 cm) acting to funnel animals toward the structure—similar to fencing funnelling wildlife toward road crossing structures. Due to high vehicle numbers during the day and on weekdays, structures located near roads received less use at these times. The orientation of the structure next to the road greatly influenced successful crossing rates. The second and third crossing structures were placed so that an animal crossing the structure walked directly onto the road. Structure four was placed parallel to the structure, so wildlife were moving parallel to the road after crossing, not directly onto the road. The fourth structure received the highest successful crossing rate by all species and recorded 68.6% of moose crossings.

Do crossing structures facilitate wildlife movement?

A comparison of successful crossings at the structures, elevated pipelines and regular sections of pipeline, was undertaken using the standardized data. The crossing structures received more successful crossings for all species combined, and separately for moose alone. Despite coyote and deer being capable of crossing the pipeline at lower pipeline heights these species used the structures frequently. Two bears, two lynx, and one wolf approached and successfully crossed at least one structure. This was surprising as these species typically take longer to habituate to road structures and were not expected to use to pipeline structures so soon after construction. Moose crossed the structures 157 out of 178 approaches to the structure (88.2%), with 229 total movements (68.6%). This was a higher proportion than seen for any other species. Wildlife crossing structures were effective in facilitating wildlife movement across the pipeline.

Recommendations

Wildlife crossing structures are recommended to allow wildlife to cross above-ground pipelines. Structures should be built with a 3:1 incline, 4 m on top, and vegetated. Ensuring a low pipeline height between structures (< 115 cm) will funnel wildlife toward the structures. Elevated sections of pipeline (> 180 cm) are also effective in facilitating wildlife movement. Wildlife crossing structures or sections of elevated pipeline should be placed every 400 m to facilitate moose movement.

When structures or elevated sections of pipeline are not used, above-ground pipelines should be built with a clearance of at least 140 cm to allow moose movement. This can be achieved following construction by modifying the ground underneath the pipeline. However, this can only occur in dry areas to avoid flooding. The pipeline should not be lowered to facilitate movement over top of the pipeline as only one moose and one deer were recorded going over the pipeline in 1.5 years of monitoring. All species showed a preference to cross underneath the pipeline. Pipelines should be placed along existing disturbances and separate from roads when possible.

These recommendations can only be effective when incorporated at a regional scale. Multiple oil and gas companies need to include these recommendations and establish monitoring plans to better understand effective means of promoting wildlife movement across pipelines. Long-term studies are required to evaluate different structure designs for target species. Earthen pipeline structures facilitated wildlife movement across the pipeline and should be incorporated into future developments.

I would like to thank my committee members, Michael Quinn (University of Calgary), Danah Duke (Miistakis Institute for the Rockies), and Roger Creasey (Shell Canada) for their assistance throughout the project.

<u>References</u>

Clevenger, A.P. and N. Waltho. 2005. Performance Indices to Identify Attributes of Highway Crossing Structures Facilitating Movement of Large Mammals. Biological Conservation 121:453–464.

Golder Associates Limited. 2004. Review of Wildlife Crossing Structures for Above-Ground Pipelines. Submitted to the South Alberta SAGD Operators, Calgary, AB.

Hinman, R. 1974. The Impact of Oil Development on Wildlife Populations in Northern Alaska. Annual Conference of Western Association of State Game and Fish Commissioners, Anchorage, AK.162:156 – 164.

Jalkotzy, M.G, P.I. Ross, and M.D. Nasserden. 1997. The Effects of Linear Developments on Wildlife: A Review of Selected Scientific Literature. Prepared for Canadian Association of Petroleum Producers. Arc Wildlife Services Limited. Calgary, AB.

Schneider, R., and S. Dyer. 2006. Death by a thousand cuts: Impacts of *In-situ* Oil Development on Alberta's Boreal Forest. Pembina Institute and CPAWS, Calgary, AB.

Young, D.A. 1989. Evaluation of Wildlife Interactions with Above-Ground Pipelines. Proceedings of the Quarterly Meetings of the Canadian Heavy Oil Association: Heavy Oil Production and the Environment. Canadian Heavy Oil Association, Calgary, AB. pp. 1–23.

Van Ballenberghe, V. 1978. Final Report on the Effects of the Trans-Alaska Pipeline on Moose Movements. Joint State/Federal Fish and Wildlife Advisory Team, Anchorage, AK. Special Report Number 23.

10. Wabamun: A large scale spill response in a prairie lake

Luanne Patterson, Canadian National Railway Company, Surrey, British Columbia
luanne.patterson@cn.ca
Brian Pimblett, Canadian National Railway Company, Surrey, British Columbia

In the early morning hours of August 3, 2005, westbound train 30351 03 derailed at mile 49.4 of the Edson Subdivision, approximately 75 km west of Edmonton, Alberta. Forty-three cars derailed in the community of Whitewood Sands along side Wabamun Lake. Of the 140 cars on the train, 25 cars of Bunker C oil, one car of "pole treating oil" (PTO), one car of toluene, and 16 cars containing oats, pulp, canola, and wallboard derailed. Eleven cars of Bunker C oil and one car of PTO leaked all or part of their contents with a portion entering Wabamun Lake.

Two major responses ensued: derailment site containment and cleanup, and lake containment and recovery operations. Within hours of the spill, the derailment site was contained with earthen berms, bell holes, and vacuum operations. Lake operations began the same morning. By the end of the day, 30 response crew using six boats had deployed 4500 ft of absorbent boom and 1000 ft of containment (river) boom.

Derailment site containment and cleanup

Derailment site remediation required the excavation and replacement of 5059 tonnes of PTO contaminated soil and 17 472 tonnes of Bunker C contaminated soil from the railway grade and adjoining residential properties. The pole treating oil, a light diesel-like product used as a carrier for the wood preservative pentachlorophenol, but not yet containing the compound, travelled overland in the railway ditch 150 m east, before reaching a sand lens and infiltrating to the groundwater table. It subsequently was observed seeping from the railway grade at the location of an old wood-stave pipe (Golder 2006a). A Vacuum Enhanced Recovery System (VER) was installed at this site to treat PTO-impacted soil and groundwater. The system uses a vacuum applied to a series of twenty, 2 inch recovery wells to recover three phases (vapour, groundwater, and free product). The three phases subsequently pass through a treatment system consisting of an air/liquid separator, an oil/water separator, a biological percolation filter, and a clay and carbon tertiary polisher. Treated water is discharged through weeping tiles up-gradient of Wabamun Lake.

Mass balance calculations were completed to determine the volume of Bunker C and PTO either still remaining in the ground or lost to the lake (Table 1). No attempt was made to calculate product recovered from the lake through absorbent materials, harvested oiled reeds, submerged oil, or debris removed from shorelines due to the inaccurate and imprecise nature of these estimates.

Table 1. Mass balance estimates for Bunker C and PTO.

Bunker C spilled		712 500 L
Bunker C free product recovered	320 000 L	
Bunker C in contaminated soil	231 000 L	
Bunker C in sludge	12 000 L	
Remaining product		149 500 L

PTO spilled		88 000 L
PTO free product recovered	28 260 L	
PTO in contaminated soil	11 000 L	
PTO VER	7946 L	
PTO loss via volatilization	Unknown	
PTO commingled with Bunker C	Unknown	
Remaining product		3000–6000 L[1]

[1] Calculated based on observations in the monitoring well network (Mitton and Pimblett 2006).

Following the remedial excavation, removal of cars, track reconstruction, and the placement of over 22 000 tonnes of clean backfill, extensive landscaping was required to restore affected residential properties, a small public park, and the CN right-of-way.

Lake containment and recovery operations

Overall management of lake operations was lead by CN Environment and CN's spill response management company, Eastern Canada Response Corporation, using the Incident Command System. Eastern Canada Response Corporation deployed a spill management team averaging 15 people throughout the 2005 response effort. More than 20 contractors reported to CN's two primary response contractors, Hazco Environmental and Quantum Remediation. Eastern Canada Response Corporation prepared detailed operation plans including a General Operating Plan covering the duration of the 2005 response, 7-day plans, daily Next-day Operating Plans, and daily Status Reports.

Shoreline cleanup assessment technique

Assessment of oiled shorelines and reedbeds was co-ordinated through Eastern Canada Response Corporation with the participation of Alberta Environment, Environment Canada, Canadian Wildlife Service, Alberta Sustainable Resource Development, CN, and Paul First Nation. Following office and field calibration training, two teams were formed based on individual specialities and mandates to assess hard shorelines and reedbeds. Shoreline assessments were completed on foot for all 66 km of Lake Wabamun's shorelines. Reedbed assessment transects were undertaken by foot or kayak with bathymetric scopes assessing for the presence and concentration of submerged oil. The process called Shoreline Cleanup Assessment Technique delineated the lake shoreline into divisions and shoreline segments based on shoreline type (Owens and Sergy 2000). Each segment was marked in the field, GPS coordinates taken, and data collected on ground features, access, and oiling conditions. These detailed Shoreline Cleanup Assessment Technique surveys were completed according to Environment Canada protocols and formed the basis of cleanup operations.

Resources

Equipment resources included 72 000 feet of containment boom deployed within the first week, and a total of 529 000 feet of absorbent boom in 2005. Up to 25 boats were on the lake with ground support by 16 vacuum trucks and five mini-vacuums, and air support by two helicopters. Staffing levels peaked at 477 employees, with 135 First Nations workers on the shoreline fronting the Paul First Nations Reserve, totalling over 300 000 man-hours in the three-month work period in 2005. Approximately 6500 m^3 of oiled reeds and debris was disposed of in 2005.

In 2006, operations peaked at over 70 employees per day totalling over 50 000 man-hours. Support was provided by five jet boats, five vacuum recovery/low pressure flushing units, and five sea-trucks. An estimated 1900 m^3 of oiled reeds and debris was disposed of in 2006.

Oiled wildlife response

Oiled wildlife was a large component of the response and fully integrated in CN's Incident Command System for the 2005 operations. Focus Wildlife, an international oiled wildlife response organization provided expert advise and personnel to implement oiled wildlife treatment, monitoring, and hazing operations. After initially setting up in the community arena on August 4, 2005, it soon became clear that larger facilities would be required. A large oiled wildlife "hospital" was formed in a warehouse in the nearby town of Spruce Grove. Sixteen Focus Wildlife staff, local veterinarians, and 1600 volunteers assisted in the creation of a full-fledged hospital housing hundreds of wildlife at a time. Hospital facilities included intake (admissions), triage, stabilization, wash, drying room, conditioning pools, animal kitchen, in-house laboratory, necropsy facilities, biological waste and wastewater management, intensive care unit, and facilities for volunteers including registration, lounge, kitchen, and training. Specialized equipment and materials were sourced throughout North America. Thirty-four species of wildlife were brought into the facility for treatment, 433 alive and 582 dead on arrival. A total of 110 were released with a success rate of 25%. This statistic compared favourably to a similar spill involving the same product and species in California in early 2005 with a survival of 14% (L. Emo, pers. comm.).

In support of the hospital operations, a large field component included staff of up to 25 working in teams of two collecting oiled and dead wildlife. Crews worked closely with other lake operations and conducted daily surveillance and inventories by boat with aerial surveys weekly. Hazing operations using effigies, beacons, and pyrotechnics were implemented in fall 2005 and summer/fall 2006 to discourage wildlife usage of higher risk regions of the lake.

Oil behaviour

The prevailing westerly winds, typical at Wabamun, blew oil along the northern shoreline, through reedbeds towards the village of Wabamun. On the second day winds changed to northerlies and pushed the large slicks and oil ribbons across the lake and onto the southern shoreline. Within two days nearly two-thirds of Wabamun Lake had been impacted by floating oil. A portion of the floating oil subsequently came into contact with sediment along the shorelines, causing an increase in density such that oil sank within the water column as sunken oil (on the lakebed), submerged oil (within the water column), or neutrally buoyant oil (near the water surface) (Parker-Hall and Owens 2006). This oil formed tarballs, or in larger quantities tarmats, in the near shore areas. Wind and wave action from prolonged or major storm events mobilized the tarballs around the lake requiring shoreline cleanup in areas not previously impacted.

The near constant wind action on Wabamun Lake caused many large and important reedbeds to be impacted by surface oil. Oil adhered to the surface of reeds, primarily *Scirpus validus* and coated the outer layer with a sticky or tacky coat. Wind and wave action spread the oil along the reed length and remobilized the oil to the water surface. Over time this thin layer of oil would weather and dull to a non-sticky asphalt-like surface of the reeds, although summer sun and heat did “melt” the oil on occasion. To avoid risk of oiling to wildlife, oiled reedbeds were harvested, cut just below the water surface using hand operated weedcutters or mechanical reed harvesters. During 2006, targeted submerged oil operations sometimes required reeds to be cut at depth near the substrate to facilitate oil recovery. Waste reeds were collected and shuttled from various locations around the lake in sea-trucks to waste collection areas and trucked to landfill.

Submerged and sunken oil recovery

Submerged oil and the potential for sunken oil proved to be one of the most difficult types of oil to successfully clean up. The general public and environmental agencies were concerned that a large volume of sunken oil might be present on the lake bottom in deeper water. Numerous techniques were undertaken to assess for the presence of sunken oil including black and white video transects, dive transects, weighted sorbent diaper drops, and remotely operated vehicle colour video transects. No evidence was shown for the presence of sunken oil and it was concluded that no pool of sunken oil existed.

Submerged oil, tarballs, and tarmats were highly visible and persistent along some sections of the shoreline. A number of techniques were used to remove submerged oil including manual removal using nets and screened forks. Vacuum systems were developed using a two or three inch trash pump on a boat with an intake hose manually operated by a crew member either in the water or by boat. The discharge hose was directed into a fine mesh-screened sieve allowing the debris and tarballs to remain while draining the water away. This method proved very useful in circumstances where moderate to heavy tarball concentrations were found. Fine sediment substrate proved problematic, causing clogged sieves. Low-pressure flushing was also employed in select areas where lower concentrations of tarballs or fine tarballs (particulate) were present. This technique used the trash pumps to generate a low-pressure water flow into the water near the substrate to encourage the near neutrally buoyant tarballs and particulate to surface for removal by manual nets or absorbent boom at the surface. Depending on the specific site conditions and type and concentration of oil, a variety of oil removal techniques were required.

Aquatics monitoring

Aquatics monitoring to determine the potential for long-term effects on the aquatic lake ecosystem was initiated within days of the spill. Initially this involved water chemistry sampling at 26 locations at nearshore and pelagic stations sampling for BTEX, F3-F4, PAHs, and Alkylated PAHs. Several early samples exceeded CCME (federal) water quality guidelines for the protection of aquatic life (PAL). By August 12, 2005 all water chemistry samples were below PAL. Initial sediment chemistry sampling was initiated August 21–September 2, 2005 and again September 27–October 2, 2005. Although not readily comparable given a change in methodology, this sampling was useful in determining spatial or temporal patterns (Golder 2006b).

More in-depth sediment sampling was conducted using sediment quality triads which use a weight of evidence approach to examine the relationship between sediment chemistry, the benthic invertebrate community, and toxicity as discussed in Golder (2006c). These three lines of evidence provide a better understanding of biological effects than can chemistry alone. Sediment chemistry analysis included PAHs, alkylated PAHs, total metals, acid volatile sulphides and simultaneously extractable metals (AVS/SEM), organochlorine pesticides, grain size, total organic carbon, and percent moisture. Benthic invertebrate community information provided *in situ* actual contaminant bioavailability based on diversity, abundance, dominance, and other key structure variables. Toxicity tests were undertaken using three species (*Chironomus tentans*, *Hyalella azteca*, and *Lumbriculus variegates*) to represent known taxonomic groups in Wabamun Lake, which could form a food source for higher organisms. Results are still pending.

Lake Whitefish (*Coregonus clupeaformis*) *in situ* egg incubation deformity studies (Golder 2006c) were completed in winter 2005/2006 to examine egg hatchability, survival, growth, and frequency and severity of deformity types in spill exposed areas versus reference areas of Wabamun Lake. Specially designed Plexiglas trays to hold fertilized eggs were deployed at known whitefish spawning areas and larvae were assessed under microscope once hatched. Semi-permeable membrane devices were placed in the water column associated with the incubation trays to provide information on the potential for exposure to hydrocarbons. Results are still pending.

Additional studies, as discussed in Golder (2006c), included toxicity testing of an algal component (*Selenastrum capricornutum*), macophyte ecosystem component (*Lemna minor*), zooplankton community (*Daphnia magna* and *Ceriodaphnia dubia*), and the larger fish community (*Pimephales promelas*). Phytoplankton and zooplankton community structure was assessed through plankton tows; however, quality pre-spill baseline data may be insufficient to establish natural trends and variations. Fish tissue chemistry and bile metabolite analysis was also completed. Results for many of these tests are still pending.

Summary

The derailment and subsequent spill at Wabamun Lake, Alberta resulted in an oil spill of a scale more commonly associated with tanker spills in open oceans or commercial waterways. Separate response efforts were immediately put in place at the derailment site and on the lake utilizing the Incident Command System. Although located in an oil-producing province, access to spill response resources in sufficient volumes was one of the largest and most controversial obstacles faced in the response effort. The derailment site remediation consisted of traditional excavation methods and a vacuum-enhanced recovery system focusing on the area impacted by pole treating oil. Recovery efforts on the lake used many tried and proven methods including classic booming and skimming techniques, low-pressure flushing, manual removal, and oiled reed harvesting. New methods were developed to suit the site specific conditions such as substrate vacuuming and the application of Shoreline Cleanup Assessment Technique to a lake environment.

A major component of the response effort was the establishment of a large-scale wildlife recovery centre with all of the components of a major hospital as well as a substantial field-level wildlife response.

Ongoing efforts continue into late 2006 and early 2007 to complete recovery/remediation efforts and to monitor the effects on the aquatic environment.

References

Golder Associates. 2006a. Final Delineation Report for the Wabamun Derailment Site. Canadian National Railway Company, PIN 2401257, Wabamun, AB.

Golder Associates. 2006b. Water and Sediment Data Summary (August–October 2005), Wabamun Derailment Site, Project Number 05-1421-057. Canadian National Railway Company, PIN 2401257, Wabamun, AB.

Golder Associates. 2006c. Lakewater and Aquatics Long-Term Monitoring Plan—2005 Workplan, Wabamun Derailment Site, Project Number 05-1421-057. Canadian National Railway Company, PIN 2401257, Wabamun, AB.

Mitton, J. and B. Pimblett. 2006. Delineation and Remediation of a Derailment Site in Wabamun, Alberta. Remediation Technologies Symposium, October 11–13, 2006. Banff, AB.

Owens, E.H. and G.A. Sergy. 2000. The SCAT Manual—A Field Guide to the Documentation and Description of Oiled Shorelines (Second edition). Environment Canada, Edmonton, AB.

Parker-Hall, H.A. and E.H. Owens. 2006. Lake Wabamun derailment: fate and persistence of the spilled oil. Prepared for CN Environment, Surrey, BC. Polaris Applied Sciences, Bainbridge Island, WA.

11. Keeping a project on track: A successful approach to managing environmental issues during new rail construction

Paul Schaap, Dillon Consulting Limited, Richmond, British Columbia
pschaap@dillon.ca

It was supposed to be simple and straightforward—the proposed twinning of just over 5.25 km of mainline track on the Canadian Pacific Railway's (CPR) Shuswap Subdivision east of Kamloops. There were "environmental" issues, including First Nations and fisheries, but the CPR did not predict the extent to which "environment" almost derailed this important capacity expansion project. Based on the CPR's experience to expect the unexpected and their learned approach to environmental due diligence, a potentially insurmountable project hurdle was successfully resolved. Paul Schaap's presentation described the CPR's approach to environmental management at the Pritchard Track Expansion Project during project planning and construction. He described the steps to addressing a series of significant and challenging events that occurred during construction. Lessons learned, in the ever-changing spectrum of "environment," were summarized.

12. Cumulative environmental effects management

Barry Wilson, Silvatech Consulting Limited, Salmon Arm, British Columbia
b.wilson@silvatech.ca
www.silvatech.ca

Silvatech Consulting Ltd. was established in 1983 and is the parent company of the Silvatech Group, which includes Earth Imaging Technologies Inc., Silvatech Resource Solutions Ltd., and a diverse group of associates. Silvatech is headquartered in Salmon Arm, British Columbia with divisional offices in Calgary, Edmonton, and Lac La Biche, Alberta. Current projects are in British Columbia, Alberta, Ontario, and the Yukon. Our core business is land base information.

The Environmental Impact Assessment came about in the 1970s along with more effective land-use planning. Today, potential environmental impacts of activities are required at both the federal and the provincial level. There is a movement towards holistic and comprehensive cumulative effects assessments of all potential development trajectories in a landscape. Cumulative effects can be simply described as the changes to environmental, social, and economic values caused by an activity in combination with other past, present, and reasonably foreseeable human activities.

Cumulative effects assessments are often environmentally centric, but it is important to be comprehensive, see the whole picture, and include social and economic components as well. Cumulative effects assessments for a regional planning or land-use study set the framework for project specific assessments and include four general steps:

1. scoping,
2. analysis,
3. management framework, and
4. follow-up.

In general cumulative effects assessments should examine the response of economic, social, and environmental indicators in response to disturbance agents including natural disturbances, forestry, agriculture, urban expansion, transportation systems, tourism and recreation, and the energy sector.

It is important to remember that models don't make the decisions; people do. We use models to assist with predicting, forecasting, understanding, mediating, distinguishing problems and concerns, identifying knowledge gaps, explaining what we know, and then summarizing. The Silvatech cumulative effects assessments model tools include spatially stratified and explicit cumulative effects simulators, regional economic models, and socio-economic models. Models do NOT predict future conditions and flows on defined landscapes; they are NOT a crystal ball that informs managers about how things will be. The models help us understand the consequences (both opportunities and risks) of defined land use scenarios, to appreciate those variables (environmental, economic, and social) that drive the landscape, and to assess the consequences of various land use trajectories. We often start with a strategic-level landscape simulation, evaluating the strategic consequences and opportunities associated with land-use practices within regional landscapes.

Linear features are a key driver in cumulative effects assessments and the key element is the zone of influence associated with edge. Some of the challenges associated with linear features include viewscapes, water dynamics, caribou, invasive vegetation, and access by humans.

Highlights from the Alberta Oilsands study are:

- 6.8 million ha study area
- 47 stakeholders covering the full range of values
- Consensus-based decision making
- Disturbance agents modelled:
    - fire (80 year fire cycle)
    - energy sector (15–30 billion m^3 bitumen extraction)

    - forestry sector (3 million m^3/yr harvest)
    - urban growth (resident population doubling within a decade)
- Integrating three models: spatial, strategic, and economic
- Goals, management objectives, and thresholds for environmental, economic, and social values
- Triad management system (intensive/extensive/conservation)
- Using the scenario planning approach
- Management is given a framework intended to:
    - make quantitative cumulative effects assessments,
    - recommend policy directions to government of Alberta, and
    - provide research and monitoring system recommendations.

The art of strategizing using scenario planning and strategic cumulative effects assessment tools is a lot like storytelling. We weave together scientific methods of quantitative analysis with often less tangible but equally important social (such as Traditional Ecological Knowledge and economic objectives in the form of scenarios). In this way we can link certainties and uncertainties about the future to the decisions that must be made today.

13. Managing unexpected and unpredicted wildlife migrations: The western toad tsunami on the Vancouver Island Inland Highway

Leonard Sielecki, BC Ministry of Transportation, Victoria, British Columbia
leonard.sielecki@gov.bc.ca

In mid-August of 2007, the Vancouver Island Inland Highway (Highway 19) in British Columbia experienced an unexpected mass migration of western toads (*Bufo boreas*), a species of special concern for the Committee on the Status of Endangered Wildlife in Canada. Without warning, approximately one million, penny-sized toadlets began migrating across a four lane, 110 km/hr section of the divided highway.

Following the guidance of Elke Wind, one of Canada's leading western toad experts, BC's Ministry of Transportation staff and environmental contractors were immediately mobilized to safeguard motorists and protect the migrating toadlets. Temporary amphibian fencing was installed to funnel the toadlets away from the highway and into safe collection areas. Traffic control was established to protect those involved in the toadlet salvage. Solid highway median barriers were replaced with modified structures to provide any toadlets by-passing the temporary amphibian fencing an opportunity to complete the highway crossing successfully. Captured toadlets were immediately relocated and released.

The magnitude of the toadlet migration across Highway 19 on Vancouver Island was unprecedented in the operational history of the BC Ministry of Transportation. Although originally anticipated to last three to five days, the migration continued for over 10 weeks. At the migration's peak, it is estimated that upwards of 50 000 toadlets attempted to cross the highway each day. As a result of the concerted efforts of the BC Ministry of Transportation staff, the Ministry's environmental and maintenance contractors, and numerous volunteers, approximately 950 000 toadlets were successfully rescued and transported across the highway without incident.

Presentations on Thursday, November 8, 2007

14. *Environmental management on the Sea-to-Sky Highway upgrade project—Lessons learned*

Grant Bruce, Hatfield Consultants Partnership, West Vancouver, British Columbia
gbruce@hatfieldgroup.com
Cheryl McQuillan, Hatfield Consultants Partnership, West Vancouver, British Columbia
cmcquillan@hatfieldgroup.com
www.hatfieldgroup.com

In advance of the 2010 winter Olympics, improvements to the 100 km Sea-to-Sky Highway between West Vancouver and Whistler are being undertaken. This $600 million project was the first large transportation Design-Build-Finance-Operate project initiated in British Columbia, and is aligned with the increasing trend of using Public-Private-Partnerships for large infrastructure projects. Improvements will include highway widening and straightening, improved sightlines, additional passing lanes, and other design innovations to reduce hazards, shorten travel times, and increase capacity of the highway. The goals of the project are to increase safety, reliability, and capacity. Approximately 13 700 vehicles use the highway each day.

The project will provide:

- Four lanes from Horseshoe Bay to Lions Bay
- Two lanes from Lions Bay to Porteau Cove (using a temporary third lane during the 2010 Olympic Winter Games)
- Three lanes from Porteau Cove to Squamish
- Three lanes from Squamish to Whistler

Hatfield Consultants was retained to provide environmental management services to the project, including providing the critical Environmental Manager position. The environmental management of the project requires co-ordination with the design, construction, traffic management, and operations/maintenance components of the team, ensuring regulatory authorities and numerous stakeholders are properly integrated into the overall environmental management of the project.

At the conference we addressed the organizational challenges and "lessons learned" along with approaches taken toward quality assurance and quality control (environmental quality management plan) and environmental training, monitoring, and reporting.

15. Environmental issues of arctic winter roads

Steve Moore, EBA Engineering Consultants Ltd., Yellowknife, Northwest Territories
smoore@eba.ca
Jeff Matheson, EBA Engineering Consultants Ltd., Vancouver, British Columbia

Winter roads are roads made on frozen ground, snow, and ice. In winter, frozen lakes and rivers, and frozen ground provides a hard surface for vehicles in places where it is too costly to build all-season roads or where the environmental costs of all-season roads are too high. Winter roads are commonly used in remote resource development areas and remote communities across Canada where travel through soft ground (especially peatlands) is only possible to do when the ground in frozen. Winter roads are particularly important in the arctic. Construction of all-season roads is complicated by the presence of permafrost and freeze-thaw processes that make them costly to maintain. Construction and operational activities associated with winter roads must consider the potential effects of permafrost regression, erosion and sedimentation, compression of organic soils in peatlands, vegetation clearing, and indirect effects on wildlife through increased hunter access, among other issues.

The Tibbitt to Contwoyto Winter Road extends from near Yellowknife, Northwest Territories, north for 560 km terminating at Contwoyto Lake, in Nunavut. The road provides winter road access for a number of mines, including the Ekati, Diavik, and Lupin mines, and other mineral exploration sites in the region. The majority of the road is on frozen lakes although there are about 70 km of road on overland portages that connect lakes. The road is managed by a group of mining companies that represent the principle users.

Beginning in 2001, detailed inventories have been conducted to better understand environmental aspects of the road's presence. Inventories are directed at developing management practices and operational procedures to minimize environmental effects. Environmental baseline data now includes high-resolution orthophotography and a digital elevation model for the entire corridor, ecosystem and wildlife habitat mapping, fish and aquatic habitat information, heritage resources mapping, and annual monitoring results. Winter road information is housed in a centralized database and is accessible through a web portal. Web-based interactive mapping allows users to view biophysical information for the entire road.

Ongoing management of the road includes consideration of effects on terrain and vegetation (through refined road alignments), permafrost, surface water, fish and aquatic habitat, wildlife and their habitat, and heritage resources.

16. *Influence of cutting time on brush response: Implications for herbivory in linear (transportation) corridors*

Roy Rea, University of Northern British Columbia, Prince George, British Columbia
reav@unbc.ca

An experiment was conducted to determine the influence the time of brush-cutting can have on plant re-growth and attractiveness to herbivores that browse in linear corridors. The influence of cutting time on leaf flush and senescence, shoot morphometry, and biomass was measured for three consecutive years after initial brush-cutting. Results indicate that morphological and phenological attributes of three woody deciduous plants were influenced by the timing of brush-cutting for up to three years after initial cutting. Brush-cutting generally stimulated plants to produce larger than normal shoots and delay leaf senescence. The degree to which plants were affected, however, varied with the timing of initial cutting and the species in question. Generally, plants cut later in the year re-sprouted more vigorously and were taller in the third year after cutting, but produced less overall biomass than when cut earlier. In the years following brush-cutting, plants cut earlier flushed leaves earlier in the spring, but delayed leaf senescence in the fall when compared to uncut controls. Results of these trials suggest that brush-cutting time influences plant response and several plant attributes known to influence plant attractiveness to moose and other herbivores. We therefore recommend that road and railway right-of-way vegetation management plans consider the influence of cutting time on plant re-growth. Such considerations can ensure that brush is cut to reduce the attractiveness of plant re-growth in these linear corridors, reduce the utilization of such brush by herbivores, and as such, mitigate collision risk between motorists and herbivores such as moose.

From: Rea, R.V., K.N. Child, D.P. Spata, and D. MacDonald. 2007. Influence of cutting time on brush response: Implications for herbivory in linear (transportation) corridors. Environmental Management 40(2):219–230.

17. *Scour protection for pipeline crossings of urban creeks using flexible concrete mats*

Matt Gellis, northwest hydraulic consultants
mgellis@nhc-van.com
www.nhcweb.com

Pipeline crossings of urban creeks are subject to an increased risk of exposure due to channel enlargement and incision, both of which are common effects of forest harvest combined with urban development. Exposed pipelines are vulnerable to hydraulic forces, debris impact and human tampering, which increase the risk to the environment and to public safety. Scour protection was designed for three pipeline crossings of urban creeks in British Columbia's Lower Mainland using flexible concrete mats. All three were characterized by design constraints including exposure or near exposure of the pipeline,

relatively high fisheries values, and residential location. The use of flexible concrete mats for scour protection was adopted rather than traditional riprap for the following reasons: the low profile of the mats reduces the impact on water levels and requires less instream excavation; the mats provide equal or greater scour protection than riprap; they conform easily to existing channel cross-sections; and they blend well with natural surroundings. Fish habitat and aesthetics were improved with the introduction of large woody debris clusters, rock riffles, pools, gravels, and by landscape rehabilitation.

Introduction

This paper discusses scour protection for three exposed or nearly exposed pipeline crossings in British Columbia's Lower Mainland. Design constraints included pre-existing flood hazard, fish habitat maintenance and/or improvement, adjacent residential properties, public walkways, and aesthetics. Armorflex™ flexible concrete mats were used as opposed to traditional riprap protection for the following reasons:

- The mats provide "hard" scour protection equal to or greater than riprap.
- The low profile of the mats reduces or eliminates any increase in local water levels, thereby avoiding exacerbation of pre-existing flood hazard.
- Less instream excavation is required as compared to riprap placement.
- They conform easily to channel cross-sections.
- The open-cell configuration allows gravel recruitment and vegetation growth, blending well with natural surroundings.

Urban creeks and pipeline crossings

Urban development increases the proportion of impermeable surface area in a catchment. Catchments with a high proportion of impermeable surface area experience faster runoff and less evaporation, evapotranspiration, and groundwater infiltration, resulting in elevated runoff volumes and peak discharges (Urbonas and Roesner 1993). In addition, runoff from impermeable surfaces such as concrete and asphalt transports less suspended sediment to urban creeks than would be the case in most natural catchments. The combination of greater peak flood discharges and lower suspended sediment can result in channel enlargement and incision. In the case of subterranean pipeline crossings, the end result is an increased risk of exposure.

Pipeline exposure is of concern for several reasons. Exposed pipeline crossings are vulnerable to hydraulic forces, debris impact, and human tampering. As such, they represent an elevated risk to public safety, the environment, and the economy. Re-establishing pipeline cover and preventing future exposure are of critical importance in reducing these risks. However, engineering design and construction require special considerations in urban residential areas. Project planning and implementation must consider multiple stakeholder values and interests, which may impose considerable constraints on design.

Scour protection options

The traditional approach to scour protection generally involves using angular rock (riprap). The rock is sized according to a combination of local experience, empirical guidelines, and hydraulic relationships (TAC 2004). Riprap has several advantages in terms of scour protection, including:

- It offers "hard" protection against scour.
- It conforms to channel cross-sections and meanders.
- It is usually relatively inexpensive (riprap costs are highly dependent on local conditions and transport distances).
- Riprap protection can be designed to "launch" in response to scour, retaining its utility over time.

While riprap is an established and often effective approach to scour protection, there are some drawbacks associated with its use:

- Riprap protection often requires a relatively thick layer of rock to be effective (normally 1.5 times the median rock diameter), which can result in elevated water levels and exacerbate floods.
- The rock layer must be keyed to the channel bed and banks, requiring substantial instream excavation.
- It will not support vegetation.
- Riprap does not offer any known habitat benefits.

An alternative to riprap for scour protection is the use of open-cell, flexible concrete mats. The mats are available in various thicknesses and configurations, and are sized according to the anticipated hydraulic forces. Benefits of using flexible concrete mats include:

- They offer "hard" protection against scour.
- They conform to channel cross-sections.
- Their lower profile (120 mm thickness) is unlikely to result in elevated water levels.
- In the event of undermining, mats will "flex" to offer continued protection.
- The open-cell mats allow gravel recruitment and vegetation growth over time, conferring possible habitat benefits.

There are some minor drawbacks to the use of flexible concrete mats:

- They are generally more expensive than riprap.
- Turnaround time is longer, as they are generally made to order and must be transported from the manufacturer.
- They do not conform as easily to sharp bends in the channel alignment.

Figure 1. Typical concrete mat installation in progress. Generally, the amount of instream excavation can be reduced since keying mats to the channel bed is optional, due to the lower profile of mats compared to riprap

Figure 2. Typical riprap bank protection installation in progress. Riprap installations generally require extensive instream excavation.

Nicomekl River pipeline crossing, Langley, British Columbia

Northwest hydraulic consultants (nhc) was retained by Terasen Gas to design scour protection for a pipeline crossing in the upper reaches of the Nicomekl River in Langley. The catchment upstream of the crossing has mostly rural agricultural land use and an area of approximately 5 km^2. The channel gradient in the crossing reach is approximately 1%. Bed material is composed of mobile sand, and near-vertical silty sand banks are held up by riparian vegetation. The channel in this reach exhibited a high degree of complexity, including numerous large woody debris accumulations and undercut banks. This reach is considered to have high fisheries value as a movement corridor and for juvenile rearing and wintering. Channel incision and enlargement (ongoing, system-wide conditions resulting from an imbalance in the hydrologic regime) were not a problem at this site. However, local scour and bank erosion had exposed the pipeline.

The objectives of our scour protection design were as follows:

- Re-establish pipeline cover and protect against future exposure
- Maintain or improve channel complexity and habitat quality
- Minimize the impact of protection works on nearby water levels
- Foster positive relationships with local stakeholders

Constraints on our design options included:

- Proximity to nearby residences (and the associated implications for construction, aesthetics, and flood hazard)
- Maintenance of fish passage
- Avoidance of the harmful alteration or destruction of fish or fish habitat

The final design incorporated the use of open-cell, flexible concrete mats over the pipe alignment. Figures 3 and 4 show mat placement during construction, and finished protection works, respectively. Some riprap protection was required upstream of the pipeline crossing at a scoured 90° bend. Rock protection was also used at the upstream and downstream ends of the mats (the mats were keyed to the bed as an added safety precaution). Prior to mat placement, the channel was contoured to ensure that low flows were concentrated enough to allow fish passage. A 10 cm layer of granular filter rock was placed and overlain by a non-woven geotextile, before the mats were placed on top.

Three rock trenches were placed upstream of the channel bend in order to prevent outflanking of the protection works during flood events. The trenches had a 1.5 m bottom width, 1.7 m top width, 1.5 m depth, and were angled 30° upstream.

Figure 3. Mat placement at Nicomekl River crossing. Note that the channel cross-section is contoured so that low flows are concentrated near the left bank (photo right).

Figure 4. Finished protection works at Nicomekl River crossing.

Large woody debris complexes composed of logs with a minimum diameter of 0.6 m were installed in and around the pool at the 90° channel bend. A large overhanging stump was placed on the downstream bank. Large woody debris complexes are intended to improve fish habitat by providing cover, refuge, and increasing channel complexity.

Along the downstream banks, seeded geotextile bags were placed as a “soft” bank protection option. The bags are intended to vegetate over time, while providing a degree of erosion protection.

A rock apron with three small riffle crests were placed downstream of the mats in order to provide hydraulic control (by backwatering the upstream pool), and to create a step-pool morphology conducive to fish passage. The riffles were field-fit to ensure no individual drop was greater than 10 cm.

At the request of the Nicomekl Enhancement Society, spawning gravels were added to the stream following construction. Small stockpiles were placed on the banks both upstream and downstream of the protection works, to be transported downstream over time. The mats themselves were also seeded with gravels.

Extensive landscape rehabilitation was undertaken following the completion of instream works, in order to improve post-construction aesthetics and reduce soil erosion. The unusual degree of effort invested in re-vegetation and aesthetics was a direct result of Terasen’s commitment to fostering positive relationships with local landowners.

Cub Creek pipeline crossing, Surrey, British Columbia

The catchment upstream of the crossing has primarily urban land use. Channel incision and enlargement were a severe problem at this site; remnant floodplains as high as two metres above the channel bed were observed. The catchment area is approximately one km^2. The channel gradient in the crossing reach is much steeper, averaging 3%, but reaching 6% immediately downstream of the crossing. Bed material is composed of gravel and banks are near-vertical glaciomarine clay. The channel in this reach exhibited a relatively low degree of complexity. This reach is considered to have moderate fisheries value as spawning and rearing habitat. The pipeline was nearly exposed, with roughly 0.3 m of cover remaining. Temporary protection works consisting of small (~200 mm) riprap and cobbles had been placed at an earlier date. Temporary rocks were inadequate protection and they had begun to migrate downstream.

The objectives of our scour protection design were identical to the objectives described above for the Nicomekl River crossing. Constraints were similar to the Nicomekl crossing, however, existing flood hazard was much lower for Cub Creek. As a result, elevated water levels were of less concern. Also, the steep “chute” section immediately downstream of the crossing may have been a pre-existing barrier to fish passage. Thus, the imperative of maintaining fish passage became a goal of maintaining or re-establishing fish passage.

Scour protection designed by nhc for Terasen Gas at the Cub Creek pipeline crossing in Surrey, British Columbia was similar to the works designed for the Nicomekl River crossing (described above), with some variations of note. Differences were mainly due to the steeper grade and faster design velocities.

Larger diameter riprap (800 mm) was used to key the downstream end of the mats, and for rock riffles. Some rock protection was also used on the banks downstream of the crossing, as opposed to the geotextile bags employed at the Nicomekl crossing. Eroded banks upstream and downstream of the crossing were protected with lateral large woody debris placements, backfilled with cobbles and small riprap (~200 mm) salvaged from temporary protection works. Large boulders (~1000 mm) were placed in the channel in order to increase turbulence and improve conditions for fish movement. No rock trenches were required, as there was little danger of outflanking the protection works given the incised channel geometry.

As at the Nicomekl site, numerous large woody debris complexes improved fish habitat and channel complexity. Mats were covered with spawning gravels, and extensive landscape rehabilitation was included to improve post-construction aesthetics, limit soil erosion, and promote positive relationships with adjacent landowners.

Figure 5. Mat placement at Cub Creek. The downstream excavation (photo right) is for keying mats to the channel bed and installation of rock riffles. These measures were necessary due to the high gradient and design velocities at this site.

Figure 6. A partial view of finished works at Cub Creek.

Price Creek pipeline crossing, Surrey, British Columbia

The Price Creek crossing is located a few hundred meters west of the Cub Creek crossing, and has very similar catchment characteristics. Channel incision and enlargement were combined with severe bank erosion at this site. Upstream of the crossing the catchment has an area of approximately 0.8 km^2 and land use is primarily urban. The channel gradient in the crossing reach averages 3%. Bed material is composed of gravel and banks are glaciomarine clay. The channel in this reach exhibited a relatively low degree of complexity, and was considered to have moderate fisheries value as spawning and rearing habitat. A 90° bend in the vicinity of the pipeline crossing posed problems of poor channel alignment resulting in excessive bank erosion; the pipeline was nearly exposed, with roughly 0.3 m of cover remaining. Minor riprap protection had been previously installed on the right bank, upstream of the 90° bend, and was deemed to be functioning adequately. Designs were originally conceived to minimize disturbance of the existing riprap, but pipeline inspection at the time of construction precluded this possibility.

The objectives of our scour protection design were identical to the objectives described above for the Cub Creek and Nicomekl River crossings. Constraints were similar to the Cub Creek crossing, however there was no pre-existing barrier to fish passage. Also, a pedestrian bridge downstream of the crossing constrained the design in terms of constructability, as we wished to avoid removing the bridge during construction.

Scour protection designed by nhc for Terasen Gas at the Price Creek pipeline crossing was very similar to the works designed for the Cub Creek crossing (described above), with a few notable variations. Riprap diameter was significantly smaller (400 mm) due to lower design discharge and velocity in Cub Creek. Very limited rock protection was used on the left bank upstream of the crossing, and no geotextile bags were used. Riprap protection was mainly applied in its pre-existing location on the left bank, upstream of the 90° channel bend. No lateral large woody debris placements were used for bank protection. Instead, a Lockblock wall was installed on the left bank immediately downstream of a 90° bend at the crossing. The Lockblock wall was chosen due to the severity of bank erosion stemming from very poor alignment, and the pre-existence of a two metre vertical bank. Channel realignment was limited to very minor smoothing of the two bends at the crossing site. Large boulders (~1000 mm) were placed in the channel in order to increase turbulence and improve conditions for fish movement. No rock trenches were required as there was little danger of outflanking the protection works given the incised channel geometry.

Similar to the Cub Creek and Nicomekl River sites, numerous large woody debris complexes improved fish habitat and channel complexity. Mats were covered with spawning gravels, and extensive landscape rehabilitation was included to improve post-construction aesthetics, limit soil erosion, and promote positive relationships with adjacent landowners.

Figures 7 and 8 show mat placement during construction, and finished protection works, respectively.

Figure 7. Mat placement at Price Creek.

Figure 8. A partial view of finished protection works at Price Creek.

Conclusions

The use of open-cell, flexible concrete mats for scour protection has numerous advantages over traditional riprap protection, including a lower profile requiring less instream excavation, reducing or eliminating impacts on water levels, a more natural appearance, and the possibilities of gravel recruitment and vegetation growth. Some drawbacks do exist, such as the relatively high cost of the mats compared to riprap, longer procurement times, and usually greater transport distances.

In the cases of the three scour protection designs described here, use of flexible concrete mats was preferred over riprap protection due to the potential habitat benefits, reduction or elimination of impacts to water levels, and a more natural looking appearance. Incorporation of the mats was well received by Fisheries and Oceans Canada; impacts to instream habitat are equal to or less than those associated with riprap protection.

Insufficient time has passed since the installation of the mats to be certain of their success. However, they have been used by a variety of proponents in numerous other locations, and qualitative assessments of their performance have tended to be positive. Consideration of flexible concrete mats for scour protection is recommended for cases where hard protection is required, and aesthetics, habitat improvement, or flood hazard are of concern.

References

Urbonas, B.R. and L.A. Roesner. 1993. Hydrologic design for urban drainage and flood control. *In* Handbook of Hydrology. D.R. Maidment (editor). McGraw Hill, New York, NY.

Transportation Association of Canada. 2004. Guide to Bridge Hydraulics. MPG Books, Bodmin, Cornwall, UK. p. 127.

18. Canadian Pacific Railway's integrated vegetation management program

David Spata, Canadian Pacific Railway, Prince George, British Columbia
david_spata@cpr.ca

The primary purpose of vegetation management in a railway context is to ensure safety for railway employees and the general public. Managing vegetation to meet railway safety requirements can be done in a manner that minimizes our environmental footprint and is consistent with other key principles of integrated vegetation management. Reducing the potential and frequency of derailments and crossing accidents helps to reduce the potential environmental impacts associated with railway operations. In particular, weed growth in rail bed areas needs to be managed as it can impede drainage and can affect track geometry. Weeds can also interfere with safety inspections and can result in slipping or tripping hazards in active work areas. Preventing vegetation and weed problems from occurring is a key objective of Canadian Pacific Railway's integrated vegetation management program**.**

Canadian Pacific Railway employs a variety of approaches to try to prevent future vegetation problems, such as the seeding of construction areas with species that require minimal maintenance, are self sustaining, and do not attract wildlife to the tracks. Canadian Pacific Railway has also implemented a multi-faceted program to reduce the occurrence of grain spills from hopper cars.

In addition to preventative measures, Canadian Pacific Railway uses herbicides in conjunction with conventional cutting and bio-control to manage existing weed problems. To achieve environmental protection and compliance objectives, only federally approved herbicide products that have low acute toxicity to mammals and aquatic organisms, are used for weed control. Canadian Pacific Railway also uses the latest technologies, such as "Weedseeker" systems to effectively manage herbicide use. The Weedseeker is a camera system mounted on herbicide application trucks that detects the presence of weeds and selectively spot treats problem areas (i.e., not a blanket spray pattern). This technology reduces herbicide use significantly, which is good for the environment and provides cost savings for Canadian Pacific Railway.

19. Assessment of change in invasive plant distribution on FortisBC rights-of-way through the Boundary region from 1999 to 2007

Barb Stewart, Stewart Consulting, Rock Creek, BC
bastewart@nethop.net
Maureen Grainger, FortisBC, Kelowna, BC
maureen.grainger@fortisbc.com

The purpose of this presentation is to provide a summary of some of the findings from an assessment done by FortisBC to evaluate the change in invasive plant distribution on FortisBC rights-of-way through the Boundary region in response to the management program implemented since 1999.

Invasive plants cause significant impacts including:

- Reduced plant biodiversity
- Displacement of native plants
- Degradation of wildlife habitat
- Increased erosion and sedimentation
- Reduced enjoyment of recreation
- Reduced crop quality and yield
- Reduced property values
- Reduced aesthetic values
- Consequences to animal health

Invasive plants are spread in a variety of ways, with spread on vehicles being the main vector for long distance spread.

In 1999 FortisBC joined the Boundary Weed Management Committee (BWMC) and committed to deliver its invasive plant management program according to the district-wide priorities set out by the committee. The co-ordinated management system in the Boundary has evolved into a single agency delivering on-the-ground treatment with co-ordination through the BWMC. The advantages of this system are reduced administration costs and more effective control, since adjacent areas are managed as well.

FortisBC has been operating an integrated pest management program involving education, co-ordination with other stakeholders, and implementation of prevention and mitigation measures. In addition to education and prevention, methods FortisBC has used include bio-control on five invasive plant species, selective herbicides on six species, and manual treatment on one species. Bio-control activity has included releasing agents at 20 sites on the rights-of-way, in co-operation with the BC Ministry of Forests and Range. Target species include Diffuse knapweed (*Centaurea diffusa*), Spotted knapweed (*Centaurea biebersteini*), and Hound's tongue (*Cynoglossum officinale*). Bio-control insects for Dalmatian toadflax (*Linaria dalmatica*) and Nodding thistle (*Carduus nutans*) have dispersed on their own from nearby release sites to sites on the rights-of-way.

Selective herbicides have been used on Leafy spurge (*Euphorbia esula*), Hoary alyssum (*Berteroa incana*), Russian knapweed (*Acroptilon repens*), Sulphur cinquefoil (*Potentilla recta*), Yellowdevil hawkweed (*Hieracium glomeratum*), and several Common bugloss (*Anchusa officinalis*) sites. Manual digging has been used to control one site of Common bugloss.

Monitoring was done at 31 locations to assess the current distribution of invasive plants on the sites. The current distribution was then compared to information collected during a helicopter survey done in 1999, pictures from previous bio-control releases, and data collected by the BWMC within the period.

Diffuse knapweed was present on 101 km of right-of-way in 1999. Nine previous bio-control releases were monitored and we found that four had large reductions in distribution of plants, two had slight reductions, one was the same, and two showed increases. More suppression was observed at hotter, dry sites and less at cooler, wet sites. Since some of the insects have dispersed throughout the right-of-way, 10 points were monitored between release sites in the hot dry zone of the west Boundary to determine if distribution was constant between release points. All sites showed large reductions in distribution of Diffuse knapweed, and the information suggests the populations appear to be starting to cycle back up. Since the majority of the transmission corridor runs through the hot dry zones, the bio-control insects are suppressing growth on over 90 km of right-of-way. Unfortunately, new invasive plant species were recorded at some of these locations.

Spotted knapweed infested 5.8 km of the right-of-way in 1999. Monitoring of four previous bio-control release sites showed no observable change in distribution, although two of the sites showed shorter, less robust plants based on picture comparisons. Since Spotted knapweed is relatively limited on the right-of-way, chemical containment continues to keep the infestations from expanding.

Hound’s tongue infested an estimated 49 km of right-of-way in 1999. Monitoring of six bio-control release sites found noticeable declines in distribution at the two-year-old releases and at the seven-year-old release in response to feeding by the weevil, *Mogulones cruciger*. At the one-year-old release sites (2006) only a slight decline was noted and it is expected that by 2008 significant declines will be observed. The agent builds populations quickly and monitoring of trial sites by Agriculture and Agri-food Canada staff found control within two years on smaller release sites. The agent has a broad ecological tolerance and is expected to establish at all sites where Hound’s tongue will grow in the Boundary.

Dalmatian toadflax infested 34 km of right-of-way in 1999. Of the three monitoring sites with Dalmatian toadflax present during 1999, all had declines as a result of the insect *Mecinus janthinus* feeding. Similar reductions were observed between release sites east of Grand Forks. Two of the monitoring sites in the West Boundary that did not have toadflax present in 1999 survey, had it present in 2007, and the bio-agent was also present.

The targeted chemical treatment program to treat Leafy Spurge, Russian knapweed, and Common bugloss has reduced the density and distribution of plants on infested sites. Hoary alyssum is being reduced at isolated sites, but continues to expand its range on the Gilpin area a little each year despite the chemical treatment program. Manual treatment of Common Bugloss at one location has resulted in an increased density of plants due likely to the high level of soil disturbance during plant removal. On the sites where Sulphur cinquefoil was chemically treated distribution has been reduced, however spread is still occurring from untreated sites on and off the right-of-way. This targeted management system in co-operation with adjacent landowners and land managers is achieving reductions in most invasive plant problems on FortisBC rights-of-way through the Boundary.

Now that FortisBC has a handle on most species of invasive plants on their right-of-way, prevention is very important to avert future problems. To date, training sessions have been held to make staff and contractors aware of the issues. A right-of-way standard outlining practices to prevent or reduce spread was drafted in spring 2007, and it is being implemented.

The presenters would like to acknowledge the BC Ministry of Forests and Range for providing access to historical bio-control release information and pictures for this project, and the Boundary Weed Management Committee for access to historical invasive plant distribution information.

For a copy of the report produced by the project contact:

Maureen Grainger, Environmental Lead, FortisBC
250-717-0818
Maureen.grainger@fortisbc.com

At the conference:

Question: Could you provide some estimates of the costs and benefits of bio-control versus chemical treatment?

Answer: Bio-control is much more cost effective in the long term, when it works, compared to herbicide application. There are many agents that have been screened and introduced, but did not establish or did not have an impact on the target plant population. The last estimate I heard was that it costs approximately $750 000 to screen one agent and get it approved for release in Canada. Then Forest Practices Branch and Range Branch begin rearing the agent and perform initial releases to determine habitat preferences. If the agent establishes, then more widespread distribution is done. I am not aware of any estimates of the initial distribution costs per agent, but I have heard the estimated long-term return on investment for bio-control is 100-fold. A reasonable estimated cost to do a release is about $200 per release including collection by BC Ministry Forests and Range, shipping, and release. But then you have to wait years for the populations to build.

20. A process to conserve species and communities at risk along rights-of way

Gilbert Proulx, Alpha Wildlife Research & Management Ltd., Sherwood Park, Alberta
gproulx@alphawildlife.ca
Dan Bernier, Timberline Natural Resource Group Ltd., Dawson Creek, British Columbia
Scott Hawker, Timberline Natural Resource Group Ltd., Vancouver, British Columbia

Roads, railways, power lines, and pipelines represent thousands of kilometres of rights-of-way where vegetation is continuously modified through tree and shrub trimming and removal. Rights-of-way impact negatively on biodiversity through habitat loss and deterioration (including spread of exotics), degradation of habitat quality (physical and chemical), habitat fragmentation and loss of connectivity between vital habitat requirements, increased mortality (predation and human-caused), population fragmentation and isolation, disruption of social structure, and more.

Because the management of rights-of-way may have a significant effect on the survival of species and plant communities at risk, effective practices need to be developed to enhance species at risk conservation while ensuring that these infrastructures are kept functionally sound and structurally safe. In this paper, we describe a stepwise process to properly identify species at risk habitats, develop guidelines to mitigate negative impacts associated with maintenance operations, and properly train crews involved in vegetation management. We present a classification scheme of habitats associated with rights-of-way, and coarse- and fine-filter management strategies to improve upon the conservation of invertebrate and vertebrate species, plants, and plant communities.

Overview of the process

The process that we propose to address species at risk conservation in rights-of-way is based on a species at risk conservation strategy that we developed and tested in managed forests in western Canada during the last decade (see Proulx *et al.* 2003; Proulx and Bernier 2005; Bernier and Proulx 2006; Proulx 2006). The process recognizes that species at risk conservation is a habitat-related issue where coarse- and fine-filter management strategies must be integrated into a multi-species management program (Proulx 2005) (see Table 1).

Table 1. Stepwise process proposed for species at risk conservation in rights-of-way.

STEP I–Species at risk list This list includes red- and blue-listed species and plant communities identified by recognized authorities.
STEP II–Field validation At the regional level, field validation is sometimes necessary to confirm the presence of species at risk. This information helps greatly in prioritizing management decisions along rights-of-way.
STEP III–Classification of habitats This is a macro-habitat classification scheme applied to areas found within and adjacent to rights-of-way.
STEP IV–Habitat management guidelines Management guidelines at stand and landscape levels are established for species-at-risk that are potentially found within or adjacent to rights-of-way.
STEP V–Field guides, manuals, and training sessions Description of species at risk and their seasonal habitats, critical habitat features, and management guidelines are summarized in field guides (Proulx *et al.* 2003; Proulx and Bernier 2006), and in greater detail in field manuals (Bernier and Proulx 2006). A formal course is given on an annual basis to people involved at all operational levels.
STEP VI–Proactive work Administrations and field crews are encouraged to acquire more knowledge about species at risk and carry out projects that would contribute to species at risk recovery.

We developed site-specific management guidelines for narrow (e.g., roads and hydroelectric distribution lines) and wide (e.g., transmission lines and pipelines) rights-of-way where coarse-filter management practices are integrated with fine-filter management measures. Our management strategy stresses the importance of buffer zones, reserves, corridors, riparian sites, and multi-species management areas (Figure 1).

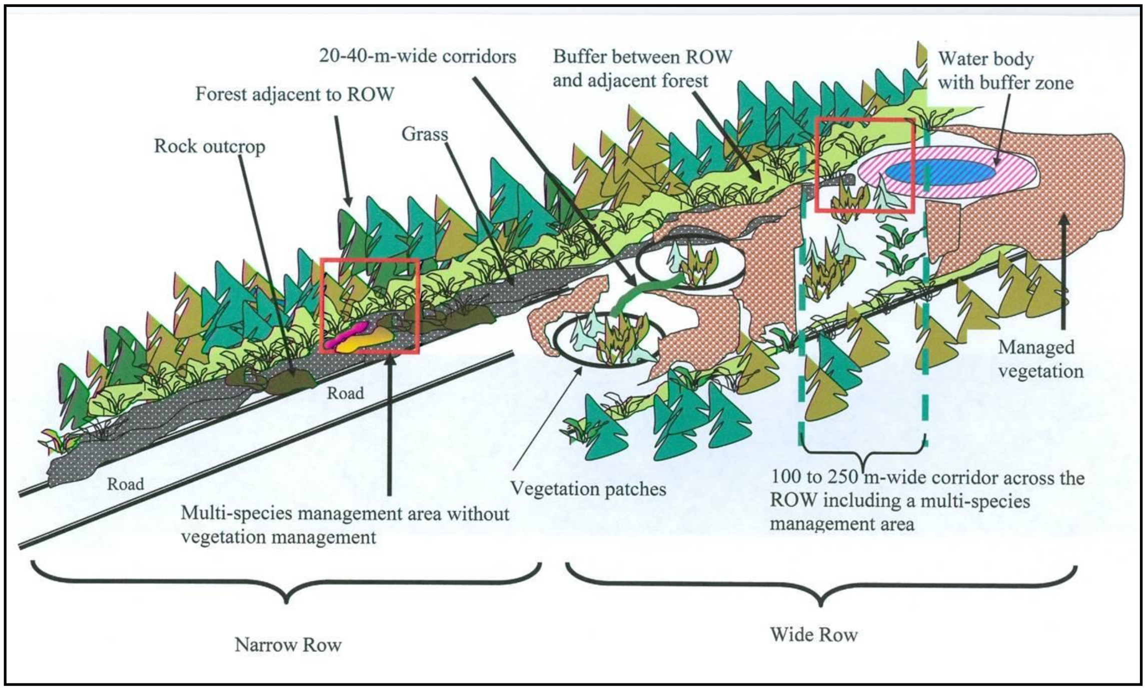

Figure 1. Example of narrow and wide rights-of-way managed for species at risk conservation.

Conclusion

Despite the importance of transportation and energy corridors across British Columbia, little work has been conducted in the past on species dynamics and habitats, and on management measures that may promote species at risk conservation while ensuring safety around the installations. Too often, managers responsible for right-of-way maintenance justify their actions (or their lack of action with reference to species at risk) on the basis of economic and safety concerns. Yet, implementing the process described above does not translate into higher costs or inadequate safety standards. It requires, however, the involvement of professional biologists and ecologists experienced in species at risk management, the establishment of a training program for people who are involved in vegetation management, and strategic planning to correct past mistakes and provide species at risk with functional habitats and resilient ecosystems.

References

Bernier, D., and G. Proulx. 2006. Identification and management of species and plant communities at risk: BC Timber Sales, Prince George Business Area. Alpha Wildlife Publications (ISBN 0-9686235-6-5), Sherwood Park, AB.

Proulx, G. 2005. Integrating the habitat needs of fine- and coarse-filter species in landscape planning. *In* Proceedings of the Species at Risk 2004 Pathways to

Recovery Conference. T.D. Hooper (editor). BC Species at Risk 2004 Pathways to Recovery Conference Organizing Committee, Victoria, BC.

Proulx, G. 2006. Management guidelines for "Species at Risk" in the Mistik FMA area (Saskatchewan). Alpha Wildlife Publications (ISBN 0-9686235-4-9), Sherwood Park, AB.

Proulx, G., and D. Bernier. 2005. A review of species at risk and biodiversity conservation in Canfor's Forest Development Plans, Forest Stewardship Plan, and Site Plans. Alpha Wildlife Research & Management Ltd. and Timberline Forest Inventory Consultants Ltd. report prepared for Canadian Forest Products Ltd., Prince George Operations, BC.

Proulx, G., and D. Bernier. 2006. A field guide to terrestrial animals, plants, and plant communities at risk in the Arrow Boundary, Kootenay Lake and Rocky Mountain Forest Districts, British Columbia. Alpha Wildlife Publications (ISBN 0-9686235-7-3), Sherwood Park, AB

Proulx, G., D. Bernier, J.M. Heron, and K.A. Paige. 2003. A field guide to species at risk in the Coast Forest Region of British Columbia. International Forest Products and BC Ministry of Water, Land and Air Protection, Queen's Printer (ISBN 0-7726-4948-0), Victoria, BC.

Posters and Displays

1. Management of potential environmental impacts during upgrades to the Trans Canada Highway in the Kicking Horse Canyon near Golden British Columbia

Chris Morley, Kicking Horse Canyon Project, Golden, British Columbia
cfmorley@shaw.ca

The Kicking Horse Canyon project is upgrading the Trans Canada Highway from two to four lanes between Golden, British Columbia and Yoho National Park. Key environmental management objectives for the project are: air and water quality protection; development and implementation effective revegetation and slope remediation techniques; reduction in animal vehicle collisions and habitat fragmentation; and protection of aquatic habitats and archaeological resources.

Environmental monitoring and implementation of sediment and drainage management plans are important environmental protection measures undertaken during construction. Since Golden experiences among the highest levels of airborne particulate matter in British Columbia, the project has a "no-burn" policy for cleared vegetation. As well, improved horizontal and vertical highway alignments will contribute to improved vehicle efficiency. Structures like the new Park Bridge are built full-span avoiding in stream impacts to the Kicking Horse River. The BC Ministry of Transportation is experimenting with several revegetation techniques to provide slope stabilization, and promote the establishment of woody vegetation for long-term treatment of disturbed slopes on the project.

The Kicking Horse River valley is an important wildlife corridor, providing habitat to deer, elk, bears, wolves, mountain goats, bighorn sheep, moose, and many other species of mammals and birds. To improve public safety and conserve wildlife resources, mitigation measures for reducing animal/vehicle collisions are being planned for the east and west segments of the project. Wildlife exclusion fencing, crossing structures (both underpasses and overpasses), and one-way earthen escape ramps are among the mitigation measures being considered.

Planning highway improvements required awareness and sensitivity to the area's archaeological resources and their significance. Key measures in protecting archaeological resources included pre-project planning, extensive review of historical information and field assessments, early involvement of First Nations, and flexibility in design where feasible.

2. Mountain pine beetle and BC Hydro

Rick Walters, BC Hydro, Williams Lake, British Columbia
rick.walters@bchydro.com

Mountain pine beetle is affecting large areas of forests in British Columbia. Ten to 12 million beetle-infested trees pose a risk to BC Hydro's electrical facilities. Dead and falling trees near high voltage power lines increase the risk of power outages, public safety hazards, and wildfires. BC Hydro is implementing a tree removal program along transmission lines to reduce the risk to its electrical facilities.

The goals of BC Hydro's Forest Health Issues and Projects Department are to:

- ensure reliable delivery of power,
- reduce the threat to public safety, and
- prevent wildfires.

BC Hydro is working proactively with communities, First Nations, stakeholders, and the BC Ministry of Forests and Range to achieve these goals.

3. Effects of seismic lines on the abundance of breeding birds in the Kendall Island Migratory Bird Sanctuary, Northwest Territory, Canada

Amber Ashenhurst, University of Alberta, Edmonton, Alberta
aashenhurst@intref.bc.ca
Susan Hannon, University of Alberta, Edmonton, Alberta

Increases in oil and gas exploration and extraction are planned in the Canadian Arctic, including the Kendall Island Migratory Bird Sanctuary in the Northwest Territories. Various studies have shown the impacts of seismic lines on vegetation, but the effects on bird abundance in the Arctic are poorly known. We evaluated the impact of new (0.5–1.5 years old) and old (10–35 years old) visible seismic lines on abundance of breeding passerines: savannah sparrow (*Passerculus sandwichensis)*, Lapland longspur (*Calcarius lapponicus)*, common redpoll (*Carduelis flammea)*, American tree sparrows *(Spizella arborea*), and red-necked phalarope (*Phalaropus lobatus)* in upland tundra, low-centre polygon and sedge/willow habitat. Effects on abundance were not statistically significant for most groups of birds along new seismic lines, although the trend in most habitats was for more birds on reference lines. Significant impacts were found for passerines grouped in upland tundra and for savannah sparrow in sedge/willow. The latter effect was possibly due to standing water along the line, but this was not significant the following year. Abundance of passerines was lower on old seismic lines than reference transects in upland tundra and low-centre polygon habitat, except for Lapland longspurs in upland tundra. Lines created 10–30 years ago have persistent vegetative changes and this appears to have reduced bird abundance. Although we did not plot individual territories, birds were seen crossing the seismic lines and sometimes perched on them, suggesting that they were not avoiding the line altogether. Rather, they may have increased territory size to compensate for vegetative changes along the lines.

Further Reading

Ashenhurst, A.R. and S.J. Hannon. 2008. Effects of Seismic Lines on the Abundance of Breeding Birds in the Kendall Island Migratory Bird Sanctuary, NWT, Canada. Arctic. *In Press*.

4. The British Columbia Ministry of Transportation Environmental Enhancement Fund

Leonard Sielecki, BC Ministry of Transportation
leonard.sielecki@gov.bc.ca

The award-winning Environmental Enhancement Fund (EEF) was established by senior executive of the BC Ministry of Transportation (MoT) in 2004 to promote environmental stewardship in the Ministry and foster partnerships with outside agencies. Working closely with other provincial and federal agencies, First Nations, non-governmental organizations (including the Nature Trust, Ducks Unlimited, the Pacific Salmon Foundation, and the Land Conservancy of British Columbia), and private landowners, the MoT has been involved in over 150 EEF-supported projects throughout British Columbia. EEF projects fall under four general categories of on-the-ground and in-stream environmental projects that directly enhance, restore, and/or protect fish and wildlife resources:

1. Fish passage restoration to improve fish passage to underutilized habitat upstream of highway stream crossings
2. Habitat restoration through the construction and the improvement of fish and wildlife habitats
3. Wildlife accident mitigation
4. Habitat acquisition to secure and protect environmentally sensitive areas in perpetuity

The Environmental Enhancement Fund supports the MoT's commitment to the British Columbia government's goal of leading the world in sustainable environmental management, with the best air and water quality, and the best fisheries management.

The Environmental Enhancement Fund supports MoT highway projects by ensuring:

- High benchmarks for environmental stewardship are set and achieved.
- Environmental best management practices are more results driven and performance based.
- Partnerships with provincial and federal agencies, First Nations, and non-governmental organizations are established to ensure environmentally sensitive

areas and habitats are protected and/or restored, and function on a sustainable basis.
- Goodwill, trust, and long-term positive working relationships are established and sustained through its projects.

The Environmental Enhancement Fund has garnered numerous accolades and awards from private and public organizations. In 2006, the Transportation Association of Canada awarded its Environment Achievement Award to the MoT for the EEF, recognizing the EEF as an exemplary contribution by a Canadian transportation agency to protecting and enhancing the environment. The EEF consistently delivers high value, tangible environmental projects linked to the highway infrastructure, in a cost-effective manner through private and public partnerships that restore and conserve British Columbia’s natural resources. Given its success, the EEF model can be adopted by any public or private agency wishing to foster environmentally sustainable linear corridor infrastructure development.

5. A landscape-scale model to predict the risk of bird collisions with electric power transmission lines in Alberta

Nikki Heck, AltaLink Management Ltd.
Michael Quinn, University of Calgary, Calgary, Alberta

A great number of birds are killed each year through collisions with power lines. AltaLink, like other electric utility companies, operates thousands of kilometers of transmission line, making it nearly impossible to identify and prioritize areas according to the degree of risk they pose to birds. The potential severity and magnitude of collisions is not well understood because, unless reported by the public, utility companies are generally unaware of problem sites. Unlike electrocutions, collisions do not cause power outages and do very little damage to the line itself. Problems occur in specific situations where certain factors exist to create high collision potential.

Past research has been focused on localized sites and has not been assessed at a larger scale. I developed a method to assess collision risk at a landscape scale using risk modelling and spatial ecological analysis. To spatially identify and prioritize high-risk areas, Saaty’s Analytical Hierarchy Technique using Pairwise Comparison Analysis in Idrisi32 and then raster calculator in ArcGIS 9.0 were used. Model validation occurred through ground-truthing at select sites. Results show that this method can predict where high-risk collision areas are. It will enable a landscape-level management approach to target and prioritize the higher risk sites for subsequent mitigation.

6. Projects, successes, and challenges of a wildlife collision prevention program

Gayle Hesse, British Columbia Conservation Foundation
wcpp@bccf.com

In northern British Columbia, insurance claims for property damage due to wildlife/vehicle collisions have more than doubled since 1996, with corresponding increases in human suffering and losses to the animal resource. Annually in British Columbia, 4 people are killed; 316 people are injured; and 4897 wild animals are recorded as killed (including 368 moose). An estimated additional 14 691 animal deaths (including 1104 moose) go unrecorded if the animal moves away from the road to die and the carcass is not recovered. Moose/vehicle collisions comprise 25.4% of the total wildlife collisions in northern British Columbia and pose a significant risk of human injury or death. Moose have a high centre of mass and a typical collision results in the moose crashing onto the vehicle roof or windshield, killing the animal and causing serious injury or death to vehicle occupants.

The Wildlife Collision Prevention Program seeks to reduce personal and environmental losses from wildlife vehicle collisions by conducting public awareness projects that assist motorists in anticipating and avoiding wildlife hazards on the road. Priority projects are media advertising; implementing rest stop and right-of-way signage; distributing informational brochures; maintaining a wildlife collision prevention web site; and facilitating and encouraging action in local communities. Current successes are the formation of a northern British Columbia Wildlife Collision Working Group; public engagement in local community projects; and partnering with local researchers on moose/vehicle collision research. Future challenges include achieving long-term funding for planning and project implementation and continued education of public and private agencies regarding the costs of wildlife collisions.

For more information about the Wildlife Collision Prevention Program, visit:

www.wildlifecollisions.ca

7. *Wetland enhancement by roads in agricultural areas*

Robert St. Clair, EBA Engineering Consultants Ltd, Edmonton, Alberta
rstclair@eba.ca

In natural landscapes negative effects of roads are well-documented and include direct mortality and the adverse effects of habitat fragmentation. However, roads can also enhance habitat quality for certain wildlife and vegetation, particularly in areas that have already been disturbed. Examples include bats or swallows using bridges to roost, and raptors hunting by roadsides. In areas where wetlands would otherwise be in short supply, such as agricultural areas, rural roads can increase wetland habitat. Examples include borrows that become mature swamps for waterfowl, marshes that form when water flow is obstructed to become moose foraging habitat, and ditches that become breeding habitat for amphibians. Here we present some examples of increased wetland habitat in agricultural landscapes that are a direct result of roads.

8. *The Jasper Leaseholder Working Group*

Jennifer McPhee, Parks Canada
jennifer.mcphee@pc.gc.ca

The Jasper Leaseholder Working Group is a functional network of partners whose members commit to a mutually supportive and positive forum to plan, operate, and maintain the diverse infrastructures within the park, while promoting enhanced stewardship of the ecological heritage of Jasper National Park.

The original Line Leaseholders Working Group was established in 1995 when a group of concerned corporations with responsibilities for managing lands within Jasper National Park joined with Parks Canada to find solutions to mutual problems. The initial motivation was to prevent the spread of non-native plants, a significant threat to the ecological integrity of the park. Later, the scope of issues addressed by the Line Leaseholders Working Group expanded to include a wider array of issues relating to the benefit of the ecosystem as well as the operational interests of its members. In 2005, with the advent of Parks Canada’s Ecological Integrity Innovation Program, former members of the Line Leaseholders Working Group were polled regarding re-establishment of the network and strong support was expressed. In March 2006 representatives of the original Line Leaseholders Working Group and others met to explore this possibility and, as a result, it was unanimously agreed that the group would become active once again, but with a more inclusive membership.

9. *Relocation of Columbian Ground Squirrels away from a pipeline construction zone*

Carmen Holschuh, Westland Resource Group
holschuh@westland.com

Columbian ground squirrels (*Spermophilus columbianus*) in six established colonies near Jasper, Alberta were relocated away from the TMX-Anchor Loop Project area during a two-week period in late July 2007. The six ground squirrel colonies occurred in the construction zone for the pipeline-looping project, and the relocation program was a measure to mitigate possible mid-winter mortality of hibernating ground squirrels related to construction activities. Columbian ground squirrels were captured using live-traps (HAV-A-HART and Tomahawk design). The animals were subsequently relocated to suitable release sites. Ground squirrels were transported in the live-traps to three different release sites. The release sites were chosen based on distance and isolation from the original colony location, and habitat conditions. New burrows were noted at release sites within two days of relocating animals, and opportunistic monitoring of colony establishment is ongoing. A capture effort of 1708 trap hours yielded 83 ground squirrels.

10. *Badger mortality and roads in the Cariboo region*

Richard Klafki, Thompson Rivers University, Kamloops, British Columbia
klafkir@unbc.ca

No abstract provided.

11. *Highway 22X bridge construction over the Bow River; Proposed interchange for Beddington Trail and Country Hills Boulevard; Proposed creek morphology and fish habitat design for Cranston Creek; in Calgary Alberta*

Sarah Hechtenthal, EnviroConsult Inc.
sarah@enviroconsultinc.com

No abstract provided.

Summary of Comments from Conference Evaluation Forms

There were 135 people at the conference, and 60 evaluation forms were returned.
Not all forms had a response for each question.

1. How well did the conference meet your expectations?

31 Fully met 26 Met most 3 Met only a few 0 Did not meet any

2. How do you rate the quality of the presentations?

20 Excellent 4 Mixed excellent/good 30 Good 3 Average 0 Poor 3 Mixed reviews

Do you have comments about any of the presentations?
Praises/complaints about specific speakers are not included.
Comments listed here will help guide the selection of future talks.

- Was expecting more on veg/fish/wildlife specific issues
- Wanted talk on modelling of species specific concerns
- A few talks promoted the companies more than their work (4)
- Some talks not in direct alignment with conference theme (5)
- Specifics on projects wanted, not overviews (3)
- Wants more science research and less project management (3)
- Lots of information sharing, this was good
- More microphones and be sure the speaker repeats the questions (2)
- Good breadth of topics
- Wants conference summary so can call speakers up for more details
- Wanted info on raptor migration along powerlines
- Wished there was a way to check before hand if the people were good presenters (i.e., nervous or boring talks).
- Wants the presentations included with the proceedings
- Like the balance between research, agency, consulting firms
- Liked the balance of topics (9)
- Like single session as opposed to concurrent sessions
- Wanted shorter introductions
- Like having speakers on time (5)
- No computer glitches
- Too much wildlife emphasis

3. Do you have any other comments about the conference? Any comments on the venue, food, registration process, etc.?

- Community Centre good location (9)
- Community Centre room was cool (13)

- Community Centre static, wanted a hotel room
- Food was good (26)
- Grateful for meeting special diet concern (5)
- Reception at Railway Museum enjoyable (16)
- Reception a bit crowded, wanted social at same place as workshop so more room, more viewing time for posters
- Conference well organized (17)
- Good attendance and range of organizations present
- Would like to have it in a town with an airport nearby
- Lunch was too long, about 1.5 hours
- Chairs are hard
- Wants presentation summaries ahead of time
- Generally positive comments (8)
- Wants Alberta Infrastructure and Transportation to attend
- Recommend additional hotels, closer to Community Centre
- Wants tables so note-taking is easier
- Wants CMI to enable carbon footprint reduction program to offset travel
- Good opportunities for networking (2)
- Wants decaf coffee on hand!
- Conference fee–good value
- 1.5 days of presentations is good amount

4. In a few years we will be holding a sequel to this conference. Which topics would you like to hear about at our next conference? Can you suggest someone we can approach to cover these topics when we send out the call for papers?

- Appreciated inclusion of "other" corridors, instead of only roads and railways
- More on transmission lines, avian protection plans (4)
- Climate change effects (2)
- Population-level studies of road effects
- What about wind power, run-of-river power projects, independent power producers? (3)
- Y2Y is a natural corridor intersected by manmade corridors
- Stormwater quality/quantity issues (2)
- Intelligent warning systems for wildlife approaching roads
- Caribou crossing success stories from northeastern Alberta
- Small mammals and amphibians—crossing mitigation strategies (3)
- Raptors, listed birds—crossing and monitoring strategies (3)
- Results of Sawaya's talk
- Updates on Banff crossing structures and Wabamun recovery
- Spill response along pipeline right-of-way
- More on species at risk and how to mitigate (3)
- More on invasive species (3)
- Slope stabilization

- Re-vegetation under extreme conditions, e.g., slope, arid, wildlife browsing
- Development of forestry roads. They have a different process for approvals. What are these differences and what are their specific challenges with respect to regulatory authorities, and possibly the conflicts with public use? How do they deal with last minute changes to their 5-year plan?
- Fish passage issues, fisheries topics (5)
- Specifications, mitigation methods
- Klafki's badger work
- Roy Rea on next stage of work (2)
- Evolving environmental issues in mining
- Access management
- Effects of linear corridor density on wildlife
- More focus on innovative ideas, who is challenging the status quo
- Environmental monitoring on construction projects
- Gaps in legislation—who protects the amphibians?
- Incentives—what works? If you have a good botanist who finds more rare plants, it just makes more work and expense for your company, but you don't have more money to do the extra work with.
- Edge effects
- Addition of a monitoring component
- Trends in regulation
- Deactivation of roads/corridors
- Motorized recreation and corridors
- Reclamation, use of large organic debris
- Cumulative effects of sediment control
- More presentations from wildlife biologists (source researchers)
- Predators and corridors, mitigation methods
- Talks from upper level MoT people
- More input from regulatory authorities
- Seismic line development
- Experience in other jurisdictions
- Do roadless areas for grizzlies (as in US) work?
- Problem solving
- Modelling of connectivity

5. CMI is considering hosting a regional science conference on "Invasive Flora and Fauna" with a focus on southeastern British Columbia. Would you find this conference useful? What topics would you like to see covered?

- Generally positive comments (26)
- Not useful to me (13)
- Impacts on birds
- Changes to community composition
- As associated with construction phase of projects (4)

- Research on alternatives to herbicides
- Pine beetle
- How to get "buy in" for use of herbicides
- Use of sheep and goats
- Wants to see it expanded to include all of British Columbia, not just southeastern part (4)
- Are there positive aspects to invasive plants? Food values?
- Stewardship and education
- Include invasive fish
- How to minimize weed transmission along corridors
- What are they doing in Europe? Australia?
- Case studies of successful restoration of grasslands after invasives eliminated (2)
- When do you give up on weed control? When do you give up on a patch and just try to control perimeters and further spread?
- Queen Charlottes as a hotbed of introduced species
- Examples of programs run by various governments and industry
- Overview of management of invasive species in BC
- What has been extirpated (fish)
- Use of hydro-seeding, native species
- Mechanisms of invasion

6. The Columbia Mountains Institute is always looking for suggestions for courses and workshops. Our niche is providing continuing education for ecologists, resource managers, foresters, biologists, and educators. We offer skill upgrading, and workshops to address current ecological issues. Do you have any suggestions for events or courses you'd like to see us organize?

- Mark/ recapture courses
- How to deal with media, how to get effective messages to the public, e.g., spill situation
- BEC and site series classification in BC
- Habitat modelling
- Controlled burns and fires to mitigate environmental impacts in remote locations
- Fisheries habitat assessment and restoration—what works, what doesn't, what does climate change mean for fish?
- SARA updates and requirements
- Landscape-level workshop—strategic mapping
- Trapping and handling of wildlife
- Managing cumulative impacts
- Relocation of unusual species such as snakes, turtles, colonizing species
- More stats courses
- Habitat suitability ranking—from the field to final management product
- Reclamation
- Monitoring systems that are working and enforced

- GIS mapping for biologists and foresters
- Use of isotopes
- Bat monitoring/capture technique workshop